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Editors
Rajinder Peshin • Ashok K. Dhawan • Fatima Bano • Karnail S. Risam

Volume 1

Natural Resource Management Ecological Perspectives

Proceeding of the Indian Ecological Society: International Conference
Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, India

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Volume 1

- Theme Papers
- Land and Water Resources,
- Crop-Environment Interactions,
- Horticulture Crops
- Forestry Tree Plantations

Volume 2

- Theme Papers
- Eco-Responsive Livestock and Fisheries Production
- Integrated Nutrient Management
- Integrated Pest Management
- Policies for Sustainable Development of Agriculture
- Success Stories
- Resource Efficient Agriculture System through Public- Private Partnerships

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Preface

Natural resource management (NRM) include improving agro-ecosystem productivity, conserving biodiversity, reducing land degradation, improving water management, sustainability of forests, managing the sustainability of wildlife and fisheries, and mitigating the effects of global climate change. The shrinking per capita natural resources lead to intensive land use and results in further environmental degradation. Widespread, serious and continuing degradation of India's natural resource base is now reflected in increasing difficulties in achieving growth rates in agriculture. Over 120 million hectare (ha) area has been declared degraded. The declining soil health and soil productivity due to loss of organic matter and carbon in most of the arable lands, groundwater declining at a greater pace and water lost due to salinity and alkalinity are threatening the sustainability of Indian agriculture. Natural resource management based on scientific principles plays a crucial role for an inclusive and sustainable growth of agriculture. Therefore, the Indian Ecological Society in collaboration with Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST) has organized an International Conference on Natural Resource Management: Ecological Perspectives, from February 18.20.2016 at beautiful campus of SKUAST, Jammu.

The following theme areas are covered in the conference:

Land and Water Resources**:** Land resource management and land use planning, water management, management of problematic soils, soil and water conservation, watershed management, water saving technologies, crop diversification, rain-fed / dry-land farming, weed management, development of integrated farming systems, organic farming, resource conservation technologies, traditional ecological knowledge, people's movements in soil - water - development paradigm, technology transfer and impact.

Crop Environment Interactions**:** Adaptation to changing climate and resilience enhancement, diversification and mitigation through climate smart agriculture, vegetation-atmosphere exchange of green house gases, sustainability of environmental resources, biodiversity conservation and its rational use, crop environment interaction assessment using advanced technologies, shift in the manifestation of insect pests and diseases, improved weather and climate services, ICT enabled early warning systems.

Integrated Nutrient Management**:** Soil health and nutrition, crop and efficient nutrient management practices, crop residue management, management of pollutants in soil.

Integrated Pest Management**:** Protection technologies for horticultural and field crops, ecological basis of insect pest/disease management, impact on ecosystem and environment, pesticide residue, spray technology, insect biodiversity, useful insects, IPM programmes and their impact

Horticulture Crops**:** Genetic resource management in fruit and vegetable crops; vegetative propagating techniques; protected cultivation; intensive production technologies for higher productivity in horticultural crops; climate change mitigation; pre & post-harvest handling and value addition; good agricultural practices in horticultural crops; socio-economic impact of National Horticulture Mission.

Forestry Tree Plantations**:** Economic, social and ecological valuation, natural resource management, climate change mitigation, biomass energy, tree health and protection, trees outside forests – adoption and management, wood products and composites, eco-tourism, policy, education and training

Eco-responsive Livestock and Fisheries Production**:** Integrated crop-livestock husbandry for optimum natural resource utilization, environmentally resilient livestock and fisheries management, water economy of livestock operations, health and production interventions for sustenance of fish production, conservation and management of aquatic resources, aquaculture in degraded lands, aquaculture impact on environment, livestock and fisheries for livelihood generation and socio-economic development.

Policies for Sustainable Development of Agriculture**:** Indicators of sustainable agricultural development, economic and social impacts of technological interventions on agricultural production, impacts of climate change on agriculture, crop livestock interactions, policies, institutions and regulations related to land , water and energy and their impacts, success stories on sustainable development, lessons learned for their up-scaling, strengthening the extension system in India: the role of the private sector.

Promoting Resource Efficient Agriculture System through Public- Private Partnerships: Panel discussion on promoting agricultural systems through public-private partnership and resource efficient agricultural system.

This compendium entitled **“Natural Resource Management: Ecological Perspectives”** divided in two volumes (1 and 2), covering the eight theme areas, includes extended abstracts, lead, oral and poster communications. Volume 1 covers land and water resources, crop-environment interactions, forestry tree plantations and horticulture crops. Volume 2 covers livestock and fisheries production, integrated pest management, and integrated nutrient management and policies for sustainable development of agriculture and success stories. The manuscripts submitted to the conference were reviewed in detail and suitable ones are documented. In all there are 708 articles on all aspects of natural resource management.

We express our sincere thanks to Dr. Pradeep K. Sharma Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu and chairperson of the conference for enormous support and encouragement.

We are extremely thankful to various key and lead speakers who agreed to present their work.

Finally we are thankful to all contributors from India and abroad for making useful contributions and timely submissions. The contribution of articles to the conference by industry reflects a synergy between public- private partnership for sustainable development and is a way forward to increase total factor productivity in agricultural research and extension. We regret that, due to overwhelming response we could not include the valuable contributions of the scientist who submitted their work after December 31, 2015.

Rajinder Peshin
Ashok K. Dhawan
Fatima Bano
Karnail S. Risam

Dated: 10.02.2016
Jammu, India

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The financial assistance received from the Indian Council of Agricultural Research (ICAR) for publication of the proceedings is greatly acknowledged. The financial support has been provided for organizing the international conference by the Centers for International Projects Trust (CIPT), World Wide Fund for Nature (WWF) India, Science and Engineering Research Board (SERB) Department of Science and Technology, Government of India and National Bank for Agriculture and Rural Development (NABARD). We acknowledge the contributions of all of them. We are also grateful to our sponsors the United Nations Food and Agriculture Organization (FAO), Excel Crop Care Ltd., Saraswati Agrochemicals India Pvt. Ltd. Jammu, BASF India and Biostadt India Limited.

We wish to express our sincere gratitude to Prof. S.K. Gupta, Prof. V. Kaul, Dr. P. S. Salathia, Dr. Vikas Sharma, Dr. Rakesh Sharma, Dr. Laxmi Kant Sharma, Raj Kumar, Soneal Kumar Dhar, Parvani Sharma, Bharat Bushan, Mukesh Kumar and Rakesh Kumar for their valuable contributions in compiling the proceedings.

We wish to thank all the authors, reviewers, invited speakers, members of advisory board and organizing team, student-volunteers and everyone who have contributed in the successful organization of the conference.

Rajinder Peshin
Ashok K. Dhawan
Fatima Bano
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Theme Papers

1

Water Harvesting and Optimum Utility Techniques of Water and Land Available in Cold Desert

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To a traveler, Ladakh is a place of immense beauty. But to the people who live in this place it is a cold desert where survival depend on careful use of sparse natural resources including water. The Ladakh farmers have always been dependent on snow and glacier melt water but unfortunately today it is rarely any snowfall in Ladakh. It is not more than 5-6 inches and snow that falls melt away within two to three days. So the climate change experienced in the last four decades poses a threat for the future.

Human settlements are found wherever little irrigation water is found available throughout the district. Since the manpower and other resources were very limited coupled with very poor tool and implements, even then the old settlers have tried to best of their ability to utilize the available land and water resources to the maximum.

Agriculture operations in Ladakh are time bound likewise in any other part of the world. It is completely dependent on timely availability of irrigation water which is further dependent of snow deposits during the past winter and rise in the atmosphere temperature in the spring. Since the weather conditions differ from year to year it largely influences the melting of glacier.

The agriculture season commences by April -May while the process of snow and glacier melting at high altitude begins around mid of June. This delay the sowing of crops thereby affecting crop productivity. Thus spring is the most crucial season for farmers, yet little water comes down through streams during spring, due to low temperature conditions that does not support the melting process of glacier.

The wind direction in the mountains is most of time south to north, because of which most of snow falls on the south side is bloom up across and deposited in the backside of the mountain to low air pressure prevalent over here. Hence north side usually has thick snow deposits and glacier formation. Therefore north facing villages are always rich in water resources and prone to soil erosion and lot of water goes waste during summer months.

River Indus, the Sindhu is the main drainages with its tributaries like Shyok, Sasoma, Zanskar, Suru and Drass rivers and all of these flow through deep gorges contributing for only 11% of cultivated land chunk of cultivated area on either side of these rivers lying waste for want of irrigation water facilities which could not be developed due to difficult geographical terrain. So the following systems have been adopted:

i) Gravity canal,
ii) Diversion canal,
iii) Water reservoir,
iv) Snow harvesting,
v) Lift irrigation, and
vi) Artificial glacier.

1. Gravity Canal

The human population in Ladakh increased manifold likewise any other part of the country but the agriculture land has not been increased correspondingly rather it shrinked due to construction of road and buildings. The present network of government public distribution system has given a negative impact on agriculture production which led to a negative sustainable policy. Thus it is imperative to bring more and more land under plough, which is the only way for a sustainable gift to the future generation.

By tapping the available water resources transacting through hard rock surface, which is ofcourse difficult but not impossible in this scientific age with advanced tool implement, machines and technology. We have taken up few such projects under the irrigation that has made water available for hundreds of acres of land. This was achieved by utilizing the existing gravitational canals cutting difficult rock surface and hard terrain. Dhacanal, Skurbuchan canal, Tar canal, Shoktsery Thang canal are some examples of such projects. These canal have been constructed completely on traditional pattern by using local available materials, completely avoided the use of cement and still the canal are functioning very effectively, which is worth mentioning.

2. Diversion Canal

Due to low air pressure the north side usually have thick snow deposits, therefore north facing villages are always rich in water resources and prone to soil erosion and lot of water go waste during summer months while south facing villages experiences acute shortage of water. To control wastage of water and ensure its proper utilization a big diversion canal at altitude between 16000feet to 18000feet above sea level have been constructed in Leh region **aize**chang La, warila with the result farmer have been able to bring more land under cultivation and grow more trees and fodder. Hundreds of acres of cultivable land is available in and around the village of south facing watershed which is lying waste due to lack of irrigation facilities.

3. Water Reservoir

Since the weather conditions differ from year to year. Sometimes the snow starts melting before the sowing time resulting in wastage of all the runoff water and some time temperature in the spring season remain so low that no melting occurs till the end of sowing season.

To overcome such erratic condition a series of reservoir are constructed across the village. The reservoir help in controlling waste going water over flown untimely and it could be stored for economic utilization as and when required. Such facilities not only help in economic use of the available water but also help in avoiding conflicts among farmers which otherwise raises due to shortage of water. The reservoirs help a lot in recharging ground water. Thus springs available down in the village get improved in water discharge. The existing reservoir and ponds are made more spacious efficient, strong and lock system.

4. Snow Harvesting

Here wind direction is mostly north to south with the result the snow fall received on the southern hill side during winter months is blown away across the hill **summit** and while passing across the range it deposits snow on northern facing pockets due to low air pressure prevalent over there. Presence of barricades or walls across the wind direction helps in retaining the snow on the south facing valley which serves as a good source of water during the following summer season. It has been observed that construction of 5feet height wall result in depositing of snow in its pocket side to a length of 12feet.Such barricades have been constructed at many suitable sites and have been found effective.

5. Artificial Glacier

A technique that would ensure water availability to farmer during the sowing period (April-may).The technology of the artificial glacier has been in operation in the area for over 10-15 years and it is performing successfully. Farmers in particular experiencing positive results from this technology success. The agriculture season commences by April-May while the process of snow and glacier melting at high altitude begins around mid of June. This delays the sowing of crops, affecting crop productivity. Spring is the most crucial season for farmers, yet little water comes down through streams during spring as the temperature do not allow glacier melting process. Farmers have to manage the available flow of water as per the established tradition.However,the main problem of making water available to farmers during spring season still persist.The need was therefore felt to develop a technique that would ensure water availability to farmer sowing period, April-May.

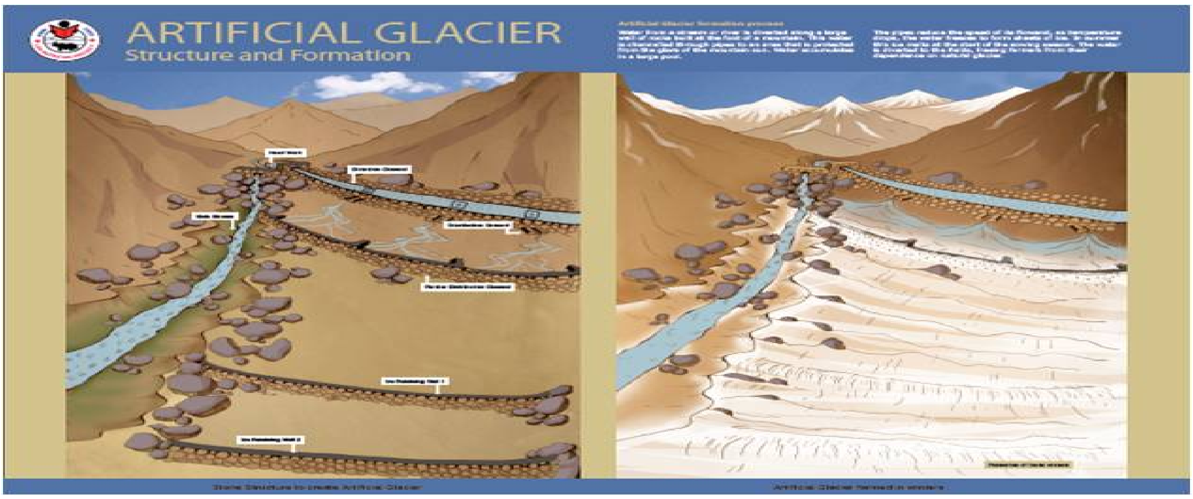

Fig. 1: Artificial glacier structure and formation

5.1. Design of Artificial Glacier

The design of artificial glacier depend on the suitability of the site availability in the shade during winter is the primary criteria. It prevents direct exposure of glacier to sunlight as well as facilitates the process of glacier formation. It should be as far as possible near the village to prevent the loss of water.

If the section of stream is very wide with a mild slope, then the dry stone masonry bund in crate wire are constructed in a series parallel to each other keeping some gap in the centre to allow summer water flow. In the month of November these gaps keep blocked and in the month of March -April it open. The numbers of bund depend upon the flow of water during the peak winter.

If the section of the main stream is narrow with steep grade then it need to be directed to a shady area by constructing a gravitational channel with a bed grade 1:30 and when it reach at the site the bed grade should be gradually increase say upto 1:50 and let it flow down through outlets. The water flowing through these small outlets, being a very small quantity of water freezes instantly. Dry stone masonry in crate wire needs to be constructed parallel to the channel in series at a distance of 50 to 100 feet according to the nature of slop of the terrain. The steeper the terrain the smaller the distance and slope between the bunds.

Objectives

1. Ensure availability of water to farmers during early spring season for cultivation.
2. Enhance crop productivity by making water available in adequate quantity and time.
3. Bring waste land, uncultivated land under economic production.
4. Improve the cropping pattern of the farmers. If a farmer gets water at the right time of sowing season they can sow more area with peas, potatoes and vegetables which are the cash crop. This kind of crops the income will be five times more than the other crops, but these are need to be sown in early spring.
5. Prevent wastage of precious water during winter months when agriculture activities ceases, the water available in the main stream merely goes waste. This water can be conserved in the form of ice and in early spring it can be used for agriculture.
6. Mobilize farmers' participation in the management of artificial glacier formation and component of irrigation system.

2

The Role of Agricultural Biotechnology in Food Security, Poverty Eradication (Youth Empowerment) and Mitigation against Vices of Climate Change

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For more than 10,000 years, farmers have been improving wild plants and animals through the selection and breeding of desirable characteristics. This breeding has resulted in the domesticated plants and animals that are commonly used in crop and livestock production. In the twentieth century, breeding became more sophisticated, as the traits that breeders select include increase in yield, disease and pest resistance, drought resistance and enhanced flavour. Traits are passed from one generation to the next through genes, which are made of DNA. All living things, including the fruits, vegetables and meat that we eat, contain genes that tell cells how to function.

Biotechnology could be simply defined as a business activity that uses biological manipulations to obtain a final new product. Biotechnology is doing business with the use of living organisms. It is a business with the living nature. Biotechnology is a biological business. Before we further discuss the details of the aforementioned issues/features of biotechnology, we need to first of all isolate agricultural biotechnology, been the core of today's lecture series which have the objective of addressing food security and poverty eradication.

The problems confronting are a) prevailing problems confronting agricultural producers: The major ones are: (i) insect pests, weeds and diseases, (ii) poor yield due to soil infertility, (iii) high cost of production due to field preparations and crop management. b) The consumers are in turn faced with the problems of: (i) nutritional value and quality, (ii) affordability,(iii) safety and food security. c) The environment is confronted with problems of: (i) pollution and contamination which are consequences of destructive exploitation and exploration of natural resources, (ii) exhaustive water usage, deforestation and increasing production of greenhouse gases.

Biotechnology can be applied to all classes of organism - from viruses and bacteria to plants and animals. It is becoming a major feature of modern agriculture, medicine and industry. Modern agricultural biotechnology includes a range of tools that scientists employ to understand and manipulate the genetic make-up of organisms for use in the production and processing of agricultural products. It can be used in genetic engineering, molecular markers, molecular diagnostics, tissue culture etc.

With the application of biotechnology, the rigorous, laborious and capital intensive food production can be minimized. (This will make farming very attractive as a result of which more people will be willing to practice agriculture),a production system that would ordinarily require hectares of land can be achieved in a small room of 15×15 metres dimension, producers do not have to go through the rigours of sailing the entire oceans, lakes and rivers to fish, farmers need not worry about the cost of mineral fertilisers if they can compost, the polluted and contaminated environment (waste) can be converted to neater and wealthier one.

Produce can now be obtained from domesticated species, and manipulations via molecular biology (breeding) and genetic engineering to obtaining desirable produce quality and quantity under a domesticate condition. The practice of biotechnology is environmentally friendly. (This means that the quality of natural resources is sustained and maintained. Resources are used in a way that conservation is facilitated, and degradation is minimized via reduction in pollution and general environmental contamination).The practice of biotechnology is economically viable: manufacturers can produce enough for self-sufficiency and sufficient cash/profit to pay for labour and other costs of production. (A pointer to food security and rapid industrialization).Biotechnology is socially just; it is an equitable system for all people including those yet to be born. It is environmentally friendly thus a sure option to afford preventive health delivery system.

It enhances the conservation of the biodiversity: rear and endangered species are conserved, preserved and protected. The practice of biotechnology is environmentally friendly (This means that the quality of natural resources is sustained and maintained. Resources are used in a way that conservation is facilitated, and degradation is minimized via reduction in pollution and general environmental contamination). The practice of biotechnology is economically viable: manufacturers can produce enough for self sufficiency and sufficient cash/profit to pay for labor and other costs of production (A pointer to food security and rapid industrialization). Biotechnology is socially just; it is an equitable system for all people including those yet to be born. It is environmentally friendly thus a sure option to afford preventive health delivery system. It enhances the conservation of the biodiversity: rear and endangered species are conserved, preserved and protected.

3

Forestry Tree Plantations: Need to Strike a balance between Indigenous and Exotic Species

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Plantation forestry has been a tool to enhance forest cover and forest productivity for long. Since the output of timber, wood or other commercially important tree produce like resin, latex, gum, etc. has traditionally been the measure of forest productivity; the major component of such forestry plantations has been the trees, both native and exotic. The plantation route has been extensively used in our country in re-establishment of logged natural forests, which fail to regenerate from seeds due to biotic pressure or ensuing edaphic factors. Some of the beautifully regenerated forests of Himalayan Fir and Spruce, Deodar, Teak and Sal are the result of such forestry tree plantations. The plantation route has also been extensively used to create forests to meet the National Forest Policy objective to bring one third of the country's geographical areas under forests. Forest tree plantations have also played an important role in enhancing productivity of the degraded forests in country's bid to meet the growing demand of wood and biomass and other commercially important tree produce. The average annual scale of such afforestation and reforestation activities has been about 1.5 million hectare over the last about 20 years. It is because of these plantation efforts that the country has been able to maintain the forest cover in the country - in fact, register increase - despite various challenges with the forest cover increasing from 21.02% (FSI, 2009) to 21.34% (FSI, 2015) of the geographical areas of the country and enhance average productivity of its forests from $<1m^3$/ha/yr to $1.3m^3$/ha/yr over the years. In addition, India has also been able to grow trees outside forest land over 2.82% of its geographical area (FSI, 2015).

The increasing reliance on exotic species for afforestation activities has, however, been an issue of debate. The *Cryptomeria* plantations in the hills of West Bengal and Sikkim; blue gum (Eucalyptus) plantations in Nilgiris; wattle plantations in Kodai hills; tropical pine plantations in Western Ghats and North-East India; rubber plantations in Tripura, Kerala and Tamil Nadu; *Casuarina* plantations in coastal areas; and plantations of mesquite (*Prosopis juliflora*), su-babool (*Leucaena*), and Eucalyptus over vast areas in drier parts of the country undertaken are but some of the examples of such afforestation efforts. These plantations have, no doubt, helped in reclaiming and rehabilitating many difficult and inhospitable sites. These plantations have, however, also impacted the local species compositions due to their allelopathic effect, and effect on soil and moisture regime. Many of these species have also become invasive adversely impacting the local biodiversity and even agriculture.

The Indian forests have been classified by Champion and Seth (1968) into various types, many of these classified as degraded, with each type with its own unique floristic composition and performing its own specific functions. The local life styles and cultures have evolved around these forest types, with local communities drawing a range of eco-services from these, including use of a range of local flora contained in these forest types for their day-to-day household use. The use of non-native species tends to alter the flow of these eco-services, impacting the livelihoods of people most dependent upon these. The rehabilitation and afforestation activities have already altered many of these forest types by planting exotic tree species. The scrub forests and the natural grasslands, so important for the local communities but considered low productivity areas due to non-production of commercial timber, have been the first casualties of the plantation drive. The desire to get logged areas quickly regenerated, and to fill natural gaps, has prompted introduction of exotic tree species into the high forests of even Deodar, Sal and Teak.

India is still far away from achieving its avowed goal of creating tree cover over one third of its geographical area and has launched an ambitious Green India Mission to create forests over an additional 5 million hectares of land. The country has also set high targets in respect of Intended Nationally Determined Contribution (INDC) of creating an additional carbon sink of 2.5 to 3.0 billion tonnes of CO_2 equivalent by 2030 through additional forest and tree cover. These high targets point towards a large scale and sustained plantation activity that is in the offing. We might be talking of creating tree woodlots over more than 50 thousand square kilometers of land every year for the next 15 years to meet the collective targets under the Green India Mission and the INDC. This plantation drive will require bringing more public as well as private land under tree cover. If the previous efforts at such afforestation and rehabilitation of degraded forests are any indication, and with little research on the native species, it is very likely that we shall again end up largely relying on exotic species to achieve this target, very adversely affecting the native species structure and the associated eco-services.

High performing exotic species would also continue to be used for growing tree plantations over private lands. Exotic species would also continue to be tried and used in tackling problem and inhospitable sites. It would, however, be necessary to use these species more judicially, and after undertaking necessary ecological studies. The sanctity of the species structure of natural forests, essential to maintain all native biodiversity components, should at no cost be altered by introducing exotic tree species. The growing concerns about biodiversity and eco-services require that the country should formulate a comprehensive strategy on choice of species for its plantation programs, keeping a healthy balance between indigenous and exotic species.

4

Utilizing Horticultural Technologies for Ecological Sustainability

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Horticulture has been a key driver to growth of agriculture sector in India and consecutively third year during 2014-15, the horticultural production (280.99 million tons from 23.41 million ha) remained more than the food production. It has been possible due to vast genetic diversity and intensive horticultural crop production system. Globally, India is the second largest producer of fruits and vegetables. It is the largest producer of mango, banana, coconut, cashew, papaya, and pomegranate, and is the largest producer and exporter of spices. India ranks first in productivity of grapes, banana, cassava, peas, papaya etc. Our track record on Research and Development in horticulture during the last fifty years can largely be considered excellent in helping us achieve present level of horticultural production. This has been possible due to intensive crop production system in horticulture. The present day technology led agriculture covering high-yielding varieties, fertilizers, irrigation, pesticides and mechanization has led to enormous gains in food production and contributed to food security in India. In many countries, however, intensive crop production has had negative impacts on production, ecosystems and the larger environment putting future productivity at risk. While several other countries are yet to get benefitted by the modern technologies, the intensive crop production system has also brought problem like land degradation, salinization of irrigated areas, over-extraction of groundwater, the buildup of pest resistance and the erosion of biodiversity. Intensive agriculture has also contributed to deforestation, the emission of greenhouse gases, and nitrate pollution of water bodies which seriously threaten our ecological sustainability. To meet the demands of a growing population we must almost double the production of horticultural crops by the year 2050, under complicated and challenging scenario of climate change and growing competition for land, water and energy.

The climate change is a reality now as witnessed by heavy rainfall and flood in Tamil Nadu December, 2015, unusual winter during 2015-16 across the north India, hail storms in Karnataka and Maharashtra seriously damaging horticultural crops during February-March, 2015; hudhud cyclone in Andhar Pradesh, Orissa and West Bengal with serious damage to crops and lives as far as Uttar Pradesh and Bihar during October, 2014. But further improvement and sustaining the productivity of horticultural crops under the threats of climate change pose greater challenge in achieving the future targets in these crops now than ever before.

Table 1: Indian Horticulture at a glance (2012-13 onwards)

Year	Fruits		Vegetables		Flowers		Medicinal & aromatic crops		Plantation crops		Spices		Grand total	
	A	P	A	P	A	P (loose)	A	P	A	P	A	P	A	P
2012-13	69.82	81.28	92.05	162.19	2.33	17.29	5.57	9.18	36.41	169.85	30.76	57.44	236.94	268.85
2013-14	72.16	88.98	93.96	162.90	2.55	22.97	4.93	8.95	36.75	163.01	31.63	59.08	241.98	277.35
2014-15	61.10	86.60	95.42	169.48	2.49	21.43	6.59	10.00	35.34	155.75	33.17	61.08	234.10	280.99
2015-16*	61.88	89.02	94.65	168.50	2.49	21.57	5.88	11.36	35.32	154.80	33.17	61.08	233.38	282.49

A= Area (00,000 ha); P= Production (00,000 metric tons). Includes honey from 2013-14 onwards (76, 81 & 83 thousand metric tons, respectively) Grand Total includes fruits, vegetables, flowers, nuts, aromatic & medicinal plants, spices, plantation crops, mushroom & honey. Source: Indian Horticulture Database: 2014-15, National Horticulture Board. (*First Advance estimate of NHB for 2015-16 Dated 15 Jan., 2016)

The challenge, therefore, is to realize increased production while avoiding the extremes of the adverse effects. The development of ecologically more sound agricultural systems that reintegrate traditional knowledge and adds new ecological knowledge into the sustainable and intensive crop production system can contribute to mitigate the challenges of ecological sustainability of horticultural production system. Sustainable intensification could be defined as producing more from the same land area while reducing negative environmental impacts and increasing contributions to natural capital and the flow of environmental services. This alternative paradigm has been observed to work in many parts of the world, and is biologically and ecologically as well as economically more efficient in producing the required outputs of goods such as edible and non-edible biological products and of water while at the same time taking care of other essential ecosystem services that regulation of soil, crop and ecosystem health, protection of habitats and biodiversity; drive carbon, nutrient and hydrological cycles as well as conserve stocks of carbon, nutrients and water, and protect soils and landscapes from erosion and other forms of degradation.

Our efforts in the past five decades have resulted in understanding the ideas of sustainable intensification helping us translate the concepts in to reality. We, now have concepts and technologies at our disposal to integrate the intensive production system and practice on field which can enhancement of ecosystem services without unavoidable damages to ecosystem like sequestration of carbon in the soils or the provision of clean water, using healthy and biologically active soils as medium for such ecosystem functions and services.

Human beings have always struggled for their survival and in this process, they have gained knowledge of complex phenomena operating in nature at various levels and suitably adjusted to face the challenges. Judicious utilization of the potential of existing genetic diversity in evolving climate resilient varieties to face these natural disasters coupled with Integrated cropping systems may offer sustainable solutions to these problems. Although tapping the potential of genetic diversity and gaining knowledge on different aspects of environment and evolving strategies to face the adverse situations is important, undue interference with Mother Nature may lead to disasters. Conservation of genetic resources, diversification, novel genes, efficient resource management, modified environment for crop production, organic production including nutrient recycling, soil and water conservation, utilization of natural diversity for pest and disease management, pollinators and enhanced ecosystem services are some of the possible alternatives to address these challenges.

However, we need to strike a balance between our needs and the carrying capacity of the local environment to achieve sustainability in all its forms. Perennial horticultural crops greatly support the sustainability and adoption of ecologically sound horticultural crop management practices can increase the sustainability of agricultural production as a whole and further help in reducing adverse consequences of intensive crop production system. An attempt has therefore, been to discuss the underlying principles and outline some of the key management practices and technologies through Utilizing Horticultural technologies for ecological sustainability.

5

Natural Resource Management for Sustainable Development of Temperate Horticulture

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After independence, the major emphasis was to achieve self-sufficiency in food production. With green revolution the dream came true and the country once deficit in food became an exporting nation. Now realizing the potential of horticulture crops the country has poised for rainbow revolution to meet nutritional security, higher farm income and export market and has become paradise for many horticultural crops like fruits, vegetables, flowers, spices and other plantation crops which are grown in one or the other place throughout the year under varied soil and agro-climatic regions which have several advantages.

- produce higher biomass than field crops per unit area resulting in efficient utilization of natural resources,
- highly remunerative for replacing subsistence farming and thus eliminate poverty level in rain fed, dry land, hilly, arid and coastal agro-ecosystems,
- have potential for development of wastelands through planned strategies,
- need comparatively less water than food crops,
- provide higher employment opportunity,
- important for nutritional security,
- environment-friendly,
- high value crops with high potential of value-addition,
- have high potential for foreign exchange earnings and
- make higher contribution to GDP

Today, India is the second largest producer of fruits and vegetables next to china with an estimated production of 81 million tonnes fruits and 162 million tonnes of vegetables from an area of 16.2 million hectares, contributing about 13% of the total world production of fruits and vegetables. Temperate Horticulture too like tropical and subtropical has assumed a great significance in north and north eastern Himalayan states playing vital role in providing nutritional and economic security of the region. Horticulture in these states, forms the backbone of economy by providing direct or indirect employment to 8-10 million people and generate revenue of 10000 crores annually. Among temperate horticultural crops, apple, pear, peach, plum, kiwi fruit, apricot, cherry, almond and walnut in fruits are important with apple, walnut and pear sharing major area while in vegetables, temperate cultivars of cole crops, bulb and root crops; capsicum, peas, high value leafy vegetables like lettuce, parsley, celery, chinese cabbage etc are commercially important. In floriculture, tulip, lilium, alestromaria, carnation and gerbera and in medicinal and aromatic plants, *Lavender, Lavendine, Geranium, Dioscoria, Pdophyllum, Pyrethrum, Mentha, Artemisia* etc are becoming increasingly significant in the recent years. A very high value and low volume crops like saffron and kalazeera which are exclusively grown in this region too are commercially important.

Judicious and sustainable utilization of natural resources and genetic wealth in the coming years would be priority for improving livelihood security through agri-horti farming system through various developmental programmes, but the fast changing climate and over population have become a major concern challenging natural resources, topography, soil, climate and horticultural crop diversity for sustainable development and improving livelihood in Himalayan region. Depleting natural resources and vagaries of weather are severely effecting long-term sustainability and agri-horti production system. Inspite of several challenges, the horticulture in temperate region has made some progress. The area, production, productivity and availability of horticulture products have increased manifolds leading to improvement in employment and farm income. But still the low productivity and high cost of production limiting profitability per unit area. Lack of elite planting material, old and senile orchards, rainfed farming, lack of efficient water, nutrient and canopy management, high infestation of insect and pests, poor transport and communication coupled with weak post harvest management affecting productivity.

Degradation of land and water resources in fragile Himalayan agro-ecosystem, effecting nutrient and water availability; poor crop and varietal diversification, monoculture and traditional orcharding system are leading to heavy incidence of pests and diseases. Inadequate number of improved genotypes/rootstocks having higher productivity, superior quality, stability and resilience to biotic and abiotic stresses; old and senile orchards, alternate bearing and replantation problems effecting productivity and quality. Inadequate availability of quality planting material elite varieties and rootstocks restricting commercialization for achieving higher productivity. Climate change leading to shift in seasons resulting in change in cropping pattern, reduced yield, quality and availability. Emergence of new pests and diseases and non-availability of suitable IPM module severely effecting the overall yield and quality. Erratic precipitation, water scarcity and constant draughts limiting water availability and causing severe crop losses; inadequate information on orchard, canopy and pollination management affecting productivity and production of quality fruit. Continuous and heavy application of pesticides, pesticide residues and sub standard spurious pesticides, fertilizers, seeds etc hindering in realization of higher productivity and quality. Lack of efficient, cost effective and eco-friendly weed control and protection technologies and forewarning systems leading to heavy losses; severe pre and post harvest losses and lack of maturity standards, post harvest processing facilities storage, cool chain transport and marketing affecting overall yield and returns. Lack of trained skilled manpower and shortage of labour resulting in poor TOT and international competition and heavy flow of fresh and processed products effecting domestic production and marketing. The challenges are many but these weaknesses have to be overcome through appropriate scientific interventions in the form of more efficient genotypes and technologies which are modern, environmentally stable, cost effective and have capacity to improve productivity as well as quality, better returns to farmers and higher employment and environmental services to the growing population besides making available enough quantity for export market. To overcome the production limiting factors and to meet ever-increasing demand of fruits and vegetables and their products, use of high yielding varieties and modern technological interventions in temperate horticulture is the need of hour.

- Exploitation of high yielding varieties and rootstocks for higher productivity.
- Production and supply of quality seed and planting material and efficient propagation techniques for mass multiplication.
- Plant architecture and canopy management for higher harvest index.
- High density plantations, protected and hybrid cultivation for higher productivity.
- Technology for rejuvenation of old senile orchards.
- Pollination management for higher fruit set and yield.
- Micro irrigation and rainwater harvesting and moisture conservation.
- Eco-friendly and integrated pest and disease management.
- Organic farming and off season cultivation.
- Post harvest management, value addition and marketing are important.

To bring major breakthrough in production and productivity of temperate horticultural crops, sincere efforts are required to develop and popularize new high yielding varieties and hybrids, high density plantations, cost effective and eco-friendly production and protection technologies and post harvest value addition to revolutionize the existing slow pace in temperate horticulture into a vibrant and competitive sector by sustainable use of natural resources, genetic wealth and climatic advantage to become more competitive to face the domestic and global market challenges and to bring higher horticultural growth, better employment and prosperity to farmers besides promoting value addition and export.

6

GHG Emissions: Impact on Agriculture and Mitigation Strategies with Special Reference to Jammu & Kashmir

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Climate change has emerged as an important area of both international as well as domestic policy making and development planning. The earth's climate has demonstrably changed on global and regional scales since the pre-industrial era, with some of these changes attributable to human activities. The recent assessment report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) has shown that climate change would have significant impact on economic sectors and ecosystems. Increasingly, the international and national studies have pointed towards damage to the environment due to anthropogenic causes including emissions of greenhouse gases, the various manifestation being increases in global average surface temperature, increases in global average sea level, and decrease in the northern hemisphere snow cover. Agriculture is strongly influenced by weather and climate. While farmers are often flexible in dealing with weather and year-to-year variability, there is nevertheless a high degree of adaptation to the local climate in the form of established infrastructure, local farming practice and individual experience. Climate change can therefore be expected to impact agriculture, potentially threatening established aspects of farming systems but also providing opportunities for improvements.

The nature of agriculture and farming practices in any particular location are strongly influenced by the long-term mean climate. Rising atmospheric CO_2 and climate change may also impact indirectly on crops through effects on pests and disease. The latest data from GHG emissions inventory of 2007 indicates that agriculture sector contributes 28% of the total GHG emissions in India. The emissions are primarily due to methane emission from rice paddies, enteric fermentation in ruminant animals, and nitrous oxides from application of manures and fertilizers to agricultural soils. The emissions from Indian agriculture are likely to increase significantly in future due to our need to increase food production. The latter would require greater emphasis on application of fertilizers and other inputs. The agriculture sector emitted 334.41 million tons of CO2 eq in 2007. The carbon emitted in J & K state was 168290 tons of C (617063 of CO_2) in 1980, which increased to 696480 tons (2.553760 Tg or million tons of CO_2) in 2000, at an annual compound growth rate of 7.36%. According to my estimates, the annual emission of GHG in the state during 2015 was, 3.666, 1.041, 8.166, 0.288 and -5.135 Tg of CO_2e from energy, industry, agriculture, waste and LULUCF sectors, respectively. Thus the total GHG emitted was 8.026 Tg during the year 2015. Maximum annual methane emission in the state is from livestock (222950 tons), followed by rice cultivation (21603 tons), manure management (2538 tons) and crop residue burning (1712 tons). Nitrous oxide emission has been of the order of 9478 tons from soils, 45.4 tons from residue burning and 1.54 tons from manure management. The annual per capita emission in J & K is only about 605 kg as against per capita emission of about 1200 kg in the country as a whole. The mitigation strategies will include improved water and fertilizer management in rice paddies, improved management of livestock population and its diet, management of organic manures, minimal tillage, residue management, use of nitrification inhibitors and improved efficiency of energy use in agriculture.

7

Health Effects of Changing Environment

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Environment has played a crucial role in our economic, social, cultural behaviour as well as on health. For thousands of years, we have been living in harmony with our environment. However, since the beginning of industrialization era in Europe 400 years ago and its subsequent spread to the rest of world, economic development and physical comfort for mankind has increased at a tremendous pace. This has resulted in detrimental effects on various global environmental factors such as rise in temperature leading to global warming, depletion of stratospheric ozone layer, loss of biodiversity, marked degradation of the air and water quality due to atmospheric pollution and upsurge in infectious and non infectious diseases.

According to the World Health Organization (WHO), 'in its broadest sense, environmental health comprises those aspects of human health, disease and injuries that are determined or influenced by factors in the environment. This includes the study of both direct pathological effects of various chemical, physical and biological agents, as well as effects on health of the broad physical and social environment, which include housing, urban development, land use and transportation, industry and agriculture'. Environmental health has emerged as an important part of medicine. The role of environment in various diseases has been well documented both in communicable and non-communicable diseases. The WHO estimates that 24% of the global diseases burden and 23% of all deaths can be attributed to environmental factors. Deaths from heart disease, cancer, respiratory disorders and many vector-borne diseases such as malaria, dengue, chikungunya and cholera are increasing due to changes in the climate. Changes in the environment have a much bigger impact in developing countries like India as because of limited attention to sanitation, hygiene, as well as quality of food and drinking water. Factors such as deforestation, increasing vehicular traffic, migration from rural to urban areas, decreasing water resources and inadequate drainage system also contribute to increase in the incidence of infectious diseases. This effect is much more evident in the vulnerable population like children and elderly. Almost 42% of acute lower respiratory tract infections in developing countries are attributable to environmental factors.

The need of the hour is to sensitize the scientific community as well as lay population about the way our ecology is being degraded, the health effects it is causing and suggest ways to remedy it. A holistic view is needed to address the problem of environmental health where agriculture, animal husbandry, public health, water safety and air pollution need to be looked at in a combined manner for education, planning and resource allocation. Therefore, a close association between scientists, public health professionals and administrators is needed for integrated design and development of framework to attain the harmony between man and nature.

8

Natural Resource Management for Ecological Sustainability of Islands

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The practice of ecological agriculture involves adopting the strengths of natural ecosystems into agro-ecosystems to enhance the agricultural production by utilizing the available natural resources. The overall strategies include using practices that (a) maximization of resource use for higher farm production through IFS (b) grow genetically superior plants with good abiotic stress tolerance (c) plant protection through ecological manipulation and (c) enhancing populations of beneficial organisms and nutrient recycling. These are accomplished by enhanced habitat management both above ground and in the soil. These measures not only facilitate management of natural resources of the island but also ensure the diversification of agricultural activity resulting in higher productivity and livelihood security.

Natural resources are vital for the survival of human race, but its endowment and proper utilization will decide the level of economic development within the ecosystem boundaries. The proper management refers to the sustainable utilization of natural resources such as land, water, soil, plants and animals, with in the ecosystem boundaries to improve the quality of life for both present and future generations. However, natural resource management problems don't have straight forward solutions. It involves ecological cycles, hydrological cycles, climate, animals, plants and human interactions. Therefore, understanding ecological natural of the agriculture is vital to enhance the productivity and provide sustainable livelihood to the people.

The management of soil and water resources, the most important natural resource, with appropriate technology is the key for providing livelihood and sustaining the economic activity in an island condition with limited land area, inadequate fresh water storage, intricate production system, and limited choice for crop combinations. Thus appropriate production technology for island conditions and its management strategy based on the ecological principles for field level adoption are very essential for sustainable livelihood security.

On the other hand, there have been observed changes in surface temperature, rainfall, evaporation and extreme events since the beginning of the 20th century. Analyses of global precipitation pattern show variations and some notable trends in recent decades. Few studies have shown a rising trend in precipitation over the middle and high latitudes of northern hemisphere. There are also many studies related to precipitation trend and pattern over India. In these Islands about 95 percent of the total annual rainfall of 3100 mm is received during May-December but deficit is experienced during January-April. The study of climatic pattern highlighted decreasing trend in rainfall and rainy days in post-monsoon season. Therefore, the emphasis should be on the sustainability of production system within the dynamic boundaries of ecological nature of the agriculture and allied areas.

9

Perspectives of Land and Water Management for Sustainable Agriculture in Jammu & Kashmir

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The State of Jammu and Kashmir falls in the great north-western, complex of the Himalayan ranges and there is a sudden rise of altitude from 305 metres to 6910 metres above sea level. J&K state comprises of 4 distinct agro-climatic zones sub-tropical, intermediate, valley temperate and cold arid. Average annual rainfall is 619 mm which ranges from 92.6 mm in Ladakh to 650.5 mm in Kashmir to 1115.9 mm in Jammu. Soils are loamy with little clay content. The lack of water resources in Jammu, the low temperature in Kashmir and the lack of both temperature and water in Ladakh region are the main hindrances in agricultural activity of the state. The Agriculture Sector in J&K faces many problems such as low growth, declining yields, unviable farming, limited scope of extending cultivated area, land degradation, hilly terrain, small and fragmented land holdings and so on. As per INCCA assessment the number of rainy days in the Himalayan region in 2030s may increase by 5-10 days on an average, with an increase by more than 15 days in the eastern part of the Jammu and Kashmir region likely to impact some of the horticultural crops. The rate of recession of glaciers is varying which is being attributed to changing pattern in winter precipitation, climate warming and anthropogenic elements. The main challenges are shrinking land base, depletion of water resources, adverse impact of climate change, shortage of Farm labour, increasing costs of inputs, uncertainties in weather, soil erosion, volatility in national and international markets. The irrigation is a critical input for multiple cropping; hence, there is a need to expand irrigation capacities of the state, particularly where they are much needed. Rainfed areas are particularly prone to annual fluctuations in production and degradation of environmental resources. Concerted efforts are needed to rejuvenate their natural resource base and also to stabilize and augment the income sources of farm households. Therefore prioritization of critical watersheds for soil & water conservation measures, where the pressure on natural resources is ever increasing, is necessary. The in-situ and ex-situ water harvesting technique can help in exploiting the full potential of the land conserving both, soil and moisture.

The present growth in crop production has to be sustained considering ecological and economic factors and agriculture development in the state would be guided in future not only by the objective of attaining food and nutritional security, but also by the concerns of declining profitability, environmental degradation and ecological un-sustainability. The approach should be to identify suitable crops, combine them spatially or temporally to design production systems and introduce management practices that ensure ecological and economic sustainability. Advances in growing crops within shelters such as poly houses are also making it possible to grow crops in new locations or during off-seasons. For sustaining the crop productivity efforts should be made to enhance the water and nutrient efficiencies by adopting resilient management practices. Seed planning, seed production, SCI (System of Crop intensification) are some of the niche areas need to be addressed immediately. This calls for developing agro-eco region-specific land-use plans based on homogeneity in soil, water and climatic features in a particular region and managing a particular land unit on watershed basis involving the local community.

10

Micro Irrigation Technology for Efficient Water and Nutrient Management

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Globally, 3240^3 m km fresh water is being utilized, out of this 69% is being used in agriculture sector, 8% in domestic, 23% in industrial and other sectors. In India around 88% water is being used in agriculture sector, which covers around 80 m ha area under irrigation. Due to the liberalisation of industrial policies and other developmental activities, the demand for water in industrial and domestic sectors is increasing day by day, which forces to reduce the percentage area under irrigation. Expected annual water demand by various sectors in 2025. The current irrigated area of around 38% of total cultivated area. The growing demand from the population calls for more efforts to enhance agricultural production activity covering cereal, millets, oilseeds and horticultural crops. Sustainable development of land and water resources is very important for a country like India which shares 16% of the global population with only 2.4% of land and 4% of water resources and judicious use of irrigation water is more important to enhance total production and area under irrigated agriculture. It can be achieved by introducing advance method of irrigation like micro-irrigation coupled with other improved fertilizer application practices like fertigation. Micro-irrigation system is irrigation system with high frequency application of water in and around the root zone of plant system. Micro irrigation system is known to be able to achieve high water use efficiency, and also results in improved crop yield. Fertilizer application through the micro irrigation system i.e. fertigation is the most advanced and efficient practice of fertilization. With micro irrigation 40-100% of water can be saved over flood method and 90-95% water use efficiency can be achieved. Significant savings in the use of fertilizers (20 to 50%) and 20-70% increase in yield can be achieved through fertigation.

11

Managing Abiotic Stresses in Agricultural Fields: ICAR-NIASM Initiative

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Globally acclaimed green revolution in late sixties and subsequent technological interventions in fields ensured sustainable food security for millions of Indians. However, a series of climate and non-climate constraints are posing greater challenges to Indian agriculture and national food security particularly when food production is to be doubled by 2050. As per an ICAR estimate, 120.8 million ha constituting 36.5 per cent of geographical area in India are degraded due to soil erosion, salinity/alkalinity, soil acidity, water logging and other edaphic problems. 60 per cent of the country's cultivated area is prone to drought and vulnerability to global climate change is visible with frequent extreme temperature episodes, erratic rainfall, flood and hailstorm. In total an average of 50% yield losses in agricultural crops are caused by abiotic factors. Keeping this in mind, establishment of National Institute of Abiotic Stress Management (NIASM) was the first step in India towards institutionalizing abiotic stress research in an innovative mode to build sustainable livelihood in abiotically stressed agro ecosystems by practicing climate resilient farming system through a deep insight, adaptation techniques and mitigation strategies. Though concerted research initiatives on influence of abiotic stresses have been undertaken in the past and are in progress, but to hasten the pace of research and re-enforce focus with a scientific approach, need was felt to consolidate these initiatives by ensuring synergies between management options and advances in molecular, biotechnological and nano-technological approaches for developing genetically improved crops, livestock and fishes. This requires scientific approach to impart tolerance in plants and animals to environmental stresses and adoption of practices that minimize their magnitude. This adaptation and mitigation potential is nowhere more pronounced than in developing countries where agricultural productivity remains low; poverty, vulnerability and food insecurity remain high; and the direct effects of climate change are expected to be especially harsh. It is a fool's errand to attempt to fully catalogue in any comprehensive way agricultural technologies with potential for climate change mitigation and adaptation over the coming decades. If history is any guide, such technologies will be developed with the passage of time and with experiences. The demand for developing such types of technologies has opened up a floodgate of opportunities - of understanding, experimenting on and mitigating multiple forms of abiotic stress at NIASM. The comprehensive strategy of the institute will prioritize characterization of the occurrence and magnitude of various abiotic stresses impacting agriculture sector. This will provide a rationale for basic and strategic research that aim it at agro-ecology specific stress mitigation and adaptation technologies for crops, horticulture, livestock and fisheries which will revolve around strategies like defining target abiotic stressors, enhancing adaptation and developing technologies for stress mitigation.

12

Crop Genetic Biodiversity with Special Reference to Oilseed *Brassica* and Wild Allies-Conservation and their Utilization

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Crop genetic resources and their wild relatives are likely to play a significant role in securing 21st century food security. This is due to their potential use in plant breeding to produce crops which withstand adverse impacts of climate change, increasing scarcity of nutrients, water and other inputs, and new pests and diseases. A high proportion of global food production is from a small number of scientifically-bred crop varieties, with narrow genetic variation. This has resulted in loss of approximately 75% of global crop genetic diversity as these new varieties replaced a much greater range of more genetically diverse traditional crop varieties (FAO 1998a).In cultivation wild plants have been transformed to make them more useful to humans.

The genus represents a wide range of crops including oilseed, many vegetables and fodder crops. In some species this whole range of uses is present. The genus Brassica also contains many wild species. Many collections at breeding institutes were intended as working collections and contain germplasm necessary for short term breeding research. The wide range of crops, species and applications cause Brassica genetic resources to be even more scattered over collections than other crops; no single collection holds the complete genetic diversity of Brassica. For an integrated approach of conserving genetic resources collections, networks on species or crops are essential. By collaboration in networks the tasks of long term conservation of the genetic diversity and making the genetic diversity available to users can be more structured, duplication of work can be avoided and gaps in collections can be traced. For several crops there are international networks coordinated by the International Plant Genetic Resources Institute (IPGRI). For Brassica such network does not (yet) exist. Regeneration of Brassica is very costly. Therefore good storage conditions in order to maintain the seed viability are essential. It is also very important to avoid unnecessary duplicates. Consequently good and accessible information on the material in the collections is needed to trace these duplicates. An international central crop database with high quality and highly accessible data would be of great help. This would also encourage a more efficient use of the material. For the wild Brassica species in situ conservation is of high importance; the *ex situ* collections help to make a small part of the diversity readily accessible for utilization. In order to guarantee availability of Brassica germplasm to future generations, funding agencies, such as national governments, need to commit themselves to support coherent conservation programmes.

13

Diversification of Rice-Wheat Cropping System to Improve Soil Fertility, Sustainable Productivity and Economics in IGP

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Rice (*Oriza sativa*)-Wheat (*Triticum aestivum*) cropping system is the most important predominant cropping system of the IGP in India. It is the "food bowl" or "food basket" of India having 53 per cent of total area under rice and wheat crops. RWS occupies around 42% of the total agricultural area in the India. Rice is mostly grown in *Kharif* (June-October) season, while wheat is mostly grown in *Rabi* (December-April) season. The three major cropping systems are rice-wheat, rice-fallow and rice-mustard- summer rice belongs to four region of IGP but pre dominated system is rice-wheat and occupies 72% of the total cultivated area. Percent rice and wheat contribution in IGP in India is 48.5 (rice) and 74.7 (wheat). The rapid spread of rice-wheat system has mainly been attributed on account of its better adaptability, availability of high yielding varieties and mechanization of both crops. The productivity of these system are higher because the agro climatic conditions *i.e.,* productive alluvial soil, maximum irrigated land, sub tropical climate is most favorable to rice and wheat crops in comparison to other cereals. Climate change is one of the most important global environmental challenges facing humanity with implications for food production, natural ecosystems, freshwater supply, health, etc. After decades of continuous cropping, over irrigation, urbanization, pest pressure, nutrient mining, burning of crop residue and water shortage are the problems covering all IGP areas. The effects of global warming combined with the region's rapidly growing population. Declining soil fertility (Punjab), development of salinity (Haryana, South-west Punjab) ground water depletion (Central & Western UP), floods (Bihar & West Bengal) are the other main constraints.

The Indian Green revolution region "Indo-Gangetic Plain" occupies nearly 15% of the total geographical area of the country. It is one of the most fertile large plain to developed agriculture based densely populated region. It produces about 50% of the total food grains to feed 40% of the population of the country. The Indo-Gangetic Region is bound on the north by Himalayas. The IGPs, also known as the "Great plains", it is formed by the basin of three distinct rivers systems-the Indus, the Ganga and the Brahmaputra. These plains comprise one of the world's greatest stretches of flat and deep alluvium. It is the source of the fertile alluvium soil which is favorable for double and triple cropping. The important crops grown in the Indian IGP are rice (*Oryza sativa* L.), maize (*Zea mays* L.), pearl millet (*Pennisetum glaucum* L.) and sorghum (*Sorghum bicolor* L.) in *Kharif* season and wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), chickpea (*Cicer arietinum* L.),and mustard (*Brassica* sp), in rabi seasons and cotton (*Gossypium* sp), sugarcane (*Saccharum officinarum* L.), and potato (*Solarium tuberosum* L.) are cash crops in this region.

In states like Punjab, Haryana and western UP (assured food bowl of the country) water table is declining roughly @ 30 to 40 cm every year. Even soil health in these states is deteriorating due to indiscriminate use of pesticides and other agro inputs. Arsenic contamination in soil and water has been reported in almost whole of Indo Gangetic alluvial plains due to deep drilling of ground water for raising paddy. There is a strong need to shift some area from rice and wheat to fruits, vegetables, agro-forestry, oilseeds, pulses and maize in these states. Rice cultivation needs to be shifted to Eastern states which have sufficient water and conducive climate for rice cultivation.

14

Resource Management Strategies in Agriculture Using GIS

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Agricultural holdings are highly fragmented in India. Each farmer's family managing small field plots separately. This pattern of farming increases nutrient variability between fields due to individual farmers' knowledge, fertilization history, crop sequence, farm management and resource availability. Consequences of which are over or under-application of nutrients which led to stagnation in productivity and nutrient use efficiency, expansion of multi-nutrient deficiencies, high extent of nutrient mining and falling farm income with obvious economic and environmental consequences. Therefore, challenges for sustaining natural resources while meeting the increasing pressures from rising population and the growing economy are extremely complex. In order to accomplish the above needs production strategies are to be changed from input intensive cropping to integrated resource management based cropping. Such shift is towards the adopting the precision farming technologies which can address the site specific input and resource variability, and crop demands. Addressing these challenges require development of tools that allow accurate representation of the spatial distribution of the relevant variables and phenomena consistently, and the methods that enable monitoring, analyzing and predicting the interaction between different natural process at different scales and the consequent changes in the natural resource base (Robert , 1999). The modern technologies like geographical information system (GIS) coupled with remote sensing (RS) has been recognized as reliable tools in agriculture to guide the application of fertilizer, irrigation, weedicide, pesticides and other farm inputs (De-Benedetto *et al.,* 2010). The adoption of this technology in Indian condition is still a dream to come true, owing to small marginal (86%) farm holdings and other problems like availability of appropriate farm machinery and location specific input recommendation suited to Indian conditions. Present paper describes the role of GIS to address the complex challenges in Indian farming scenario.

1. GIS based input management

GIS is widely used for linking of spatial information with attribute data in the underlying database. Since GIS can collate, store, manage, retrieve, analyze and display spatially referenced information, it can be used for various aspects of crop management like:

(i) Organising the database for efficient storage and retrieval.
(ii) Data validation and editing (checking and correction).
(iii) Generalisation and classification (reclassifying data, aggregation or disaggregation) of data.
(iv) Integration (overlaying, combining map layers) of different layers.
(v) Data interpolation (kriging, spline functions, IDW and extrapolation) and analysis.
(vi) Maintenance of database security and integrity.

2. Resource management under cropping system through GIS

GIS provides ways to overlay different 'layers' of data: the land use, cropping system and coverage, soil information and other structures for their efficient and sustainable use. In case of crop management various parameters that may affect agricultural production viz. soil chemical and physical properties, crop phonology, and different management practices (e.g., tillage practices, crop seeding rate, fertilizer and pesticide application and crop yield data) can be evaluated using GIS analytical capabilities. Since cropping system followed on piece of land is mainly governed by land topography, ecological conditions, farmers socio-economic conditions, available infrastructure and enterprises, use of GIS for efficient system based crop management may become paramount significance. The recent effort made by Singh (2014) at Modipuram to work out the cropping system maps using satellite data (MODIS data) and its integration field level input use (fertilizer, residue, irrigation water, tillage and other management practices) has shown promising in developing site-specific nutrient recommendation for wider domain applicability.

Resource conservation technology like Precision farming, variable rate fertiliser applications technologies etc. requires accurate field variability mapping from before sowing to till the harvest of the crop. An interactive use of RS and GIS can play significant role for enhancing efficacy of these techniques.

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Diversification of Existing Cropping System- An Approach towards Higher Productivity and Sustainability

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India witnessed a paradigm shift in food grain production and from a food deficit state at independence, became a food surplus nation. The food grain production shot up from 51 million tonnes (mt) from 97 m ha (1950-51) to a record of 257.07 million tons in 2014-15. This showed a growth rate of 360 per cent with a meagre 24 per cent increase in gross cultivated area. This was possible through a combination of development of high yielding varieties and use of improved crop production technologies. The cereal based cropping systems (Rice - wheat, rice - rice and maize/pearlmillet - wheat etc) contributed mostly to the food basket. However, this also led to many second generation problems in post green revolution phase in all intensively cultivated areas, threatening the very sustainability of the important agricultural production systems, and thereby national food security. It is estimated that India would need about 345 mt food grains to feed around 1.5 billion population by 2030. Similarly, the increased demand for feed and fodder, resource degradation, climate change, new pests and diseases, slow growth in farm income, changing dietary pattern of the population and policies demand a new paradigm shift in our future research and development planning. All these call for a system's approach vis-à-vis crop diversification to deal with the emerging issues and new challenges.

Diversification of agriculture refers to the shift from the regional dominance of one crop to regional production of a number of crops, to meet ever increasing demand for cereals, pulses, vegetables, fruits, oilseeds, fibres, fodder and grasses, fuel, etc. It aims to improve soil health and a dynamic equilibrium of the agro-ecosystem. Crop diversification takes into account the economic returns from different value-added crops. Crop diversification may also be viewed to shift from one crop to another in order of changing needs such as i) from low value to high value crops, ii) from water loving crop to water saving crop (aerobic rice, SRI), iii)from single crop to multiple / mixed crop, iv)from crop alone to crop with crop-livestock-fish-apiculture, and v) from agriculture production to production with processing and value addition.

India is the world's second largest producer of vegetables after China. However, hardly 2% of the vegetable is processed. The availability of prompt and reliable market information for different commodities would considerably improve the decision making capacity of farmers in the country. Vegetables are a vital source of minerals, vitamins and dietary fibres and play an important role in human nutrition in supplying adequate quantity of free radicals, anti-oxidants and micronutrients.

Researches show that the consumption of vegetables, especially cole crops reduces the risk of cancer of alimentary canal and respiratory tract of humans. Attention has been paid to vitamins such as vitamin C, pro-vitamin-A and dietary fibre in all these vegetables. In recent years it has shown that the plant tissue contains a whole variety of potential anti-carcinogenic secondary metabolites. These include flavonoides, glucosinolates and isothycyanates. Thus vegetables are the main source of these antioxidant and anti-carcinogenic plant substances which prevent cancer diseases.

India & World: India has been bestowed with wide range of climate and physic-geographical conditions and as such is most suitable for growing various kinds of horticultural crops such as fruits, vegetables, flowers, nuts, spices and plantation crops (coco nut, cashew nut and cocoa). Its horticulture production has increased significantly over the last two decades and as per the final estimates, by 2013-14, it has increased to about three times (2.87) since 1991-92 and to about twice (1.90) compared to the production in 2001-02. This has placed India among the foremost countries in horticulture production, just behind China. As per National Horticulture Database 2014, during 2013-14, India's contribution in the world production of fruits & vegetables was 13.6% & 14% respectively. Total production of fruits during 2013-14 was about 89 million tonnes while that of vegetables was 163 million tones whereas the third advance estimates put the production at 86 million tonnes and 167 million tonnes respectively for 2014-15.

India is the largest producer, consumer and exporter of spices. It is the second largest producer of fruits and vegetables in the world and occupies first position in the production of fruits like mango, banana, papaya, sapota, pomegranade, acid lime and aonla and vegetables like peas and okra. it is next only to china in production of many vegetables like potato, tomato, onion, brinjal, cabbage, cauliflower and broccoli etc.

As per National Horticulture Database 2014, India's significant horticulture production is despite its comparatively lower productivity. Both in case of fruits & vegetables productivity of India (12.3 & 17.3 tonnes per hectare respectively) is about half of the productivity of USA (23.3 and 32.5 tonnes per hectare). During 2013-14, India's productivity was marginally better than the world average in case of fruits (11.4 tonnes per hectare) whereas it was below the world average (19.6 tonnes per hectare) in case of vegetables. Comparison of

India's horticulture productivity with that of China, the leading producer of fruits & vegetables, also gives identical results as in case of overall global productivity with significantly lower vegetable productivity whereas the productivity in case of fruits surpassing that of China. In case grapes production India's yield is best amongst the major producers of the fruit.

Exports: Besides meeting the increasing demand of the domestic population, which continues to grow, India exports some portion of its horticulture produce. During 2013-14 total exports of horticulture produce by India was 3.69 million metric tonnes which amounted to about Rs 143.6 billion. Even though the quantum of export decreased in comparison to the year before i.e. 2012-13 when it was 3.7 million metric tonnes , the value of export of horticulture produce increased by about 35.6% from Rs 105.9 billion in 2012-13. Except for 2010-11 when the exports of horticulture declined by about 7%, the export of horticulture produce has seen an increased during the last six years.

16

Integrating Farming System for Livelihood Security: An Approach Towards Sustainable Agriculture

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In J&K state the agriculture is at a cross-roads wherein the small holdings, profitability, livelihood security and sustainability issues are the factors adding to the existing agrarian crisis in the state in particular and the country in general which requires a decisive direction shift at the policy level towards adoption of integrated farming system. Thus there is a need of fundamental change from the unilateral, top-down, prescriptive “knowledge generation and transmission” models of agriculture development adopted in the country so far, which have in fact resulted in an ecological, economic and social crisis in the farming sector of the state during 40 years of adoption and that climate change is one more imperative for drastic change to address the situation. Climate change is already a reality for farming community and that conventional models of agricultural research and extension have failed to address the need of the hour unless some fundamental recasting in the form of diversified farming system is adopted. The immediate need for interventionist action precludes traditional models of research and support systems and requires alternative but urgent programmatic interventions, led by farmers’ institutions and their local resources, knowledge and innovations. Existing mainstream models of farming are GHG-inducing and are not conducive to adaptation either given their high external-input dependency-models which increases the risk of vulnerable farmers. Integrated farming system a key to sustainable agriculture, on the other hand, holds immense mitigation and adaptation potential, specifically in the context of climate change even as it improves rural livelihoods and addresses the ecological crisis in farming of today under various climatic regions of Jammu in particular and state in general. Jammu region of the J&K state is bestowed with varying climate zones i.e. subtropical, intermediate and temperate zones, which is best suited for diversified farming, as the promotion of single enterprise is neither beneficial from economy point of view nor is sustainable under the given climate change crisis. The integration of Crops, Horticulture, Animal ,Fish cum Poultry, Mushroom, Vermicompost, Apairy, Biogas and Boundary plantation enterprises in Jammu region under integrating farming system is having the potential to improve the farm income to three folds besides will address the sustainability issues in the long run.

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Integrated Farming System for Sustainable Agriculture: An Overview

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Farming Systems in India are location specific wherein basic components are crop, animal and homestead. Integrated Farming system (IFS) is one where high quality food, feed, fibre and renewable energy are produced by using soil, water, air and nature sustainably with little polluting inputs. The major types of Farming system models in India are subsistence farming, shifting, plantation, intensive, mixed, multiple and commercial agriculture, dry farming, crop rotation, sedentary and terrace cultivation, lay farming, agroforestry, dairy, cooperative and vertical farming. Inclusion of apiculture, sericulture, duck rearing, fishery and mushroom cultivation is the recent approach. Organic farming is a type of sustainable farming in IFS which is still in infancy stage and requires cluster approach in this country. Integrated pest management in organic farming excludes pesticide and genetically modified crops. Organic pest management comprises of pest alternative crops, crop rotation, cultural practices, soil management, mulches, pest scouting, insect identification, plant diversity, natural enemies and bio-pesticides. Sustainability of Organic farming systems is evident by the presence of insect decomposers and pollinators in higher proportions than in conventional farming systems. The holistic approach is more often on plant and soil health known as plant positive approach.

18

Agriculture and Industrial Agro-forestry: A Model for Food, Fuel and Wood Security

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Global warming, on the one hand, and rapid and degradation due the growth of people-land ratio on the other, has created a compelling need to explore multiple land-use practices to maintain social, economic and ecological sustainability in India. One of the more promising methods to optimise land-use and meet the multiple needs of rural households is generally known "agroforestry" (AF) -growing trees in combination with crops or animals. AF is most commonly associated with small farmers who promote it with the purpose of satisfying family or local needs. It has also been promoted by governments, but with mixed success.

One form of AF is relatively recent but highly promising in terms of scale and sustainability. These are AF plantations supported by wood-based industry to create a secure and sustainable raw material base for their operations by promoting the production of wood with inter-crops on lands hitherto used only for agriculture. Since these plantations are promoted with the objective of strengthening supply chains, it is expected that, if implemented successfully, they can potentially be on an industrial scale.

By providing productive and multiple land-use options, AF can be a vital intervention in a country like India where land-ownership is over whelmingly small. It not only hedges farmers significantly from seasonal risks, but the wood harvest income provides farmers with a lump-sum amount for making major investments in the farm. Simultaneously, it emerges as a viable option for businesses interested in wood but unable to promote large-scale captive plantations due to various laws of the land. A partnership between the company and small-holders to produce wood, food and fuel needed by both partners can emerge as a winning model. It also presents a unique opportunity for companies to promote sustainable livelihoods for resource poor households even while ensuring a sustainable supply of raw material for industrial production.

ITC promotes pulp-wood plantations in districts neighbouring its pulp mill in Khammam district of Telangana state with species such as eucalyptus, subabul, casuarina and bamboo. The programme commenced with multi-location trials in 1992 followed by the Farm Forestry component in 1998-99. Converting an idle asset into one that generates significant incomes made this an attractive proposition for farmers. The intervention also enabled ITC to fine-tune the model before taking it to economically weaker households through Social Forestry in 2001-02, targeting poor, primarily SC/ST households, providing them with the means to turn their underperforming lands into a sustainable livelihood opportunity and an income-generating asset.

Even though the programme successfully promoted over 23,000 ha in 9 years, block plantations were still considered risky by small holders. There was also compelling evidence of growing pressure on agricultural land due to increasing population and competition from urbanization and industrialisation. What was clearly required was an intervention in which trees and field crops production would complement rather than compete for available land. Consequently, ITC launched the AF programme in 2010-11, which enabled pulpwood species and agricultural crops to be grown together throughout the 4-year maturation cycle of Bhadrachalam clonal stock. Using a paired row design with wider spacing, (see Annexure A) the model was standardizedin collaboration with research organisations.

- Two rows of trees planted at a spacing of 1.5 m between rows and 1 m from tree to tree. After two rows of trees, 8.5 m space is available for field crops.
- Tree rows are planted in the East-West direction to further minimise shade effect.
- Land availability is 75% for field crops and 25% for the tree crop.

1. Spread and Coverage

AF plantations now 24,243 hectares area comprising 46 million trees, clearly making it one of the largest efforts by any private organisation. Implemented in 12 districts of Andhra Pradesh, Telangana and Karnataka, the coverage and spread of the programme is sufficiently large to enable conclusions generalised for the model's implementation elsewhere.

2. Major Findings

Data is collected for each season in order to capture major impacts, outcomes and emerging trends. In addition, three independent studies were conducted by reputed organisations to assess the programme in terms of its original objectives and suggest improvements. A few of the more significant findings discussed below are based on these sources.

From the evidence available (see Annexure B), AF is preferred by small and marginal farmers compared to large farmers. , This was supported by responses gathered during FDGs which revealed that bigger farmers opt for less labour intensive crops (like pulp-wood) and they can also afford to block part of their land holding for trees and await incomes by the fourth year. Whereas it was imperative for small-holders to optimise land-use in order to maximize annual incomes. Diversifying into tree crops also emerged as an important risk mitigation strategy for them.

AF did not constrain farmers from the choice of their intercrop; all field crops cultivated customarily were found in the AF fields (see Annexure C).Commercial crops were the most preferred crops with cotton emerging as the most dominant in rainfed fields within this category.

Economic analysis of how AF performed vis-à-vis pure block plantation of trees and only field crops clearly shows AF as the clear front-runner in terms of earnings per acre (see Annexure). Its 25% higher than pure block plantation and 18% higher than field crops.

The model a highly attractive proposition for resource starved small and marginal farmers by the lump-sum earnings every four years which can be invested in productive assets or towards improving the HDI of households. Some of the major investments made by households were in the areas of agricultural improvement, irrigation, household assets, health and education, all of which are critical for setting in motion a virtuous cycle of growth (see Annexure E). Other benefits, which have yet to be quantified, but are attested for by farmers include: i) takes pressure off from the remaining natural forests for wood supply, ii) brings in diversification on farm lands and improves soil health, iii) A useful model for providing wood and food security for nation and stable and better incomes for farmers, and iv)Once planted, the same set of trees are harvested for a total of four times, giving returns to farmers for 16 years.

3. Way-forward

The AF model reduced the land available for field crop by about 20-25%. The challenge is to achieve the gross yields equal to that obtained if the entire land was under agriculture by increasing productivity per hectare. Steps are now being taken to achieve higher productivity with less input usage through sustainable agricultural practices. Initiatives aimed at improving soil health and soil moisture are being taken up with farmers' participation. In addition, an exclusive programme has been planned for sustainable cotton crop productivity enhancement by adopting standard cultivation practices prescribed by Better Cotton Initiative promoted by WWF India.

4. Conclusion

ITC's AF programme converges business and social goals with multi-dimensional benefits: small-holders are enabled to realise the full potential of their land by growing commercial pulpwood plantations that provide significant incomes, ITC benefits from a cost-effective, sustainable raw material base for its Paper & Paperboards business, while the large-scale green cover creates significant carbon sinks and positively impacts the environment. The AF model therefore has the potential to bring down pressure on existing forests and, simultaneously, insulate farmers to large extent from extreme climate episodes. Thus, the intervention can contribute to meeting the needs of food, wood and energy through crop intensification within available land. At the same time, Industrial AF can make large-scale reforestation much more practical in economic terms. Such models can be replicated in different geographies and with other trees species based on enabling research.

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Micro-climate Modifications in Agroforestry Systems

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Trees are increasingly grown to suffice wood and biomass needs, in both temperate and tropical regions, as well as in developed and developing countries. In this book chapter we reviewed several studies explaining microclimate modifications in agroforestry systems from tropical to temperate regions. We systematically elucidate the effect of microclimate (light/solar radiation, temperature including air and soil temperature, soil moisture, relative humidity and wind speed) in these agroforestry systems. The microclimate changes caused by trees in tree-crop associations contain shading of the understory crops, increased relative humidity, reduced air and soil temperatures, and decreased wind velocity. The canopy cover also affects the microclimate of the understory. From the literatures we concluded that the microclimate has positive effects on the agroforestry systems to conserve the soil, maintain the soil moisture (because of shade) protect the crops from wind breaks, tree's shade improve the yield of understory crops such as coffee, turmeric, wheat, pastures etc. Microclimate also helps to improve the yields of trees.

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Integration of Poplar Improvement Programme with Its End-use: WIMCO's Experience

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Wimco, implements unique poplar improvement programme that starts with making manipulated crosses among selected parents, multistage screening of hybrid seedlings for 3-4 years at nursery stage, 8 years at local level screening and further 6-8 years at multi-locational trials conducted through-out the poplar growing region in Punjab, Haryana, Uttar Pradesh and Uttarakhand followed by testing of wood for making match splits which is the main business of the company. Field level screening is conducted for growth, form, yield, insect and disease resistance, etc., whereas, screening for wood is conducted for match splint parameters both at lab and operational scales. Individuals exhibit wide variation for most of the studied characters at all levels of field and industrial screening. Match splint, one of the smallest wood product in direct use, need high quality wood in term of its physical and anatomical characteristics. This presentation includes results of various field and industrial level screenings of poplar clones to elaborate the holistic approach in improvement, production and end use in this industry. The results on wood characteristics and match splints are also presented on the relative performance of tissue culture origin poplar with that of traditionally propagated from stem cuttings. Wimco also helps other R&D organizations and industrial units by supplying them the marked wood of identified clones for conducting their testing for other end uses. Poplar is presently used for more than three dozen products, of which the share of panel industry is maximum and that of match industry is very low (0.5-0.6%). Marked clonal wood has been supplied to Forest Research Institute (FRI) Dehradun and Indian Plywood Industries Research and Training Institute (IPRITI), Bangaluru for its trials for other end uses. Results of some of the clonal screening trials on other products have also been included in the presentation.

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Productive and Protective Potentials of Agroforestry

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The Green Revolution led intensification of agriculture has made the country self sufficient in food grains, however, we ended up in deterioration of natural resources and other risks associated with indiscriminate use of agrochemicals and unscientific use of land. In spite of being aware of such impacts, conservation of natural resources remains the most neglected aspect of civilization's predicament. Paradoxically, meeting the basic requirements on one hand (food, shelter, income, etc.) and conservation of natural resource on the other (water, soil, biodiversity, etc.), beyond doubt are big challenges before mankind. It is the high time to develop technologies and landuse practices with potential to make both ends meet. The framework for achieving the same was acknowledged at the World Summit on Sustainable Development held at Johannesburg, South Africa by the participating nations. Five domain areas of Water, Energy, Heath, Agriculture and Biodiversity were identified as potential pathways leading the ways in the direction of achieving the Millennium Development Goals (MDGs) modified as Sustainable Development Goals w.e.f. January 2016 to be achieved in next fifteen years. Agroforestry is a land use system, which contributes directly or indirectly to materialize the sustainable landuse goal.

Agroforestry offers not only a sustained production, but also a progressive increase in productivity per unit area with additional environmental benefits. It buffers against the vagaries of climate through its unique way of amelioration of microclimate and reshapes the agro- ecosystem with enhanced stability and resilience. Global warming and associated problems of climate change has pressed the need for land use system that would be more dependable in production and more sustainable in terms of resource conservation to ensure food security. However, the negative aspects of trees in farmland such as competition for light, water, nutrients, allelopathy, etc. are equally important, which needs to be considered before introducing trees into farmland. These interactions arising at the interface between tree and crops are crucial as they decide the economic and environmental viability of the system. The selection of suitable tree component, which confer more of positive effects is one of the key factor deciding the success and adoption potential of any system/model. Some of the potential benefits and services provided by agroforestry technologies that virtually contribute towards achievement of sustainable development and ensure food security without depleting the natural resource are discussed in this paper with the support of updated scientific achievements.

2

Land and Water Resources

1.

Consequence of Land Degradation on Yield, Income at Farm Level in the Nilgiris of Tamil Nadu: An Empirical Estimation

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Keywords: Soil conservation technologies, yield, income NPV, BCR, IRR, damage function

Introduction

The Nilgiris is home to several beautiful hill stations popular with tourists. In India, hill areas have serious problems of landslides, torrents, slips and encroachments. In Tamil Nadu, land degraded by water erosion alone is 41% of the total geographical area of the state and is affected by various forms of soil erosion. The resource allocation to soil conservation programmes has increased phenomenally over various plan periods in India. We analyzed the nature of conservation technologies adopted by the farmers and to study the impact of crop damage on productivity, income at farm level.

Materials and Methods

Sample respondents were selected using multistage purposive sampling from the five categories of watersheds "very high, high, medium, low and very low", priority watersheds at the rate of 50 in each priority watershed. The samples were post stratified into marginal, small, medium and large farmers based on land holding pattern. Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) were used to study the technical feasibility and economic viability of the different conservation technologies. Agricultural damage function was used to measure the yield loss due to soil erosion. On-farm income and maintenance of soil conservation structures influenced negatively and significantly in crop damage.

Table 1: Financial analysis of soil conservation technologies adopted in tea crop

Discounted measures	Conservation technology		
	Staggered trench	Stone wall	Water way
NPV	19237	74335	45454
BCR	1.03	1.08	1.15
IRR (%)	14.99	15.58	15.31

Table 2: Financial analyses of soil conservation technology adopted in annual crops

Measure	Bench terrace			
Discounted measure	Carrot (*Daucus carota*)	Potato (*Solanum tuberosum*)	Cabbage (*Brassica oleracea var. capitata*	Beans (*Phaseolus coccineus*)
NPV	57101	42008	34603	32538
BCR	1.40	1.20	1.22	1.12
IRR (%)	34.81	32.29	28.47	22.46

Results and Discussion

Agricultural damage function explained the value of loss in crop productivity due to soil erosion compared with average crop productivity in the locality in the unaffected area. Annual crops positively influenced the yield damage (Table 3). On-farm income and maintenance of soil conservation structures influenced negatively the agricultural damage. It is implicit that one per cent increase in income *Ceteris paribus* had decreased the damage by 1.54 per cent. Increase in maintenance of conservation structures by one per cent *Ceteris paribus* would decrease the damage by 0.19%. On-farm income and maintenance of soil conservation structures influenced negatively and significantly in crop damage. Constraints to farmers were the high cost of conservation technologies.

Table 3: Results of the Agricultural Damage Function

Variables	Coefficients	t- Statistics
Intercept	12.83886***	16.82692
SOCINV	-0.55422**	-2.27817
FRMSIZ	-0.04403	-1.07618
INSTSUB	-0.07148*	-1.94074
OFINC	-0.03882	-1.26121
ONINC	-1.54318***	-12.1744
MANTCE	-0.19616***	-3.38582
ANULCRP	0.273196***	3.383281
PRCNTRET	-0.08067*	-1.95152
EROPOTEL	0.064047	0.984901
R Square	0.61	
Number of observation	250	

Note: P>0.01***, P>0.05**

Where,

AGRDMG	-	Aggregate damage (Rs./ha)
SOCINV	-	SWC investment expenditure (Rs/ha)
FRMSIZ	-	Farm size (ha)
INSTSUB	-	Share of subsidy total soil conservation investment (Rs/ha)
OFINC	-	Annual off-farm income (Rs/Household)
ONINC	-	Annual net farm income (Rs/ha)
MANTCE	-	Maintenances of soil conservation structures
ANULCRP	-	Area under annual crops (ha)
PRCNTRET	-	Percentage of treated area to the total farm land area
EROPOTEL	-	Erosion potential of soil (1 if High; 0 otherwise)

2.

Consumptive Use, Water Use Efficiency and Yield of Summer Groundnut *(Arachis hypogaea* L.*)* under Different Land Configurations, Irrigation Regimes and Potassium Levels

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Keywords: WUE, consumptive use, land configurations, irrigation regimes, potassium levels, yield of groundnut

Introduction

Groundnut (*Arachis hypogaea* L.) is most important money minting legumes-cum oilseed crops of India. Irrigation water is one of the most important inputs that is scarce and expensive. Mulching is useful for moderating soil temperature, conserving soil moisture and for controlling weed growth. Application of mulch not only helps in realizing higher yields, but also contributes in reducing water requirement by 40% and eliminates crop weed competition (Basu, 2008). The medium black soils in the intensive cropping area started depleting in potassium on account of long run from high to medium and to low levels. In such conditions groundnut crop may respond to potassium application. In view of this, a field experiment was conducted to evaluate the effect of land configurations, irrigation regimes and potassium levels on summer groundnut.

Materials and Methods

The field experiment was conducted in 2010-2011 and 2011- 2012 at Post Graduate Institute Farm, Mahatma Phule Agricultural University, Rahuri, India. The experiment was laid out in split - split plot design with three replications. The treatments comprised of three main plot treatments of land configurations namely flat bed, broad bed furrow (BBF) and broad bed furrow (BBF) + polythene mulch (black), three subplot treatments of irrigation regimes namely 0.6, 0.8 and 1.0 Irrigation Water/ Cumulative Pan Evaporation (IW/CPE) ratios and three sub-sub plot treatments of potassium levels of 20, 40 and 60 kg K_2O/ha and replicated thrice. The gross plot size was 5.10 x 3.60 m^2 and net plot size was 4.50 x 3.00 m^2 for flat bed and 4.50 x 2.40 m^2 for BBF and BBF + polythene mulch. Recommended dose of fertilizer (25: 50 NP kg/ha) was applied to all the treatments and K was applied as per treatments. The polythene mulch used was of 7 micron thickness. The variety used for experimentation was '*RHRG 6083'*.

Results and Discussion

The treatment combination of 1.0 IW/CPE ratio with flat bed was recorded higher consumptive use of water (732.1 mm and 728.9 mm) and lower water use efficiency (11.16 kg/ha- mm and 10.36 kg/ha- mm) in the year 2011 and 2012, respectively. It was followed by 0.8 IW/CPE ratio with flat bed. While, lower consumptive use of water (448.0 mm and 459.3 cm) and higher water use efficiency (11.16 kg/ha- mm and 10.36 kg/ha- mm) was observed in combination of 0.6 IW/CPE ratio with BBF + polythene mulch in the year 2011 and 2012, respectively. It was followed by 0.8 IW/CPE ratio with BBF + polythene mulch.

The growth and yield contributing characters, dry pod yield (4915 kg/ha) and haulm yield (9189 kg/ha) on pooled mean basis were recorded significantly higher at harvest in the broad bed furrow + polythene mulch

In respect of irrigation regimes, the growth and yield contributes*,* dry pod yield (4278 kg/ha) and haulm yield (8676 kg/ha) were recorded significantly higher on pooled mean basis in the application of irrigation at 1.0 IW/CPE ratio. However, it was at par with irrigation at 0.8 IW/CPE ratio As regards, potassium levels, growth and yield contributing characters*,* dry pod yield (4123 kg/ ha) and haulm yield (8441 kg/ha) on pooled mean basis were recorded significantly higher at application of 60 kg K_2O ha^{-1}. However, it was at par with application of 40 kg K_2O/ha (Table 1).

The irrigation at 1.0 IW/CPE ratio with broad bed furrow + polythene mulch recorded significantly higher dry pod yield (4953 kg/ha) and haulm yield (9238 kg/ha) on pooled mean basis. However, it was at par with treatment combination of broad bed furrow + polythene mulch with irrigation at 0.8 IW/ CPE and Broad bed furrow + polythene mulch with 0.6 IW/CPE ratio.

The use of BBF + polythene mulch with irrigation at 0.6 IW/CPE ratio and application of 40 kg K_2O/ha for summer groundnut is beneficial for achieving higher yield and net realization.

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Table 1: Effect of land configurations, irrigation regimes and potassium levels on growth and yield contributing characters at harvest and yield of summer groundnut

Treatment	Plant height (cm)	Number of branches plant^{-1}	Number of composite leaves plant^{-1}	Leaf area plant^{-1} (dm^2)	Spread plant^{-1} (cm)	Dry matter per plant^{-1} (g)	Test (100 kernel) weight (g)	Dry pod yield plant^{-1} (g)	Dry pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
A. Land configurations (P)										
Flat Bed	27.6	9.1	104.1	20.1	35.2	75.7	38.5	24.7	3355	7537
Broad Bed Furrow (BBF)	30.6	10.1	118.6	23.5	39.1	80.5	40.2	25.3	3809	7958
BBF + Poly mulch	36.4	12.0	134.7	26.8	42.7	96.4	43.9	28.7	4915	9189
SE (m) ±	0.79	0.49	2.03	0.39	0.68	0.31	0.56	0.24	17	34
CD at 5%	4.81	1.40	12.33	2.39	2.73	1.86	3.39	1.47	106	212
B. Irrigation regimes (I)										
0.6 IW/CPE	28.7	9.5	102.4	19.9	36.2	75.5	38.8	24.6	3559	7510
0.8 IW/CPE	32.3	10.7	125.4	24.8	40.1	86.6	41.6	26.8	4243	8497
1.0 IW/CPE	33.5	11.0	129.6	25.8	40.7	90.6	42.2	27.3	4278	8676
SE (m) ±	0.22	0.34	2.15	0.42	0.51	1.30	0.18	0.19	16	38
CD at 5%	0.74	1.06	7.43	1.44	1.77	4.02	0.61	0.64	56	134
C. Potassium (K_2O) levels (F)										
20 kg ha^{-1}	30.0	9.7	109.5	21.0	37.2	80.5	39.4	25.6	3842	7945
40 kg ha^{-1}	31.6	10.5	121.6	24.2	39.2	84.2	41.2	26.2	4115	8297
60 kg ha^{-1}	32.9	10.9	126.2	25.3	40.6	87.9	42.1	26.9	4123	8441
SE (m) ±	0.45	0.15	2.20	0.43	0.54	1.28	0.16	0.07	15	26
CD at 5%	1.35	0.45	6.43	1.27	1.58	3.80	0.45	0.21	45	75
Interaction										
P x I	Sig.	NS	NS	NS	NS	Sig.	Sig.	Sig.	Sig	Sig.
P x F/I x F/P x I x F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
General mean	31.5	10.4	119.1	23.5	39.0	84.2	40.9	26.2	4027	8228

3.

Developing Natural Resources Inventory Using LISS-IV Satellite Data for Better Land Use Planning in Kashmir Himalayas

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Keywords: Land use/land cover, LISS-IV data, natural resources, remote-sensing, Kashmir Himalayas.

Introduction

The application of remote sensing and geographical information system technology is useful for obtaining accurate multispectral and multi-temporal data for overcoming data discrepancies available in the public domain. In order to generate satellite based digital data, the natural resource mapping of the Kashmir Valley was carried out in a phased manner at the Centre for Climate Change and Mountain Agriculture, Sheri-Kashmir University of Agricultural Sciences and Technology of Kashmir, India. The study has generated information regarding various land use land cover classes namely area under agriculture, horticulture, forests, mixed plantation, built up, water resources, barren land, snow and glaciers etc**.**

Materials and Methods

In the first phase thematic maps of two districts (Budgam and Kulgam) were generated. In this study Indian Remote Sensing Satellite (IRS-P6 also known as ResoureSat-1), of which Linear Imaging Self Scanning (LISS-IV) data of November-December 2012, with a spatial resolution of 5.8 m at 1: 10,000 scale was used. In the phase of generation of the subsidiary layers Advanced Spaceborne Thermal Emission and Reflection Radiometer - Digital Elevation Model (ASTER DEM) of 30m spatial resolution was used and the thematic layers thus generated include watershed characteristic layers (drainage, contour, watershed, basin maps) and terrain characteristics layers (including slope, aspect, relief maps etc). These maps help in understanding the present status and dynamics of the available natural resources and thereby help in devising strategies for sustainable management of the resources.

Results and Discussion

The study revealed that in district Budgam, agricultural land covering an area of 38985 ha and amounting to 32.7% of the total geographical area is the dominant natural resource followed by forest cover (21.94%), snow and glacial cover (13.5%) and mixed plantation (8.4%). In district Kulgam, snow cover is the dominant class occupying an area of 35981 ha amounting to 29.9%, of the total geographic area followed by dense forests (22%), horticulture (mainly orchards) (12.1%) and agriculture (10.8%), barren/ wastelands cover (6.2%). The paper also presents the change detection studies of the concerned districts using LandSat ETM of 1999-2000. These subsidiary layers give an insight into the overall on ground scenario and thus help in developing a consensus on site specific management and planning of the natural resources and adhering to "best management practices".

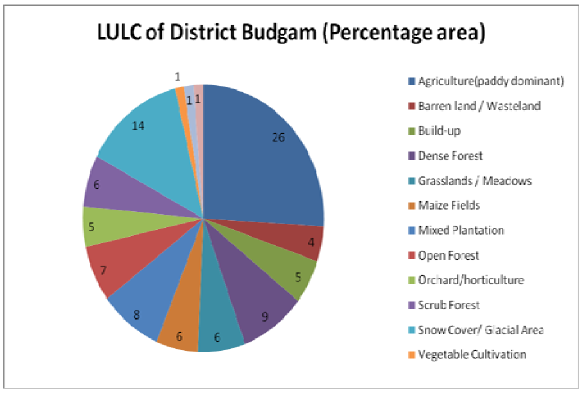

Fig. 1: LULC of District Budgam, Kashmir

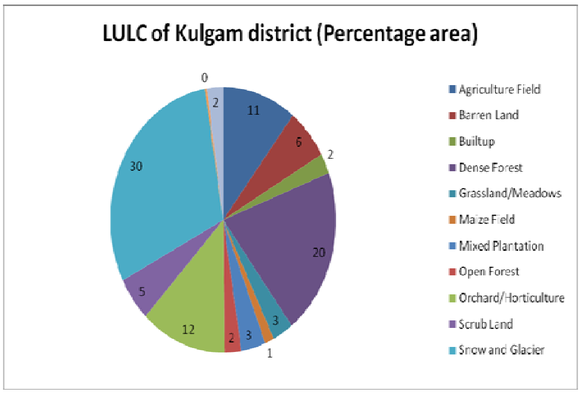

Fig. 2: LULC of District Kulgam, Kashmir

4.

Land Resource Utilization, Degradation and Policies in Mountains: Evidences from Jammu & Kashmir-India

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Keywords: Land-use, land-degradation, mountains, India

Introduction

The Jammu and Kashmir state, fallings in north-western complex of the Himalayan ranges, is characterized by various first and second order mountain specificities. The neglect of land deterioration, cost of mismanagement and the limitedness of land will be severe in such settings owing to dependence of majority on land-based activities and poor scope of secondary economic activities. Therefore, the choice of issues addressed in this study was to make a comprehensive look at the evolution of land reforms/ policies, pattern of land-use shifts, magnitude of land degradation, and determining factors for sustenance of land-based activities in the state.

Materials and Methods

This study perused the secondary information obtained from diverse sources. The land-use land-cover satellite (resourcesat) image/data (IRS P6 LISS III) generated/maintained by Directorate of Environment and Remote Sensing was examined to surmise about the land degradation and other secondary information for this study was collected from records of Revenue Department published by Directorate of Economics and Statistics, Government of Jammu & Kashmir. While the inter-sectoral budgeting technique was employed to examine the land-use shifts, regression functions (tested for estimation errors) of various structural forms were estimated to quantify the determinants of land degradation, land-use intensity and unproductive land-use.

Results and Discussion

Perusal of the satellite and revenue department data revealed that over 75 thousand sq km area was found degraded in the state. The extent of land degradation varies across districts and regions. Most of the serious form of land degradation in the state was accelerated water/wind erosion, soil loss, high run offs, depletion in quality/productivity of land-uses that are removed from land-capability optimalities. The underlying observed causes of degradation are complex web of social, economic and institutional factors. Although a number of acts/law and reform measures have been launched from time to time to improve productivity of land resources and to secure the tenurial relations. Although the land governance through the reform system in over all terms have good pay off but the various law and legislations have poor implementation in the state. The dynamics of land-use pattern, as indicated by the estimates of inter-sectoral budgeting (Table 1), revealed an unfavourable shift from desirable to undesirable ecology class which expectedly will have serious long-term ecological implications. Urban demand for land around cities has increased rapidly for non-agricultural or residential purposes. Unexpectedly the regression estimates revealed negative role of urbanization and land scarcity in improvement of agricultural intensification. On the other hand agricultural density and area under rice are significant determinants of unproductive land-use. The study emphasized on the evolution of suitable institutional mechanism, in addition to few other policy suggestions, for scientific management, and conservation of land resources in the state.

Table 1: Budgeting of inter-sectoral land-use shifts

Land-use sector	Annual rate of change ('000 ha)			
	1970-82	1983-98	1999-2011	1970-2011
Ecological sector ($\Delta E = \Delta E_1 + \Delta E_2$)	-24.0	5.0	12.0	-7.0
Desirable ecological sector (ΔE_1)	-18.2	-31.0	-9.0	-58.2
Undesirable ecological sector (ΔE_2)	-5.8	36.0	21.0	51.2
Agricultural sector (ΔA)	13.0	8.0	24.0	45.0
Non-agricultural sector (ΔN)	29.4	-14.0	-46.0	-30.6
Net sectoral change ($\Delta N + \Delta E1 + \Delta E2 + \Delta A$)	18.4	-1.0	-10.0	7.4

The first accounting identity linearly summed up the area under all land-use classes which was equal to the total reporting area, given by Equation (1): $R=Fr+P+M+N+U+W+Fc+F+C$…(1) Or also, $\Delta R= \Delta Fr+\Delta P+\Delta M+\Delta N+\Delta U+\Delta W+\Delta Fc+\Delta F+\Delta C$ … (2). Then, the total land endowment was grouped into three broad sectors, viz. (i) ecological sector (E) (ii) agricultural sector (A), & (iii) non-agricultural sector (N) which are further divided into two sub-sectors, viz. (i) the desirable ecology (E_1), and (ii) undesirable ecology (E_2) and then, the net changes within each sector were grouped as per equation (3)-(5): $\Delta E=\Delta E_1+\Delta E_2=(\Delta Fr+\Delta P+\Delta M)+(\Delta U)$…(3); $\Delta A=\Delta Fc+F+\Delta W+\Delta C$…(4); $\Delta R=\Delta E_1+E_2+\Delta A+\Delta N$…(5). where, R= Total reporting area, Fr= Area under forests, P= Area under permanent pastures, M= Area under miscellaneous tree crops, N= Area under non-agricultural uses, U= User and barren lands, W= Culturable wastelands, Fc= Current fallows, F= Fallow lands other than current fallows; and C= Net area cultivated.

5.

Mapping of Traditional Land Use Pattern of Apatani Tribes in Arunachal Pradesh, India

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Keywords: Traditional land used, Apatani, Arunachal Pradesh, sustainable livelihood, mapping, GIS

Introduction

Traditional land use usually refers to the method and technology of using land, which has been passed down for many generations. And they are normally practised around the world especially in those undergoing development. The region like the North East India, the local community adopts the traditional *jhum* cultivation, where the topography limits the practice of various system of cultivation. The traditional land use systems of Apatani tribe are recognized for their efficiency in sustainable land and resources management. The need for conservation of natural resources amongst traditional societies is an integral part of their socio-cultural belief systems. The paper dealt with documentation and mapping their system of land use for meeting their basic needs on a sustainable basis without having to destroy the nature around them.

Materials and Methods

The Apatani tribe belongs to Tibeto-Mongoloid stock and confined to the Apatani group of villages in Ziro of Lower Subansiri district in Arunachal Pradesh. Located at an altitude of 1524 to 2738 m above msl between 26°55' - 28°21' N latitude and 92°40' - 94°21'E longitude. The climate is humid sub-tropical to temperate with annual rainfall of 235 cm and temperature ranges between 30.6°C and 1.1°C. Extensive field survey and data collection was done followed by various formal and informal interviews with the locals. The satellite imagery of resources at II/LISS III data of March 2011 was used for generation of land use land cover LULC using Erdas imagines 9.2.

Results and Discussion

The study has able to document and map 6 types of land used system in the Ziro Valley of which integrated farming of wet rice cultivation with aquaculture along with finger millet *Eleusine coracana* on the ridges was found to be promising. The area of wet rice cultivation was found to be the largest followed by pine (*Pinus wallichiana*) and pine and bamboo mixed (Table 1). Moreover, recycling crop residues and use of organic wastes of the village for sustaining soil fertility was an efficient way of sustainable utilization of resources. Under their land used system the Apatani categorized the artificial forest into 3 types namely Bije, Sansung, and Morey. Bije are normally the individual bamboos *Phyllostachys spp.* plantation whereas the Sansung are mostly individual forests mostly dominated by pine trees *Pinus wallichiana* and Morey are the mixed forest. Morey's are usually classified as Uru Morey (Sub-clan forest), Hallu Morey (Clan forest), Lemba morey (Village forest), Booth morey (Community forest) etc.

The rich traditional ecological knowledge system practiced by the Apatani tribe for the maintenance of their sustainable livelihoods exemplifies their position as efficient resource managers, which has also drawn the attention of the United Nations Educational, Scientific and Cultural Organization (UNESCO) to designate the Apatani/ Ziro Valley as a World Heritage site. Community based natural resource management as found amongst the Apatanis could significantly contribute towards the integration of 'Traditional Land Use System' into biodiversity conservation and this could prove to be a very useful tool in conserving and managing the rapidly depleting biodiversity in the developing tropics while at the same time focusing on the sustainable livelihoods of these traditional developing societies, as cultural diversity in the Eastern Himalayas is a very effective method for protection of both natural resources and the cultural integrity and survival.

Table 1: Different types of land used system and their species composition.

Area name	Species composition	Area (km^2)
Plantation & horticulture	*Actinidia Spp (Kiwifruit); Amomum subulatum (Large cardemom)*	4.44
Pine plantation	*Pinus Wallichiana*	10.735
Pine & bamboo plantation	*Pinus Wallichiana, Phyllostachys bambusoides* and *Phyllostachys manii*	16.009
Agriculture land	*Oryza sativa*; *Eleusine coracana* and	61.61
Bamboo plantation	*Phyllostachys bambusoides* and *Phyllostachys manii*	4.119
Jhum land	Zea mays; *Oryza sativa*; *Solanum tuberosum* etc	2.686
Unreserved forest	*Pinus*; *Quercus*;*Magnolia*; *Rhus*; *Pyrus*; *Alnus*; *Michelia*; *Rhododendron* species etc.	171
Community forest	*Pinus*; *Quercus*;*Magnolia*; *Alnus*; *Michelia* species	19.957

6.

Production Potential of Cotton Based Intercropping System under Dryland Condition of Vidarbha Region of Maharashtra

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Keywords: Cotton, intercropping, dryland, LER, SYI

Introduction

Cotton (*Gossypium hirsutum*) is an important cash crop of Vidarbha region of Maharashtra. It is a long duration crop (150-200days duration) mainly grown under dryland condition. Generally 2 to 3 dry spells occur during growing period of cotton which affects the productivity of crop in this region. Therefore, to reduce the risk of crop failure during the *kharif* season due to the aberrant weather conditions, intercropping systems is practiced. The short and long duration legumes were tried for intercropping systems in different row proportion with cotton to know the effect of intercrops on the productivity of cotton based intercropping system.

Materials and Methods

Field experiment was conducted under dryland condition for 5 years in rainy (*kharif*) seasons from 2007-08 to 2011-12 at the Research farm of AICRP for Dryland Agriculture at Akola, Maharashtra. The experimental site was a Vertisol with clayey texture, pH of 7.8, low in soil organic carbon(0.41%) and available N(222.8 kg /ha), medium in available P(16.2 kg/ ha) and high in available K (333 kg ha^{-1}). The cultivar, spacing and fertilizer dose adopted in sole crops were: cotton - 'AKH 8828', 60 cm × 30 cm and 25: 25: 0 kg N: P_2O_5: K_2O/ha as basal dose and 25 kg N/ha as top dressing at 30 DAS; for pigeonpea(*Cajanus cajan*)-'C 11', 60 cm × 20 cm and 25:50:0 kg N: P_2O_5: K_2O/ha as basal; for soybean(*Glycine max* L)-'TAMS 38', 30 cm × 8 cm and 30: 75:0 kg N: P_2O_5: K_2O/ha. In intercropping systems, same cultivars were adopted as in sole crops. However, the spacing adopted were: in cotton + soybean (1:1), 30 cm inter-row and 30 cm and 8 cm intra-row spacing in cotton and soybean respectively; in cotton + pigeonpea, both in 4:2 and 6:2 systems - 60 cm inter-row and 30 cm and 20 cm intra-row spacing in cotton and pigeonpea respectively; and in cotton + soybean + pigeonpea + soybean (3:2:2:2) system - 45 cm inter-row and 30 cm, 8 cm and 20 cm intra-row spacing in cotton, soybean and pigeonpea, respectively. The fertilizer dose of cotton was given to all the intercropping systems. Seed cotton equivalent yield (SCEY) was determined by taking into account the actual yields (kg/ha) attained by crops along with the prices (per kg) of the crops. The land equivalent ratio (LER) is measured to assess an intercropping system for its superiority based on the yield attained under sole and intercrops in a given season (Willey, 1979).

Results and Discussion

Pooled mean of five seasons indicated significantly highest seed cotton equivalent yield (1537kg ha^{-1}) in cotton: soybean: pigeonpea: soybean (3:2:2:2) intercropping system. Treatment of sole soybean and cotton + soybean (1: 1) recorded seed cotton equivalent of 1406 and 1392kg ha^{-1} respectively which were comparable with cotton: soybean: pigeonpea: soybean (3:2:2:2) intercropping system(Table 1). Lowest seed cotton equivalent yield was recorded in sole cotton (976kg ha^{-1}).

Pooled mean of five seasons of experimentation indicated significantly highest (Rs. 48156ha^{-1}) gross monetary return in cotton: soybean: pigeonpea: soybean (3:2:2:2) intercropping system. Treatment of cotton + soybean (1: 1) intercropping system and sole soybean recorded comparable gross monetary return with cotton: soybean: pigeonpea: soybean (3:2:2:2).

Pooled data indicated significantly highest net monetary return of Rs. 29914 ha^{-1} in cotton: soybean: pigeonpea: soybean (3:2:2:2) intercropping system as compared to other treatments.

Table 1: Seed cotton equivalent yield GMR, NMR, B: C ratio, SYI and LER(Pooled)

Treatment	SCEY (kg ha^{-1})	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	B:C ratio	SYI	LER
T_1 Sole C	976	31969	14956	1.88	0.29	1.00
T_2 Sole S	1406	43777	27636	2.84	0.26	1.00
T_3 Sole P	1113	37829	24182	2.66	0.09	1.00
T_4 CSPS(3:2:2:2)	1537	48156	29914	2.71	0.49	1.29
T_5 CS (1: 1)	1392	45936	27563	2.50	0.30	1.16
T_6 CP (4: 2)	1036	34564	17462	2.02	0.16	1.05
T_7 CP (6: 2)	1116	36519	18891	2.07	0.18	1.07
S. E. (m)±	49	1627	1628	-		
C.D. at 5%	150	5015	5015	-		
C.V.%	15.48	15.83	-	-		

Pooled mean indicated maximum B: C ratio (2.84) recorded in sole soybean followed by cotton: soybean: pigeonpea: soybean (3:2:2:2) intercropping system (2.71).

Sustainable yield index indicate that intercropping system of cotton: soybean: pigeonpea: soybean (3:2:2:2) recorded 0.49 SYI which was higher than the other treatments.

Data regarding land equivalent ratio indicated that intercropping system of Cotton: soybean: pigeonpea: soybean (3:2:2:2) recorded 1.29 LER which was higher than the other treatments.

Pooled data indicated that cotton: soybean: pigeonpea: soybean (3:2:2:2) intercropping system gave significantly highest seed cotton equivalent yield of 1537kg ha^{-1}. The same system recorded highest gross and net monetary returns of Rs. 48156ha^{-1} and Rs. 29914 ha^{-1} respectively with B: C ratio of 2.71, higher sustainable yield index (0.49) and higher land equivalent ratio (1.29).

7.

Productivity of Marigold in Response to Wastewater Irrigation, Land Configuration and Nitrogen Levels

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Keywords: Irrigation, marigold productivity, nitrogen, raised bed, wastewater

Introduction

The alarming situation of limited availability of fresh water and disposal of wastewater especially in the urban and peri-urban areas has forced the researchers to think about appropriate reuse of wastewater in agricultural sector. Therefore, safe use of wastewater for irrigation in suitable crops to avoid food chain contamination while sparing the fresh water resources for other purposes is needed priority. Non-edible crops like marigold have shown the potential to be cultivated successfully using wastewater. Marigold (*Tagetes* spp.) is an important and commonly grown commercial flower crops in India. Among loose flowers, it has the potential to fetch high market price due to higher demands. In addition to this, it has also been reported as an important crop for phytoremediation of soil pollutants. Therefore, while sustaining the income of the farmer it has greater scope for using wastewater for irrigation and reducing the pollutants load of the soil. There is also need to explore appropriate production technologies like land configuration to reduce direct contact of wastewater to plants for pathological concerns and optimization of nutrient requirement for higher productivity.

Materials and Methods

An experiment was conducted to assess the impact of wastewater irrigation and nitrogen under different land configuration in marigold at IARI, New Delhi during *kharif* season 2014. The experiment consists of two sources of irrigation water (Ground water and Wastewater) and three levels of nitrogen (0, 60 and 120 kg/ha) under raised and flat bed condition with three replications in split plot design. The soil of the experimental field was sandy loam in texture with low in available N content, medium in phosphorous and high in potassium. The soil pH and EC was 7.7 and 0.62 respectively. The municipal wastewater and tube well water was used for irrigation as per treatment. The mean monthly values (October-March) of Nickel, Lead, Chromium, Manganese, Zinc, Iron, Cobalt, Copper and Cadmium of ground and waste water were 4.20, 166.2; 0.59, 17.50; 11.26, 101.6; 36.0, 471.4; 43.4,1173.6; 773.0, 21102.5; 0.48, 5.44; 6.16, 81.96 and 0.07, 0.51ppb respectively. The crop was raised through transplanting of 30 days old seedling of marigold variety 'Pusa Arpita'. Two rows of marigold were planted on each raised bed spaced at 90 cm whereas under flat bed planting row to row spacing was 45 cm. Plant to plant spacing was 45 cm in both raised and flat bed planting. A uniform dose of 75 kg/ha each of P_2O_5 and K_2O was applied before transplanting whereas nitrogen was applied as per treatments in two equal split half at first week and remaining half at 45 days after transplanting.

Results and Discussion

Irrigation with wastewater produced significantly higher flower yield (13.2 t/ha) than that of ground water (12.7 t/ha). Though irrigation with waste water recorded higher plant height, total branches, flower diameter and weight over freshwater irrigation but the differences were statistically non significant. Irrigation with 100% domestic wastewater recorded comparable dry matter production and flower yield to that of normal water in marigold (Jagathjothi and Amanullah 2015). Raised bed planting also produced significantly higher flower yield (13.3 t/ha) as compared to flat bed planting. The growth of marigold in terms of plant height and branching influenced significantly with the application of nitrogen. Application of 120 kg N/ha produced taller plants than that of lower dose of nitrogen. Similarly, 120 kg N/ha resulted in 62 and 30% higher number of branches over control and 60 kg N/ha respectively. Yield attributes like flower diameter and weight were also increased significantly by 16 and 14% respectively with the application of 120 kg N/ha as compared to 60 kg N/ha. Due to significant improvement in growth and yield attributes, higher dose of nitrogen (120 kg N/ha) resulted 118.8 and 25.5% increase in flower yield over control and 60 kg N/ha, respectively. Maharnor *et al.* (2011) have also reported that plant height, number of branches, spread of plant and flower yield of marigold increased with increasing levels of nitrogen upto 150 kg/ha.

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Table 1: Effect of waste water irrigation, land configuration and nitrogen levels on growth and yield of marigold

Treatment	Plant height at first picking (cm)	Plant height at last picking (cm)	Total branches	Flower diameter (cm)	Flower weight (g)	Flower yield (t/ha)
Source of irrigation						
Waste water	76.1	94.9	21.2	5.1	3.08	13.2
Ground water	74.8	92.0	20.3	4.9	2.91	12.7
CD (P=0.05)	NS	NS	NS	NS	NS	0.40
Land configuration						
Raised bed	76.8	93.7	21.4	5.0	3.11	13.3
Flat bed	74.0	93.2	20.2	4.9	2.88	12.6
CD (P=0.05)	2.70	NS	0.96	NS	NS	0.40
Nitrogen levels						
0 kg N/ha (Control)	67.9	80.9	16.0	4.30	2.58	7.9
60 kg N/ha	74.9	92.2	20.2	4.90	2.99	13.7
120 kg N/ha	83.6	107.3	26.2	5.70	3.41	17.2
CD (P=0.05)	2.75	5.34	1.78	0.28	0.27	0.90

8.

Factors Affecting the Productivity of Rapeseed Mustard in Sub-Tropics of Jammu

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Introduction

Among the nine edible oilseed crops in India, rapeseed mustard possesses a significant position. Rapeseed mustard group mainly consists of toria *(brassica rapa)*, raya *(brassica juncea)* and gobhi sarson *(brassica napus)*. In India, it contributes nearly 80% of the total *rabi* oilseed production. Area under rapeseed mustard is 6.3 million ha with a production of 7.4 metric tonnes and productivity of 11.76 q/ha (Directorate of Rapeseed Mustard Research, 2013). In terms of rapeseed mustard productivity, global ranking of India is 28th (Bhardwaj, 2013). There is variation in the production and productivity of rapeseed mustard in different states. The productivity of rapeseed mustard in J&K is 6.98 q/ha (Department of Agriculture, 2013), which is far less than the national average. In the Jammu region rapeseed mustard is mainly cultivated in rain fed areas. In rain fed areas, Toria crop is the main cultivated oil seed crop followed by gobhi sarson and raya. A study was undertaken to ascertain the input use and factors affecting the productivity of rapeseed mustard crop in the sub-tropics of Jammu region.

Materials and Methods

Samba and Kathua districts were selected purposively because of maximum subtropical area under rapeseed mustard in these two districts. A list of rapeseed mustard growers was obtained from the state Department of Agriculture. Out of the available list of 656 mustard growers, 120 mustard growers were selected randomly by using random number generator. The data was collected with pretested interview schedule consisting of both open and close ended questions. The collected data of 119 respondents was analyzed using SPSS software and other appropriate statistical tools as one of the farmer had not grown any of the rapeseed crop though was in the provided list.

Results and Discussion

It has been envisaged from the study that total area of the sampled farmers was 169.25 ha, out of which 68.38% was rainfed. Rapeseed mustard crops were cultivated on 33.25 ha (19.65%) of the total area. Out of the total area under rapeseed mustard cultivation, 84.51% (28.10 ha) is rainfed. Area under toria, raya and gobi sarson cultivation was 23.71 (71.31%), 3.40 (10.22%) & 6.14 (18.47%) ha, respectively. The finding of the study revealed that farmers grow mustard in unirrigated areas, use their own seed and majority of them not using recommended seed rate. The variation from the recommended dose was observed in the application of Urea & DAP. However none of the farmers had applied MOP. Analysis of data further revealed, that age have non-significant relation with the cultivation of toria, raya and gobhi sarson. This is also supported by the study conducted by Asiwal *et al.* (2012) in Sikar district of Rajasthan. In case of raya, number of family members associated with farmer in farming has significant correlation with cultivation of raya. In case of gobhi sarson, education and irrigated land holding has significant correlation with its cultivation.

Model	Toria yield				Gobi Sarson yield				Raya Yield			
	B	Std. Error	t value	Sig.	B	Std. Error	t value	Sig.	B	Std. Error	t value	Sig.
(Constant)	3.851	0.925	4.162	0.000	7.056	2.620	2.694	0.012	4.406	2.667	1.652	0.150
Seed rate	0.138	0.086	1.599	0.113	-0.230	0.318	-0.722	0.477	0.228	0.155	1.475	0.196
Date of sowing	0.529	0.458	1.154	0.251	0.133	0.751	0.177	0.861	-1.730	1.073	-1.612	0.158
Urea 1st topdressing	-0.012	0.014	-0.901	0.370	-0.067	0.040	-1.669	0.107	-0.013	0.028	-04.6	0.699
Urea 2nd topdressing	-0.033	0.030	-1.117	0.267	0.009	0.073	0.125	0.902	-	-	-	-
DAP	0.015	0.006	2.349	0.021*	0.083	0.023	3.570	0.001*	0.104	0.042	2.459	0.049*

The results further revealed that production variables namely application of DAP is significantly affecting the productivity of all three rapeseed mustard crops under study namely toria, raya and gobi sarson. Rest of the selected production factors namely application of urea, seed rate & sowing time were not significantly affecting the productivity of toria raya and gobi sarson.

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9.

Relevance of Soil Health Indicators for Assessing Degraded Lands and Their Management for Sustainable Crop Productivity

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Keywords: Visual indicators, physical indicators, chemical indicators, biological, indicators degraded land.

Introduction

Soil degradation leads to losing of soil functions to produce goods of value to humans and is becoming serious threats worldwide. It has been observed that soil health is rapidly deteriorating due to increasing water and wind erosion, acidity, salinity, alkalinity, water logging, fast depletion and contamination of ground water, desertification, imbalance application of nutrients and pesticides, declining rate of organic matter and beneficial soil microbes, faulty practices of irrigation and water management, intensive farming practice particularly with wheat and rice. Excess use of fertilizer application resulted in leaching of nitrates into the ground water and its contamination with nitrates has increased drastically apart from rendering the cultivable lands sick. Consequently, soil health is becoming downgraded. If such degradation is not countered, it may hamper the sustainability of soil fertility and productivity of different crops in the long run.

Materials and Methods

Several methods of soil health evaluations have been developed such as soil card design and test kits (Ditzler and Tugel, 2002), visual soil assessment (Mueller *et al.* 2009), and soil quality index methods (Doran & Jones, 1996). The indicators which are visual, physical, chemical and biological are typically based on farmers' practical experience and knowledge of local natural resources. The soil health card contains these indicators that are affected by land management and can be used to assess the current status of health and quality of soils.

Results and Discussion

The four indicators *viz.,* visual indicators, physical indicators, chemical indicators and biological indicators are found to be highly useful to assess the extent of degradation of land due to various reasons (Box 1). On the basis of low, medium and high ranges of vegetation, exposure of sub soil, changes in colour, flooding, erosion induced fertility changes, extent of soil strength, soil structure, soil texture, infiltration rate, soil depth, water holding capacity, soil pH, electrical conductivity, soil organic matter, cation exchange capacity, plant available nutrients, contaminants, and some other biological properties such as microbial biomass, soil respiration and potential mineralizable N a soil can be assessed. Accordingly their reclamation and management strategies can be decided by adopting scientific approach in terms of checking erosion, enhancing water conservation, amending problematic soil by suitable dose of gypsum, pyrites and lime, more use of organics, balanced application of nutrients as per the crop requirement so that their soil fertility and productivity can be improved

Box 1: Soil health Indicators and related process they impact.

Visual Indicators

- Topsoil depth: Rooting volume for crop production, water and nutrient availability
- Salinity: Water infiltration, crop growth and soil structure
- Soil surface: Erosion, crusting, sealing and infiltration

Physical Indicators

- Soil texture: Indicates how well water and chemicals are retained and transported
- Aggregation: Soil structure, erosion resistance, crop emergence and infiltration.
- Soil depth and rooting. Indicates productivity potential.
- Infiltration and bulk density: Describe potential for leaching productivity and erosion.
- Water holding capacity: Describe water retention.

Chemical Indicators

- Soil pH: Define chemical and biological activity threshold.
- Electrical Conductivity. Define plant and microbial activity threshold
- Soil organic Matter: Define soil fertility and stability.
- Extractable N, P and K: Describe plant available nutrients.

Biological Indicators

- Microbial biomass: Describe microbial potential and respiratory for carbon and nitrogen.
- Soil respiration: Define a level of microbial activity and provide an estimate of biomass activity.
- Potential mineralization N: Describe soil productivity and N supplying potential.

Source: Doran, J.W., Sarrantonio, M. and Leibig, M. A. 1996.

and sustained in a long run. Developing countries are degrading their lands rapidly and destroying ecosystems as compared to their counterpart. In view of above, soil health was concluded to be an appropriate concept for the poly-function approach necessary for soil assessment. Currently, soil resource assessment and monitoring is entering a new era, in terms of quality of information produced by use of state-of-art geographic information system and remote sensing technologies and will significantly improving the acceptance and use soil health information.

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10.

Brick Kiln Industry: Boon or Bane to Farming Community

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Keywords: Brick kiln, soil, health and cropping pattern

Introduction

Farming in India is highly risky venture as it depends upon climatic conditions, soil health, seed, fertilizer and insect pest management. Majority of population of Jammu and Kashmir depends on agriculture and it provides more than 70% employment. Today's farmers are undergoing transition phase. Continuous efforts of governments to uplift the living and economic status of farmers does not seems to be fruitful. Farmers are now giving up the traditional farming because it is not providing high returns comparatively to other non farming enterprises. There is a steep shift in demand of bricks for building the infrastructure, buildings, and others. There is immense scope of growth and is a profit making venture with result a large number of brick kilns are being set up by industrialists in Jammu, Kathua and samba districts of Jammu province of the state. The soils is the major raw material for making bricks besides water and fuel wood. The pollutant produced by kilns adversely affected the soil, water, crops and health of people residing in the vicinity of these kilns.

Materials and Methods

The present study was undertaken in the three blocks namely Bhalwal, Marh and Bishnah of district Jammu purposely as these blocks have higher number of brick kilns. In each of selected block 4 villages were purposely selected which are located in the close vicinity of brick kilns. In each of the selected village 10 farmers were selected randomly thus farming a sample of 120 respondents. Each respondent was interviewed with pretested schedule and the data was compiled and analysis was done with the help of statistical tools.

Results and Discussion

The results in Table 1 indicated that majority (65%) of the respondents were unaware of the adverse effect of removal of top layer of soil for making bricks. Eighty three percent of the respondent prefers to lease out their land for a fixed period. Forty eight percent had changed the cropping pattern and 22% of respondents left farming. About 15% of the respondents were found affected with respiratory diseases caused by dust and smoke emitted by chimneys of kilns. It has been observed that there is significant effect on the economic status of farmers in short term gain basis but in long term basis it has disastrous effect on human as well as on soil health.

Table 1: Farmers' perception on the adverse effect of Brick Kilns (N=120)

Statement	Agree (%)	Disagree (%)
Affect of removal of top layer of soil	35	65
Selling/ leasing of land to brick kiln	83	17
Changing cropping pattern due to kiln	48	52
Respiratory diseases caused by dust and smoke emitted by chimneys of kilns	15	85
Left out the farming	22	78

11.

Sustainable Utilization of Degraded Sloping Lands through Diversified Farming System in Shivalik Himalaya

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Keywords: Agroforestry system, resource conservation, sloping lands

Introduction

Himalayas, being one of the youngest, highly complex, fragile and diverse mountain ecosystems of the world are vulnerable to biological and physical disturbances induced by human beings. Ecological security of these Himalayan ecosystems is crucial for the livelihood of people living in this region. The degradation of these Himalayas was probably due to increasing demand of food and consequently adoption of faulty agricultural practices and excessive deforestation in the region. Flash floods, high runoff and soil erosion are consequences of such practices in past which had led to degradation of lands and hence decreased production. The need of the hour is to develop land use technologies which fulfil the demand for livelihood security and simultaneously address to the environmental concerns.

Materials and Methods

With the objectives of utilizing degraded sloping land, diversified crop production and resource conservation a land use system was developed in experimental farm of Indian Institute of Soil and Water Conservation at Mansadevi, district Panchkula. One hectare land having slope varying from 12 to 15% was selected in 2010-11. Aonla (*Embilica officinalis*) and Dake *(Melia composite)* were planted on the upper one third part with Bhabbar (*Euliopsis binata*) grass. In middle portion on outer edge of the terraces subabool (*Leucaena leucocephala*) was planted in a liner row as hedge and guava (*Psidium guavagava*) was planted in the interspaces of subabool. At lower end, a farm pond was dug to collect the runoff generated through the system. Agriculture crops were grown on the terraces. Runoff and soil loss were measured during rainy season.

Results and Discussion

The farming system developed for sloping land of Shivalik region was capable of producing fodder, fuel, timber, fruit and food from the same land use unit. The products obtained from the system was distributed throughout the year thus resulted in sustainable income (Fig. 1). Water harvested in pond during the rainy season was recycled for supplemental irrigation thus increasing the cropping intensity to 200 per cent. Since Shivalik region has bouldry soil hence lining of pond improved the water availability even during April-May. The water in the pond was also used for cultivation of the fish. The increased vegetation conserved runoff and soil loss from the system over years. The system so developed clearly show that at every quarter, the farmer can reap the benefit from one component or the other component of the land use system and simultaneously reduce the runoff and soil loss.

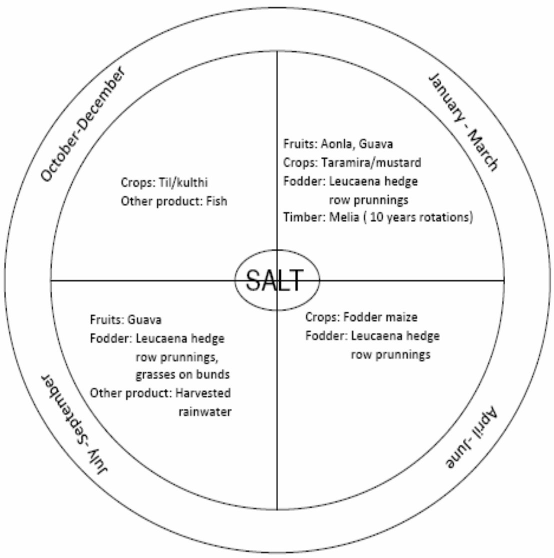

Fig. 1: Multiple output from SALT model distributed throughout the year

12.

Role of Aquatic Insects in Studying the Bio-Monitoring of Lakes and Streams in Kashmir Himalaya

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Keywords: Biomonitoring, Dal Lake, ephemeroptera, plecoptera, trichoptera, Wullar Lake

Introduction

The freshwater ecosystems are being subjected to increased level of human disturbances throughout the world. An assessment of the status of inland water ecosystem shows that globally most threatened aquatic ecosystems are to be found in Indian subcontinent. For assessing the freshwater deterioration the aquatic insects could be easily exploited for determining the changing water quality conditions in lotic as well as in lentic aquatic ecosystems.

Materials and Methods

This study was conducted in two freshwater lakes of Kashmir Valley namely Wullar Lake and Dal Lake. Sampling of different aquatic organisms was done on monthly basis (5 times in a month) throughout the year from 2014-15. The aquatic organisms were collected with the help of kick nets, dip nets or triangular nets. The samples were killed and preserved in 70% ethanol, labeled and placed in the insect vials specially designed for the above mentioned purpose and were placed in the laboratory of Research and Training Centre for Pollinators, Pollinizers and Pollination Management, SKUAST-Kashmir. The samples were identified upto the family, genus or species level with the help of the dichotomous keys.

Results and Discussion

EPT families found in Dal lake (2014-15): The most abundant family so far recorded was Chironomidae (Diptera) followed by Hydropsychidae (Trichoptera) and Baetidae (Ephemeroptera) [Table 1]. The over abundance of the family chironomidae shows the highest pollution influx in this lake because of anthropogenic activities.

EPT families found in Wullar Lake (2014-15): The most abundant family so far reported was (Ephemerellidae (Ephemeroptera), Baetidae (Ephemeroptera) and Hydropsychidae (Trichoptera) [Table 2]. The least abundance of the family Chironomidae shows less inflow of pollutants in this lake.

Table 1: EPT families found in Dal Lake (DL= Dal Lake)

Order	Family	Study site				
		DL1	DL2	DL3	DL4	DL5
Ephemeroptera	Baetidae	53	47	33	31	20
	Caenidae	21	13	11	07	02
	Ephemeridae	08	03	01	0	0
Trichoptera	Hydropsychidae	73	42	19	13	08
	Philopotamidae	28	23	18	16	13
Plecoptera	Perlidae	03	01	0	0	0
Diptera	Chironomidae	83	71	65	53	46

Table 2: EPT families found in Wullar Lake (WL=Wullar lake)

Order	Family	Study site				
		WL1	WL2	WL3	WL4	WL5
Ephemeroptera	Baetidae	73	61	52	41	32
	Caenidae	43	37	23	19	08
	Ephemeridae	28	27	21	17	16
	Ephemerellidae	83	42	19	13	08
Trichoptera	Hydropsychidae	61	52	43	19	06
	Philopotamidae	52	43	17	0	0
	Leptoceridae	17	14	09	06	0
	Rhyacophilidae	08	03	0	0	0
Plecoptera	Perlidae	08	0	0	0	0
Diptera	Chironomidae	07	02	0	0	0

13.

Waterlogged Wasteland Treatment through Agroforestry

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Keywords: Waterlogged area, transpiration rate, Eucalypt, ground water table

Introduction

India covers 147.75 million ha area under different soil degradation classes explained by National Bureau of Soil Survey and Land Use Planning (NBSS & LUP). Under these categories salt-affected soils spreads in 6.73 million ha area and waterlogged in 6.41 million ha area (including 1.66 million ha surface ponding and 4.75 million ha subsurface waterlogging). The reclamation processes includes biological, chemical and mechanical measures. The short rotation, fast growing tree based agroforestry systems showed potential in bio-drainage treatment to prevent water logging.

Materials and Methods

Data on plant species used in agroforestry systems of India and their potential transpiration rate is collected from the scientific papers published in reputed journals (Agroforestry Systems, Current Science, Tropical Ecology, Indian Journal of Ecology, Indian Journal of Agroforestry, The Indian Forester etc.) and technical reports/bulletins of research institutes. On the basis of collected data this manuscript is formed for showing further views in research in such areas.

Results and Discussion

Bio-drainage: It may be defined as “pumping of excess soil water by deep-rooted plants using their bio-energy”. The deep tree roots reached up to excess soil water and can pump out it easily without deteriorating the soil environment (Fig. 1). It uses the transpirative capacity of vegetation and especially trees to reduce elevated ground water table of an area. Short rotation fast growing (SRFG) tree species such as *Eucalyptus* spp, *Casuarina* spp, *Terminalia arjuna*, *Pongamia pinnata* and *Syzygium cuminii* are used in bio-drainage treatment in waterlogged area of the country (Pandey *et al.,* 2015). Other tree species used in bio-drainage treatment are given in Table 1. The use of bio-drainage treatment is depends on ground water Electrical Conductivity, transpiration rate, soil salinity/alkalinity and climatic conditions.

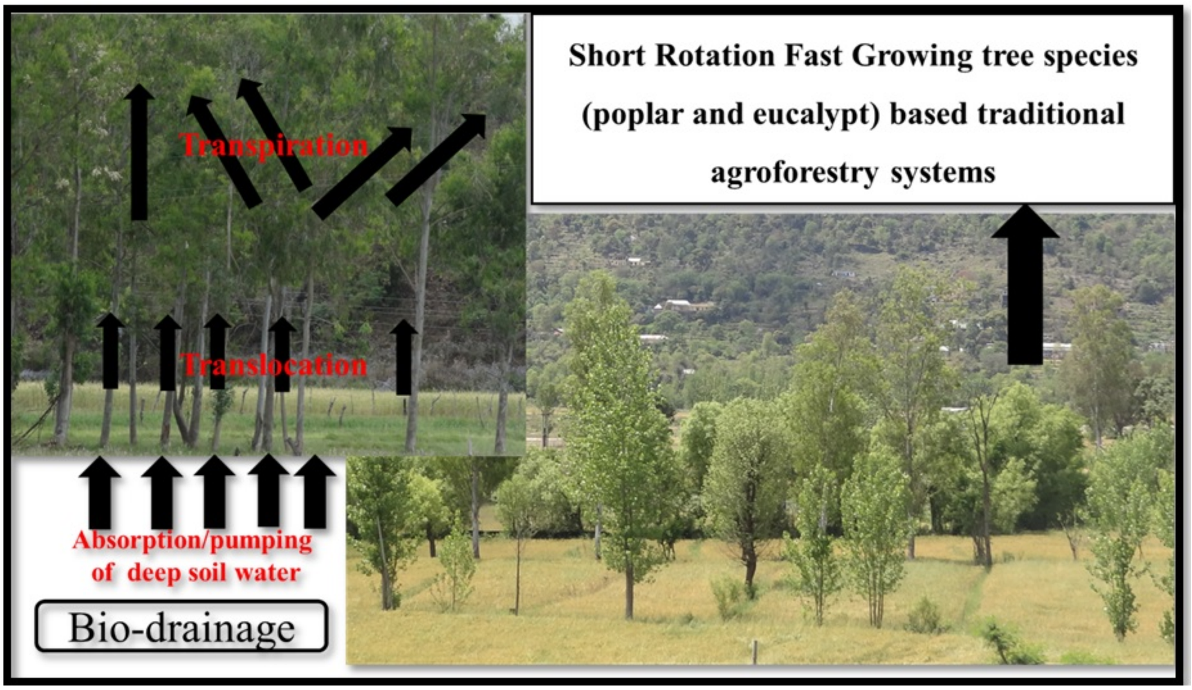

Fig. 1: Bio-drainage concept with an example of agroforestry system.

Ram *et al.* (2011) reported 0.84- 0.86 m total drawdown of groundwater in 3 years of April 2006, 2007 and 2008 under *Eucalyptus tereticornis* + wheat (clone C-7) in fields of Haryana (northwest India), where 10% area (0.44 m ha) is waterlogged resulting in reduced crop yields and abandonment of agricultural lands.

Table 1: Tree species used for bio-drainage treatment in India

Tree species	Tree Family	Rate of transpiration (gm/leaf/hrs)
Acacia tortilis, A. nilotica, A. farnesiana	Mimosoideae	2.63 m mol. m^{-2} s^{-1}
Albizia procera (Roxb.) Benth	Mimosoideae	
Azadirechta indica	Meliaceae	2.88±0.2
Butea monosperma	Fabaceae	
Callistemon lanceolatus	Myrtaceae	
Casuarina spp. (*C. gluaca, C. equisaetifolia, C. obesa*)	Casuarinaceae	
Dalbergia sissoo	Fabaceae	2.67-3.28 m mol. m^{-2} s^{-1}
Eucalyptus spp. (*E. tereticonris, E. calamdulensis; E. hybrid*)	Myrtaceae	2.72-3.06 m mol. m^{-2} s^{-1}
Grevillea spp.	Protaceae	
Melia azedarach	Meliaceae	
Morus alba		
Parkinsonia aculeata	Caesalpinioideae	
Pithecellobium dulce	Mimosoideae	
Pongamia pinnata	Fabaceae	
Populus spp.	Salicaceae	13 - 200 gpd/tree
Prosopis juliflora, P. cineraria,	Mimosoideae	
Salix babylonica, S. monosperma, S. xuchonensis	Salicaceae	10 - 50 gpd/tree
Salvadora persica, S. oleoides	Salvadoraceae	
Syzygium cuminii	Myrtaceae	
Tamarix aphylla; T. troupii, T. articulata	Tamaricaceae	
Terminalia arjuna,	Combretaceae	
Bamboos (*Bambusa cacharensis* R. Majumder (Betua), *B. vulgaris* Schrad. ex Wendl. (Jai borua) and *B. balcooa* Roxb. (Sil borua).	Bambusoideae	2.58 m mol. m^{-2} s^{-1}
Phragmites australis	Poaceae	
Cynodon dactylon	Poaceae	4.5 - 14.1 mm/day
Sorghum bicolor	Poaceae	2.0 - 9.8 mm/day
Trifolium sp.	Fabaceae	4.5 - 9.9 mm/day
Typha spp.	Typhaceae	8.5 - 28.2

The factors such as, soil salinity, soil bio-physico-chemical properties, ground water salinity, plant growth rate, plant rate of respiration and leaf area of plant; tree-crop combinations in such areas should be taken in to consideration for bio-drainage treatment. Further recommendation includes, identify waterlogged areas and classify, identify tolerant tree, crop and grass/herb species and Eco-physiological research for individual plant species.

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14.

MLR Based Statistical Downscaling of Temperature and Precipitation in Lidder Basin Region of India

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Keywords: Climate change, statistical downscaling, multiple linear regression, future prediction.

Introduction

In the present study, the multiple linear regression technique was employed to relate the predictors of Global Circulation Model namely the CGCM3 (Canadian Centre for Climate Modelling and Analysis) with the predictands such as the locally observed monthly precipitation and temperature at Pahalgam meteorological station located in the Lidder river basin. The predictors as obtained from CGCM3 are mean sea level pressure (mslpas), mean air temperature at 2m (Tempas), Relative Humidity, Short wave radiation, meridonial velocity and zonal velocity. The relationships so developed were used to predict the future climate at the end of 21st century, in the form of monthly projections for precipitation and minimum and maximum temperatures.

Materials and Methods

The study was conducted in the Lidder river basin region of district Anantnag of Kashmir province. The Lidder Valley has been carved out by the river Lidder, a right bank tributary of the river Jhelum (Fig. 1.). It has a catchment area of 1159.38 km^2 which constitute about 10% of the total catchment area of the river Jhelum (Bhat *et al.,* 2007).

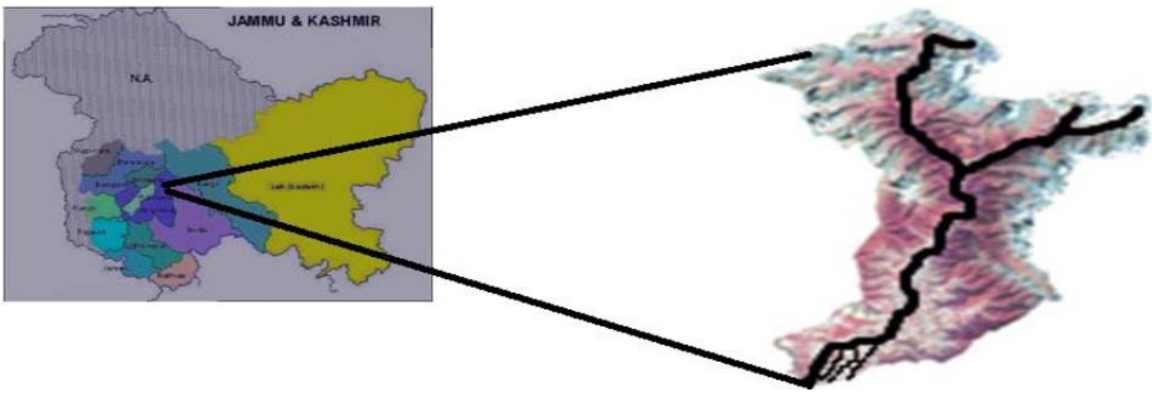

Fig. 1: Lidder basin

The association of three or more variables may be represented by the multiplelinear regression and correlation analysis. The multiple-regression relation may be expressed in the form of Eq. (1),

$x_1 = f(x_2, x_3, x_4 \ldots x_m)$ .... (1)

Where, $x_1, x_2, x_3, x_4, \ldots, x_m$ are m variables. This equation gives the estimate of x_1 for given values of all other variables. If Eq. (1) is linear, the regression is referred to as multiple linear regression and the association is multiple linear correlation.

The daily precipitation and temperature data at Pahalgam meteorological station of Lidderbasin for the period 1978-2014 were obtained from India Meteorological Department (IMD) Srinagar. The above mentioned predictor data for Global Circulation model CGCM3was obtained for the year 1961-2100. For multiple linear regression (MLR) analysis, the predictand data set for the period 1978 -2010 was used for calibration and that of 2011-2014 was used for validation purposes. Sensitivity analysis was carried out to find the predictor-predictand relationships.Ninedeseasonalized predictors and three deseasonalizedpredictands (monthly maximum and minimum temperatures, precipitation) were used to investigate correlation coefficients among predictors and to evaluate their predictive ability when used in a multiple linear regression (MLR) downscaling model. Based upon the value of coefficient of determination, air temperature, relative humidity, meridonialvelocity and zonal velocity at different levels were important explainable predictors for the daily maximum and minimum temperatures while as mean sea level pressure (Mslpas), tempas (mean air temp at 2m), relative humidity and short wave radiation were explanatory predictors for precipitation. The relationship of maximum and minimum temperature, precipitation with the appropriate predictors was expressed by regression equations in the form of Eq. (2),

$y = a_1X_1 + a_2X_2 + a_3X_3 + \ldots + a_n X_n$ .... (2)

Where, y= Predictands (Local station Max.Temp, Min. Temp. and Precipitation), and $X_1, X_2, X_3 \ldots X_n$ are different GCM predictors.

Results and Discussion

The 100 year annual projections of local weather parameters (precipitation, maximum temperature and minimum temperature) at Pahalgam are shown in Fig. (2). The annual precipitation, average annual maximum and minimum temperature showed an increase of 18.07%, 0.62°C and 0.76°C respectively during the course of 21st century which is shown in Table 1 and Fig. 2.

Table 1: Variation of annual weather parameters at Pahalgam station of Lidder river basin during 21st century

GCM Model	Change in Precipitation %	Maximum Temperature Change (°C)	Minimum Temperature Change (°C)
CGCM3	+ 18.07	+ 0.62	+ 0.76

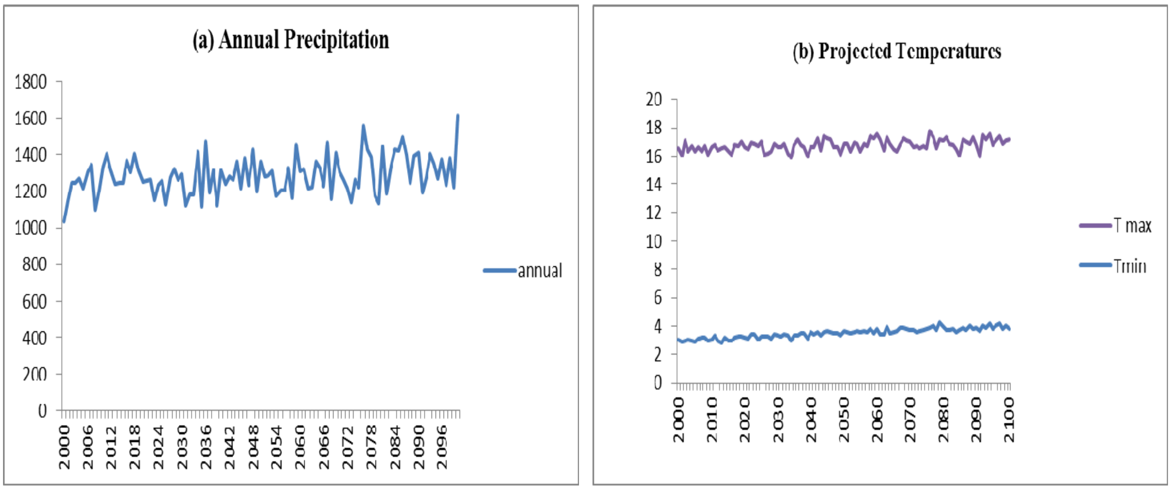

Fig. 2: Variation of (a) total annual precipitation (b) average annual maximum temperature (Tmax) and average annual minimum temperature (Tmin) of Lidder river basin during 21st century.

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15.

The Impact of Climate Change on Seasonal Floods of a Kashmir River Jhelum in Kashmir J&K

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Keywords: Hydraulic regimes of rivers, hydro power capacity, ecological economic values of rivers, use and non use values

Introduction

The Himalayas have more different scenario of this natural resource owing to its natural setting. Water, either in glacial form or in springs/ river form reflects the nature's ultimate beauty in Kashmir. Kashmir valley is an adventurous destination of J&K state. Apart from irrigating the agricultural fields, the river has an enormous (hydro) power generating potential. Drinking water, drainage, water transport and sand extraction are the other common use values of this river benefiting directly the inhabitants of the Jhelum basin. Climate change has contributed to a rise in extreme weather events - including higher-intensity hurricanes and heavier rainfalls across the country. This paper focuses on rain-generated floods that occur in the summer. The impact of climate change on summer floods is a more complex issue as the increase of extreme precipitation-snowfall events is potentially counterbalanced by a thinner snowpack and a reduction of ice-jams due to the warmer winter climate. As rains become heavier, streams, rivers, and lakes can overflow, increasing the risk of water-borne pathogens flowing into drinking water sources. Downpours can also damage critical infrastructure like sewer and solid waste systems, triggering sewage overflows that can spread into local waters.

Materials and Methods

The Study was based on both primary and secondary data. The primary data was collected from sample respondents living with in and around the river (beneficiaries of the River) and secondary data was collected Indian metrological department Srinagar. The study was designed and initiated by well-designed pretesting of questionnaires.

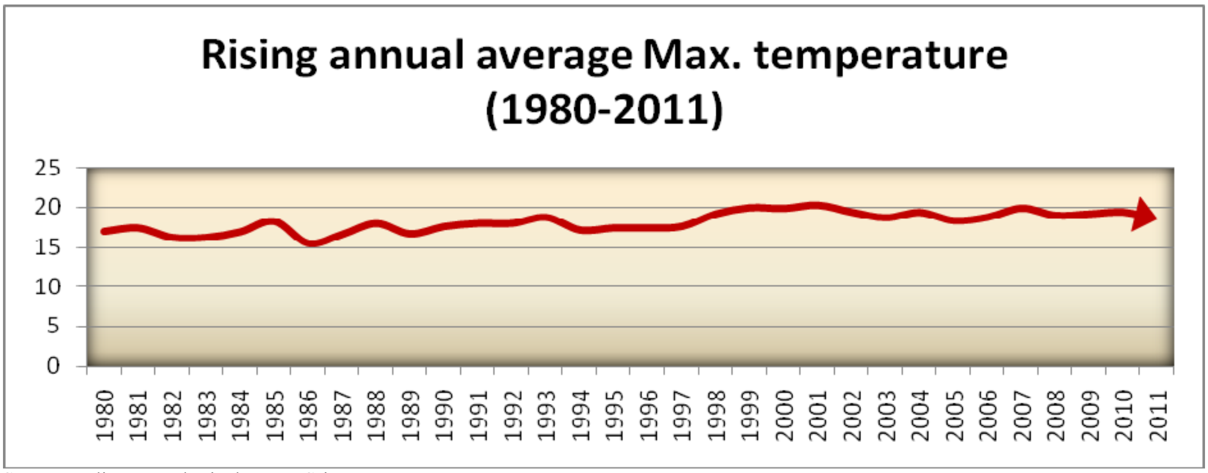
Results and Discussion

Climate change will increase the frequency of heavy rainstorms, putting many communities at risk for devastation from floods. Flooding can cause a range of health impacts and risks, including: death and injury, contaminated drinking water, hazardous material spills, increased populations of disease-carrying insects and rodents, moldy houses, and community disruption and displacement. A measure of the extent and severity of the September 2014 storms can be seen in the number Years from 1980-92, 1993-2004 and 2005-2015 these are twelve yearly averages in rise in temperature, maximum recorded. The stormy weather continued into September 2014 with a major rainfall in September 2014 continued for 4-5 days, which caused widespread damage and flooding in southern entire Kashmir valley of Jammu and Kashmir. This continuous sequence of rise in temperature and rain events led to increasing saturation of the ground so that widespread flooding became inevitable.

Table 1:

Year	1980-1992	1993-2004	2005-2015
Twelve Yearly Averages	17.14442	18.7968	19.05343

Source: Metrological Deptt Srinagar



Source: Indian metrological Deptt. Srinagar

16.

Variation in the Surface and Hardpan Levels of Wet Rice Fields

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Keywords: Puddling, surface level, hardpan level, dumpy level

Introduction

Rice (*Oryza sativa L.*) is one of the most important cereal crops and provides food for almost half of the world population. One of the causes which contribute to low productivity of rice is uncontrolled puddling, i.e. without control over the depth of puddling, and non uniformity of surface and hardpan levels. In view of eliminating all these problems and to conserve water, a study was undertaken by the Department of Farm Machinery, Tamil Nadu Agricultural University, Coimbatore to measure the variation in the surface and hardpan levels of the wet rice fields in Coimbatore.

Materials and Methods

Surface and subsurface levels were measured by using dumpy level. The maximum differences in the surface and hardpan levels were measured and plotted in SURFER 7 software. The areas of 1, 2, 3, 4 and 5 fields are 100 m^2 (10 X 10), 120 m^2 (10 X 12), 140 m^2(10 X 14), 320 m^2 (20 X 16), 484 m^2 (22 X 22) respectively. The field was marked for 2 X 2 m plots, by using bamboo pegs. The readings were taken for each 2m interval by keeping the staff at surface (surface reading), and by sinking the staff into the puddle field manually (hardpan reading). Distinctively such hardpans have higher penetration resistance of 150 k Pa (Ramachandran and Jesudas, 2013).

Results and Discussion

It was observed that there is a gradual change in the level of the field from one end to another end. This may be because, absence of reference point while leveling the field and it followed the implement movement in the field. The movement of the implement has a great effect on the contour profiles of the experimental plots. The mean surface, hardpan levels and depth of puddling values are given in Table 1. The maximum difference in the levels of the surface and subsurface plots were observed as 0.39m, 0.39m 0.27m, 0.43m, 0.48m and 0.42m, 0.45m, 0.17m, 0.42m, 0.45m for 1, 2, 3, 4, 5 field plots. It was clear that the depth of puddling varies in the range of 8.2 cm to 21 cm at 95% confidence interval. The observed value of depth of puddling is varying much from the mean value, hence it was concluded that the depth of puddling has to be controlled for better crop performance and machinery operation. The observed layout of the rice field is shown in Fig. 1

Table 1: Variation in surface and subsurface of the conventionally puddled rice fields (All dimensions are in m)

Field No.	Surface level (m)		Subsurface level (m)		Depth of puddling (m)	
	Mean (μ)	Standard deviation (σ)	Mean (μ)	Standard deviation (σ)	Mean (μ)	Standard deviation (σ)
1	1.507	0.105	1.647	0.141	0.140	0.053
2	1.064	0.055	1.274	0.057	0.210	0.069
3	1.562	0.185	1.644	0.195	0.082	0.041
4	2.650	0.268	2.848	0.244	0.198	0.129
5	1.787	0.031	1.963	0.043	0.176	0.048

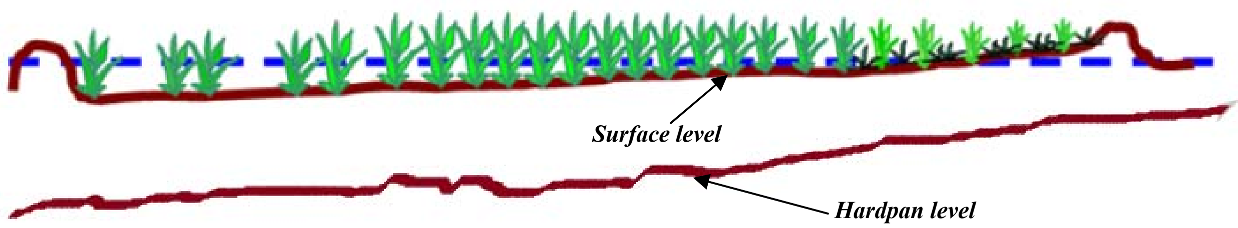

Fig. 1: Observed layout of the field

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17.

Development of Water Resources through Rejuvenating Rivulets to Mitigate the Drought Conditions in Rainfed Agriculture

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Keywords: Rivulets, ground water, storage, gravity yield, hydraulic drop

Introduction

Excess runoff harvested in the farm pond and check dams recharges existing wells. Further, with conserved water applied through micro-irrigation systems such as drip and sprinkler irrigation, it will be possible to double the area of protective irrigation. Experiences elsewhere suggest that scientific approach for *in-situ* conservation and harvesting of rainwater provide substantial benefits by not only facilitating lifesaving irrigation at critical periods and creating opportunities for second sowing but also by ensuring effective management of assets created. In view of above by considering the geological formations and non-availability of the adequate perennial water source "Rejuvenating rivulets on ground water potential" in concurrence to the geological profiles, topography and soils, the study was undertaken to study the ground water fluctuations, compute gravity yield and ground water storage and determine the aquifer parameters.

Materials and Methods

Akola is located at latitude 20.7° North and longitude 77.07° East. It is at an altitude of 282m above sea level. The rivulet of 2 km length was selected for the study. The deepening and widening of existing rivulets was carried out. The average top and bottom width of rivulets was increased up to 10 to 12m and 6 to 7 m respectively and the depth was increased up to 3 m. The CNBs were constructed in series by maintaining bottom of the Cement Nallah Bandh (CNB) at upstream side to the top of the CNB (Highest Flood Level) of the downstream with the height of 2 to 2.5 m. In this fashion all the CNB's were constructed in series in view to store the runoff in beats. After deepening and widening, the depressions were created of 100 m length, 4-5 m width and 0.3 m depth in between the two CNBs along the drainage network to increase the storage capacity and opportunity time to conserve the water.

Pumping test was performed to estimate the hydraulic properties of aquifers including hydraulic conductivity, transmissibility, hydraulic resistance and leakage factor. Standard procedure was adopted for conducting the pumping test. The drawdown and recovery was recorded for 6 hours and 30 minutes. For the study it was assumed that the flow in the aquifer is steady and the well is unconfined.

Results and Discussion

The result indicated that the average maximum water fluctuation was observed 5.16 m before and 7.01 m (in 2013) and 3.32 m (in 2014) after rejuvenating in the month of October. The water level fluctuation in the wells with respect to the driest May was observed enhanced after rejuvenating rivulets. The average gravity yield (Y_g) was observed as 1.81 per cent before and 6.54% (in 2013) and 3.27% (2014) after rejuvenating rivulets.

The minimum hydraulic drop was observed 14.23 m before and 13.57 m in the month of August 2013 and 13.70 m in the month of July 2014 after rejuvenating rivulets (Table 1). The increase in cumulative ground water storage (ΔS_g) was observed enhanced after rejuvenating rivulets.

Table 1: Gravity yield, cumulative storage and hydraulic drop before and after rejuvenating rivulets

Month	Before widening &deepening 2012-13			After widening &deepening 2013-14			After widening &deepening 2014-15		
	Av. Y_g (%)	Hydraulic drop (m)	cum. ΔS_g (ha-m)	Av. Y_g (%)	Hydraulic drop (m)	cum. ΔS_g (ha-m)	Av. Y_g (%)	Hydraulic drop (m)	cum. ΔS_g (ha-m)
May	1.81	17.42	0.00	6.54	16.23	0.00	3.27	13.33	0.00
June	1.81	16.73	1.81	6.54	14.48	12.03	3.27	13.04	0.00
July	1.81	16.17	5.72	6.54	13.97	36.36	3.27	13.70	-2.16
Aug.	1.81	14.23	11.77	6.54	13.57	77.43	3.27	15.08	10.14
Sept.	1.81	14.83	16.47	6.54	15.11	82.93	3.27	14.70	20.99
Oct.	1.81	14.58	18.68	6.54	13.81	91.69	3.27	14.38	21.71
Nov.	1.81	15.25	18.10	6.54	13.98	82.40	3.27	14.83	16.55
Dec.	1.81	15.41	15.39	6.54	14.28	72.20	3.27	15.19	11.64
Jan.	1.81	15.19	12.74	6.54	14.65	66.32	3.27	14.92	14.13
Feb.	1.81	15.51	9.77	6.54	15.13	59.64	3.27	15.15	9.48

The average recovery of the well was found enhanced by 35% from 7 m^3/hr to 10.74 m^3/hr. On the basis of drawdown and recovery trend the aquifer parameters were determined and average values of the aquifer parameters are given in Table 2.

Table 2: Aquifer parameters determined by pumping test

Aquifer parameters	Values
Hydraulic Conductivity (K)	2.79 x 10^{-5} m/sec
Transmissibility (T)	2.91 x 10^{-4} m^2/sec
Hydraulic Resistance (C)	37.72 min
Leakage Factor (B)	0.1 m

From the results it was concluded that due to rejuvenating rivulets in the watershed gravity yield of aquifer enhanced subsequently by 1.8 to 3.5 times. The well water levels in the study area increased drastically as a result the ground water storage (ha^{-m}) in the study area was enhanced by 1.5 to 5 times. Thus the rejuvenating rivulets in the watersheds can strengthen the surface and subsurface water resources. The enhanced water resources can useful for protective irrigation to the crops during moisture deficit period.

18.

Monitoring Heavy Metal Pollution in Coal Mine Spoils by Utilising Ants

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Introduction

Soil quality assessment requires a multidisciplinary approach that integrates physical, chemical and, increasingly biological methods. Since ants are colonial and many species are ground-nesting the worker ants easily accumulate heavy metals. Hence, long term effects of soil pollutants can be easily detected by monitoring ant diversity, abundance and heavy metal accumulation in pollution-tolerant ant species.

Materials and Methods

The study area is located in Northern Coal field Limited, Singrauli (latitudes 23°47' to 24°12′ N and longitudes 81°48′ to 82°52′ E), in Madhya Pradesh, India. We selected coal mine spoils of 3 different ages: 3, 8 and 12 year old. Ant diversity and abundance were studied by the pit fall trap method. The two most common and abundant species *Cataglyphis longipedem* and *Camponotus compressus* were collected by nest digging and hand picking and minor caste ants were digested in a mixture of nitric acid and perchloric acid (3: 1).

Results and Discussion

A total of 9 species were collected from coal mine sites and 11 species were recorded from reference site. The abundance of *C. longipedem* decreased with the age of the mine site, whereas abundance of *C. compressus* increased with the age of the mine site. The BSAFs of the three heavy metals in *Ct. longipedem* is ranked as Zn>Fe>Mn while in case of *C. compressus* the ranking is Fe>Zn>Mn. The BSAFs concentration increased with increase of mine site soil heavy metal concentration. While metal pollution loading in *Ct. longipedem* was consistently high and low in case of *C. compressus,* for all the sites. Body content of heavy metals: Fe, Zn, Mn in the two ant species increased with increase in mine spoil soil concentration indicating that ant body metal pollution load is co-related to the back ground level of pollution at each site. The distribution pattern and abundance of the two species, *C. longipedem* and *C. compressus* is apparently affected by metal pollution though habitat characteristics may also play an important role. This can facilitate the ranking of sites with varying degree of pollution on the basis of this biological parameter. The results of the present study also indicate that since ant diversity and abundance also reflect their pollution tolerance ability, ants appear to be good candidates for bio-monitoring.

19.

Flood Prediction Analysis for Krishna River Basin: Case Study of Wadanepalley Gauging Station

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Keywords: Flood prediction, regression models, feed forward back propagation neural network, relevance vector machine, correlation coefficient, RMSE.

Introduction

Floods, earthquakes and forest fires are the most threatening natural hazards in the world and claim thousands of life and destroy properties every year [WBGU 2000]. Flood refers to the phenomenon of influx of water beyond its normal confines to an area resulting in disruption of normal human activities, destruction of properties, loss of animal and human lives, and environmental damages. To reduce damage, forecasting of flood events is very useful. The present study investigates the discharge pattern of Krishna River at Wadanepalley gauzing site. We also examined the accuracy using performance metrics to identify the best model using Artificial Neural Networks and machine learning techniques.

Materials and Methods

In the present research work, the daily discharge data for 2009 of Krishna River at Wadanepalley gauging station is used for prediction of flood. To analyze the pattern of the discharge, Auto Regressive Integrated Moving Average (ARIMA), Back Propagation Artificial Neural Network (BPNN) with a weight of 0.1% is applied with normalized data to predict the flood values. Also machine learning techniques called Relevance Vector Machine (RVM) and Gaussian Process Regression (GPR) are also applied for the prediction of discharge data. The performance evaluation metrics includes Root Mean Square Error and Correlation Co-efficient is used to examine the accuracy of predication.

Results and Discussion

It was observed that the RVM model shows the best performance with the lowest Root Mean Square Error (RMSE) and highest correlation co-efficient for both training and testing data. The BPNN is the second best model, followed by GPR. As specified in Table 1, ARIMA is having moderate prediction accuracy with less correlation co-efficient. The RVM model performance is improved by 21.25% in correlation co-efficient and reduces in RMSE by 85.71% as compared to the performance of ARIMA. RVM also produced some improvement over GPR with about a 10.2% improvement in Correlation Co- efficient and RMSE value of RVM is reduced by 0.2% when compared to GPR. As with, the RVM model resulted in improvement with about 0.5% over BPNN for Correlation Co- efficient as well, and 0.25% reduction in RMSE as compared to BPNN

Table 1: Performance measurements of ARIMA, BPNN, RVM and GPR

Method	Correlation co-efficient	Root Mean Square Error
Auto Regressive Integrated Moving Average (ARIMA)	0.78	±0.42
Back Propagation Neural Network (BPNN)	Train: 0.94 Test: 0.88	±0.07
Relevance Vector Machine (RVM)	Train: 0.99 Test: 0.98	±0.08
Gaussian Process Regression (GPR)	Train: 0.89 Test: 0.81	±0.10

Reference

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20.

Importance of Sub Surface Drainage in Amelioration of Salt Affected Soils and Enhancing Crop Productivity

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Keywords: Subsurface drainage, salt affected soils, cation and anion discharge

Introduction

Generally all soils will be having some amount of salts, of which some salts will be essential plant nutrients for crop growth and production. However, if these salts are in excess, the growth, yield and quality of most crops is adversely affected. If the soils contain enough salts to impair the crop productivity is called as "salt affected soils". At present in Karnataka out of 27,14,358 ha irrigated area, 2,68,582 ha area (9.9%) is infested with water logging, salinity and alkalinity problems. Hence, a study was taken at subsurface drains installed area to see the changes in water logged and salt affected soils, amount of salts removed and changes in the crop yield.

Materials and Methods

Soils of the study area are medium to deep black cotton soils belong to order Vertisoils. After installation subsurface drains in 136 acres of problematic soils of Tyavangi village, rice crop was grown for two seasons by applying required quantity of amendments, manures and fertilizers. During the crop period leachate discharged from each outlet was measured and analyzed for soil reaction(pH), electrical conductivity (EC), exchangeable sodium percentage (ESP), cations and anions concentration (Jackson, 1973). Crop cutting experiment was taken from all the farmers' field and similarly, soil samples were collected from each field from both the seasons to study the chemical changes in soil.

Results and Discussion

A total of 1.26 million liters of leachate was discharged to natural nala through 10 outlets of subsurface drains, through which totally 19.65 tons (t) of salts were removed. Maximum quantity of cations removed was sodium (1.61 t) and anion removed was bicarbonate (9.13 t). The installation of sub surface drainage increased the rice yield to an extent of 22.99% and 25.13%, whereas application of gypsum in alkali soils and application of sufficient quantity of organic manures and required quantity of NPK nutrients increased the yield to an extent of 35.68% and 38.28% in the first and second year, respectively (Manzoor *et al.,* 2006).

Table 3: Rice yield in crop cutting experiment in sub surface drainage installed problematic farmer's field of Tyavangi village

Farmers details	Acres	Yield data of rice 2013 (Before subsurface drainage) Date: 20-30.11.13 (q ha^{-1})	Yield data of rice 2014 (After subsurface drainage) Date: 30.05.14		Yield data of rice 2013 (Before subsurface drainage) Date: 20-26.11.14	
			q ha^{-1}	Increased yield ha^{-1} (%)	q ha^{-1}	Increased yield ha^{-1} (%)
Rajappa	5.00	21.60	28.89	33.74	29.23	35.33 (G)
Kumarappa	5.00	20.80	26.67	28.21	27.97	34.47 (G)
Danamma	10.00	21.60	25.78	19.34	30.18	39.70 (G)
Nagarajappa	1.00	21.60	26.67	23.46	28.56	32.22
Sannamma	3.32	20.80	27.30	31.23	29.20	40.38 (G)
Katti Nagappa	0.30	20.80	28.00	34.62	28.63	37.64 (G)
Ningamma	0.20	22.40	26.67	19.05	26.88	20.00
Honnamma	3.32	20.80	25.78	23.93	28.50	37.00 (G)
Jannumakka	0.22	20.80	26.67	28.21	28.05	34.85 (G)
Rudresh	2.08	21.60	25.78	19.34	30.40	40.74 (G)
Shekarappa	1.30	20.00	27.65	38.24	29.60	42.31 (G)
Rayanna	0.37	20.00	28.40	42.00	27.89	39.44 (G)
Ramachanrappa	0.37	21.60	23.82	10.30	29.50	36.59 (G)
Anjaneya swamy	6.29	20.80	34.40	16.48	0.00	0.00
Thippanna	5.20	21.60	0.00	0.00	28.64	37.69 (G)
		Average data of 66 farmers				
Mean % increase in yield		21.42 (65)	26.49 (63)	23.80 (63)	27.38	27.89 (62)
Mean % increase in yield			26.41 (59)	22.99 (59)	26.97	25.13 (49)
Mean of gypsum applied farmers			27.67 (4)	35.68 (4)	28.93	38.28 (13)

Note: Values in parenthesis indicate number of farmers; G- Gypsum applied

The soil samples collected before and after installation of subsurface drainage, clearly indicated that pH has been drastically reduced from 8.52 to 7.98 with EC values increased from 0.66 to 1.30 dSm^{-1}. Similarly, ESP has been reduced to a greater extent from 14.71 to 9.14 with a highest value of 35.80 reduced to 9.28. These soil properties indicate that the soils of the study area have been improved with reduction in pH and ESP. The study clearly indicated that by installation of sub surface drainage in water logged, saline and alkali soils, and application of gypsum in alkali soils will helps to get good rice yield in salt affected soils by reclaiming these problematic soils.

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21.

Direct Seeded Rice (DSR) Cultivation: A Water Saving Technology

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Keywords: DSR, rice cultivation, productivity and ecosystem.

Introduction

Direct Seeded Rice (DSR) in Haryana is a most feasible and sustainable alternative rice-ecosystem in view of depleting water resources, reduced labour use and climate risks being major concerns in conventional method of cultivation. Rice (*Oryza sativa*) is the most prominent crop of India since it is the staple food of more than 70% of population of the country. It also plays vital role in country's food security. India is the second largest producer of rice after China. Haryana is second largest state to contribute in central procurement pool of rice after Punjab.

Materials and Methods

To collect the primary data on the prospects of water saving technology multistage sampling technique was applied. From 29 states of the country, Haryana state was purposively selected being highest contributor in rice production in India. Four districts i.e. Kaithal, Karnal, Kurukshetra and Yamuna Nagar were selected purposively having maximum area under rice cultivation in Haryana. Then similarly, one block of each district namely Sadhaura, Shahbad, Assand and Pundri were selected on the basis of area under direct seeded rice (DSR) cultivation. Further two villages were selected from each block which have maximum DSR culture.

Results and Discussion

In Table 1 the production related prospects of DSR cultivation technology are given. Majority of the farmers in the study area agreed on 'better economic returns of DSR in comparison to transplanting' with weighted mean score 2.95 occupied 1st rank, 'DSR cultivation require less water than transplanting' with weighted mean score 2.93 occupied 2nd rank, followed by 'low production cost due to fully crop mechanization' occupied 3rd rank, 'your past experience favors the direct-seeded rice (DSR) over transplanting' occupied 4th rank, 'farmer friendly being easy to produce' occupied 5th rank, 'better quality of crop produce' occupied 6th and 'early maturity (7-10 days) results in timely sowing of succeeding crops' occupied 7th rank with weighted mean scores of 2.82, 2.78, 2.72, 2.68 and 2.29, respectively. Study emphasized that farmers are ready to adopt this technology due to better economic returns, less water requirement than conventional method and low production cost due to fully mechanization. The findings of the study are in consonance with the study of Gill *et al.* (2006) who reported increased water productivity of DSR over transplanting. The findings are in agreement with study of Tripathi (2004) who also reported higher net returns of DSR over transplanting.

Table 1: Production related prospects of DSR cultivation technology reported by rice growers (N=120)

	Statements	Prospects level			Total weighted score	Weighted mean score	Rank order
		Agree	Undecided	Disagree			
1.	Better quality of crop produce	92 (76.67)	17 (14.17)	11 (9.16)	321	2.68	VI
2.	Better economic returns in comparison to transplanting	116 (96.66)	2 (1.67)	2 (1.67)	354	2.95	I
3.	Farmer friendly being easy to produce	90 (75)	26 (21.67)	4 (3.33)	326	2.72	V
4.	Low production cost due to fully crop mechanization	102 (85)	14 (11.67)	4 (3.33)	338	2.82	III
5.	Early maturity (7-10 days) results in timely sowing of succeeding crop	39 (32.5)	77 (64.17)	4 (3.33)	275	2.29	VII
6.	Direct-seeded rice (DSR) cultivation require less water than transplanting	113 (94.17)	5 (4.16)	2 (1.67)	351	2.93	II
7.	Your past experience favors the direct seeded rice (DSR) over transplanting	102 (84)	9 (7.5)	9 (7.5)	333	2.78	IV

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22.

Antimicrobial Sensitivity/Resistance Pattern of *Escherichia coli* Isolates from Drinking Water Sources of Jammu

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Keywords: *Antibiogram*, antibiotics, drinking water, *E. coli*, faecal pollution, Jammu

Introduction

The widespread pollution of water has rendered readily accessible sources of water unsuitable for human and animal consumption. Provision of supplying drinking water free from micro organisms is the first task for introduction of environmental sanitation and hence analysis of water for its bacteriological quality is of paramount importance. An analysis was conducted to determine if the water fulfills the biological parameters of fitness for drinking in accordance with standard procedure (World Health Organization W.H.O, 2008). The study enumerates the indicator organisms based faecal pollution of drinking water sources of Jammu.

Materials and Methods

To determine the water quality 125 samples were collected from different drinking water sources of Jammu (Inputs to filtration plants, post filtrated water from these filtration plants and the households supplied by them, tube wells, filling stations and water sources of livestock and poultry). *E.coli* isolates were subjected to antibiotic sensitivity test against a panel of 17 antimicrobial agents. All the isolates were subjected to antibiotic sensitivity testing by Kirby Bauer disc diffusion method according to the standards procedures recommended by Clinical Laboratory Standards Institute (CLSI, 2012). Inoculum for culture sensitivity test was prepared by inoculating single colony of *E. coli* in 5 ml nutrient broth and incubated at 37°C for 4 hours. Antibiotic discs were placed on inoculated agar surface and the sensitivity of particular antibiotic was determined by measuring the diameter of the zone of inhibition. The result was interpreted as sensitive, intermediate or resistant.

Results and Discussion

E. coli isolates (57) isolated randomly from 125 different drinking water sources of Jammu region were subjected to antibiotic sensitivity test against a panel of 17 antimicrobial agents. Based on the Clinical Laboratory Standards Institute interpretive standards for *E.coli* isolates, the isolates were found most sensitive to cephalexin (92.9%), ciprofloxacin (91.22%), amikacin (91.22%) while the sensitivity to chloramphenicol, streptomycin and nalidixic acid was 87.09%. Highest intermediate pattern (14.03%) was recorded for norfloxacin, levofloxacin and polymixin-B. Resistance to ampicillin was 89.4% followed by Lincomycin (85.41) and Amoxycillin (77.19) as depicted in Table 1.

Table 1: Antimicrobial Sensitivity/Resistance pattern of *E.coli* isolates

Name of the antibiotic	Conc.	Zone size interpretation			Pattern of Antibiogram of *E.coli* - isolates in per cent (n=57)		
		Resistant mm or less	Inter- mediate mm	Sensitive mm or more	Sensitive	Inter- mediate	Resistant
Amikacin (Ak)	30 µg	14	15-16	17	91.22 (54)	3.50 (2)	1.75 (1)
Ampicillin (A)	10 µg	13	14-16	17	8.77 (5)	1.75 (1)	89.4 (51)
Amoxycillin (Am)	30 µg	13	14-17	18	14.03 (8)	8.77 (5)	77.19 (44)
Azithromycin (AZM)	15 µg	13	14-17	18	78.94 (45)	10.52 (6)	10.52 (6)
Cefotaxime (CTX)	30 µg	14	15-22	23	87.71 (50)	7.01 (4)	5.26 (3)
Cephalexin (Cp)	30 µg	16	17-22	23	92.9 (53)	5.26 (3)	1.75 (1)
Chloramphenicol (C)	30 µg	12	13-17	18	89.47 (51)	1.75 (1)	8.77 (5)
Ciprofloxacin (Cf)	10 µg	15	16-20	21	91.22 (52)	8.77 (5)	0.00 (0)
Gentamicin (G)	15 µg	12	13-14	15	82.45 (47)	12. 28 (7)	5.26 (3)
Levofloxacin (Le)	5 µg	13	14-16	17	75.43 (43)	14.03 (8)	10.52 (6)
Lincomycin (L)	10 µg	11	12-15	16	6.25 (3)	8.33 (4)	85.41 (41)
Nalidixic acid (Na)	30 µg	13	14-18	19	89.47 (51)	7.01 (4)	3.50 (2)
Nitrofurantoin (Nf)	300µg	14	15-16	17	75.43 (43)	8.77 (5)	15.78 (9)
Norfloxacin (Nx)	10 µg	14	15-16	17	80.70 (46)	14.03 (8)	5.26 (3)
Polymixin B (Pb)	300 units	11	-	12	78.94 (45)	14.03 (8)	7.01 (4)
Tetracycline (T)	10 µg	14	15-18	19	85.96 (49)	7.01 (4)	7.01 (4)
Streptomycin (S)	10 µg	11	12-14	15	89.47 (51)	7.01 (4)	3.50 (2)

Figures in parentheses are the number of isolates.

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23.

Effect of Long Term Use of Sodic Waters and Gypsum on Soil Properties in Coarse Textured Soils

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Keywords: Sodic waters, gypsum, soil properties

Introduction

The sodic waters can be gainfully exploited by using required amount of amendments, which basically depends upon the magnitude of their residual sodium carbonate (RSC) content. Soil amendments like gypsum ($CaSO_4.2H_2O$) mitigate the adverse effect of sodic waters because of its solubility, low cost, availability and ease of handling (Deshmukh, 2014). The application of gypsum with sodic irrigation water has been established for raising crops but question regarding its continuous use over period of time need to be answered as gypsum is a direct source of calcium and its addition in soil profile results in its precipitation as $CaCO_3$ and soil may become calcareous in nature.

Materials and Methods

A study was started in 1983 at Research Farm, Chaudhary Charan Singh Haryana Agricultural University Regional Research Station, Bawal, Haryana (India) in loamy sand textured soils with three natural sodic waters with varying RSC of 2.8, 12.0 and 16.0 me l^{-1} and two amendments treatments *i.e.* no amendment (G_0) and gypsum 100% neutralization of RSC of irrigation water above 2.8 me l^{-1} (G_{100}). According to water quality classification criteria (Eaton,1950), water having RSC > 2.5 me/l are classified as sodic water therefore, water with RSC 2.8 me l^{-1} was taken as control. The recommended package of practices was followed to raise all crops in various cropping systems of the zone. The soil samples were collected after harvest of wheat crop in *rabi 2*012-13. The soil samples 0-15 cm were analyzed for soil pH, ESP and SAR using standard procedures except calcium carbonate content which was determined up to the depth of 120 cm.

Results and Discussion

The results indicated that the soil pH, exchangeable sodium percentage, sodium absorption ratio and CaCO3 content increased significantly with increasing RSC level of irrigation waters. The mean soil pH was 9.18, 9.52 and 9.66 irrigated with 2.8, 12.0 and 16.0 me 1^{-1} RSC waters, respectively (Table 1). The soil pH under G_{100} was 9.26 and 9.43 with 12.0 and 16.0 me 1^{-1} RSC waters, respectively, indicating a significant effect of the amendment. Neutralization of RSC of sodic water of 12.0 me 1-^{-1} with gypsum maintained the pH values of the soil statistically at par to 2.8 me 1^{-1}RSC of water without gypsum after the harvest of crop as compared to RSC water of 16 me l^{-1}. The mean soil ESP was 32, 48 and 55 in 2.8, 12.0 and 16.0 RSC mel^{-1} water irrigated soils, respectively and the application of gypsum decreased the ESP to 39. Similarly, mean SAR was found to be 31.55, 45.14 and 54.10 $(mmol^{-1})^{½}$ under 2.8, 12.0 and 16.0 RSC levels, respectively and application of gypsum decreased the SAR to 36.93$(mmol^{-1})^{½}$. The calcium carbonate content increased from 0.94 and 1.21 per cent at 0-15 cm depth to maximum of 3.28 and 3.94 per cent at 90 -120 cm soil profile depth in RSC waters of 12.0 and 16.0 me l^{-1}. Thus keeping soil with sodic water of RSC 12.0 me l^{-1} and 16.0 me l^{-1} in non-calcareous category (< 4% CaCO3) with addition of gypsum continuously for thirty years (Table 2). Significant interaction between RSC levels and amendment was observed. Thus it is concluded that in coarse textured soils, sodic waters up to RSC 12.0 me l^{-1} could safely be used for crop production with gypsum as amendment without any adverse effect on soil properties.

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Table 1: Effect of sodic waters and gypsum on soil pH, ESP and SAR

Sodic water (me l^{-1})	Soil pH			ESP			SAR $(mmol^{-1})^{½}$		
	G_0	G_{100}	Mean	G_0	G_{100}	Mean	G_0	G_{100}	Mean
2.8	9.18	9.18	9.18	32	32	32	31.55	31.55	31.55
12.0	9.78	9.26	9.52	56	39	48	52.98	37.29	45.14
16.0	9.89	9.43	9.66	63	45	55	66.23	41.96	54.10
Mean	9.61	9.35		50	39		50.25	36.93	
CD(05)	Sodic water-0.07 Gypsum-0.07 Sodic water x Gypsum-0.12			Sodic water-1.51 Gypsum-1.51 Sodicwater x Gypsum-2.62			Sodic water-1.34 Gypsum-1.34 Sodic water x Gypsum-2.32		

Table 2: Effect of sodic waters and gypsum on soil calcium carbonate content (%)

Soil Depth (cm)	RSC 2.8	RSC 12.0		RSC16.0	
	G_0	G_0	G_{100}	G_0	G_{100}
0.15	0.56	0.67	0.94	0.84	1.21
15-30	0.73	0.95	1.59	1.07	1.86
30-45	0.88	1.39	1.71	1.60	2.64
45-60	1.18	1.99	2.42	1.97	3.27
60-90	1.68	2.19	2.74	2.41	3.86
90-120	1.73	2.15	3.28	2.44	4.56
CD (05)	RSC-0.07, Gypsum-0.07, RSC x Gypsum-0.11				

24.

Effect of Sowing Dates and Irrigation Regimes on the Yield of Summer Groundnut and Water Saving under Micro Sprinkler Irrigation System

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Keywords: Sowing dates, irrigation regimes, summer groundnut, micro sprinkler

Introduction

Flood irrigation may result in soil compaction, but with use of micro-sprinkler, aeration in root zone of crop is maintained which helps in increasing the peg formation. Micro-sprinkler remains 45 cm above the soil surface and with uniform emission, microclimate required for flowering and interception of peg in the soil becomes easier. The changing climate in some tropical locations a minimal increase in temperature of some crops will reduce yields. The optimum temperature for groundnut (*Arachis hypogaea*) growth is between 27 and 30°C. In view of the above, efforts were made to find out appropriate sowing time and irrigation regimes along with water requirement and water use efficiency for summer groundnut.

Materials and Methods

A field experiment in summer was carried out consecutively for 3 yrs at Mahatma Phule Krishi Vidyapeeth, Rahuri (MS). The soil of the experimental plot had a plain topography, with clay loam texture, medium soil depth and good drainage. The soil was alkaline in nature and low in available N&P and high in available K content. The experiment was laid out in split plot design with twelve treatments and three replications. There were three main plot treatments of sowing dates at 7th Meteorological Week (MW) (12-18 Feb.), 9th MW (26 Feb- 4 March) and 11th MW (12-18 March) and four sub plot treatments of irrigation regimes namely 0.6, 0.8, 1.0 Irrigation Water/Cumulative Pan Evaporation (IW/CPE) through micro sprinkler irrigation and 1.0 IW/CPE (surface irrigation). The summer groundnut (Var. TAG-24) was sown on raised beds at 30x10 cm spacing.

Results and Discussion

The maximum dry pod and haulm yields were recorded in 7th M.W. sowing and were significantly superior over sowing dates in 9th and 11th M.W. In irrigation regimes 1.0 IW/CPE ratio with micro sprinkler irrigation system gave highest dry pod yield of groundnut being significantly superior over 0.6 IW/CPE with micro sprinkler and 1.0 IW/CPE ratio with surface irrigation system. The water use efficiency was the maximum in 7th MW and 0.8 IW/CPE treatments with micro sprinkler. The 11th MW had water saving of 21.36% in 0.8 IW/CPE treatment with 35.33% increase in yield. The overall use efficiency of water can be improved by reducing the evaporation, particularly in areas where the evaporation is quite high. This can be achieved by selection of appropriate - specific cropping system where crop growth matches with the available water supply system (Acharya and Hati, 2002). The net seasonal income was the maximum in 1.0 IW/CPE micro sprinkler irrigation system followed by 0.8 IW/CPE treatment and 1.0 IW/CPE ratio surface irrigation treatment with highest Benefit: Cost (B: C) ratio under micro sprinkler irrigation treatment. There was no alarming change in the chemical parameters as far as the sowing dates and irrigation regimes were concerned. Hence, it can be concluded that, sowing of summer groundnut is recommended in 7th meteorological week (12th to 18th February) with micro sprinkler irrigation system with irrigation interval of 3-4 days (Twice week) and 0.8 IW/CPE ratio be followed for irrigation depth for getting higher yield and water saving with higher water use efficiency.

Table 1: Groundnut yield, total water applied, water use efficiency, water saving and yield increase due to various treatments (Pooled results)

Treatment	Yield of dry pod (q/ha)	Total water applied (cm)	Water use efficiency (Kg/ha-cm)	Yield increase (%)	Water saving (%)
Sowing dates					
7th MW	35.90	91.85	39.08	38.45	-
9th MW	33.06	91.82	36.00	27.50	0.03
11th MW	25.93	87.74	29.55	-	4.47
SE - +	0.90				
CD at 5%	2.74				
Irrigation regimes					
0.6 IW /CPE	25.84	61.44	41.95	-	39.60
0.8 IW /CPE	34.97	79.99	43.61	35.33	21.36
1.0 IW /CPE	36.46	98.49	36.93	41.10	3.18
1.0 IW /CPE surface	29.19	101.72	28.79	12.96	-

Reference

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25.

Heavy Metal Assessment in the Water and Sediments of River Yamuna

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Keywords: Heavy metals, aquatic ecosystems, atomic absorption spectrophotometer and River Yamuna

Introduction

In the recent years, aquatic ecosystems have been polluted by the large quantities of hazardous chemicals round the globe. Heavy metals are one of the most common contaminants which have been released into the rivers by both natural as well as anthropogenic processes. Heavy metals may pose serious ecological threats to the aquatic ecosystems due to their toxicity persistence, abiotic degradation and bioaccumulation leading to biological damage and endangering human health, if get a chance to enter food chain. Our study aims at the seasonal assessment of some heavy metals in water and sediment samples of River Yamuna.

Materials and Methods

Distribution of heavy metals and physico-chemical variables were studied in water and sediment samples in the different stretches of River Yamuna i.e.; Delhi(SI), Mathura(SII) and Agra(SIII) during summer, monsoon and winter season for a period of 1 year (from April 2014 to December 2014). For the study of physico-chemical characteristics, surface water samples were collected seasonally. The parameters like water temperature, pH, sodium, potassium, phosphates, nitrates, biological oxygen demand and chemical oxygen demand were analyzed. Percent organic matter in the sediment samples was determined. Seven heavy metals (As, Cd, Cr, Cu, Fe, Pb and Zn) in both water and sediment samples were analyzed using Atomic Absorption Spectrophotometer, Agilent Technologies 200series AA.

Results and Discussion

The lowest Water Temperature was recorded in winter and the highest in summer. The pH exhibited generally higher values in winter and lower in summer. An increase in Dissolved Oxygen (DO) content was observed in winter, however it declines as the temperature starts increasing during the summer. Phosphate concentration was found to be highest in summer and lowest in monsoon. The highest values of Nitrates, Sodium and Potassium concentrations were found in winter and lowest during monsoon. The lowest and highest values of Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were observed during winter and monsoon respectively. The organic matter of the sediment samples was found to be highest in winter and lowest in summer.

The average concentration of all the heavy metals was highest during summer in both the water (3.79mg/l) and sediment (1048.60 mg/kg) samples (Table 1). The metal concentration varied in the order of Fe > Zn > Pb > Cr > Cu > As > Cd in water samples and Fe > Cr > Pb > Zn > Cu > As > Cd in sediment samples. In water samples, water quality parameters like DO, BOD and COD and the concentration of all the heavy metals (except Zn and Cd) were found above the permissible limits for drinking purpose as given by Indian Council of Medical Research (ICMR) and World Health Organisation (WHO). However, in sediment samples, all the heavy metals were found to lie above the permissible limits for the protection of aquatic life as given by Canadian Council of Ministers of the Environment (CCME). By comparing the accumulation of heavy metals in water and sediments, it can be concluded that the heavy metals are highly accumulated in sediments than water, since the sediments act as reservoir for all contaminants and dead organic matter.

Table 1: Average (Mean±S.D) seasonal variation of Heavy Metals in Water (mg/l) and Sediments (mg/kg) of River Yamuna for the year April 2014 to December 2014

Seasons →	Summer		Monsoon		Winter	
Heavy Metals ↓	Water (mg/l)	Sediment (mg/kg)	Water (mg/l)	Sediment (mg/kg)	Water (mg/l)	Sediment (mg/kg)
Arsenic	0.08±0.01	7.56±1.42	0.005±0.0006	3.38±0.38	0.005±0.0006	5.37±0.99
Cadmium	BDL	0.95±0.17	BDL	0.15±0.03	BDL	0.15±0.03
Chromium	0.88±0.26	232.26±8.75	0.07±0.05	79.38±21.57	0.16±0.06	113.13±13.95
Copper	0.60±0.07	66.45±6.03	0.09±0.006	23.18±2.39	0.29±0.08	46.59±4.18
Iron	3.79±0.71	1048.6±60.05	1.15±0.144	984.43±17.99	2.03±0.06	863.35±50.34
Lead	0.91±0.05	176.86±4.43	0.05±0.021	42.89±10.26	0.13±0.02	104.36±9.42
Zinc	1.89±0.16	104.36±10.56	0.03±0.021	53.93±13.14	0.69±0.12	83.89±4.68

26.

Impact of Different Moisture Regimes on Physiological Attributes, Water Requirement, Water Use Efficiency and Andrographolide Content in Kalmegh (*Andrographis paniculata* Burm F.)

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Keywords: Kalmegh, moisture regime, andrographolide, proline, pan evaporation.

Introduction

Kalmegh (*Andrographis paniculata* Nees.) is an annual herbaceous plant, belongs to the family Acanthaceae and is one of the important medicinal crops indigenous to India, where leaves and aerial parts have been used in Indian System of Medicine since time immemorial for the treatment of common cold, fever, malaria, leprosy, pharyngotonsillitis, diarrhoea and hypertension (Pandey and Mandal, 2010). Water, comprising 80-90% of the biomass of non-woody plants, is the central molecule in all physiological processes of plants being the major medium for transporting metabolites, nutrients and secondary metabolites in Kalmegh.

Materials and Methods

The field experiment with different moisture regimes on physiological attributes, water requirement, water use efficiency and andrographolide content in Kalmegh (*Andrographis paniculata* Burm F.) was carried out at College of Horticulture Bengaluru, in *rabi* 2014-15 using randomized complete block design with 3 replications. The study consisted of seven different moisture regimes based on the pan evaporation, which includes watering to 100%, 90%, 80%, 70%, 60%, 50% and 40% pan evaporation.

Results and Discussion

The water requirement was more with irrigation regimes of 100% Pan Evaporation (406.6 mm). Whereas, the lowest water requirement (162.6 mm) was observed with 40% PE (162.6 mm). Among irrigation levels, the highest water use efficiency (12.4 Kg ha-mm^{-1}) was observed with 40% PE. While, lower water use efficiency was with 100% PE (7.6 Kg ha-mm^{-1}). The andrographolide were estimated using high performance liquid chromatography (HPLC) and the chromatograms of andrographolide content at 40% PE level. The active principle in kalmegh is diterpenoid lactone andrographolide and was found to be influenced by moisture regimes. The highest leaf (2.730%) and stem (1.766%) andrographolide content was recorded in moisture regime of 40% PE and the lowest was with 100% PE (1.065% and 0.961%) in leaf and stem, respectively.

The results indicated that, 100% PE moisture regime needs higher water and the higher moisture stress resulted in increase in proline and andrographolide content in kalmegh.

Table 1: Water requirement and Water use efficiency and andrographolide content of kalmegh as influenced by soil moisture regimes

Treatments	Water requirement (mm)	Water use efficiency kg ha^{-1} mm^{-1}	Andrographolide in leaf (% w/w)	Andrographolide in stem (% w/w)
T_1	406.6	7.6	1.065	0.961
T_2	365.9	7.7	1.318	1.102
T_3	325.2	8.3	1.393	1.164
T_4	284.6	9.1	1.690	1.405
T_5	243.9	10.0	1.892	1.484
T_6	203.3	10.5	2.287	1.765
T_7	162.6	12.4	2.730	1.766

Reference

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27.

Increasing Water Use Efficiency through Use of Hydrogel in Indian Mustard (*Brassica juncea*)

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Keywords: Irrigation scheduling, hydrogel, Indian mustard, IW/CPE

Introduction

Water use efficiency is vital for the oilseed crops. Major changes in irrigation management and scheduling in order to increase the efficiency of use of water have become the requirement in the present scenario. Also the use of superabsorbent polymer like pusa hydrogel has a great potential in enhancing water and nutrient use efficiency. The polymer in soil can store extra water and enable plants to utilize that water over an extended period of time, which can absorb and retain water at least 400 times its original weight and make at least 95 per cent its stored water available for plant absorption. Micro sprinkler and trickle fertigation permits application of nutrients directly at the rhizosphere (Rathore *et al.,* 2015). Since nutrients are applied to a limited soil volume, the fertilizer use efficiency is also high. The arising need for sustainable crop production to efficiently utilizes the scarce natural resources especially water and nutrients could appropriately addressed by micro irrigation system with fertigation device. This is only way ahead to increase oilseed productivity especially that of rapeseed-mustard by minimizing the wastage of technical inputs and maximizing the resource use efficiency.

Materials and Methods

Field experiment was conducted for efficient use of limited irrigation water in mustard crop using superabsorbent polymer chemicals (hydrogel). The experiment was laid down in split plot design with and without the use of hydrogel in main plot and irrigation scheduling in sub plots with three replications. The treatments comprised of, control (no irrigation and no hydrogel), no irrigation with hydrogel, 0.4 IW/CPE ratio (without hydrogel), 0.4 IW/CPE ratio (with hydrogel), 0.6 IW/CPE ratio (without hydrogel), 0.6 IW/CPE ratio (with hydrogel), 0.8 IW/CPE ratio (with hydrogel), and 0.8 IW/CPE ratio without hydrogel). During cropping season, range in minimum and maximum temperature was 3.4- 17.6 and 19.1- 33.8°C. However the range of wind speed, sunshine hours, and pan evaporation was 1.7-4.0 KMPH, 5.5 8.2 hrs and 1.0 4.2 mm /day respectively. Four rainy days was observed during February month with total rain fall of 29.7 mm. This rainfall was at full siliqua development stage of the crop.

Results and Discussion

Significant effect was observed on seed, biological and oil yield, and production efficiency of Indian mustard with and without hydrogel under different levels of irrigation scheduling. Maximum seed yield was recorded under irrigation scheduling (0.6 IW/CPE ratio) with hydrogel; however it was statistically at par with IW/CPE ratio (0.8) (Table 1). The maximum increase in seed yield (39.3%) of Indian mustard was recorded at irrigation scheduling of 0.4 IW/CPE ratio, closely followed by 0.6 IW/CPE (34.1%). A 26.5% increase in seed yield was noticed at 0.8 IW/CPE ratio. At every level; of irrigation scheduling, higher seed yield was observed with hydrogel compared to no hydrogel. Even with no irrigation, 30.4% increase in seed yield was recorded under use of hydrogel than no irrigation without hydrogel. Biological yield was higher under optimum irrigation scheduling under both with and without hydrogel in Indian mustard, however it was even higher under 0.8 IW/CPE without use of hydrogel. It was clear from the table that harvest index improved under use of hydrogel than without hydyogel. This might be one reason for yield enhancement under use of hydrogel. Oil content was exceptional higher under no irrigation under both the conditions but it was the maximum under no irrigation with use of hydrogel. The trend in oil yield was similar as it was in case of seed yield. Maximum oil yield was recorded when crop was irrigated at 0.8 IW/CPE ratio along with hydrogel. Rathore *et al.*, 2014 also reported similar trend. Forgoing results of the study infer that sustainably higher mustard productivity can be obtained when crop is irrigated at 0.6 IW/CPE ratio along with pusa hydrogel.

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28.

Leaf Area Index, Yield Attributes of Sorghum under Irrigation with Saline Water and Different Management Practices

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Keywords: Saline water, leaf area index, yield attributes, yield.

Introduction

The major problems confronting agriculture nowadays throughout the world is the decreasing availability of fresh water and the quality of irrigation water has also deteriorated. As a result, deficit irrigation and saline water irrigation have been used more prevalently in agriculture to overcome drought and sustain crop yields. With the use of saline waters for irrigation, there is need to undertake appropriate management practices to prevent the development of soil salination for crop production. Application of organic manures is one of the easiest methods to mitigate the adverse effects of use of poor quality water.

Materials and Methods

An experiment was carried out at the Water Technology Centre, College Farm, College of Agriculture, Rajendranagar, Hyderabad in *rabi*, 2012-2013. The experiment was laid out in strip plot design with four main treatments, four sub treatments and three replications. The main treatments comprised of quality of irrigation water and sub treatments comprised of management practices. Sorghum (*Sorghum bicolor*) variety CSV-216 R was selected for experiment. Ten plants from each plot were selected for recording leaf area index, weight of ear heads, length of ear head, thousand grain weight, no for grains per ear head and yield.

Results and Discussion

Leaf area index (LAI) during all the stages of growth (30, 60 and 90 days after transplanting) were found to be significantly influenced by water quality levels and management practices. Among water quality levels, the highest LAI was recorded with C_2 (good) quality which was on par with C_3 (marginal) quality. Alternating the irrigation with C_3/C_4 quality was found to be better than C_4 (poor) quality. Among management practices, application of farm yard manure (FYM) at the rate of 10 t ha^{-1} had recorded significantly the highest LAI followed by *in situ* green manuring and magnetic treatment. During all the stages, the interaction effect was found to be non significant. The yield attributes studied were length of ear head, weight of ear head, test weight and number of grains ear head^{-1}. Length of ear head and test weight were significantly influenced by both water quality levels, management practices and their interactions. The weight of ear head and number of grains ear head^{-1} was significantly influenced by water quality levels and management practices but not by their interactions. The highest length of ear head was recorded by C_2-FYM followed by both C_3-FYM and alternative irrigation with C_3/C_4-FYM. The highest test weight was also recorded by C_2-FYM followed by C_3-FYM and C_3/C_4-FYM. Similar trend was noticed with regard to weight of ear head and number of grains ear head^{-1}. The yield of sorghum was significantly influenced by water quality levels, management practices and their interactions. The highest grain and straw yield was recorded by C_2-FYM (2.35 t ha^{-1} and 5.85 t ha^{-1}) followed by C_3-FYM (2.19 t ha^{-1} and 5.75 t ha^{-1}) and C_3/C_4-FYM treatments (2.06 t ha^{-1} and 5.74tha^{-1}).

Table 1: Effect of saline water irrigation and management practices on stover, grain yield (t ha^{-1}) and water productivity (kg m^{-3}) at harvest of *rabi* Sorghum

Treatments	Stover Yield (t ha^{-1})					Grain Yield (t ha^{-1})				
	Control	FYM	GM	MT	Mean	Control	FYM	GM	MT	Mean
C_2	4.56	5.85 (28)*	5.67 (24)	5.21 (14)	5.32 [6]**	1.04	2.35 (126)*	1.86 (79)	1.44 (39)	1.67 [24]**
C_3	4.51	5.75 (27)	5.57 (23)	5.20 (15)	5.26 [5]	0.97	2.19 (126)	1.77 (83)	1.33 (38)	1.56 [16]
C_4	4.33	5.73 (32)	5.36 (24)	4.66 (8)	5.02	0.82	1.92 (135)	1.54 (88)	1.13 (38)	1.35
C_3/C_4	4.41	5.74 (30)	5.48 (24)	4.82 (9)	5.11 [2]	0.90	2.06 (130)	1.63 (82)	1.24 (38)	1.46 [8]
Mean	4.45	5.77 (30)	5.52 (24)	4.97 (12)		0.93	2.13 (129)	1.70 (83)	1.28 (38)	
	S.Em (±)		C.D (P=0.05)			S.Em (±)		C.D (P=0.05)		
W	0.04		0.13			0.01		0.04		
M	0.02		0.06			0.01		0.05		
W at same M	0.03		0.10			0.02		0.06		
M at same W	0.05		0.15			0.02		0.06		

* Figures in parentheses () indicate the percentage of increase over control
**Figures in parentheses [ ] indicate the percentage of increase over C_4 quality

Table 2: Effect of saline water irrigation and management practices on LAI of *rabi* Sorghum at 30, 60 and 90 DAS

Treatments	30 DAS					60 DAS					90 DAS				
	Con-trol	FYM	GM	MT	Mean	Con-trol	FYM	GM	MT	Mean	Con-trol	FYM	GM	MT	Mean
C_2	1.28	1.82 (42)*	1.67 (31)	1.47 (31)	1.56 [9]**	5.31	6.23 (17)	5.70 (7)	5.48 (3)	5.68 [3.3]	3.23	4.38 (36)	3.78 (17)	3.55 (10)	3.74 [7]
C_3	1.24	1.80 (45)	1.65 (33)	1.44 (16)	1.53 [7]	5.22	6.07 (16)	5.81 (11)	5.49 (5)	5.65 [2.7]	3.03	4.36 (44)	3.78 (25)	3.45 (14)	3.66 [5]
C_4	1.17	1.72 (47)	1.52 (30)	1.30 (11)	1.43	5.18	5.84 (13)	5.53 (7)	5.43 (5)	5.50	2.83	4.13 (46)	3.63 (28)	3.34 (18)	3.48
C_3/C_4	1.23	1.79 (46)	1.58 (28)	1.38 (12)	1.50 [5]	5.21	5.98 (15)	5.68 (9)	5.40 (4)	5.57 [1.3]	3.03	4.26 (41)	3.74 (23)	3.45 (14)	3.62 [4]
Mean	1.23	1.78 (45)	1.61 (31)	1.40 (14)		5.23	6.03 (15)	5.68 (9)	5.45 (4)		3.03	4.28 (41)	3.73 (23)	3.45 (14)	
	S.Em (±)		C.D (P=0.05)			S.Em (±)		C.D (P=0.05)			S.Em (±)		C.D (P=0.05)		
W	0.01		0.05			0.05		NS			0.03		0.12		
M	0.01		0.03			0.03		0.09			0.03		0.10		
W at same M	0.03		NS			0.06		NS			0.06		NS		
M at same W	0.03		NS			0.07		NS			0.06		NS		

* Figures in parentheses () indicate the percentage of increase over control
**Figures in parentheses [ ] indicate the percentage of increase over C_4 quality
W: Water quality (Main Treatments): M: Management practices (Sub Treatments)
C_2: Irrigation with C_2 quality (good) water M_1: Control (No organic manure and magnetic treatment)
C_3: Irrigation with C_3 quality (marginal) water M_2: FYM @ 10 t ha^{-1}
C_4: Irrigation with C_4 quality (poor) water M_3: GM: Green manuring *in situ* (Sunnhemp)
C_3/C_4: Alternate irrigations with C_3 followed by C_4 M_4: MT: Magnetic treatment to irrigation water

29.

Modeling of Ground Water Tables depths for sustainable management in Districts of West Bengal

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Keywords: Ground water, seasonal, modeling, forecasting

Introduction

Water, one of the major components of natural resource, is a major concern to the policy makers throughout the world. Only 2.5% of total available water is usable, sometimes not readily accessible. About 68.7% of fresh water is piled up in high latitude and altitude as snow and glaciers and 29.9% is remaining as ground water and soil moisture. Ground water table is an important indicator not only for sustainable agriculture but also for assured supply of water to industries and other activities. In this regard fluctuations of ground water table play an important role. Keeping in mind, the importance and scarcity of available water resources, it has become imperative to study the behavior of ground water and its fluctuations; model and forecast the fluctuation in advance to help policy formulation for efficient ground water management.

Materials and Methods

The present study has been under taken with the help of ground water level data on seasonal basis (i.e. January, May, August and November) from an average 655 ground water measuring sites for the period 2005 to 2013 for seventeen districts of West Bengal. Rainfall data for the period are also included in the analysis. Regression with dummy variables and step down regression is adopted to get the average values of ground water table depth for different districts in different seasons. In order to model and forecast the ground water table depths during different seasons for different districts, time series as well as seasonal ARIMA (SARIMA) are used. Among the competitive models, best models are selected and are used subsequently for forecasting purpose.

Results and Discussion

Analysis of the data for each district indicate spatio-temporal variations of ground water table depths among the districts of the states, maximum being during the month of May and minimum being during the month of August/November. Analysis also reveals that dummy variable technique in combination with the other auxiliary variables in the regression models can explain the variations in ground water table depths quite efficiently. The study reveals that no uniform superiority of either the ARIMA or the SARIMA models can be established. The future projections of ground water table depths are not uniform for various districts. As such the study suggests for a need of district wise specific management strategy for agricultural, industrial as well as ecological sustainability.

Table: Average ground water table depth in 17 District of West Bengal (m) during (2005-13)

District	January	May	August	November	Average
Bankura	4.715	6.198	2.391	3.404	4.177
Birbhum	4.808	6.381	2.636	3.681	4.377
Burdwan	4.951	6.581	3.591	4.013	4.784
Coochbihar	3.185	3.44	1.495	2.304	2.606
Dakshin Dinajpur	4.407	7.303	3.19	3.735	4.658
Darjeeling	4.267	4.971	2.166	3.325	3.67
Hooghly	5.882	7.536	3.966	4.789	5.543
Howrah	3.767	4.936	2.6	3.421	3.681
Jalpaiguri	4.274	4.604	2.193	3.093	3.549
Maldah	4.855	6.826	3.562	4.128	4.843
Midnapur	7.073	8.961	4.311	4.987	6.333
Murshidabad	5.855	7.557	4.353	5.529	5.824
North 24 parganas	4.309	5.397	2.988	3.624	4.079
Nadia	3.804	4.878	2.932	3.294	3.727
Purulia	4.76	6.976	2.309	3.667	4.428
South 24 parganas	4.157	4.539	3.277	3.841	3.953
Uttar Dinajpur	2.944	4.074	1.774	2.287	2.77

30.

Physico-chemical Studies of Devika River and its Adjoining Water Bodies in Udhampur Town

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Keywords: Devika river, biological oxygen demand, chemical oxygen demand, dissolved oxygen, ponds (bowlis).

Introduction

Today the biggest threat for environment is the continuous addition of unwanted material termed as pollutant leading to degradation of the existing climatic conditions. Pollution caused by pollutants can be classified as water pollution, air pollution or land pollution. Water pollution is one of the biggest threats and needs to be addressed at macro level as well micro level. The existing water bodies whether associated with religious sentiments or man made for recreational purposes both have turned out to be biggest threat in terms of health measures. The need of the hour is to study the level of deterioration caused to these water bodies. Riverine system of Jammu & Kashmir (J&K) has been governed mainly by river Tawi. Our study was aimed to reveal the physical and chemical characteristics of river Devika and its adjoining water bodies in Udhampur region of J&K state.

Materials and Methods

Surface water samples were collected from different locations during January month along the course of the Devika River and 8 ponds (bowlis) in Udhampur. The samples were collected in 1-litre double cap plastic bottles. The samples were analyzed for its pH, temperature, dissolved oxygen, hardness, total dissolved solids, chloride, magnesium.

Temperature and pH were measured in the field using digital meters immediately after sampling. The samples were analysed for determining the concentrations of various chemical constituents such as, calcium, magnesium, chloride, bicarbonate, carbonate, total dissolved solids (TDS),Biological oxygen demand (BOD), Chemical oxygen demand,(COD) in the laboratory using the standard methods as suggested by the American Public Health Association (APHA 1989 and 1995). Ca^{2+}, Mg^{2+} and Total Dissolved Solids (TDS) were analysed by volumetric titrations. Concentrations of Ca^{2+} and Mg^{2+} were estimated titrimetrically using 0.05-N EDTA. Chloride was estimated using 0.05-N $AgNO_3$. The accuracy of the chemical analysis was verified by calculating ion-balance errors and the errors were generally found to be around 10%.

Results and Discussion

Highest calcium content has been observed in Devika river (4.127 mg / lt) and Mangu di bowli (4.180 mg / lt) one of water bodies associated with the river. However the magnesium content is higher in Devika bowli (0.5103 mg/ lt) and Sansu bowli (0.5103 mg/ lt) while highest report has been from Devika river. The present observation reveals that rock strata had a considerable influence on the concentration of the salts in the adjoining water bodies of Devika river in Udhampur region of J&K.

Table 1: Results for analysis of ponds (bowlis) of Udhampur (2013) Town.

Sample	Devika river	Devika bowli	Saken bowli	Sansu bowli	Mangu di bowli	Mianbagh bowli	Kallar bowli	Khatrairi bowli	Billan bowli
Dissolved oxygen mg/lt	19.6	22.9	21.2	25.7	21.1	24.6	24.3	21.9	24
Biological oxygen demand mg/lt	0.0782	0.0662	0.0560	0.0360	0.0712	0.0600	0.0560	0.0630	0.0464
Chemical oxygen demand mg/lt	0.125	0.048	0.218	0.094	0.212	0.017	0.068	0.171	0.085
Calcium mg/lt	4.127	3.300	2.719	3.125	4.180	3.679	3.570	3.091	3.496
Magnesium mg/lt	0.6813	0.5103	0.3861	0.5100	0.4139	0.4006	0.4617	0.3766	0.3888
Chloride mg/lt	21.6	22.1	19.6	24.2	22.1	24.3	20.8	19.8	22.6
Total hardness (ppm)	63	69	78	81	85	86	79	79	71
Permanent hardness(ppm)	20	21	34	21	23	28	21	24	30
Total solids (gm/ml)	0.074	0.076	0.092	0.082	0.077	0.086	0.081	0.097	0.079
Total dissolved solids (gm/lt)	0.009	0.007	0.009	0.006	0.009	0.008	0.008	0.009	0.006
pH	7.8	7.4	7.5	7.2	7.4	7.4	7.3	7.5	7.4
Temperature °C	19	20	20	20	19	20	19	19	20

31.

Potential of Bacterial Consortium in Remediation of Yamuna River Water

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Keywords: Bacterial consortium; Yamuna river water, city of Taj

Introduction

Water is essential resources for sustainable life and environment which we have always thorough to be available in abundance and free gift of nature. River Yamuna is one of the most polluted rivers of India. The Yamuna River has been reduced to a small stream, draining industrial effluents, sewage, dirt and other toxic substances. In biological treatment, the microorganisms degrade the organic pollutants using them as a carbon source to produce metabolic energy to survive. In the present study the efficiency of the bacterial consortium were studied and the efficient organisms were then optimized to study the optimal bioremediative capacity.

Materials and Methods

The water samples were collected in pre-sterilized Biological Oxygen Demand (BOD) bottles, from river Yamuna situated in the city of Taj - Agra, India. Nutrient agar media were used as a nutritional medium for the growth of microorganisms. The bacterial isolates present in the Yamuna River water were isolated by serial dilution (Pour-Plate) technique. Identification was made following Bergey's Manual of Systematic Bacteriology. The ability of bacterial isolates was tested in aforementioned broth media (media in liquid form). The analysis of initial physico-chemical parameters such of collected samples were carried out by standard methods.

Results and Discussion

In collected water samples from the Yamuna River of Agra, city of Taj, a total 25 bacterial strains were obtained. The bacterial isolates having highest prevalence i.e. 100% throughout were selected and identified on the basis of their morphological, physiological and biochemical characteristics. After biochemical test for confirmation of the identified bacteria, a new technique of BD-BBL Crystal Mind Auto reader was also used for rapid identification of bacteria. It showed results between 95 to 99% purity of identified bacteria. The bacteria were tentatively identified as: *Rhodopseudomonas palustris, Rhodobacter spheroides, Bacillus subtilis, B. fusiformis, Pseudomonas* sp. The physico-chemical characteristics of the Yamuna waste water before and after treatment are presented in Table 1. All the physico-chemical parameters except DO showed maximum values in untreated Yamuna water sample but the bacterial consortium treated showed much reduction in the physical and chemical parameters to the way of improvement. Perceiving bacteria as dangerous is now turning towards greater awareness of the microbial world as a fundamental element of life. The results of present study indicate that Effective Microbes technology helps in the reduction of water impurities. Moreover, the regular monitoring of water pollution level of river basin, appropriate purification treatment and community participation in water resources management will certainly help managers in taking informed decisions for water resources sustainability and management. The observation revealed that the inoculation of bacterial consortium in water may release the nutrients through biodegradation of the organic/inorganic matter of water sources, which promote the plant growth.

Table 1: Physico-chemical characteristics of Yamuna water before and after treatment with bacterial consortium

Parameters	Winter		Summer		Monsoon	
	Untreated	Treated	Untreated	Treated	Untreated	Treated
pH	8.9	7.3	9.6	7.8	7.9	7.1
Acidity	395	102.5	498.7	79.3	234	97.2
Alkalinity	895	95	1197	124	459	56.8
Hardness	986	542	1834	524	654	243
TS	43.5	6.3	56.8	7.0	29.3	8.3
TDS	26.7	5.2	32.9	4.9	20.2	6.1
TSS	16.7	1.1	23.9	2.1	9.1	2.2
DO	8.8	86	3.8	62.4	5.6	78.9
BOD	21.7	8.9	29.9	3.3	10.3	0.8
COD	100	28	152.9	24.3	84.9	23.9

32.

Response of Growth and Survival of Multipurpose Tree Species (MPTS) to Rain Water Conservation Techniques under Rainfed Conditions

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Keywords: Growth, survival, moisture conservation techniques, karanj, sitaphaland bel

Introduction

Moisture is the constraint in commercial cultivation of arid horticultural crops. Hence, the is to develop technologies which not only require low water input but also have high water use efficiency. Moisture being a rare commodity in arid ecosystem, the first and foremost requirement is to conserve the available soil or rain water. For conservation of rain water both *n-situ* and *ex-situ* technologies have been developed. Scarcity of irrigation water at critical periods of crop growth is a limiting factor for successful cultivation in the arid and semi-arid region. Therefore, soil moisture conservation will definitely help in augmenting production. The present investigation was therefore, undertaken to study the effect of soil conservation techniques on growth of tree species in terms of height and collar diameter.

Materials and Methods

The present study conducted for most suitable moisture conservation techniques and locally available mulching materials in 3 years old karanj (*Pongamiapinnata*), sitaphal (*Annonareticulata*) and bel (*Aeglemarmelos*) planted at 4 m x 4 m on agro ecology and environment centre farm Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in randomized block design from 2012-2013 to 2014-15. Treatments were applied before rainy season. The treatments consisting of half-moon terracing [Fig. 1] (T_1), mulching with locally available grasses at the rate of 10kg/ plant (T_2), compartment bunding with bund height of 0.15 m (T_3), use of soybean(*Glycine max)* as cover crop (T_4) and control (T_5). Observation on growth parameters viz., plant height, and collar diameter and soil moisture content at different soil depth for the each year was carried out and analysed statistically.



Karanj ***Sitaphal*** ***Bel***

Fig. 1: Plants provided with half-moon terracing as conservation practice

Results and Discussion

Data pertaining to the growth of Karanj, Sitaphal and Bel indicated the favorable effect of soil and water conservation techniques on the growth of trees. The maximum pooled mean plant height in T_1 (48.75cm) followed by T_2 (44.35cm), T_3 (38.95 cm), T_4 (33.65 cm), and minimum in T5 (29.20cm). Similarly the higher pooled Collar diameter was observed in T1 (2.62cm) followed by T_2 (2.49cm), T_3 (2.41cm), T_4 (2.34 cm) and minimum in T_5 (2.16 cm). The highest pooled mean survival was observed in T_1 (69.37%) followed by T_2 (61.45%), T_3 (56%), T_4 (50.85%) and minimum in T_5 (43.25%) over the period of 3 years (2012-13 to 2014-15). The maximum increase in soil moisture content was observed 4.10 to 11.28% as in T_1 followed by T_2 (2.73 to 10.19%), T3 (1.89 to 6.55%), T4 (0.75 to 4.73%) over T5. In case of sitaphal the maximum pooled mean plant height was observed in T_1 (50.14 cm) followed by T_2 (43.54 cm), T_3 (37.07 cm), T_4 (33.17cm) and minimum in T_5 (29.17cm). Similarly the higher pooled Collar diameter was observed in T_1 (2.80cm) followed by T_2 (2.66 cm), T_3 (2.52 cm), T_4 (2.37 cm) and minimum in T_5 (2.29 cm).

Table 1: Effect of soil conservation techniques on Survival of Dry land trees Species

Species	Treatment	Survival %			
		2012-13	2013-14	2014-15	Pooled mean
Karanj	T_1	56.3	73.95	77.85	69.37
	T_2	48.05	65.95	70.35	61.45
	T_3	42.55	60.65	64.80	56.00
	T_4	37.0	54.00	61.55	50.85
	T_5	31.15	45.15	53.45	43.25
	F Test	Sig.	Sig.	Sig.	Sig.
	CD at 5%	3.17	1.47	2.35	2.25
Sitaphal	T_1	48.45	53.50	64.32	55.42
	T_2	38.95	46.80	60.55	48.76
	T_3	36.40	41.10	54.85	44.11
	T_4	31.95	36.65	46.70	38.43
	T_5	28.07	31.70	41.15	33.64
	F Test	Sig.	Sig.	Sig.	Sig.
	CD at 5%	2.18	2.43	3.87	3.25
Bel	T_1	53.95	67.0	73.02	64.65
	T_2	47.85	58.20	66.96	57.67
	T_3	43.22	51.75	59.82	51.59
	T_4	39.65	46.52	54.20	46.79
	T_5	32.05	41.82	44.55	39.47
	F Test	Sig.	Sig.	Sig.	Sig.
	CD at 5%	1.16	2.09	3.08	3.38

The highest pooled mean survival was observed in T_1 (55.42%) followed by T_2 (48.76%), T_3 (44.11%), T_4 (38.43%) and minimum in T_5 (33.64%) over the period of 3 years (2012-13 to 2014-15).

The maximum increase in soil moisture content was observed 7.17 to 16.94% as in T_1 followed by T_2 (5.92 to 11.14%), T_3 (4.96 to 8.46%), T_4 (2.08 to 5.32%) over T_5.

The maximum pooled mean plant height of belwas observed in T_1 (34.68cm) followed by T_2 (31.07 cm), T_3 (28.27 cm), T_4 (26.22 cm), and minimum in T_5 (24.05 cm). Similarly the higher pooled Collar diameter was observed in T_1 (2.53 cm) followed by T_2 (2.44cm), T_3 (2.31cm), T_4 (2.19 cm) and minimum in T_5 (2.09 cm).

The highest pooled mean survival was observed in T_1 (64.65%) followed by T_2 (57.67%), T_3 (51.59%), T_4 (46.79%) and minimum in T_5 (39.47%) over the period of 3 years (2012-13 to 2014-15).

The maximum increase in soil moisture content was observed 5.44 to 10.34 as in T_1 followed by T_2 (3.48 to 7.50), T_3 (2.32 to 5.97), T_4 (1.66 to 5.15) over T_5.

From the pooled analysis it is concluded that, for the satisfactory establishment of the dry land tree species (Karanj, Sitaphal and Bel etc.) in terms of higher height, collar diameter, survival and moisture conservation the half-moon terracing treatment (T_1) was found significantly better followed by Mulching with locally available grasses at the rate of 10kg/ha (T_2), compartment bunding with bund height of 0.15cm (T_3), use of soybean as cover crop (T_4) and control (T_5).

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33.

Impact of Resource Conservation Technologies on Soil Properties and Productivity of Diversified Maize Based Cropping System

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Keywords: Maize-wheat, resource conservation technologies, zero tillage

Introduction

Traditionally, maize (*Zea mays* L.) and wheat {*Triticum aestivum* (L.) emend. Fiori & Paol.} are grown after thoroughly tilling the field for good crop emergence. At the same time it gives birth to a finer and loose-setting soil structure and modifies soil bulk density and soil moisture content. So, reducing soil disturbance by zero tillage with residue covers can overcomes the edaphic constraints by increasing organic matter, hydrothermal regulation and energy management over traditional tillage practice (Gill and Jat, 2007). Furthermore, inclusion of legumes and vegetables in the existing cropping system can increase the productivity and profitability of farmers by sustainable means. Sustainable crop production also requires a careful management of all nutrient sources available in the farm, namely organic manures, inorganic fertilizers and integration of legume crops in cereal based cropping system (Wakene *et al.,* 2007).

Materials and Methods

A field experiment was carried out at Palampur (32°6′ N and 76°3′ E and 1290 m amsl), Himachal Pradesh, India, in *kharif* 2012- *rabi* 2014. The experiment was laid out in split-plot design with three replications. The treatments in main plot were the combinations of two tillage methods namely zero tillage (ZT) and conventional tillage (CT), and three cropping systems namely maize-wheat (M-W), baby corn+frenchbean - pea - summer squash (BC+FB-P-SS) and maize+soybean - gobhi sarson+toria (M+S-GS+T). The treatments in sub-plot were the combinations of two mulch levels namely no mulch (NM) and crop residue mulch (CRM), and two fertilizer levels namely recommended dose of fertilizers (RDF) and 75% of RDF + 25% N through FYM (INM).

Results and Discussion

Table 1 reveals that maize grain equivalent yield (MGEY), available N and K was significantly higher under conventional tillage as compared to zero tillage. Lower MGEY under zero tillage was owed to poor yield of individual crops due to lower crop emergence and high crop weed competition. Higher available N and K under conventional tillage might be due to increased mineralization of nutrients due to disturbance of soil than under zero tillage. Among cropping systems, BC+FB-P-SS gave significantly highest MGEY and resulted in higher available K over the traditional M-W and M+S-GS+T cropping system. The higher MGEY under BC+FB-P-SS was due to higher production of vegetables namely namely baby corn (*Zea mays* L.), pea (*Pisum sativum* L.) and summer squash (*Cucurbita pepo* L.) and their market value. Applying crop residue mulch improved the soil physical properties, reduced water evaporation losses and increased the yield of individual

Table 1: Effect of treatments on MGEY (mean of 2 years) and soil pH, OC, EC and available N, P and K after completion of experiment

Treatment	MGEY (kg/ha)	pH	OC (%)	EC (dS/m)	N (kg/ha)	P (kg/ha)	K (kg/ha)
Tillage							
ZT	13183.6	5.47	1.19	0.40	423.0	41.3	205.4
CT	14663.7	5.42	1.17	0.39	458.7	39.4	217.1
LSD (P=0.05)	919.8	NS	NS	NS	20.7	NS	8.4
Cropping systems							
M-W	8044.2	5.42	1.19	0.40	441.5	40.3	205.6
BC+FB-P-SS	23382.1	5.41	1.19	0.39	430.7	39.7	207.8
M+S-GS+T	10344.8	5.50	1.17	0.40	450.4	41.2	220.4
LSD (P=0.05)	1126.6	NS	NS	NS	NS	NS	10.3
Mulch							
NM	13425.4	5.41	1.14	0.40	431.5	39.6	206.8
CRM	14421.9	5.48	1.22	0.40	450.2	41.1	215.7
LSD (P=0.05)	341.6	0.06	NS	NS	15.7	NS	NS
Fertilizer							
RDF	13627.8	5.42	1.17	0.40	437.8	39.1	209.1
INM	14219.5	5.47	1.20	0.40	443.9	41.7	213.4
LSD (P=0.05)	341.6	NS	NS	NS	NS	1.9	NS
Initial	-	5.42	1.12	0.38	418.5	40.1	198.7

ZT=Zero Tillage; CT=Conventional Tillage; M-W=Maize-Wheat; BC+FB-P-SS=Baby Corn+Frenchbean-Pea-Summer Squash; M+S-GS+T=Maize+Soybean-Gobhi Sarson+Toria; NM=No Mulch; CRM=Crop Residue Mulch; RDF=Recommended dose of Fertilizer; INM=75 per cent RDF + 25 per cent N through Organic Manure crops and therefore MGEY than no mulch. Crop residue mulch also increased the soil pH and available N after completion of the experiment than no mulch which may be ascribed to higher organic matter which acts as a buffer in the acidic soil. Integrated nutrient management also resulted in significantly higher MGEY and available P over pure inorganics. Higher availability of P in soil might be due to, addition of FYM increased the absorptive power of the soil for cations and anions particularly phosphates and nitrates. This resulted in higher uptake of nutrients from soil for vigorous growth of crops and higher yield.

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34.

Rotifers as Bio Indicators to Water Quality in Khajiyar Lake, Himachal Pradesh, India

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Keywords: Bioindicators, eutrophication, pollution, rotifers

Introduction

The bio-monitoring using planktonic communities as indicators in relation to the physico-chemistry of the system have a definite role to play in assessing water quality. They respond to dissolved oxygen, pH, and free carbon dioxide levels etc. Rotifers have been used in pollution studies either as bioindicator species. Rotifers also play very significant role in the food chain and biological productivity of freshwater environment and are said to be the best indicator of the trophic status in comparison to the other groups of zooplankton. The present investigates their presence, abundance and distribution in relation to physico-chemical characteristics as an index of water quality in fresh water Khajiyar lake ecosystem.

Materials and Methods

The surface water samples of Khajiyar Lake at three sites were collected for six months over the year in the month of April-May in summer, July-August in rainy season and December-January in winter from July 2011 to May 2012. The samples were analyzed for different physico-chemical characteristics like temperature, secchi disc transparency, conductivity, total solids, total dissolved solids and total suspended solids, pH, dissolved oxygen, free carbon dioxide, alkalinities, chloride, nitrates, total phosphate- phosphorus, sodium and potassium (APHA, 2000). For qualitative and quantitative enumeration of rotifers, the samples were collected for six months over the year in summer, rainy and winter season.

Results and Discussion

Total number of rotifers showed highly significant and positive relationship with conductivity (r= 0.859, **$p<0.01$), total solids (r= 0.904, **$p<0.01$), total dissolved solids, total suspended solids and positive relation with free carbon dioxide (Table 1). A highly significant and positive relation (r= 0.776, **$p<0.01$) of chloride concentration with rotifers was also obtained. Such an association is an indication of pollution as during the course of present investigation the values of chloride were always obtained more than 18.0mg/l which is the minimum range indicating pollution in fresh water ecosystem. The higher concentration of free carbon dioxide (11-26.8 mg/l), chloride (20.2 - 33.1mg/L), nitrate (98- 485µg/L), total phosphate (610- 2320µg/L) and their significant association with total rotifers along with the presence and abundance of *Keratellacochlearis*, *Keratellavolga,* and *Branchionushavanaensis* revealed that the Khajiyar Lake is polluted.

Reference

APHA 2000. *Standard Method of Examination Of Water And Waste Water*. 21st Edition, American Public Health Association, New York, USA.

Table 1: Co-efficient of correlation among physico-chemical characteristics and number of rotifers

	Dissolved oxygen (mg/l)	Free carbon dioxide (mg/l)	Total solids (mg/l)	Total dissolved solids (mg/l)	Total suspended solids (mg/l)	Total Alkalinity (mg/l)	Total Phosphate Phosphorus (µg/l)	Nitrate Nitrogen (µg/l)	Chloride (mg/l)	Sodium (mg/l)	Potassium (mg/l)	No. of Rotifers (org./l)
Dissolved oxygen (mg/l)		-0.982**	-0.675*	-0.669*	-0.710**	-0.851**	-0.938**	-0.987**	-0.690*	0.049	-0.557	-0.301
Free carbon dioxide (mg/l)			0.635*	0.627*	0.679*	0.877**	0.880**	0.962**	0.588*	-0.174	0.465	0.273
Total solids (mg/l)				0.999**	0.997**	0.832**	0.860**	0.783**	0.928**	0.578*	0.737**	0.904**
Total dissolved solids (mg/l)					0.996**	0.825**	0.857**	0.778**	0.929**	0.586*	0.737**	0.907**
Total suspended solids (mg/l)						0.867**	0.876**	0.812**	0.917**	0.532*	0.732**	0.884**
Total Alkalinity (mg/l)							0.867**	0.889**	0.716**	0.154	0.688*	0.607*
Total Phosphate Phosphorous (µg/l)								0.974**	0.896**	0.294	0.745**	0.561*
Nitrate-Nitrogen (µg/l)									0.781**	0.814**	0.617*	0.447
Chloride (mg/l)										0.682*	0.834**	0.776**
Sodium (mg/l)											0.656*	0.736**
Potassium (mg/l)												0.596*

35.

Spatial Variation of Groundwater Quality of IARI Farm, New Delhi

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Keywords: Water, cations, anions, groundwater, quality, spatial variation.

Introduction

Ground water plays an important role in agriculture. It is estimated that about 43 million hectare areas is irrigated by the groundwater out of the net irrigated area (57 m ha) in India. The rate of depletion of ground water levels and deterioration of ground water quality is of immediate concern in major cities and towns of the country. In the farm of Indian Agricultural Research Institute (IARI), large numbers of experiments were carried out by the different Division of IARI with the cultivation of different crops using different dose of fertilizers and pesticides. The intensive cultivation practices may deteoriate the quality of groundwater and it is the major source of irrigation at IARI farm. Keeping this in view, the present study was planned to assess the groundwater quality of Indian Agricultural Research Institute farm, New Delhi, India.

Materials and Methods

The study was conducted at the farm of Indian Agricultural Research Institute, New Delhi in 2010-11. The IARI farm is situated between the latitude of 28°37'22'' N and 28°39'00'' N and latitudes of 77°8'45'' E and 77°10'24'' E at an average elevation of 230 m above mean sea level. The farm has an area of 473 ha comprising mainly of farm land, residential complexes and office buildings. Out of 473 ha area, about 280 ha is under extensive agriculture. The climate of the area is semi-arid with an average annual temperature of 24°C and average annual rainfall of 710 mm. the soil type varies from sandy loam to clay loam. The 22 groundwater samples were collected with their GPS location from the different tube wells located at IARI farm during post-monsoon season in November, 2010. The EC, pH, cations (Na^+, K^+, Ca^{2+} and Mg^{2+}) and anions (Cl^-, CO_3^- and HCO_3^-) in groundwater samples were determined with standard methods described in APHA (2005). The minimum, maximum, and mean concentrations of physico-chemical parameters of groundwater quality of IARI farm are presented in Table 1.

Table 1: Minimum, maximum, and mean values of physico-chemical parameters

Category	Characteristics	Unit	Min.	Max.	Mean	Maximum permissible limits (FAO, 1985)
General Parameter	pH	0-14	6.85	8.15	7.47	6.5-8.4
	Electrical conductivity	dS/m	0.87	3.88	2.07	3
	Total dissolved solids	mg/L	560	2485	1295	2000
Major Cations	Calcium (as Ca^{2+}) + Magnesium (as Mg^{2+})	me/L	4.80	21.40	10.93	25
	Sodium (as Na^+)	me/L	3.10	17.20	10.25	40
	Potassium (as K^+)	me/L	0.09	0.34	0.18	2
Major Anions	Carbonates (as CO_3^{2-})	me/L	0.00	2.4	0.30	0.1
	Bicarbonates (as HCO_3^-)	me/L	5.80	10.00	7.70	10
	Chlorides (as Cl^-)	mg/L	4.00	30.40	12.88	30

Results and Discussion

The pH of the groundwater in the study area lies in the ranges between 6.85 and 8.15 with a mean value of 7.47 indicating alkaline nature of the groundwater. The EC varied from 0.87 to 3.88 dS/cm with a mean value of 2.07 indicating higher mineralization in the region. Calcium and magnesium contents range between 4.80 and 21.40 me/L with a mean value of 10.93 me/L. Sodium values ranged from 3.10 to 17.20 me/L with a mean value of 10.25. It indicated that the sodium content in the groundwater of IARI farm was below maximum permissible limit of 40 me/L for irrigation. The potassium content in groundwater was ranged from 0.09 to 0.34 me/L. Two factors are responsible for the scarcity of potassium in groundwater, one being the resistance to potassium minerals to decomposition by weathering (Golditch, 1938) and the other is fixation of potassium in clay minerals formed due to weathering. The chloride concentrations in the groundwater ranged from 4.0 to 30.40 me/L with mean value of 12.88 me/L. the higher chloride concentrations were observed in the groundwater of Top block area whereas lower concentrations were found in the groundwater of new area of IARI farm. The carbonate concentrations in the groundwater ranged from 0.00 to 2.40 me/L with mean value of 1.43 me/L. The bicarbonate concentrations in the groundwater ranged from 5.80 to 10.0 me/L with mean value of 7.70 me/L. The higher bicarbonate concentrations were observed in the groundwater of Main block-16 (MB-16) area whereas lower concentrations were found in the groundwater of Main block-14 (MB-14) of IARI farm.

References

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36.

Sustainable Agriculture through Two-Tier Rain Water Management System in Rainfed Agriculture

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Keywords: Cropping system, conservation, rain water management, contour, two-tier system

Introduction

Rainfed area in the Purna River Valley are highly diverse ranging from resource rich area with good agricultural potential to resource poor area with much more restricted potential with salinity and sodicity. Soil management in the saline tract of the Purna Valley is difficult due to the severe erosion rate, swelling, cracking and seizing characteristics. The erosion hazards are greater under cereals and millets crops cultivation. Black gram has been found effective in controlling run off and soil loss as compare to cereals and millet crops. Hence the present investigation was carried out to study the productivity, profitability and water use efficiency through suitable double cropping system (two tier system) in saline tract of the Purna River Valley in Amravati district of Vidarbha.

Materials and Methods

The experiment was carried out in randomized block design with five rain water management systems. The treatments A) comprised conventional system, control (T1), B) mono tier system cultivation across the slope (T2) and contour cultivation (T3), C) two tier system, cultivation across the slope with protective irrigation (T4), and Contour cultivation with protective irrigation (T5) system of rain water management (RWM). Three cropping system i.e. green gram (*Vigna radiata*) - chickpea (C1), soybean - chickpea (*Cicer arietinum*) (C2) and green gram-safflower (*Carthamus tinctorius L.*) (C3) were followed under each rain water management system. One protective irrigation of 2.5 to 3.0 mm depth was given. Economics and statistical analysis in terms of net returns, benefits cost ratio and production efficiency value in terms of kg ha^{-1} day^{-1} and $Rs.ha^{-1}day^{-1}$ were calculated. The individual year's data and pooled data of six years were statistically analysed with the standard methods.

Results and Discussion

The pooled data (Fig. 1) over a period of six years revealed that the double cropping system of soybean-chickpea was found superior followed by Green gram-Chickpea in mono and two tier system of rainwater management.

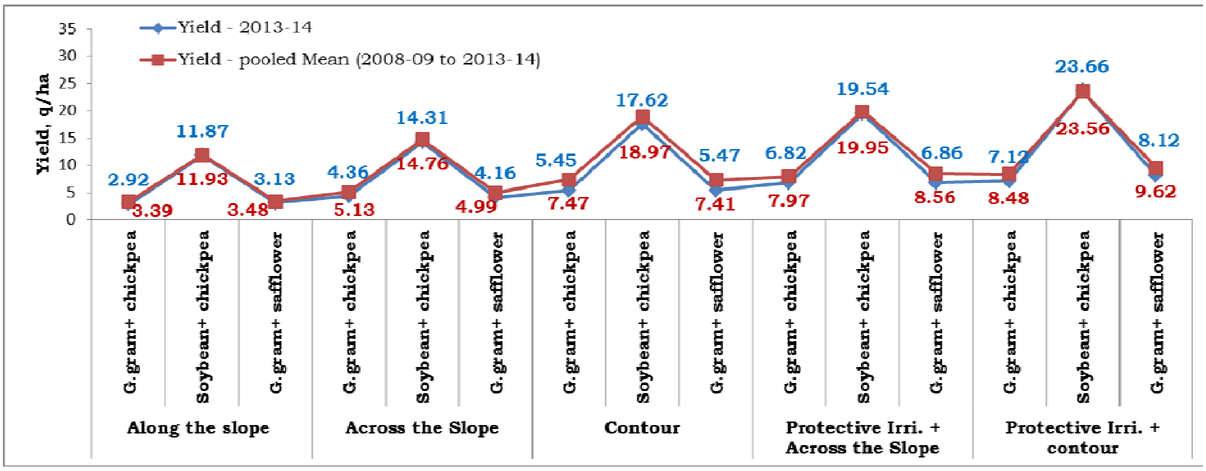

***Fig. 1:** Yield of different cropping system under various system of rain water management (2008-09 to 2013-14)*

The highest net return of Rs. 87076 per ha was obtained from soybean-chickpea cropping system which was highest over to the net returned received from green gram - chickpea (Rs. 68937/ha) and Green gram Safflower (Rs. 48784 per ha.) under two tier system of rain water management. Double cropping system of Green gram + Chickpea and Soybean + chickpea observed statistically at par in B: C ratio. Similarly highest B: C ratio and water use efficiency was recorded in green gram-chickpea cropping system over soybean- chickpea in two tier system followed by mono-tier system of rainwater management, similarly highest rainwater conservation was observed in contour cultivation followed by across the slope cultivation.

The highest gross returns of Rs. 1,15,865 and net return of Rs. 87076/ ha was obtained from the soybean - chickpea in two tier system of rain water management. The lowest gross returns of Rs.35,424 and net return of

Rs. 14,401/ha was found in the green gram-safflower cropping system with conventional system of moisture management (i.e. along the slope cultivation).

Table 1 shows that the production efficiency increased with increasing combination of moisture management practices under both the cropping systems.

Table 1: Production efficiency value under various moisture conservation practices

	Rain water management	Cropping system	Gram equivalent yield (kg ha^{-1})	Crop duration (days)	Production efficiency value (kg ha^{-1} day^{-1})	Production efficiency value (Rs ha^{-1} day^{-1})
Conventional	Along the slope	G.gram + chickpea	1384.13	175	7.92	3.47
		Soybean + chickpea	1501.84	205	7.33	2.58
		G.gram + safflower	1325.57	200	6.63	2.59
Mono tier	A/S	G.gram + chickpea	1812.71	175	10.35	5.72
		Soybean + chickpea	1758.19	205	10.81	5.96
		G.gram + safflower	1763.44	200	8.82	4.46
	Contour	G.gram + chickpea	2296.29	175	13.12	8.27
		Soybean + chickpea	2686.44	205	13.11	8.11
		G.gram + safflower	2199.33	200	10.99	6.45
Two tier	P I + A/S	G.gram + chickpea	3131.81	175	17.89	12.61
		Soybean + chickpea	3426.34	205	16.64	11.44
		G.gram + safflower	2549.28	200	13.41	7.87
	P I + contour	G.gram + chickpea	3486.03	175	19.92	14.45
		Soybean + chickpea	4034.56	205	19.68	14.25
		G.gram + safflower	2807.21	200	14.04	9.19
CD (p=0.05)			423.36	-	1.68	1.57

From the results it is concluded that the two tier system i.e. contour and across the slope cultivation with protective irrigation during dry spell in monsoon and moisture stress in winter is beneficial over mono tier system of rain water management. Thus, for the sustainable rainfed agriculture the two-tier rain water management system is beneficial in terms of productivity and net returns.

37.

Water Quality Index for Sustaining River Ecology: A Case Study of Two Hydropower Projects in Series on Satluj River

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Keywords: River ecology, water quality, turbidity

Introduction

Whereas water quantity is determined by a single parameter - the volume or rate of flow during a given time period, the water quality is described in terms of concentration of several constituents (20 odd common constituents to hundreds). Comparison of water quality in terms of a list of constituents is not easy. For example, a water sample containing six components in 5% higher than permissible (hence objectionable) levels; pH, hardness, chloride, sulphate, iron and sodium may not be as bad for drinking as another sample with just one constituent - mercury at 5% higher than permissible. Water quality indices (WQI) aim at giving a single value to the list of constituents and their concentrations present in a sample. In the present study, two existing indices proposed by National Sanitation Foundation (NSF), USA and Central Pollution Control Board (CPCB), India have been used for assessing the water quality status of Satluj river reach affected by two hydropower projects in series namely Nathpa Jhakri Hydropower Project (NJHEP) and Rampur Hydropower Project (RHEP). In addition, a new index (named as Satluj WQI due to its application in Satluj river) is proposed in the context of evaluating the river ecology status by incorporating the turbidity parameter in CPCB-WQI.

Materials and Methods

NSF-WQI is based on 9 water quality parameters i.e. dissolved oxygen (DO), Faecal coliform, pH, biochemical oxygen demand (BOD), nitrates, phosphates, temperature, turbidity and total solids. This index is primarily meant for assessing the water quality for drinking purposes. CPCB-WQI considers four parameters (DO, BOD, pH and faecal coliform) for the purpose of maintaining quality of river water for mass bathing and recreation only. Sediment concentration of flows downstream of dams and barrages is influenced; not only by the releases from the dam but also due to addition of sediments: (i) flushing from desilting chambers and (ii) runoff from mined areas and muck disposal sites. Thus, turbidity is an important parameter which must be considered while assessing the status of river ecology. In this context, a new index (Satluj-WQI) has been proposed with the inclusion of turbidity parameter in CPCB-WQI. The Satluj-WQI standard considering river bathing standards as per CPCB criteria and Aquatic Life Turbidity Criteria (for lean season and rainy season) as followed by Department of Ecology, State of Washington, USA (http: //www.ecy.wa.gov/ecyhome.html) have been found to be 55 (lean season) and 47 (rainy season) in this case.

Results and Discussion

The Satluj WQI at U/S of Nathpa dam, D/S of desilting complex of NJHEP, D/S of Jhakri and D/S of Rampur are compared in Fig. 1 (rainy season) and Fig. 2 (lean season). The Satluj WQI is higher than Satluj WQI standard at all the locations and also during rainy season and lean season. It is mainly because the water quality parameters (DO, BOD, pH, faecal coliform) are well within acceptable limits even though turbidity of Satluj river is very high. The excessive turbidity during the post-project condition will have adverse impact on the aquatic life. The lean season Satluj WQI at D/S of Rampur for the post-NJHEP and post-RHEP condition just meets the standard. This may be attributed to higher turbidity and higher faecal coliform expected in the post-RHEP situation.

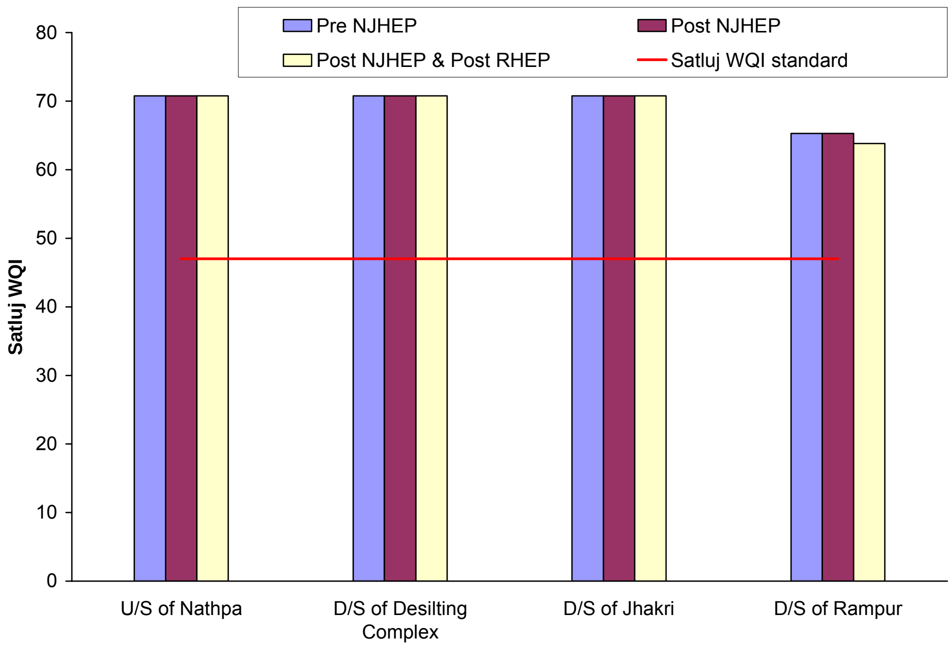

Fig. 1: Satluj WQI at various locations for pre and post-project conditions of NJHEP and RHEP during rainy season

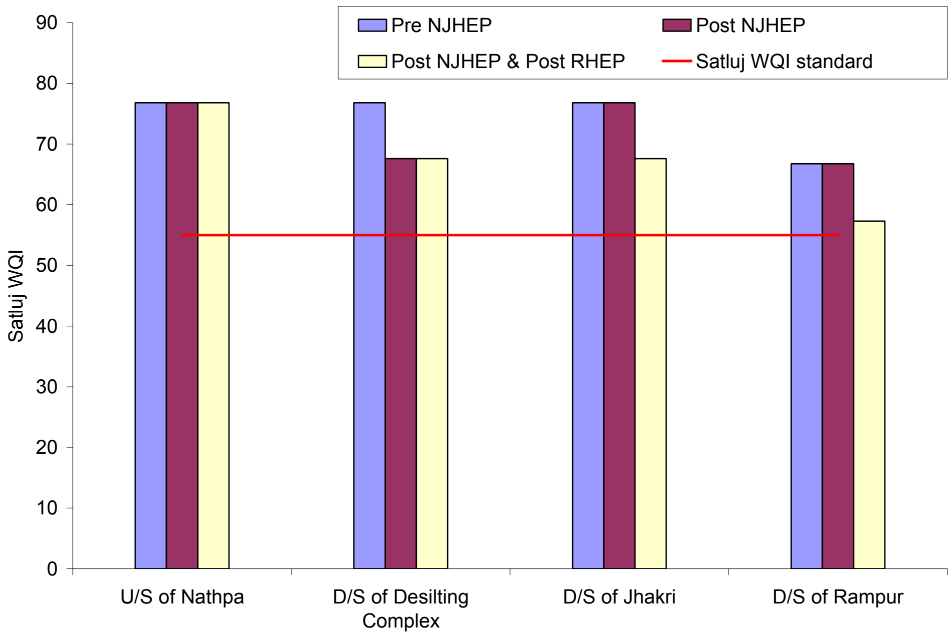

Fig. 2: Satluj WQI at various locations for pre and post-project conditions of NJHEP and RHEP during lean season

38.

Water Savings and Water Productivity Assessment through Quantification of Irrigation Water in Aerobically Grown Basmati Rice under Different Soil Organic Amendments

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Keywords: Basmati rice, water productivity, organic amendments, aerobic culture

Introduction

The availability of water for agriculture is declining due to more areas under high water requiring crops like rice (*Oryza sativa* L.). The scarcity of water has been creating a sense of insecurity among the rice growers and stress on judicious use of available water with kind motive to improve water productivity. Thus, an urgent need to search out for the alternative technologies wherein the rice crop is grown with less use of water like cultivation of rice in aerobic culture (Xue *et al.*, 2008). To ensure the success of aerobic rice cultivation, use of organic amendments may provide some relief by improving the water holding capacity as well as its retention for longer duration in the soil.

Materials and Methods

The experiment was laid out in a split-plot design with three replications at SKUAST-Jammu, Chatha. The main plot treatments comprised of four basmati cultivars namely Basmati-370, Basmati-564,Sannwal basmati and Ranbir basmati and sub-plots consisted of six treatments of soil organic amendments including control namely $T_{1:}$ Control (recommended fertilizer dose), $T_{2:}$ *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) on N-basis, $T_{3:}$ *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) followed by application of vermicompost on N-basis (1: 1), $T_{4:}$ *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) followed by application of vermicompost and mulching with *dhaincha* (*Sesbania aculeata*) on N-basis (1: 1: 1),T_5: *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) followed by application of FYM on N-basis (1: 1) and $T_{6:}$ *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) followed by application of FYM and mulching with *dhaincha* (*Sesbania aculeata*) on N-basis (1: 1: 1) as sub-plot treatments. To maintain aerobic conditions during crop growing period of rice, the depth of water for irrigation was fixed to 4 cm and irrigation was applied as and when the soil moisture depletion reached 50% of the field capacity based on soil feel appearance method standardized for sandy loam soil of the experimental field. The number of irrigations given to the crop and total irrigation water applied in different treatments are given in Table 1.

Table 1: Quantification of water under different soil organic amendments

Treatments of Basmati rice	Irrigation water used (l/ha/irrigation)	No. of irrigations applied	Total irrigation water applied (lakh l)	Water saved (%)	Water productivity (Kg/ha mm)
T_1	400000	6	24	Nil	10.08
T_2	400000	4	16	33.33	13.98
T_3	400000	4	16	33.33	13.27
T_4	400000	5	20	16.66	8.71
T_5	400000	4	16	33.33	13.29
T_6	400000	5	20	16.66	8.98

Results and Discussion

The basmati crop in treatments T_2,T_5 and T_3 registered a highest water saving to the tune of 8 lakh l/ha (33.33%) with a mean water productivity of 13.98 kg/ha mm, 13.29 kg/ha mm and 13.27 kg /ha mm and treatment T_1 (RFD) which received highest number of six irrigations with a mean water productivity of 10.08 kg/ha mm of basmati rice. From the results of the study it can be safely concluded that, though, all the treatments of soil organic amendments registered a saving in irrigation water over treatment T_1 but the water productivity recorded by treatments T_2,T_5 and T_3 is higher which signifies that supplementation of N through *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*); *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) and FYM (1: 1) as well as *In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) and vermicompost (1: 1) basis have been found better nutrient sources for improving water retention not only from control (RFD) but even from other treatment combinations of organic sources i.e T_6 (*In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) followed by application of FYM and mulching with *dhaincha* (*Sesbania aculeata*) on N-basis (1: 1: 1)) and T_4 (*In-situ* green manuring of *dhaincha* (*Sesbania aculeata*) followed by application of vermicompost and mulching with *dhaincha* (*Sesbania aculeata*) on N-basis (1: 1: 1).

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39.

Yield and Water Saving of Broccoli (*Brassica oleracea* var. *italica*) under Drip Irrigation and Mulch

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Keywords: Broccoli, drip irrigation, mulch, water saving.

Introduction

Quantifying the response of water demanding broccoli(*Brassica oleracea* var. *italica*) to irrigation and mulch is important for establishing the irrigation management strategies and water-savings. Drip irrigation may be an alternative of conventional irrigation due to its higher water use efficiency (Himanshu *et al.*, 2013).). Mulching is also useful in dry seasons for conserving moisture and nutrients in soil profile. The information on the judicious use of irrigation water with different mulches in broccoli production is scanty in West Bengal. Therefore, the present study was attempted to evaluate the effect of drip and surface furrow irrigations with mulches on yield and WUE of broccoli.

Materials and Methods

Field experiment was conducted at Bidhan Chandra Krishi Viswavidyalaya, Gayespur, West Bengal during winter seasons of 2011-12 and 2012-13 in split-plot design replicated thrice. Main plot treatments consist of four levels of irrigation such as surface irrigation with IW/CPE 1.0 and three drip irrigations at 1.0, 0.8 and 0.6 ETc (crop-evapo-transpiration), and three mulch levels like no mulch, black polythene (50 μ thickness) and paddy straw mulch @ 5t/ha in sub-plots. The volume of water for drip irrigation= Σ (daily pan evaporation× pan factor × crop factor × area of plot × percentage wetting - effective rainfall × area of plot)

Results and Discussion

The results showed that drip irrigation at 0.8 ETc showed significantly higher plant height (45.69 cm), no of leaves plant^{-1} (17.66), leaf size index (743.99 cm^2), plant spread (89.94 cm), curd diameter (14.43 cm) and marketable curd yield (17.82 t ha^{-1}) of broccoli, which was at par with drip at 1.0 ETc (Table 1). Minimum growth and yield was obtained with drip irrigation at 0.6 ETc in both the years. Similarly, significantly the higher plant variables and curd yield was obtained with use of black polythene mulch over paddy straw and no mulch treatments. However, drip irrigation at 0.6 ETc registered maximum water use efficiency of 117.31 kg ha-mm^{-1} and water saving of 38.43%. The interaction effect showed that drip irrigation at 0.8 ETc along with black polythene mulch produced significantly higher marketable curd yield.

It can be concluded from the study that drip irrigation at 0.8 ETc in combination with black polythene mulch gave the best results in terms of growth and yield of broccoli. Water use efficiency was recorded highest in drip at 0.6 ETc which was comparable with 0.8 ETc under the same level of mulch. Therefore, the water-saving drip technology can be promoted for cultivation of broccoli in the water scare regions of West Bengal.

Table 1: Effect of irrigation and mulch on growth, yield attributes and yield of broccoli (mean data)

Treatment	Plant height (cm)	No. of leaves Plant^{-1}	Leaf size index (cm^2)	Plant spread (cm)	Curd diameter (cm)	Marketable curd yield (t ha^{-1})
Irrigation level						
Surface irrigation IW/CPE 1.0	63.65	34.05	662.83	81.48	10.70	15.24
Drip 1.0 ETc	71.69	39.22	758.42	92.41	14.43	17.82
Drip 0.8 ETc	70.65	38.40	743.99	89.94	13.43	17.59
Drip 0.6 ETc	62.00	32.94	637.32	80.94	9.72	14.74
SEm (±)	1.21	0.43	12.41	1.51	0.36	0.27
CD	3.74	1.33	36.00	4.43	1.11	0.84
Mulch						
No mulch	61.06	33.79	661.71	78.54	9.69	14.93
Back polythene mulch	71.90	38.51	753.15	92.25	14.36	17.89
Paddy straw mulch	67.99	36.27	687.10	87.78	12.04	16.23
SEm (±)	1.25	0.46	13.28	1.64	0.40	0.31
CD	3.86	1.42	39.42	4.85	1.23	0.92

Reference

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40.

Comparative Limnological Study of Two Urban Lakes (Dal Lake and Bellandur Lake), India

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Keywords: Physico chemical parameters, Dala lake, Bellunder lake, ecosystem, statistics.

Introduction

Dal lake Srinagar Kashmir and Bellunder lake Bangalore are having a greater importance in their respective cities or we can say that they are the main water bodies in these cities. Dal lake is a Himalayan urban lake which is mostly used for tourism, it is India's most beautiful and second largest lake in the state of Jammu and Kashmir, the lake is surrounded by mountains on its three sides, the geographic location of lake is 34°18'N and 74°91'E and 1523 meters above sea level. Secondly the Bellunder lake providing water for irrigation, recreation, sports events, domestic use, commercial use, also situated on the extreme eastern part of Bangalore city located in Daccan plateau of south Indian peninsula, the terrain of region is relatively flat and sloping towards south of Bangalore city. Relative slope of region is found to be very gentle and gentle to gentle slope. the geographic coordinate of lake is 77°35′ west and 77°45′ east and latitude 12°50′ south and 13°00′ north. And contour height is 870 meters above mean sea level.

Aquatic ecosystem worldwide are being severely altered or destroyed at a rate greater than that at any other times in human history and far faster than they are being restored. Despite the fact, number of restoration plans by National and International agencies, there has been no significant improvement in lakes environment but the lakes condition as a whole continue to deteriorate at an alarming rate thereby threatening the very existence of the lakes besides posing serious health hazard to the people living within and around the lakes. The present study attempts to record physico chemical parameters of both lakes and then comparison of both lakes is made.

Materials and Methods

The sampling was done on monthly basis during forenoon (900-1200hrs). Three water samples were collected at three locations each from the three basins of the Dal lake and Bellundar Lake. Analysis was carried out according to standard methods (APHA, 1992), PH and conductivity (EC) of water sampes were determined by portable digital PH meter and conductivity meter respectively. DO, CO_2, chlorides and phosphates have been estimated by WINKLER method, titration method (Sodium carbonate), titration method ($AgNO_3$) and stannous chloride method respectively.

Results and Discussion

The lake water is slightly acidic for Dal Lake and for Bellandur Lake it is slightly alkaline. There is high amount of dissolved solids, which includes Phytoplankton (*Euglenophyceae members*), chlorides, Phosphate, and, other ions resulting in Turbidity in water body. For both the lakes the water has very less Dissolved Oxygen. This may be attributed due to high organic waste from Sewage and high algal growth. Chloride concentration in the Bellunder Lake is comparatively very high due to the faecal contamination and effluent/ sewage discharge into the lake. High phosphates in both the lakes may be due to agricultural activities in the catchment area and also sewage (detergents). This enhances the rate of Eutrophication in both the lakes.

Table 1: Physico chemical analysis report of Dal Lake

Sample site	pH	water temp (°C)	Ec (µs)	DO (mg/l)	CO_2 (mg/l)	chloride (mg/l)	Phosphate mg/l
Nagin	8.1	8.1	250	5.4	1.8	9.9	0.16
Hazratbal	7.6	8.0	247	6.3	2.3	1.4	0.15
Bod Dal	7.4	8.2	243	6.2	2.1	15.2	0.16

Table 2: Physico chemical analysis report of Bellandur Lake

Sample site	pH	Water temp (°C)	Ec (µs)	DO mg/l	CO^2 mg/l	chloride mg/l	Phosphate mg/l
Site A	7.76	28.4	950.00	1.91	14. 3	115.33	0.41
Site B	8	28.4	956.00	1.48	8.88	115.73	0.37
Site C	6.14	29.8	934.00	6.43	10.6	112.92	0.46

The present investigation of both lakes reveals that the both lakes are under extreme environmental stress. the main stress is due to the unplanned developmental activities in the catchment area which directly have negative affect on the respective lakes because both lakes are urban and have greater importance in their respective cities i.e. Dal lake Kashmir and Bellandur lake Bangalore, by our investigations I have seen and analyzed that the lakes need proper planning for rejunavation and for the survival of ecosystem and ecological balance.

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41.

Application of SWAT Model for Runoff and Sediment Yield Prediction for Savitri Basin in Maharashtra (India)

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Keywords: Rainfall, evaporation, digital elevation model, regression coefficient, Nash coefficient

Introduction

The Soil and Water Assessment Tool (SWAT) (Arnold *et al.* (l998) and Neitsch *et al.* (2001a) is a distributed parameter, continuous time hydrologic model applicable mainly for agricultural watersheds. It is one of the most recently developed physically based distributed parameter hydrologic long term model by merging SWRRB and ROTO into one watershed scale under the USDA-ARS continuing efforts in NPS pollution modeling and evaluation. The present study deals with the evaluating the performance of SWAT model for forecasting surface runoff and sediment yield from Savitri basin catchments of Konkan region receiving heavy rainfall during monsoon period. Total runoff data of Savitri basin from 1991 to 2011 (21 years) were used to evaluate the model out of which data from 2005 to 2011 (7 years) were used for forecasting the surface runoff and sediment yield was also predicted for same duration but calibrated by considering the data of Birwadi Station.

Materials and Methods

The SWAT-12 model was run to prediction of runoff and sediment yield for Savitri Basin. The inputs were used as Digital elevation model (DEM), Land used and cover map, Soil map and weather data of study area included as rainfall, temperature (max and min), evaporation, humidity, wind velocity (max and min), etc. The gauged data of study area as streamflow on daily basis and sediment yield data collected from Superintending Engineer, Hydrology Unit Division, Nashik, for duration of 1991 to 2011. These data were used input to the SWAT-12. The land phase of the hydrologic cycle is based on the following water balance equation. The flowchart for operation of SWAT model is given in Fig. 1. The Savitri basin was auto delineated into 29 sub basin by the model taking to account suggested flow accumulation threshold of 99663 ha, and which were further divided into 71 Hydrology Response unit (HRUs). Each HRU was evaluated by the multiple hydrologic response unit option by considering land used cover area of each sub catchments 30 per cent and soil class as 30 per cent and slope parameter 30 per cent found to be optimal for the study area. The simulated runoff and sediment yield from Savitri basin was compared with the runoff measured at Mahad hydrologic station. The SWAT model was run on daily time step for prediction of Runoff with inputs parameter and calibrated for their performance.

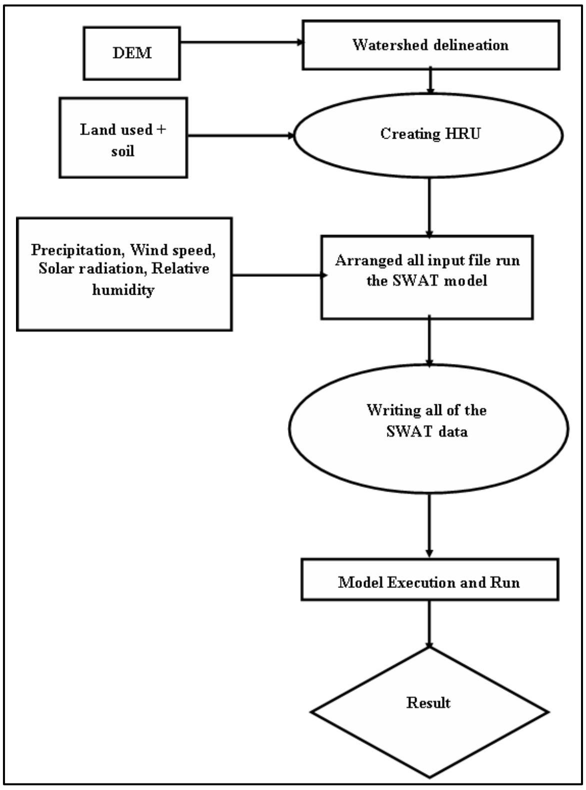

Fig. 1. Flow chart for operation of SWAT model

$$SW_t = SW_0 + \sum_{t-1}^{t}\left(R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw}\right) \quad \text{.......... (1)}$$

Where,

SW_t= final soil water content, mm; SW_0= initial soil water content, mm;
t= time, days; R_{day}= daily rainfall, mm;
Q_{surf}= daily surface runoff *i,* mm; E_a= daily mean evapotranspiration, mm;
W_{seep}= amount of percolation and by pass flow exiting the soil profile bottom, m;
Q_{gw}= amount of return flow (mm); and *i* is the index for day.

Results and Discussion

The performance of the SWAT model during calibration period and forecasting period for Savitri basin was evaluated using adopted statistical indices presented in Table 1. It is observed that, regression coefficient (R) value during calibration period was 0.974 whereas during forecasting period it was 0.961. The Root Mean Square Error (RMSE), Coefficient Error (CE), Volumetric Error (EV), Mean absolute deviation (MAD) and Mean absolute percentage error (MAPE) were 38.56 cumecs, 91.97 per cent, 17.62 per cent, 3.44 per cent and 1.29 per cent during the calibration period, whereas during forecasting period were 38.73 cumecs, 91.54 per cent, 7.61 per cent, 4.15 per cent and 4.89 per cent respectively. These statistical indices values are found within the appropriate range. The R value approaching to 100 indicates better model performance during calibration and forecasting period. The RMSE value remains nearly same but lowest value indicate the model performed better. The higher RMSE values indicate that the model over or under estimate the runoff. The other statistical indices such as - CE, EV, MAD and MAPE values were found in the acceptable range. The higher value of CE which approaches to 100 means the model performance is better similar results were observed for SWAT model while simulating runoff during calibration and forecasting period. The EV value approaches to the zero means the model performing well. In present study the similar results were obtained of Savitri basin for runoff simulation during calibration and forecasting period. The EV is comparatively low in case of forecasting compared to calibration period. The MAD and MAPE approaching to one indicate the model is performing well. It is observed that the daily observed and predicted runoff during calibrated period were 120.51 cumecs and 137.50 cumecs whereas during forecasting period it is 127.8 cumecs and 142.8 cumecs, respectively. The percentage deviation between observed daily average runoff and predicted daily runoff during calibration and forecasting period were 14.09 per cent and 11.73 per cent. It is revealed from study that the SWAT model over predict the runoff as compared to observed runoff for Savitri basin. The sediment yield simulated by SWAT for Savitri basin during calibration and forecasting period estimated using SWAT-12. It is observed that, the sediment yield is fluctuating with changing the rainfall pattern and amount. The more the rainfall the sediment yield peak is also changes and increases. But it is also observed that the sediment concentration found to be more in initial period of storm or during growing season and reduces during the recession season. The daily average sediment yield was predicted during calibrated and forecasting period for Savitri basin was 232.90 Tons/day and 273.56 Tons/day, respectively.

Table 1: Statistical performance of SWAT model for Savitri basin to predict runoff during calibration and forecasting period.

SWAT Model	R	RMSE	CE	EV	MAD	MAPE
During Calibration (1992 to 2004)	0.974	38.56	91.97	17.62	3.44	1.29
During forecasting (2005-2011)	0.961	38.73	91.54	7.61	4.15	4.89

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42.

Soil Moisture Dynamics during Intervening Periods of Rice-Wheat Sequence as Affected by Different Establishment Methods

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Keywords: Soil moisture dynamics, establishment methods, intervening periods, rice wheat sequence.

Introduction

Delineation of soil moisture dynamics during the intervening cropping periods perhaps the most ignored aspect as the scientists were busy in analysing the effect of already applied treatments onto the land and water productivity, which could be exploited for cultivating the intervening crops *viz.* moong. Moreover as per our knowledge there is no information available which expressed the residual effect of the applied treatments during cropping season onto the soil moisture dynamics during intervening period. We delineate the soil moisture dynamics during four intervening periods.

Materials and Methods

The present investigations were carried out during intervening periods of wheat 2012-13 and rice 2013; rice 2013 and wheat 2013-14; wheat 2013-14 and rice 2014 and rice 2014 and wheat 2014-15 using time domain reflectrometer, electronic tensiometers, soil thermometers (upto 0-10 cm) and mini-lysimeters to delineate soil moisture dynamics as affected by different establishment methods of rice and wheat sequence.

Results and Discussion

Zero tilled wheat plots (ZTW) evaporates 7.6% and 12.8% more, retained 10.3% and 9.4% lower volumetric moisture content at 7.5 cm soil depths and reported to had 28, 18 and 18% and 21, 16 and 17% higher soil tension values at 10, 20 and 30 cm soil depths because of reported 2.2% and 2.1% higher soil temperature than the conventionally tilled (CT) wheat plots during intervening periods after wheat 2012-13 and wheat 2013-14. However, after rice 2013, ZT plots reported to conserve 4.0% higher moisture content because of reported 2.3% lesser soil temperature which evaporates 27.6% lesser after rice 2013. On an average, CTWDSRCT plots had 14, 29 and 45% lower SWT values than the ZTWDSRZT plots after rice 2013. However, after rice 2014, CTW-DSRZT (conventionally tilled wheat and zero till direct seeded rice) plots conserved more moisture than ZTW-DSRZT (zero till wheat and zero till direct seeded rice) plots an exception of CTWDSRCT plots which were almost equally effective in conserving the soil moisture (Fig. 1). On an average, soil matric tension (SMT) reported to be 36% higher in CTWDSRZT than CTWDSRP plots at 10cm soil surface. Further, ZTW-DSRZT plots on an average dried 8% faster than ZTW-DSRP plots. At 20cm, DSRZT plots dried 3% faster than its allied plots while at 30cm depth, in DSRP plots, SMT values increased 12% and 11% higher under CTW block and ZTW blocks, respectively than its allied plots. SMT readings in all the ZTW plots on an average increased at much more faster rates (24%) than CTW plots. The ZT plots had 1.4% higher water depths than the CT plots. Evaporation losses pragmatic to be higher (17.2% and 7.3%) in ZTW-DSRZT plots as compared to the ZTW-DSRCT and CTW-DSRCT plots which might improved declining crop and water productivity in the region.

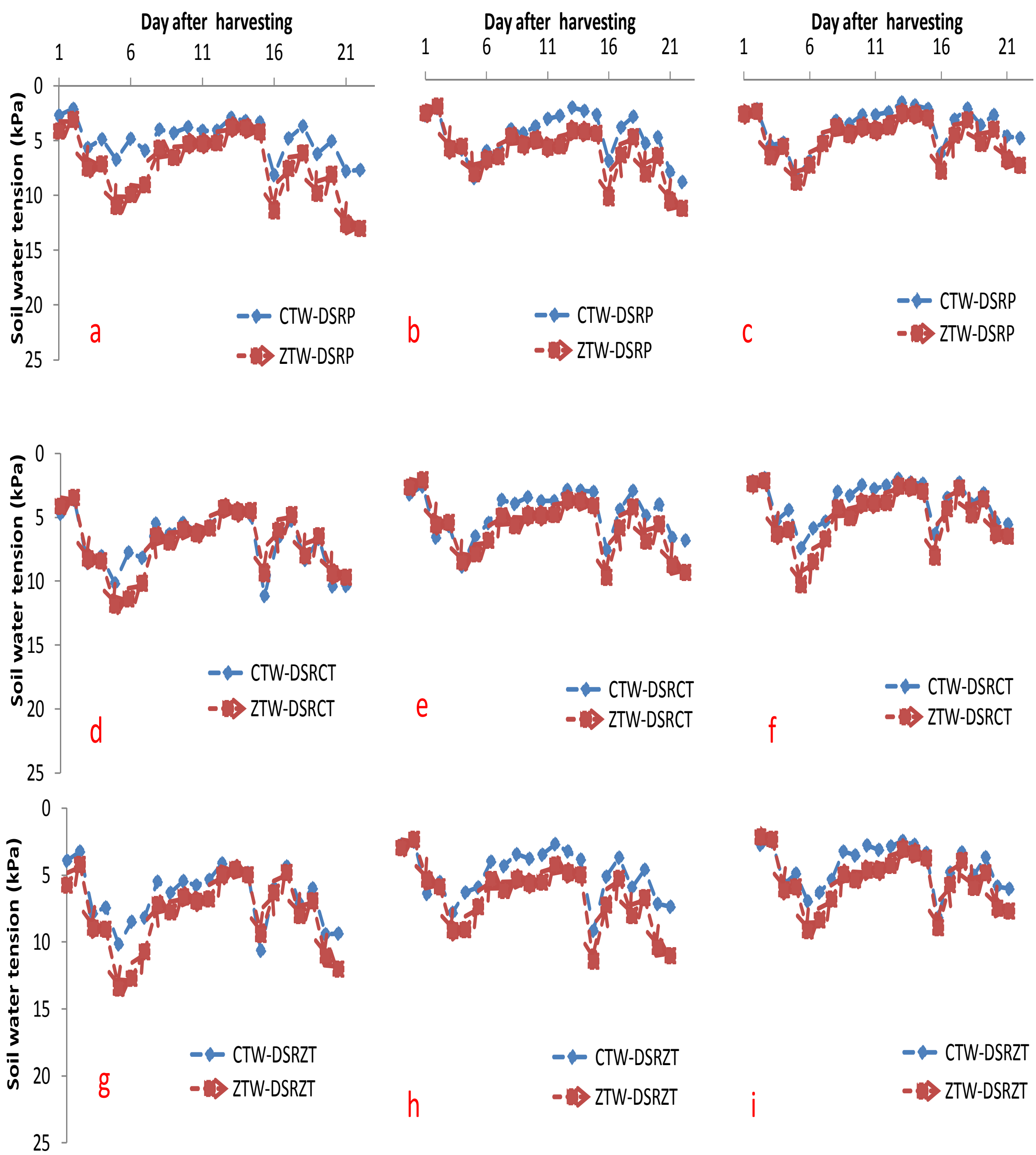

Fig. 1: Temporal fluctuations in soil matric potential after rice -2014 in CTWDSRP vs. ZTWDSRP from 10-30 cm soil depth (a-c), in CTWDSRCT VS ZTWDSRCT from 10-30 cm soil depth (d-e) and CTWDSRZT vs. ZTWDSRZT from 10-30 cm soil depth (g-i)

43.

Methane and Nitrous Oxide Emission from Soils of Kumaoun and Garhwal Divisions of Uttarakhand

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Keywords: Methane, nitrous oxide, Uttarakhand

Introduction

The suspected danger of climate change associated with increasing atmospheric ratio of CH_4, N_2O and CO_2 requires assessing the emission potential of soils and developing certain inexpensive mitigation techniques to reduce the emission of these gases from the fields of different crops without any adverse effect on the yields. Therefore, two hundred eighty four soil samples of *Tarai* (plain), *Bhawar* (sub-Montane) and Hilly region of Kumaoun and Garhwal divisions of Uttarakhand state were collected from government and university farms and farmers fields of Almora, Bageshwar, Champawat, Nainital, Pithoragarh, Udham Singh Nagar, Dehradun, Hardwar and Pauri Garhwal districts (Fig. 1) growing rice, wheat or potato crops.

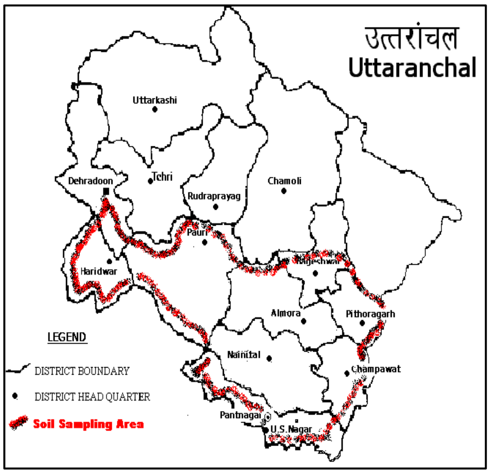

Fig. 1: Districts of Uttarakhand showing soil sampling area

Materials and Methods

These soil samples were processed and analyzed for EC, pH, OC, available N, P and K through standard procedures and incubated for one month in gas drawing device (Fig. 2) for methane and nitrous oxide emission at submergence and field capacity moisture conditions. The emitted methane and nitrous oxide from inculcated soils at zero time and one hour time was collected and analyzed by gas chromatograph and calculated by using weight of soil, volume of air sample, concentration and molecular weights of CH_4 or N_2O and volume of head space upon the soil in the device. The gas concentration at zero time was subtracted from the gas concentration at one hour to get the amount of gas emitted during one hour time period.

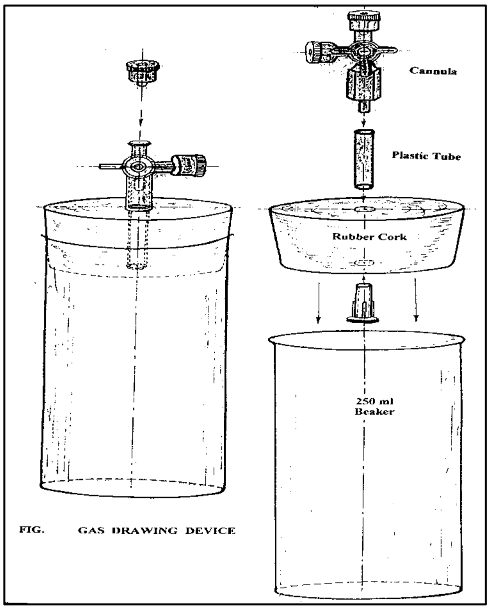

Fig. 2: Gas Drawing Device

Results and Discussion

The results indicated that most of the soils were under low to medium available nitrogen and medium to higher range for organic carbon, available phosphorus and potassium. The farmers were advised about various methods to increase the available nitrogen status of their soils to achieve good yields of crops. There was no emission of nitrous oxide from these soils. Some soils recorded negative emissions or absorption of methane. The average methane emission at field capacity was low as compared to submergence moisture which indicated that continuous submergence of soil for one month drastically increased the methane emission. The pooled mean of methane emission at submergence and field capacity moisture conditions indicated that submerged condition emitted 135.66 x 10^{-4} mg kg^{-1} h^{-1} as compared to field capacity, which emitted only -14.51 x 10^{-4} mg kg^{-1} h^{-1}. In the submerged conditions the average methane emission was maximum in E_3 block, Crop Research Centre (CRC) Pantnagar soils (1305.72 x 10^{-4} mg kg^{-1} h^{-1}) and minimum in Shukla farm, Sitarganj soils (-38.33 x 10^{-4} mg kg^{-1} h^{-1}). In the field capacity condition the average methane emission was maximum in Someshwar soils (42.89 x 10^{-4} mg kg^{-1} h^{-1}) and minimum (-277.73 x 10^{-4} mg kg^{-1} h^{-1}) in village Gumod Baparu, Champawat soil. Although the results are quite useful for this newly carved state, but soil of remaining districts should also be collected and analyzed for all green house gases to prepare a well informative data base.

44.

Effect of Various Mulching on Soil Properties and Fruit Quality Attributes of Eureka Lemon (*Citrus Limon* Burm) in Dryland Area of Jammu

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Keywords: Soil properties, mulching and quality attributes.

Introduction

In Eureka lemon (*Citrus limon* Burm*)* has become the important fruit crop of rainfed condition of arid and semi arid region of the country because of its thornlessness and heavy bearing nature. In rainfed areas the major constraints are moisture stress, inherently poor soil fertility and undulating topography. The conservation of soil moisture by application of mulches becomes essential for portable cultivation under rainfed condition. Mulches not only conserve soil moisture but also impart manifold beneficial effect, like suppression of extreme fluctuation of soil temperature, reduce water loss through evaporation, resulting more stored soil moisture, maintenance of soil fertility, improvement in growth and yield. Organic mulches are also improved the organic matter content of soil and better soil aeration. Moreover, mulching by plastic polyethylene has proved its effectiveness in conserving the soil moisture and increasing the growth, yield and quality in different citrus cultivars.

Materials and Methods

A study was carried out at Rainfed Research Sub-Station for Sub-tropical fruits Raya, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in 2010-11. Two years old plants of air layered Eureka lemon which were planted in 2007 at a distances of 5m x 5m was treated with different types of mulches. The treatments were: $T_{1,}$ Bajra straw, $T_{2,}$ Maize straw, $T_{3,}$ Grasses, $T_{4,}$ Brankad, $T_{5,}$ Farmyard manure, $T_{6,}$ Black polyethylene and $T_{7,}$ control (no mulch). Ten centimeter thick mulches viz bajra straw, maize straw, grasses, brankad, farmyard manure and inorganic mulching 400 gauges black polyethylene was spread on plant basin during April. The significance of soil analysis and fruit analysis was calculated by Randomized block design (RBD) with help of SPSS 16.0.

Results and Discussion

The highest soil organic carbon content and available nutrients of nitrogen, phosphorus and potassium was significantly increased in farmyard manure followed by brankad (*Adhotada vassica*), maize straw, bajra straw, grasses and lowest in black polythene mulch of tree basin in both the years (Table 1). The TSS% was significantly increased in black polythene and was lowest in control. The fruit yield of black polyethylene, farmyard manure, brankad, maize straw, bajra straw and grasses mulches 15.9, 12.4, 10.6, 9.3, 8.2 and 7.1% higher than that of without mulch. Thus it may be concluded that the farmyard manure is increase in soil organic matter due to limited population of domestic animals it may not be sufficient for mulching in *kandi* areas. The black polyethylene sheets are poor aeration, non decomposable nature and high cost are the constraints for local farmers. The beneficial effect of the brankad (*Adhotada vassica*) is the biodegradable nature, locally and easily available materials in these areas. This is a viable option under rainfed condition for improving the soil properties, higher production and fruits quality.

Table 1: Effect of various mulching on soil properties and fruit quality attributes of Eureka lemon

Treatment	SOC	Available nutrients			Yield /plant (kg	TSS (%)
		Nitrogen	Phosphorus	Potassium		
Bajra straw	5.42	226.00	19.12	159.82	4.25	6.50
Maize straw	5.95	230.25	19.45	163.75	4.30	6.55
Grasses	5.22	223.13	18.79	155.89	4.20	6.62
Brankad (*A. vassica*)	6.17	233.75	19.70	166.55	4.36	6.42
Farmyard manure	6.70	238.75	20.56	174.70	4.45	6.57
Black polyethylene	4.15	213.25	17.67	152.18	4.62	6.77
Control	4.33	215.00	18.14	153.52	3.90	6.30
SEm±	0.03	2.00	0.45	1.04	0.02	0.02
CD (p=0.05)	0.08	6.00	1.36	3.14	0.08	0.07

45.

Salinity Stress Induced Changes in Physiological and Reproductive Performance of Chickpea Genotypes

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Keywords: Osmotic potential, lipid peroxidation, proline, ovule receptivity

Introduction

Chickpea (*Cicer arietinum* L.) belonging to family fabaceae, is an important cool season pulse crop contributing 39% to the total production of pulses in the country. Salinity whether of soil or water is a great problem to agriculture throughout the world Problem of soil salinity is further aggravated because of use of poor quality water for irrigation and poor soil drainage properties. Salinity adversely affects both qualitative and quantitative features of male fitness i.e. number of pollen produced, their viability, germination and male fecundity (Dhingra and Verghese, 1986) and finally seed quantity and quality (Dhingra *et al.*, 1996).

Materials and Methods

The present investigations was conducted on three chickpea genotypes (*Cicer arietinum* L.) namely CSG 8962, HC-5 and C235, differing in their relative salinity tolerance. Osmotic potential was determined using psychrometric technique (Model 5100-B Vapor Pressure Osmometer, Wescor Inc. Logan, Utah, USA). malondialdehyde (MDA) *In vitro* pollen germination and tube growth was assessed on the semi-solid medium contained in petriplatesThe sodium (Na^+) and potassium (K^+) contents of leaves and nodules were determined from oven dried ground material using diacid mixture. Na^+ and K^+ contents were estimated using the flame photometer (Elico, India) and further expressed on Na^+/K^+ ratio.

Results and Discussion

Saline irrigation resulted in decrease in RWC (%) of roots and nodules significantly. The more '-ve' value of Ψ_s of root and nodules (Table 1) and higher accumulation of proline and TSC (Table 2) in different plant parts helped in maintaining the RWC (%).MDA content increased in all the genotypes with salinity; the increase MDA being more in leaves of C235 and in root of HC-5. Salinity induced accumulation of total soluble carbohydrates in root and nodules. Total soluble carbohydrate content increased with saline irrigation, the increase was higher in CSG 8962 amounting to nearly double of the content of C235 (73.65%) at 9.0 dSm^{-1} over respective control. K^+/Na^+ ratio decreased in all the parts, decrease being minimum in CSG 8962 and maximum in C235. Pollen viability, *in vitro* germination and tube length decreased with increase salinity in all the genotypes while salinity did not affect ovules number and its receptivity.

Table 1: Effect of saline irrigation on osmotic potential (-MPa) in root and nodules of chickpea genotypes after 10 days of treatment.

Salinity level (dSm-1)	Roots			Nodules		
	Genotypes			Genotypes		
	CSG 8962	HC-5	C235	CSG 8962	HC-5	C235
Control	0.51	0.56	0.50 0.52	0.91	0.75	0.53
3.0	0.73	0.75	0.54 0.67	0.87	0.81	0.67
6.0	0.88	0.86	0.62 0.78	1.11	0.86	1.21
9.0	1.02	0.82	0.89 0.91	1.19	0.81	1.31
Mean	0.78	0.74	0.64	1.02	0.81	0.93
CD at 5%	Genotypes	=	0.061	Genotypes	=	0.084
	Salinity	=	0.070	Salinity	=	0.097
	Genotypes x Salinity	=	0.122	Genotypes x Salinity	=	0.168

Table 2: Effect of saline irrigation on proline content in root and nodules of chickpea genotypes after 10 days of treatment.

Salinity level (dSm^{-1})	Roots				Nodules			
	Genotypes				Genotypes			
	CSG 8962	**HC-5**	**C235**		**CSG 8962**	**HC-5**	**C235**	
Control	0.112	0.068	0.064		0.098	0.079	0.091	
3.0	0.118 (5.35)	0.073 (7.35)	0.080 (25.00)		0.106 (12.24)	0.082 (3.79)	0.130 (42.85)	
6.0	0.121 (8.03)	0.096 (41.17)	0.137 (114.00)		0.283 (188.77)	0.178 (125.33)	0.164 (80.21)	
9.0	0.152 (35.71)	0.198 (191.00)	0.184 (187.50)		0.326 (232.65)	0.230 (191.10)	0.283 (210.90)	
Mean	0.201	0.108	0.116		0.203	0.142	0.167	
CD at 5%	Genotypes	=	N.S.		Genotypes		=	0.023
	Salinity	=	0.037		Salinity		=	0.027
	Genotypes x Salinity	=	N.S.		Genotypes x Salinity		=	0.027

46.

Traditional Methods of Maintaining Soil Health in Poonch District of North-West Himalayas

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Keywords: Traditional methods, organic recycling, soil health, North-Western Himalayas.

Introduction

Poonch is one of the hilly, tribal, remote and border districts of Jammu and Kashmir (J&K) in the North-Western Himalayas. Mostly, farmers of the district are economically backward and uneducated belonging to *Gujjar* (who tend cattle and buffaloes) and *Bakarwal* (who rear sheep and goats) communities. The traditional methods of maintaining soil health practiced by the *Gujjars* and *Bakarwals* were documented under this study.

Materials and Methods

To understand and document the traditional methods of maintaining soil health, an intensive field study was undertaken among the farmers of *Gujjar* and *Bakarwal* communities in purposively selected ten villages of Poonch district. Elders, both men and women were consulted and their narrations on various concepts of maintaining soil health were recorded.

Results and Discussion

Gujjars and *Bakarwals* are fully aware of the fact that regular recycling of organic wastes in the soil is the most efficient method of maintaining optimum levels of soil organic matter. Application of Farm Yard Manure (FYM), locally called as *goha or pah,* is one of the most useful and significant indigenous methods practiced by the *Gujjar-Bakarwal* almost in every village of the district from ancient time (Table 1). *Gujjasrs* and *Bakarwals* also put into practice their traditional knowledge of *in-situ* manuring. In this practice cow, buffalo, sheep and goats are used to left in open fields for 2-3 days for their dung and urine. *In-situ* manuring is mainly employed before the sowing of *Rabi* crops (winter crops) at higher altitudes where people had large number of sheep and goats.

Spraying of ash is another common and indigenous practice followed by the *Gujjar* and *Bakarwal* communities. Through this practice, they also enrich soil in its phosphorous content for the next crops. The amount of ash applied has not been yet quantified but mainly practiced for crops like onion (*Allium cepa* L.), garlic (*Allium sativum* L.), coriander (*Coriandrum sativum* L.), and spinach (*Spinacia oleracea* L.).

The indigenous methods of maintaining soil fertility by increasing the soil faunal diversity (earthworms, ants, arthropods, nematodes, mycorrhiza etc.) are the time tested ones by the *Gujjar* and *Bakarwal* communities of the North-West Himalayas. Keeping agricultural land fallow for a brief period of 4-6 months is also a general practice in the rain-fed areas located at higher altitudes like Mandi, Loran, Chandimarh, etc. No crop is cultivated during *Rabi* season due to extreme cold from December to March as fields remain covered with heavy snow that leads to very low temperature. Farmers well recognized that fallowing of land provide time to soil for convalescence, which otherwise gets exhausted due to intensive cropping. Terracing is another critical aspect of rain-fed agriculture in the hilly areas of Poonch district. They not only substantially reduce erosion but also make it easier to carry out practices like zero tillage.

Table 1: Traditional methods of maintaining soil health practiced by the *Gujjars* and *Bakarwals* alongwith their scientific rationale

Traditional Methods	Scientific Rationale
Application of Farm Yard Manure (FYM), locally called as *goha or pah*	Maintaining optimum levels of soil organic matter and plant nutrients
In-situ manuring	Reduction in transportation cost of manures to the fields located at higher altitudes
Spraying of ash	Enrichment of soil in phosphorous
Increasing the soil faunal diversity	Increasing soil biological activity
Fallowing of land	providing time to soil for convalescence
Terrace cultivation	Reducing soil erosion

The above descriptions are just a few of the hundreds of traditional eco-friendly soil health management practices performed by the *Gujjar* and *Bakarwal* farmers of Poonch district (Table 1). The uniqueness of these practices is their suitability to the local conditions, their economic feasibility and easy implementation.

47.

Imparting Resilience in Soil through Vermicomposting

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Keywords: Climate change, National Initiative on Climate Resilient Agriculture (NICRA), vermicompost

Introduction

Krishi Vigyan Kendra Pulwama has adopted village Wakherwan under the National Initiative on Climate Resilient Agriculture (NICRA) project. The main aim of this project is to help agriculture to cope up with the changing climate and climatic vulnerability through research and technology demonstration. To introduce corrective measures in the adopted village at Wakherwan, Pulwama as per NICRA guidelines, vermicomposting has been carried out in the village that will help the farmers to adapt to changing climate. Vermicomposting has applications that can reduce global warming. Vermicompost is entirely natural organic product, cheaper than chemical fertilization, pollution free and highly economical and profitable.

Materials and Methods

A training programme was conducted on low cost vermicomposting units and villagers were motivated for undertaking vermicomposting in order to improve the productivity of agricultural lands. The farmers had enough raw materials available in the form of cow dung and farm waste which could be readily used in these vermicompost units. A total of 10 vermicompost units were constructed in the village. Farmers were assisted in constructing the vermicompost units and all the material needed for constructing the pits were provided. Regular inspection and guidance was provided to the beneficiaries whenever required.

Results and Discussion

A total 112.5 qunital of vermicompost in 2 batches was produced from the vermicompost pits. When this organic manure was used in the fields, the quality of the fruits and vegetables (fruit size and color) and vegetable seed germination increased in comparison to farmers practice in the area. Improvement has been observed in soil health because it reduces application of chemical fertilizers, soil crusting and increases soil moisture retention and its availability for crop growth. Vermicomposting has been adopted by the farmers in the Wakherwan village and have shown keen interest for the same.

Table 1: Economic Benefits from the introduction of Vermicompost Units

Inter-ventions	Technology demonstrated	Critical input (Variety, Fertilizer / Chemicals doses)	No. of farmers	Area (ha)	Measurable indicators of output	Economics of demonstration (Rs./ha)				Remarks
						Gross Cost	Gross Return	Net Return	BCR	
Low-cost Vermi-compost	Vermi-composting	Vermiculture, cow dung, Farm waste, Kitchen wastes, Tin sheets, Labor	5	15x10 feet	112.5 qlts vermi-compost @ 2 batchs	52000	140625	88625	1: 2.70	Five (5) vermicompost units damaged due to unseasonal rainfall and snow.

48.

Spatial Variability of Oxidizable Soil Carbon and Mineralizable Nitrogen in Jammu District of Jammu and Kashmir, India

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Keywords: Soil mapping, spatial variability, mineralizable nitrogen, oxidizable soil carbon, Jammu district

Introduction

Soil testing provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for maximizing crop yields and enhancing returns. GIS (Geographical information system) technique is now widely used to delineate variation in soil properties as well as their mapping. A soil fertility map for a particular area can prove highly beneficial in guiding the farmers, manufacturers and planners. It, however, must first address the measurement and understanding of variability. A study was conducted to assess the spatial variability of oxidizable soil carbon and mineralizable nitrogen and bring out their prediction maps for Jammu district.

Materials and Methods

Soil samples were collected from the entire Jammu district on a directed sampling basis representing multiple land use /land cover systems and were analysed in the laboratory for oxidizable soil carbon and mineralizable nitrogen using standard procedures. The data was subjected to geo-statistical analysis and final maps of individual soil properties were generated using interpolation techniques in ArcGIS 9.2.

Results and Discussion

Wide variations in soil properties were observed. Topography, vegetation and management practices seem to be the major factors contributing to their variability. Soil fertility maps provide clear information on the patterns and trends with respect to individual soil properties. Interesting variations with respect to soil organic carbon content were observed (Fig. 1). Based on the limits for OC i.e. low (<0.50%), medium (0.50-0.75%) and high (> 0.75%), the soils were in general low in organic carbon content in the cultivated *kandi*areas of Vijaypur, Purmanadal, Dansal and Khore blocks. The northern areas of the Jammu district had relatively higher organic carbon content owing to the natural agro-forestry systems as well forests here. In fact more than 1.0% organic carbon was observed in soils under the forests. In the southern blocks of RS Pura and Bishnah, it varied between medium to high.On the whole, majority of the soils of the district were low (<280 kg/ha) in available nitrogen (Fig. 2). Areas showing medium (> 280 kg/ha) N content could be largely because of management practices (relatively high application of N fertilizers). The areas under low N content were subdivided further to get a clear picture of the N status. As in case of OC, the cultivated and degraded *kandi* areas had N content of less than 190 kg/ha.

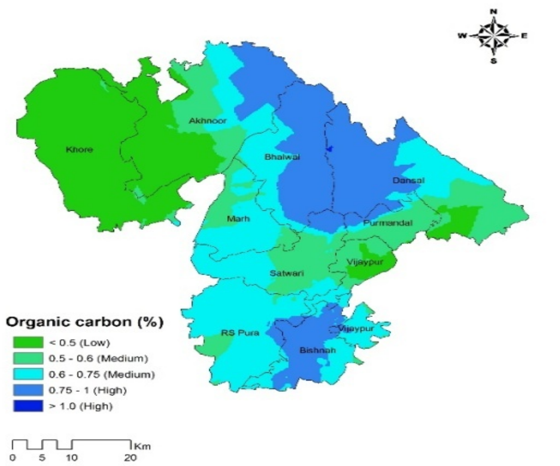

Fig. 1: Oxidizable soil carbon map of Jammu district of J&K

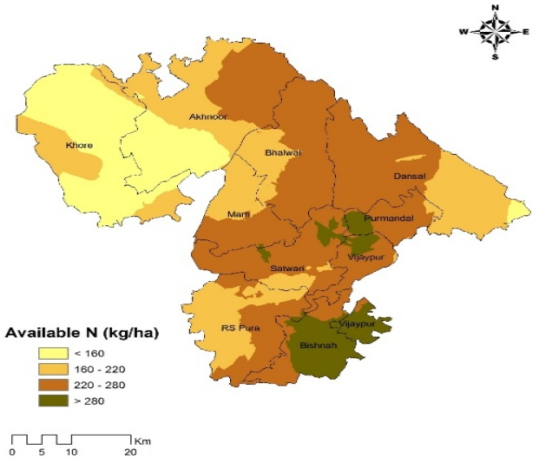

Fig. 2: Mineralizable nitrogen map of Jammu district of J&K

49.

Effect of Water Use Policy on the Optimum Design of Tank System in Watershed

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Keywords: Watershed, tanks, rainwater harvesting, irrigation, semi-arid

Introduction

Different water storage structures in the form of nala bunds, percolation tanks, farm ponds are constructed on the drainages lines in the watershed. The water in these storage structures is used for either groundwater recharge or irrigation to the crops or for both purposes. But the sizes of these tanks and their locations will change according to the water use policy from these tanks. At present these tanks are located and designed in the watershed with experience and thumb rules. But with the help of the 'SOFTANK' model it is possible to decide their locations and design these tanks based on the water use policy. The SOFTANK (Simulation Optimization For Tanks) model is developed for designing tank system based on the concept of integrated water storage system in the watershed. With the help of this model it is possible to analyze different scenarios that arises due to combination of different tanks, their locations and their water use policy. In this paper comprehensive analysis is given where the SOFTANK model is applied for Pimpalgaon Ujjaini watershed in Ahmednagar district of Maharashtra state. Two tanks with different tank locations and water use as groundwater recharge or irrigation is considered.

Materials and Methods

A comprehensive methodology is developed to optimally design tank system for the watershed which takes into account three water storages i.e. soil water, surface water and groundwater. Different options resulting from combination of number of tanks, their locations and water use can be simulated and analyzed. The combination giving maximum net benefits can be selected as the best combination. There are two tanks in the Pimpalgaon Ujjaini watershed which are used for groundwater recharge only. In the new analysis only two tanks are considered but their locations are varied at different stream points on the drainage line and option of water use as groundwater recharge and irrigation is also simulated in addition to the existing;groundwater recharge only'. The simulation gives the complete water balance for different combinations along with cost economics.

Results and Discussion

SOFTANK model was applied to the Pimpalgaon Ujjaini watershed for six combinations resulting from three tank strategies and two water use policies. Tank capacities for different strategies were estimated in simulation mode and are given in Table 1 while the economics is given in Table 2. From the Table 1 it is seen that tank capacities are less for the tank strategy No 49 in which tanks are located in the lower part of the watershed. As tanks move upstream (as in strategy No 58 and 94) tank capacities increases to meet the downstream release (DSR) criterion. Storage capacities are more by 1.77 to 2 times when water in the tank is not used for irrigation as compared to when it is used for irrigation along with groundwater irrigation. In the case of strategy No 94 where the tanks are further upstream, tank capacities are found same for both the management options of groundwater use and tank and groundwater use for irrigation. This is due to the requirement of meeting the 58% DSR criterion. Storage capacity obtained by simulation is 1.27 times that of existing storage capacity in the case of tank strategy No. 94gw (existing strategy and management option). Major difference is found in the capacity of tank No 2 where the simulated tank capacity is about 2.5 times of the existing tank capacity. Inflow capacity ratios for simulated tank capacities are uniform for both tanks whereas they differ (0.61 and 1.51) in the existing tank system. This indicates that in the proposed methodology tank capacities are more appropriate with the supply and demand parameters of the tank. Final conclusion is that if the tanks were located at stream point No. 2 and 4 and both tanks were used for irrigation (Strategy No. 49tgw) then it could have given higher benefits (B: C ratio 2.54) than existing strategy and management (B: C ratio 2.01).

Table 1: Tank capacities for Pimpalgaon Ujjaini watershed

Strategy\Tank No.	Tank 1	Tank 2	Total storage capacity, m^3	Inflow/capacity ratio Tank-1	Tank-2
49gw	198100.36	313495.00	511595.36	2.93	2.86
49tgw	104665.57	147226.74	251892.31	6.03	6.18
58gw	259241.53	278848.49	538090.03	2.26	2.27
58tgw	150366.28	153193.01	303559.29	4.47	4.05
94gw (17 yrs)	654411.46	505664.21	1160075.67	0.74	0.81
94tgw(17 yrs)	654411.46	505664.21	1160075.67	0.74	0.81
94gw (Evaluation)	695876.69	216937.45	912814.14	0.61	1.51

Table 2: Project economics for different tank strategies for Pimpalgaon Ujjaini watershed

Strategy	Initial cost, Rs	Maintenance cost, Rs	Cultivation cost, Rs	Total cost, Rs	Benefits, Rs	BC ratio
49gw	889296	35572	12609446	13534313	34008685	2.50
49tgw	822410	32896	12563278	13418585	34179194	2.54
58gw	902221	36089	12585559	13523868	33990930	2.50
58tgw	842915	33717	12542394	13419025	34155194	2.53
94gw (17 yrs)	1046232	41849	12225640	13313721	33640810	2.50
94tgw(17 yrs)	1061280	42451	12123166	13226896	33641106	2.52
94gw (EM)	1158000	46320	7014626	8218946	16560771	2.01

50.

Identification and Quantification of Areas Vulnerable to Soil Erosion and Deposition in a Himalayan Watershed Using Remote Sensing and GIS

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Keywords: Soil erosion, sediment yield, GIS, remote sensing.

Introduction

Soil erosion strongly affects crop yield, undermines the long term productivity of farm land and sustainability of farming system, and posses a major threat to the livelihood of the farmers and rural communities. The United Nations Environmental Programme reported that crop productivity has reduced and has become uneconomic on about 20 million ha of land each year due to soil erosion and resulting degradation of land. The eroded soil is also threatened by the loss of storage capacity (1-2% annual reduction globally) of multipurpose reservoirs due to sedimentation which affects society at large. Whether the main concern of soil and water conservation planning is towards prevention of on-site or off-site effects of erosion, there was a growing need for tools that enable defining spatial distribution of erosion within a catchment i.e., identifying areas of source and sink-soil erosion and deposition. In the present study a model was developed in remote sensing and geographical information system (GIS) environment for identification as well as quantification of the areas of sediment erosion and deposition in a Himalayan watershed for prioritization of areas for watershed treatments.

Materials and Methods

The model developed in the present study comprises of three major components (1) the assessment of seasonal gross soil erosion (GSE) for each grid/cell; (2) the assessment of seasonal local transport capacity (TC) for each grid/cell; and (3) transport limited accumulation algorithm for routing sediment from each of the discretized grid/cell to the outlet of the watershed by taking into account the local transport capacity of each cell. Gross soil erosion in each cell is calculated using commonly used Universal Soil Loss Equation (USLE) by carefully determining its factors followed by overlaying various thematic layers in Imagine®8.6 and ArcGIS®9.3 software. Input maps like Digital Elevation Map (DEM), land use map and soil map were prepared from Shuttle Radar Topography Mission (SRTM) data, LANDSAT Thematic Mapper (TM) satellite data and digitizing National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) soil maps, respectively. By overlaying gross soil erosion and transport capacity of each discretized cell, a net soil erosion and deposition map was extracted. The net erosion map estimated on a cell basis for the watershed was further grouped into the six scales of severity of erosion: Slight (0 to 5 t ha^{-1} $year^{-1}$), Moderate (5 to 10 t ha^{-1} $year^{-1}$), High (10 to 20 t ha^{-1} $year^{-1}$), Very High (20 to 40 t ha^{-1} $year^{-1}$), Severe (40 to 80 t ha^{-1} $year^{-1}$) and Very Severe (> 80 t ha^{-1} $year^{-1}$) as per the guidelines suggested for Indian conditions.

Results and Discussion

The model was calibrated with four years' observed sediment yield data (1979-1983), and validated with three years' data (1985-1987). The developed model estimated sediment yield with very high accuracy i.e. 0.6%, -1.1% and -10.8% deviations were found for years 1985, 1986, and 1987, respectively. It was found that 6.9% of total watershed area of Bino watershed is under deposition. As can be seen from Fig. 1, most of the deposition of sediment occurred on the sides of drainage channels when they reach valleys and also on flatter land areas in the cultivated valley land. Study reveals that soil loss in 10.6% area of Bino watershed is above soil loss tolerance limit, which is defined as the acceptable rate of soil erosion at which the quality of a soil as medium for plant growth can be maintained. Mandal and Sharda (2011) found soil tolerance limit was 5 tonne/ha/year for this region. Therefore, comparison between soil tolerance limit and prevailing soil loss can be the best criteria for deciding the priority areas as well as treatment activities within the watershed. In the present study, the formulated model has potential to identify the areas where soil loss exceeds the permissible/tolerance limit (10.6% of watershed area has been identified in the present study) and these are the areas where immediate soil conservation measures have to be implemented.

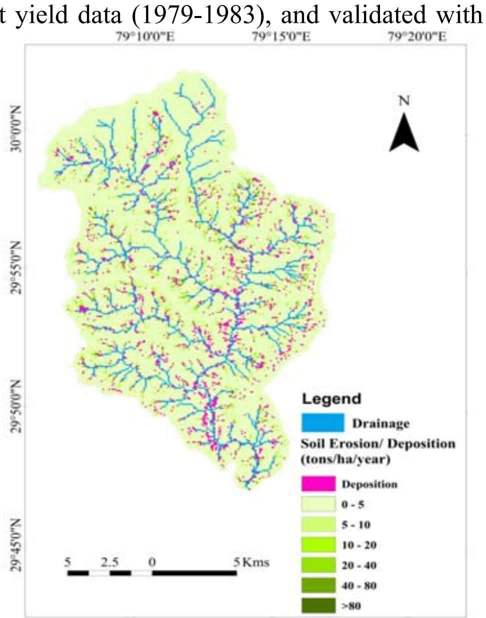

Fig. 1: Net erosion/deposition map of Bino watershed

51.

Water Management Structures and Their Role in Watershed

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Introduction

Success of any watershed management plan depends on best scientific approach and practices. Some of the most critical elements of watershed management are correct demarcation of boundaries, watershed area, stream order, excepted discharge, type and location of check dams and recharge structures within the watershed. The Best Management Practices (BMP) in any watershed ensures its success. Watershed development should always be promoted with the focus of groundwater recharge, for which identification of potential groundwater recharge zones is important. After identification selection of appropriate recharge structure and diversion of stream towards the potential recharge area is another important step. A watershed treatment plan (Bhagavan& Raghu, 2005) illustrates that how planned construction of groundwater recharge structures such asup stream side check dams on streams/surface runoff contributes in the groundwater recharge and also dilutes the groundwater pollutants.

Materials and Methods

Within a watershed implementation of Best Management Practices (BMP) is essential. Implementation of BMP required in depth understanding of watershed characteristics. Each stream order within a watershed has different discharge and it increases with increase in stream order. Thus check dam design, its height and type of recharge in different orders of stream should be different (Fig. 1). In any watershed, planned construction of check dams and different recharge structures at suitable locations, helps in sustainable development of groundwater in term of both quality and quantity.

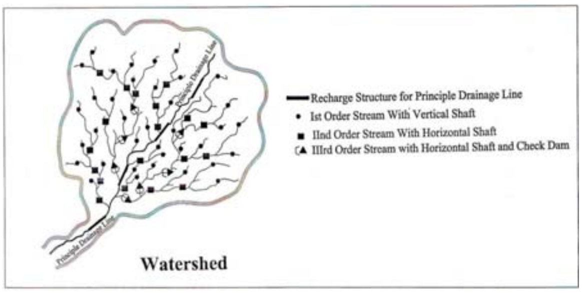

Fig. 1: Stream orders and locations of different recharge structure (Source: Misra et al., 2015).

Results and Discussion

Best Management Practices and their implementation help in improving the performance of watershed. Case study of Anantapur district, Andhra Pradesh demonstrate that construction of recharge structures at correct locations on different stream orders can provide a solution to water quality and scarcity problems. In urban watershed a good site design can drastically reduce impacts of new construction and development on environment. Site design and selection of suitable recharge structures and their dimensions all are the part of planning in watersheds, but site design and planning alone cannot make watersheds worthwhile. Success of watersheds depends on their combination and integration with other protection tools of watershed, such as, conservation of land, sediment control, erosion control and favorable topographical settings along with type of recharge structure on a particular stream order.

Table 1: Type of watershed and suitable recharge structures

Type of watershed	Watershed Area	Stream Order and total discharge (Cumsec)	Type of recharge structure
Macro watershed	> 50,000 Hectare	I II III IV or more	Check Dam & Vertical Shaft (VS) Check Dam & Horizontal Shaft Check Dam &Horizontal shaft (HS) Check dam &HS& L Shape Channel bunds
Sub-watershed	10,000 to 50,000 Hectare	I II III IV or more	Check Dam &Vertical Shaft (VS) Check Dam & Horizontal Shaft Check Dam & Horizontal Shaft (HS) Check Dam & HS & L Shape Channel bunds
Milli-watershed	1000 to10000 Hectare	I II III IV or more	Check Dam &Vertical Shaft (VS) Check Dam &Vertical Shaft Check Dam & Horizontal Shaft (HS) Check Dam & HS & L Shape Channel bunds
Micro watershed	100 to 1000 Hectare	I II III IV or more	Vertical Shaft (VS) Check Dam &Vertical Shaft Check Dam & Horizontal Shaft (HS) Check Dam & HS
Mini watershed	1-100 Hectare	I II III IV or more	Vertical Shaft (VS) Vertical Shaft Horizontal Shaft (HS) Check Dam & HS

Selection of suitable recharge structures and their location within a watershed depends on type of watershed, its area, stream order and excepted discharge of water during precipitation. Table 1 shows the type of recharge structures and their corresponding stream orders for different types of watershed.

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52.

Drought Investigation for Crop Planning in Badri Gad Watershed of Uttarakhand

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Keywords: Rainfall analysis, drought month, normal month and surplus month and water storage structure

Introduction

Rainfall analysis plays important role for crop planning, water harvesting and drought management particularly in rainfed area of hilly region. The average rainfall of the region is generally considered as the basis for deciding irrigation management and cropping pattern. But it has been observed that the knowledge of mean annual rainfall may not be that much useful to deciding the irrigation and water management activities for crop production. Weekly, seasonally analysis of rainfall data and monthly drought analysis of the region will be helpful for irrigation planning and drought management.

Materials and Methods

The study area is located in Narendra Nagar block of Tehri Garhwal district of Uttarakhand. The watershed is located in between the longitudes of 78°00' 21.02"E and 78°10' 21.43" E, and latitudes of 30°32' 23" and 30°38' 19.63" N. The total area of the watershed is 11,668.20 ha (116.68 km^2) with a perimeter of 51.82 km. The climate of the study area is humid temperate with an average rainfall of 1234.76 mm (1985-2008) of which about 70 to 80% is received during June to September. The average temperature in this area varies from 3°C to 30°C. The rainfall data were collected, for a period of 24 years (1985 to 2008) from agro-meteorological observatory, College of Forestry, Hill Campus, Ranichauri of G.B. Pant University, Pantnagar. The data were analysed for rainfall behaviour, weekly, monthly and annual rainfalls, determination of normal, drought and surplus months in the year, determination of normal, drought and surplus years.

Results and Discussion

Rainfall analysis revealed that more than 20 mm rainfall occurred during 23rd week followed by subsequent weeks, which continued up to 39th week. The uniform rainfall was observed from 23rd to 39th week with the minimum value of 23.26 mm during 24th week. Duration from 40th to 22nd week, which fall in non-monsoon seasons, the rainfall showed poor and erratic behaviour. It was observed that 22 weeks having uniform distribution with 20 mm assured rainfall. The maximum rainfall occurred during June-September months (about 64% of the annual rainfall). Poor rainfall was observed during remaining months, particularly October, November and December.Drought analysis depicted that maximum number of drought month, normal month and surplus month, were identified November, June and September, July (Table 1). In year wise analysis it was observed that years 1999, 2007 and 2008 were having maximum i.e. 6 months as drought months, years 1990 and 1997 were having maximum i.e. 8 months as normal months and years 1999, 2000, 2003 and 2008 were having maximum i.e. 3 months as surplus months.

Table 1: Month wise distribution of number of months to be drought, surplus and normal at Badri Gad watershed

Month	Drought month	Normal month	Surplus month
January	9	15	0
February	8	15	1
March	8	16	0
April	11	13	0
May	9	13	2
June	2	19	3
July	1	3	20
August	1	5	18
September	1	19	4
October	18	5	1
November	21	3	0
December	16	8	0
Total	**105**	**134**	**49**
Per cent of total study period	**36.46**	**46.53**	**17.01**

53.

Improvement of Water Yield in Micro Watersheds of Shivalik Region

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Keywords: Micro watershed, Shivalik region

Introduction

In the Shivalik region good forest cover improves the hydrologic regime as water which seeps down in these catchments may reoccur at far off distance or it may add to the ground water. However, they may not provide optimum water yield in the form of surface runoff to the water harvesting structure constructed in the nearby downstream area**.** This is due to over saturation of various soil and water conservation measures and growth of extensive vegetation in the watershed which tend to reduce the surface runoff. In order to optimize the water yield and minimize soil loss a hydrological study was initiated with five natural, micro hilly watersheds located in lower Shivalik region.

Materials and Methods

Five micro watersheds namely MWS-30, MWS-31, MWS-32, MWS-33and MWS-34 located within Research Farm of Indian Institute of Soil and Water Conservation, Research Centre Chandigarh were selected for study. All the micro-watersheds were gauged with 0.6m deep 2: 1 broad crested triangular weirs. The runoff was measured by automatic water level recorders. These watersheds were calibrated for initial two years. Areas of these watersheds varied from 0.813 ha to 4.75 ha and overland slope varied from 32.1 to 50.6%. Land use of watersheds MWS-30, MWS-31, MWS-32 and MWS-34 was mixed forest and shrubs whereas land use of control watershed MWS-33 was grass (*Eulaliopsis binata*).All the watersheds except grass watershed were densely infested with *lantana camara*, therefore, first of all lantana was removed from all the watersheds so that other useful vegetation could come up as ground cover. Physiography and soil characteristics of all the micro watersheds were studied. The soil texture of the watersheds was sandy loam to loamy sand. More coarse fractions were found in upper reaches of watershed. In post calibration period (2007-2009) fifty per cent crown of each tree was removed from lower, middle and upper part of each watershed in 2007,2008 and 2009 respectively which allowed the sun light to penetrate to the ground cover and encouraged lower storey vegetation to come up. Later on shrubs were removed in strips at different intensities namely 30%, 40%, 50% and complete removal from MWS-30, MWS-31, MWS-32, and MWS-34 watersheds.

Results and Discussion

Physico-chemical characteristics of watersheds showed that organic carbon (OC) percentage was 0.81% in grass watershed (MWS-33). Clay percentage of watershed varied between 13 to 18% (Table 1). Percentage of water stable aggregates (WSA) were found maximum in MWS-34 (40%)) and minimum (17%) in grass watershed (MWS-33). Lowest OC and WSA percentage of grass watershed (MWS-33) indicated that soils of MWS-33, was more prone to erosion. The steady state infiltration rate was measured during the month of March 2005. Steady state infiltration rates ranged between 1.31 to as high as 11.2 cm hr^{-1} in different reaches of watersheds.

Table 1: Physico-chemical characteristics of sols in watersheds

Watersheds	Sand (%)	Silt (%)	Clay (%)	O.C. (%)	N (Kg/ha)	% WSA
MWS-30	73	9	18	1.77	413.6	37
MWS-31	81	6	13	1.28	486.6	22
MWS-32	75	8	17	1.63	514.3	34
MWS-33	81	5	14	0.81	419.2	17
MWS-34	74	11	15	1.16	416.7	40

Vegetation survey of all the micro-watersheds from time to time indicated that the under storey vegetation has increased. The dominant plant species found were khair (*Acacia catechu*), reru (*Caesalpinia sepiaria*), chhal (*Anogeissus latifolia*) and behad (*Grewia optiva*). On comparing plant canopy in upper storey between 2005 and 2008 it was found that there was very little difference in overall percentage of canopy. This is because effect of growth in initial three years was nullified to some extend due to removal of 50% crown of trees. Impact of vegetation manipulation started to come after 2011 in the form of increased surface runoff in four micro watersheds as compared to control which varied from 1.3% to 8.4% during 2012. There was overall reduction in soil loss during 2007 to 2012 due to increase in ground cover by natural regeneration of other vegetation in place of lantana. On an average it reduced from 3.1 to 0.6 t/ha in these watersheds. Study further reveals that if grass land watershed is not disturbed it may help in reduction of runoff and soil loss but for increasing water yield vegetation manipulation is must. Thus for increasing water yield in densely forest areas, over saturated with conservation measures, vegetation manipulation would be required for benefitting ponds and reservoirs.

54.

Optimum Design of Tank System in Watershed for Pre Decided Downstream Release

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Keywords: Watershed, tanks, rainwater harvesting, irrigation, semi arid

Introduction

In the watershed projects in India, there is debate on 'upstream downstream conflict' of the watershed projects. When developing the watershed and constructing the water harvesting structures no thought is given on the downstream effects of the interventions. However, it is possible to design the optimum tank system in the watershed for a desired downstream release of water (from the watershed). In this paper tank systems are designed for any desired downstream release (DSR) with the help of 'SOFTANK" model developed for the purpose. The SOFTANK (Simulation Optimization For Tanks) model is developed for designing tank system based on water balance in the watershed. When all the tank strategies for the watershed are simulated for downstream releases between 0 and 100, then one best tank strategy for each DSR level is obtained. The plot of net benefits vs DSR level gives the optimum tank strategy for that watershed (i. e. strategy giving maximum net benefits). The trend of the graph also suggests whether tank system for the watershed is economical or not.

Materials and Methods

A comprehensive methodology is developed to optimally design tank system for the watershed which takes into account three water storages i.e. soil water, surface water and groundwater. Tank system can be designed for different downstream releases for the watershed. Effect of *in-situ* water conservation practices is also considered in the methodology. The methodology is converted into computer simulation model 'SOFTANK'. The model can be operated in calibration, simulation, evaluation and optimization mode. The model can be used for evaluating the existing tank system and developing the optimum tank system for the new watershed project. Different management scenarios can also be simulated with the model.

Results and Discussion

SOFTANK model was applied to the Pimpalgaon Ujjaini watershed and the findings suggested that tank system was economical for the watershed. It is found that 42% runoff is harvested by the existing tank system and 52% runoff goes as downstream release from the watershed. Inflow-tank capacity ratio (0.82) suggests that tanks are not filled to their full capacity and hence over designed. In-situ rain water harvesting (RWH) treatments like continuous contour trenches (CCT) in the catchments of the tanks will further reduce the inflow to the tanks and hence not recommended. On the basis of the analysis an optimum tank strategy for the Pimpalgaon Ujjaini watershed is suggested.

Table 1: Net benefit versus DSR for Pimpalgaon Ujjaini watershed

Input DSR, %	Output DSR, %	Tank strategy	Initial cost Rs	Maint. cost Rs	Crop cultivation cost Rs	Total cost, Rs	Gross benefits, Rs	Net benefits, RS
20	28	319	1111520	44461	12547334	13703315	34044029	20340714
30	37	58	1086906	43476	12564275	13694658	34348596	20653939
40	49	85	1012107	40484	12612237	13664828	34358057	20693229
50	60	49	833295	33332	12665042	13531669	34196250	20664581
60	67	58	805677	32227	12649486	13487390	34153068	20665678
70	72	49	768920	30757	12669951	13469628	34134524	20664897
80	80	58	758688	30348	12659341	13448376	34104325	20655949
90	90	58	720598	28824	12659109	13408530	34023329	20614799

55.

People's Knowledge on Coastal Biodiversity Management and Conservation Issues: Impact of a Development Intervention in an Ecologically Critical Area of Bangladesh

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Keywords: Biodiversity, knowledge, development intervention, impact

Introduction

In order to preserve the major biodiversity bases of the country, the Bangladesh Government in its declared eight areas as ecologically critical areas (ECAs), and the "Coastal and Wetland Biodiversity Management Project" (CWBMP) was launched in 2003 for three coastal ECAs. Since 2005, the Department of Environment (DoE), in collaboration with some partner Non-government Organizations (NGOs) and United Nations Development Programme (UNDP), has been promoting participatory biodiversity management and conservation activities among the local people. The study was undertaken to assess coastal people's knowledge on biodiversity conservation issues as an outcome of the development campaign.

Materials and Methods

The study was conducted in the Sonadia ECA of Maheskhali upazila under Cox's Bazar district. The population of the study included two groups of peoples in the ECA - members of the Village Conservation Group (VCG, a community based organization) and the non-VCG members of the locality. There were 100 members (one from each household) in two VCGs the sttudy area, while there were around 350 non-VCG households in the study location. These 450 households constituted the population of the study. However, data were collected from 100 randomly selected respondents (50 VCG members and 50 non-VCG members) by using a structured questionnaire during the months of April-May, 2013. People's knowledge on coastal biodiversity conservation issues were measured by developing a knowledge test having seven dimensions of biodiversity conservation (Table 1) issues.

Results and Discussion

The major focus of the study was to assess situation of coastal people's knowledge on biodiversity conservation and management issues due to participation in the activities under the project. Computed knowledge scores of the VCG members and non-members have shown in the Table 1.

Table 1: Coastal people's knowledge on biodiversity conservation issues

Dimensions of coastal biodiversity conservation	Knowledge score[1] (mean and s.d.[2])		t-value	Rank order
	VCG members (N=50)	Non VCG members (N=50)		
Agriculture (field crop production)	11.31 (1.01)	9.41 (1.45)	5.606***	6
Horticulture (fruits and vegetables production)	11.43 (0.99)	9.63 (1.45)	7.229***	5
Wildlife conservation	13.95 (1.30)	11.04 (1.58)	10.059***	3
Fisheries resources management	11.60 (1.25)	9.82 (1.52)	9.253***	4
Eco-tourism development	7.60 (1.44)	6.53 (1.09)	4.191***	7
Community development	14.61 (1.1)	12.14 (1.19)	10.799***	2
Environmental issues	15.04 (1.21)	12.82 (1.33)	8.734***	1

[1]Possible range of scale score for each dimension: 0-18
[2]Denotes standard deviation; figure in the parenthesis indicating s.d.
***Significant at 0.001 level of probability

Data presented in Table 1 revealed that there were clear differences between the VCG members and non-members of the locality regarding their knowledge on different dimensions of coastal biodiversity conservation and management issues. In all seven dimensions of coastal biodiversity issue, the VCG members had significantly higher knowledge than their non-VCG member neighbours. Secondly, considering a 0-18 scale, the obtained average knowledge scores of the respondents in environment, community development and wildlife conservation issues are quite satisfactory. Thirdly, the data show that people had better knowledge on some issues (environment, community development and wildlife conservation) than issues of fisheries resource conservation and management, horticulture, agriculture and eco-tourism.

Correlation coefficient was computed to test the relationship between the selected characteristics of the respondents and their knowledge on biodiversity conservation, the result of which is presented in Table 2.

Table 2: Relationship between the selected characteristics of the respondents and their knowledge in biodiversity conservation

Selected characteristics of the People of Sonadia ECA	Correlation co-efficient (r) with 98 d.f.
Age	-0.285**
Education	0.486 **
Family size	0.001
Farm size	0.099
Annual income	0.049
Training exposure	0.497**
Organizational participation	0.385**
Extension media exposure	0.769 **
Cosmopoliteness	0.408 **
Social participation	0.492**
Experience in biodiversity management activities	0.538**

*= Significant at p<0.05, **= Significant at P<0.01

Data presented in Table 2 show that eight characteristics of the respondents (age, education, training exposure, organizational participation, extension media exposure, cosmopoliteness, social participation and experience in biodiversity conservation activities) showed significantly positive relationship with their biodiversity conservation knowledge, while family size, farm size and annual income did not show any significant relationships with the same. It could be concluded that gradual involvement of local people in coastal and natural resource management through different participatory programmes will increase people's knowledge on complex environmental and biodiversity knowledge and will pave their increased participation in such programmes.

56.

Economic Impact of Different Water Conservation Practices Used for Vegetable Production in Hills of Uttarakhand

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Keywords: Impact assessment, water conservation, irrigation, Uttarakhand

Introduction

Inadequate rainfall is a serious constraint for agriculture sector (Benites and Castellanos, 2003) causing low yield or crop failure particularly in low rainfall or dry-land areas. In Uttarakhand, the percentage of net irrigated area to net sown area was around 48% in 2009 indicates that about half of the cultivated area is un-irrigated (Tuteja, 2013). Due to the limited irrigation facilities, the states' agriculture productivity is very low. Rain water conservation hereto is highly needed for sustainable hill agricultural development. Conservation of natural resources especially, soil and water plays an important role for sustaining the ecosystem and biodiversity. Keeping the condition in mind, we took up a study to analysed the economic impact of water conservation practices for vegetable production in hills of Uttarakhand.

Materials and Methods

For identifying the efficacy of water conservation practices in hills of Uttarakhand, the present study was carried out in Almora, Nainital and Pithoragarh districts, with sample size of 112 farmers The data were collected with the help of structured questionnaire by personal interview method on inputs used, cost of cultivation and production of vegetables under five irrigated conditions, viz. rain-fed, open manually irrigated, open micro irrigated, protected manually irrigated and protected micro irrigated practices used by farmers during 2013 to 2014. Capital budgeting technique was used to analysed the data and compared economics of abovementioned water conservation practices used by farmers for vegetable cultivation.

Results and Discussion

Results showed (Table 1) that the average yield of all vegetables (tomato, capsicum french bean, cauliflower and cucumber) were found as 110.55 q/ha in rain-fed condition, 130.43 q/ha in open manually irrigated condition, 155.91 q/ha in open micro irrigated condition, 177.52 q/ha in protected manually irrigated condition and 206.58 q/ha in protected micro irrigated condition. The average costs of cultivation were worked out as Rs. 67.64 thousand per ha in rain-fed condition, Rs.78.70 thousand per ha in open manually irrigated condition, Rs. 83.16 thousand per ha in open micro irrigated condition, Rs. 96.60 thousand per ha in protected manually irrigated condition and Rs. 93.47 thousand per ha in protected micro irrigated condition. After deducting the cost of cultivation from gross return, the net return arrived at Rs. 40.70 thousand per ha in rain-fed condition, Rs.69.99 thousand per ha in open manually irrigated condition, Rs. 102.37 thousand per ha in open micro irrigated condition, Rs. 173.23 thousand per ha in protected manually irrigated condition and Rs. 187.48 thousand per ha in protected micro irrigated situation with B: C ratio 1.60, 1.89, 2.23, 2.79 and 3.01 in open rain-fed, open manually irrigated, open micro irrigated, protected manually irrigated and protected micro irrigated conditions respectively.

Table 1: Economic comparison of vegetable production under different water conservation practices

Treatments	Average yield (q/ha)	Gross cost ('000Rs/ha)	Average price (Rs/q)	Gross return ('000Rs/ha)	Net. return ('000Rs/ha)	B: C ratio
Open rain-fed	110.55	67.64	980	108.34	40.70	1.60
Open Manual Irrigated.	130.43	78.70	1140	148.69	69.99	1.89
Open with MIS	155.91	83.16	1190	185.53	102.37	2.23
Protected Manu. Irrigated.	177.52	96.60	1520	269.83	173.23	2.79
Protected with MIS	206.58	93.47	1360	280.95	187.48	3.01

Study showed that the average yield, net return and B: C ratio (Fig. 1) were increased at increasing rate from open rain-fed to protected micro irrigated water conservation practices used by farmers. Economic indicators like profitability index and net present value showed positive impact of water conservation technology on income of farmers. As per the farmers' perception, there is a need for technical and financial support as well as trainings for maintenance and management of adopted technology to sustain it for long term.

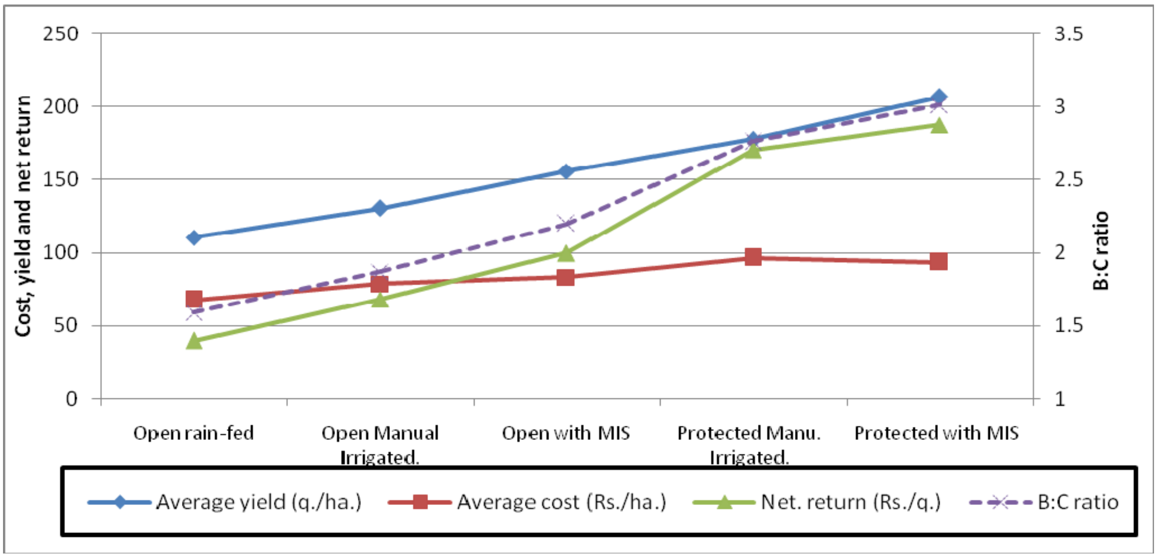

Fig. 1: Economic Impact of different water conservation practices used for vegetable cultivation

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57.

Soil Water Conservation Measures for Enhancing Survival, Growth and Resource Conservation in Bamboos

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Keywords: Soil erosion, conservation measures bamboo

Introduction

Soil and water erosion are one of the major problems in the Himalayan foothills. ty. Establishment of vegetation on these sloping lands is very difficult task. Growing of bamboos on these lands using soil and water conservation measures can provide affordable alternatives in place of expensive conventional conservation measures. Bamboos due to its fast growth and multiple economic and ecological benefits can help in enhancing productivity and resource conservation. Despite of experimental evidences of high soil and water conservation value of bamboos, its adoption in the Himalayan foothills has not been very encouraging due to poor productivity which is mainly attributed to limitation of soil moisture. Adoption of soil moisture conservation measures on these lands can enhance productivity of bamboos and associated vegetation by increasing ground water recharge.

Materials and Methods

The present study was initiated in 2012 on steep sloping land (> 25%) in Timli Range of Kalsi Forest Division near Mednipur village in District Dehradun for evaluating two species of bamboo- *D. strictus* which is widely grown in foothills, while another *D. hamiltonii* is being introduced as it has high productivity potential. Both the species were raised with soil conservation measures *viz*., rectangular trenches, semicircular trench and V-shaped trenches for improving soil moisture. Data was recorded on growth, runoff, soil loss, siltation, soil moisture and associated vegetation.

Results and Discussion

In 2014, growth parameters revealed that height growth was the maximum in semicircular trenches in both the species. Culm girth also followed the same trend. Number of culms/clump was highest in *D. hamiltonii* in semicircular trenches. *D. hamiltonii* registered higher biomass than *D. strictus* in all the treatments. In both the species, higher biomass was observed in semicircular trenches. Runoff varied from 3.7% in rectangular trenches to 13.8% in control (without bamboo and trench). Highest soil loss was observed under control. All the trench treatments were found to reduce the soil loss. Siltation was higher (18.3%) in rectangular trenches in *D. strictus* while in *D. hamiltonii* higher siltation (18.9%) was recorded in semicircular trenches. Soil moisture increased by 19% in semicircular trenches in *D. hamiltonii.* Lantana infestation was also found to be effectively controlled under *D. hamiltonii.* From initial results, it can be concluded that due to its fast growth, bamboos with trenching measures are effective in checking runoff and soil loss.

Species	Trench type	Height (m)	Culm girth (cm)	No. of culms	Culm weight (kg/clump)	Runoff (%)*	Soil loss (q/ha)	Siltation (%)
DS	Rectangular	2.45	20.5	3.9	1.9	4.2	90	18.3
DS	Semicircular	3.57	25.7	4.9	5.9	3.7	70	15.0
DS	V shape	2.95	20.3	4.0	3.2	4.2	80	9.4
DS	No trench	2.29	20.7	4.6	2.3	11.3	470	-
DH	Rectangular	2.64	17.9	7.1	4.7	3.6	60	15.0
DH	Semicircular	5.18	26.7	9.3	6.3	4.0	60	18.9
DH	V shape	3.21	22.6	6.9	3.2	3.7	70	9.4
DH	No trench	2.60	16.5	4.3	1.3	10.6	430	-
Control						13.8	660	-

58.

Soil, Water and Carbon Conservation in Mango under Soil and Water Conservation Measuresin Degraded Alfisols of Goa

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Keywords: Carbon sequestration, mango, soil and water conservation

Introduction

Rehabilitation of sloping and degraded lands requires an effective combination of erosion control measures and crops. These are often associated with soil and water conservation and sequestration of carbon in soil. Goa region experiences varying rainfall from 2700-3800 mm per annum. The soils vary from light texture to heavy texture with and without gravels. The terrain is undulating and leads to severe soil erosion in these areas. Land resources being finite and non-renewable, land degradation shall continue to be a major threat to global food security and environmental quality in 21st century (Lenka *et al.*, 2013). Thus, there is a lot of scope for rehabilitation of such degrading lands from further erosion. Several studies have demonstrated successful management of degraded lands using restoration measures but limited data is available on conservation of carbon along with soil and water. So, studies were undertaken to estimate effect of mechanical and bio-engineering measures and their combination on soil, water and carbon conservation under mango.

Materials and Methods

In order to assess the effect of mechanical and bio-engineering measures and their combination on soil and water conservation under mango (*Mangifera indica*) (variety: Mankurad), a scientific study with treatments continuous contour trenching + vegetative barrier (CCT+Vb), staggered contour trenching + vegetative barrier (SCT+Vb), vegetative barrier (Vb) alone and no erosion control measure (control) treatments was initiated. Runoff loss and soil loss was monitored at a regular interval during rainy season (June-September). Depth-wise soil moisture content was estimated regularly during post-rainy season till onset of next monsoon to evaluate effect of restoration treatments on soil moisture conservation. Depth-wise soil organic carbon content was estimated to the carbon stock in soil under different restoration treatments. Carbon loss through runoff was also estimated.

Results and Discussion

The CCT+Vb and SCT+Vb were able to reduce the runoff by 47% and 36% over control. The order of soil loss was observed as CCT+Vb (5.5 t ha^{-1}), SCT+Vb (8.8 t ha^{-1}) and control (18.4 t ha^{-1}) (Fig. 1). Both CCT+Vb and SCT+Vb appeared to be most promising to conserve soil and water compared to control. Soil and water conservation measures have immense effect on the sequestration of carbon in soils. By means of reducing runoff and soil loss along with runoff, restoration measures save valuable soil organic carbon from washing away from fields. CCT+Vb and SCT+Vb could save 12.9 and 9.6 Mg C ha^{-1} eroding away compared to control. This mechanism reduces net C flux to the atmosphere by increasing C sink potential of soils. The stored organic carbon helps in soil aggregation which in turn increases water storage capacity of soils. Thus this process also contributes to enhance moisture retention in soil indirectly.

Depth-wise soil moisture content under conservation measures was monitored periodically after the cessation of monsoon (Fig. 2). Relatively higher soil moisture content of 13.8%, 20%, and 0.7% was recorded under CCT+Vb over control during November, January and March, respectively.

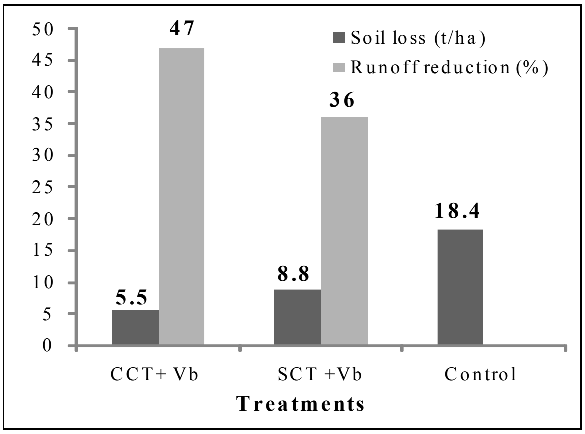

Fig. 1: Effect of restoration measures on soil loss and runoff reduction under mango.

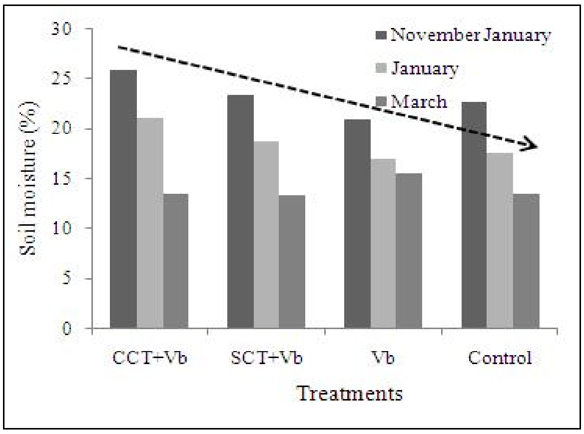

Fig. 2: Effect of restoration measures on soil moisture retention during post-rainy season.

The present investigation showed that soil and water conservation measures have profound effect on soil and soil moisture conservation and C sequestration in restoration of degraded lands. Combination of mechanical measure and vegetation (continuous contour trenching + vegetative barrier) proved to be the best in conserving soil moisture, soil and organic carbon. Considering cost of trenching, second viable economic restoration treatment that farmer can adopt to conserve soil and water is staggered contour trenching + vegetative barrier.

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59.

In-situ Moisture Conservation for Sustainable Crop Production for Maize Based Cropping System in Rain-fed Condition of Jammu, India

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Keywords: *In-situ* moisture conservation, maize based, rain fed condition

Introduction

Soils in dry lands are generally low in organic matter (OM), light in texture and low in moisture retentive capacity. The most important factor in dry farming is the conservation of moisture for proper and timely utilization by the crops. Tillage modifies the soil physical properties near the surface which in turn can influence evaporation rates and how water is redistributed within the profile during and after precipitation. Use of chemical fertilizers alone consistently further deteriorates the soil health, because of loss of organic matter. Management of tillage and nutrient management will not only conserve soil moisture, but also improve the status of Soil OM. Reduced tillage practices have shown improvement in productivity and saving in energy, however little information is available on their effect on dynamics of soil physical and chemical properties. Thus the study will be useful for maintaining soil health and sustainability in productivity.

Materials and Methods

A field experiment was conducted in three consecutive seasons of 2009 - 10, 2010-11 and 2011-12 at Dryland Research Sub Station, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Dhiansar, Jammu, India, located at latitude 32°17' to 37°05' N, longitude 72°40' to 80°30'E and altitude ranges between 215 to 7012 meters above MSL. The soil was sandy-loam having pH 6.9 along with electrical conductivity of 0.05m mhos/cm at 25°C and organic carbon 0.34%, respectively. In the experimental soil available nitrogen, phosphorous and potassium was 159, 18 and 124 kgha^{-1}, respectively. The experiment was replicated at three times.

Results and Discussion

The year wise pool data of three years showed highest maize *(Zea mays*) equivalent yield (30.40q/ha.) in intercropping of maize with mungbean *(Vigna radiate)* (Maize+ Mungbean) followed by maize with cowpea *(Vigna unguiculata)* (28.18q/ha.). The lowest grain yield was recorded in sole maize. Among the mulching highest grain yield of maize was recorded (29.28q/ha.) with farm yard manure (FYM) followed by leaf mulching (28.08q/ha.). However, the lowest grain yield was recorded in control (without mulching). The highest cost of cultivation (Rs./ha.) was found in C2M2 and C3M2 while it was lowest in C1M1. The highest gross income (Rs./ha.), net income(Rs./ha.) and B: C ratio was found in C2M4 (Table 1).

Table 1: Yield and relative economics of different treatments.

Main-treatment	Sub - treatment	Grain yield (q/ha)	Stover yield (q/ha)	Cost of cultivation (Rs. /ha)	Gross income (Rs/ha)	Net income (Rs. /ha)	B: C Ratio
C1	M1	22.18	32.53	17764	24915.50	7151.50	0.40
	M2	23.06	33.98	25514	25912.00	398.00	0.01
	M3	23.49	34.61	23264	26395.00	3131.00	0.13
	M4	23.65	35.28	23514	26596.50	3055.5	0.12
	Mean	23.09					
C2	M1	27.57	42.80	20934	31088.50	10154.00	0.48
	M2	28.34	45.26	28684	32020.00	3336.00	0.11
	M3	31.51	47.63	26434	35467.00	9033.00	0.34
	M4	34.18	53.94	26684	38586.00	11902.00	0.44
	Mean	30.4					
C3	M1	25.28	40.84	20934	28586.00	7652.00	0.36
	M2	28.14	45.03	28684	31798.50	3114.50	0.10
	M3	29.24	46.69	26434	33036.50	6602.50	0.24
	M4	30.04	47.15	26684	34277.50	7593.50	0.28
	Mean	28.17					

C1=Maize sole, C2= Maize + Mungbean, C3=Maize + Cowpea, M1= No mulch (control), M2=Straw mulch 10t/ha., M3=Mulching with *Adhatod vesdia* leaves@10t/ha and M4= FYM mulching@10t/ha
Market value of the product - Maize @Rs. 1050/q and Stover @Rs50/q

60.

Conservation Tillage and Mulching on the Productivity of Wheat under Irrigated Conditions of Jammu Region

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Keywords: Conservation tillage, mulching, wheat

Introduction

Conventional tillage practices in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system degrade the soil and water resources, thereby threatening the sustainability of the system while continuous ploughing at same depth leads to the formation of hard pan in lower layers over a period of time. The technologies of conservation tillage provide opportunities to reduce the cost of production, save water, increase yields, improve efficient use of resources and benefit the environment. Mulching reduces the deterioration of soil by way of preventing the runoff, minimizes the weed infestation and checks the water evaporation losses. Thus, it facilitates for more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of wheat.

Materials and Methods

A two year field experiment was conducted *rabi* 2013 and 2014 at the Research Farm Chatha, Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The soil tested sandy loam in texture, neutral in reaction (pH 7.7), low in organic carbon (0.40%), low available nitrogen and medium phosphorus and potassium. The experiment was laid out in split-plot design with three replications. The treatments comprised four tillage treatments in main plots namely zero, reduced, conventional tillage and furrow irrigated raised bed and three mulching treatments in sub-plot with Lantana (*Lantana camara*), Parthenium (*Parthenium hysterophorus*) and Leucaena (*Leucaena leucocephala*) at the rate of 6 t/ha. The variety of wheat RSP-561 was used for sowing. The recommended dose of N: 100, P: 50 kg and K: 25 kg/ha were applied through urea, diammonium phosphate and muriate of potash respectively. The full dose of P and K and half dose of N were applied at basal and remaining 50% N applied in two equal split doses at crown root initiation and ear initiation stage of wheat during both the years. All other operations were performed as per package of practices during both years of experiment.

Results and Discussion

Among the different tillage system furrow irrigated raised bed (FIRBS) recorded higher grain (40.6 q/ha) and straw yield (61.94 q/ha) but it found at par with reduced tillage (Table 1). Zero tillage treatment (34.43 q/ha) was found at par with conventional tillage. Among the different mulches treatments, Leucaena gave highest grain yield (40.19 q/ha) followed by Lantana mulch (36.68 q/ha). The increase in grain yield of wheat may be due to increased soil moisture storage, suppressing weed growth and providing optimum soil temperature resulting in better growth and yield (Chakraborty *et al.*, 2008). Reduced tillage gave higher net return (Rs.42364/ha) and benefit-cost ratio (1.64), where as lowest in conventional tillage. Amongst mulching, Leucaena gave higher net return (Rs. 43446/ha) and befit-cost ratio (1.60) followed by Lantana treatments. Reduced tillage (one time rotavator followed by sowing with seed-drill) along with mulching with Leucaena (6 t/ha) was found most suitable in terms of higher productivity and profitability of wheat for Jammu region.

Table 1: Effect of tillage and mulching on the grain and straw yield of wheat

Treatments	2 year mean			
	Grain yield (q/ha)	Straw yield (q/ha)	Net return (Rs)	B: C ratio
Zero tillage	34.43	53.35	38810	1.80
Reduced tillage	38.79	59.20	42364	1.64
Conventional tillage	36.99	56.26	34639	1.17
FIRBS	40.60	61.94	40370	1.31
SE(m)	0.78	0.91	-	-
CD at 5%	2.71	3.17	-	-
Lantana	36.68	56.65	37352	1.39
Parthenium	36.24	55.09	36342	1.34
Leucaena	40.19	61.33	43446	1.60
SE(m)	0.55	0.64	-	-

Reference

Chakraborty, D., Nagarajan and Aggarwal, P. (2008) Effect of mulching on soil and plant water status, and the growth and yield of wheat (*Triticum aestivum* L.) in a semi-arid environment. *Agricultural Water Management*, **95**: 1323-1334.

61.

Site-specific Crop Diversification in India

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Keywords: Crop diversification, productivity, nutrient use productivity, profitability

Introduction

Undoubtedly, India got self-sufficiency in food grain production with the ushering in of the Green Revolution. The self-sufficiency in food grain production was achieved at the cost of degradation (physically, chemically and biologically), diminishing biodiversity, depletion of ground water table, increase in environmental pollution, elimination of useful birds on account of high pesticide use and contamination in foods, ultimately affecting the human health. These emerging threats in the irrigated agriculture system have put greater challenge before agricultural scientists to maintain the balance between production and consumption to fulfill the food and nutritional security across the regions and sustainability of resources. The recommendation with regard to important production factors like fertilizer management, water management, weed control, disease and insect pest management has been formulated for component crops need to be integrated into cropping system mode. Substantial saving in input resources is accrued, when recommendations on cropping system basis are adopted. Crop diversification in area, where continuous cropping of cereals-cereal systems is in vogue, has been advocated as one of the effective tools for minimizing the second-generation problems and to make a breakthrough in the productivity and profitability.

Materials and Methods

The crop diversification can deliver many agronomic and ecological benefits simultaneously, while maintaining or enhancing the scale of efficiency of production. The crop diversification plans the existing cropping system were compared with the diversified cropping systems in South Alluvial Plain zone of Bihar, Mid high altitude intermediate zone of J&K, Central plain zone of Punjab, Central plain zone of U.P., Vindhyan plain zone of U.P., Bhabar and Tarai zone of Uttarakhand, Plain zone of Chattisgarh, Plateau and Satpura hill zone of M.P., South Gujarat heavy rainfall zone, Vindhyan Plateau zone of M.P. and Eastern plain zone of U.P.

Results and Discussion

In this regard, besides adoption of proper input management technologies, diversification of the system through introduction of crops of diverse nature may be a good preposition to break the monotony of the predominant cereal based systems and to sustain productivity over a period of time. For diversification of rice-wheat system, several options are available different zones (Table 1).

The diversified cropping systems resulted in increased rice equivalent yield, productivity, profitability and nutrient use productivity at all the locations over existing cropping systems.

Rice-wheat system is the most widely adopted cropping system in the country and has become mainstay of cereal production. The states of Uttar Pradesh, Punjab, Haryana, Bihar, West Bengal and Madhya Pradesh are now the heart land of rice-wheat cropping system with an estimated area of 10.5 million hectares. Despite enormous growth of this cropping system in the country during the past few years, reports of stagnation in the productivity of these crops, with possible decline in production in future, have raised doubts on its sustainability. Important issues emerging as a threat to the sustainability of rice-wheat system are over mining of nutrients from soil, disturbed soil aggregates due to puddling in rice, decreasing response to nutrients, declining ground water table, build up of diseases/pests, build up of Phalaris minor, low input use efficiency in north western plains, low use of fertilizer in eastern and central India, lack of appropriate varietal combination, shortage of labour during optimum period for transplanting rice.

Table 1: Efficient crop diversification options for rice-wheat farmers

Cropping system K - R - S	REY (t/ha/yr)	Productivity (kg/day/ha)	Profitability (Rs./ha/day)	NUP (kg grain/ kg nutrient use)
South Alluvial Plain zone of Bihar				
Rice-wheat	7.7	21.1	38.6	21.4
Rice-garlic-maize	11.2	30.6	76.4	23.7
Mid high altitude intermediate zone of J&K				
Rice-wheat	9.2	25.3	87.4	26.4
Rice-cauliflower-french bean	11.0	30.1	93.8	53.2
Central plain zone of Punjab				
Rice-wheat	11.0	30.0	33.0	25.1
Maize-potato-onion	18.2	50.0	84.2	45.1
Central plain zone of U.P.				
Rice-wheat	8.8	240.	36.4	28.1
Maize-potato-sunflower	15.3	41.9	56.4	20.5
Vindhyan plain zone of U.P.				
Rice-wheat	8.5	23.2	32.3	17.7
Rice-potato-green gram	14.3	39.2	58.2	22.2
Bhabar and Tarai zone of Uttarakhand				
Rice-wheat	11.9	32.7	91.5	23.9
Rice-rapeseed-sunflower	12.6	34.5	93.1	23.1
Plain zone of Chattisgarh				
Rice-wheat	8.6	23.7	90.2	32.0
Rice-brinjal-green manure	10.7	29.4	112.4	54.0
Plateau and Satpura hill zone of M.P.				
Rice-wheat	6.7	18.4	53.7	16.7
Rice-berseem(f)-berseem (s)	10.5	28.7	103.3	47.7
South Gujarat heavy rainfall zone				
Rice-wheat	6.9	18.9	48.3	20.9
Rice-onion-veg. cowpea	8.6	23.5	52.2	22.0
Vindhyan Plateau zone of M.P.				
Rice-wheat	5.4	14.6	33.4	14.1
Rice-berseem(f)-berseem (S)	7.2	19.6	62.4	23.8
Eastern plain zone of U.P.				
Rice-wheat	7.1	19.4	37.0	15.9
Rice-potato-green gram	15.5	42.3	97.9	11.5

K= *Kharif,* R= *Rabi,* S=summer, REY= rice equivalent yield, NUP= nutrient use productivity

62.

Effect on Production of Maize Crop through Improved Mechanization of Agricultural Operations under Rainfed Condition

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Keywords: Mechanization, maize in dryland, resources conservation

Introduction

Farm mechanization has been one of the drivers of the Green Revolution and saving on input costs of production. Maize (*Zea mays*) is one of the most important *kharif* season crops in rainfed areas of Jammu & Kashmir (J&K). The net cultivated area of J&K is 7.52 lakh ha out of which about 4.38 lakh ha is under rainfed agriculture and area under Maize crop is 3.19 lakh ha. Mean Annual Rainfall in low altitude sub- tropical zone (Jammu etc.) is 1115 mm but about 58% crops are grown under rainfed conditions. The undulation of the field consumes more resources in terms of inputs i.e. water, nutrients, manpower and machineries. Maize is mostly raised as a rainfed crop and, therefore, tillage operation is very important for in-situ moisture conservation. Therefore, it is very necessary to optimize the resources for maximizing productivity of maize crop under rainfed condition. The mechanization of maize cultivation in the region is still in its infancy, has tremendous potential and merits immediate attention. The opportunities are excellent for mechanizing the maize crop in the hills of Jammu and Kashmir state by adopting the improved tools and implements for different operations suitable for the region, which can reduce the time, cost of operation and drudgery over traditional methods. A study was conducted to evaluate the impact of resource conservation machineries viz-a-viz its comparative performance of improved implements with conventional methods of maize cultivation, mechanization prospectus and to trim down the cost of cultivation under rainfed areas. Maize sowing by a maize planter ensured a proper plant stand and produced 20-25 percent increased yield over the conventional method of sowing (broadcasting).

Materials and Methods

This paper describes the prospectus in amenability to maize cultivation mechanization in hilly regions of J&K State based on the field experiments conducted at Dryland Research Sub Station Rakh Dhiansar as well as Farmers' field in *Khaner* village for two consecutive years in 2012 and 2013. The Resource conservation machineries namely laser land leveller and rotavator were used for land levelling and preparation of seed bed. Three rows maize planter was used for maize sowing with the onset of south west monsoon. The recommended fertilizer was applied through the planter at the time of sowing. Simultaneously, the same maize crop was sown in the field developed by tractor with tiller and maize sown by broadcasting method (farmers' practice). The evaluation was comparative in utilization resource conservation machineries and farmers' practice of maize cultivation in rainfed region of Jammu. Similar inputs had been applied in both the fields to evaluate the impact of machinery component.

Results and Discussion

The grain yield showed a remarkable increase in improved techniques in maize variety K-517. The maize grain yield with normal farmers' practice was 1310 kg/ha while it was 1672 kg/ha in improved practice of mechanization as shown in Fig. 1 Similar types of results reported by Vatsa and Singh, 1996. Sowing maize by improved technique by using maize planter in the field prepared by rotavator and levelled by laser land leveller resulted in crop yield increase by 27.6% over the farmers practice (broadcasting) with B: C ratio of 1.41.

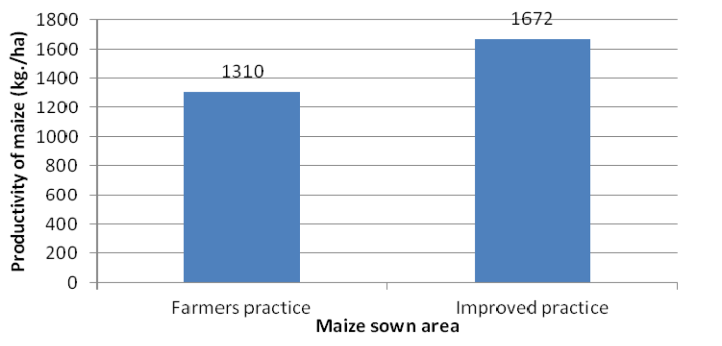

Fig. 1: Comparattive Effect on Production of Maize Crop through Improved Mechanization

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63.

Tillage and Weed Control Methods on Productivity and Profitability of Maize

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Keywords: Maize, weed control, conventional tillage, zero tillage, productivity, profitability

Introduction

Maize is most sensitive to weeds competition. The damage is estimated between 10 to 15% of total production. Tillage methods have significant effect on grain yield, biological yield, grain number per corn and leaf index. Combination of different methods of weed control appears necessary due to importance of weed management in maize. The aim of this study was to determine the effects of weed control methods under different tillage sequences adopted during rainy and winter seasons on weed population density and maize yield

Materials and Methods

The treatments comprised of tillage methods in main plots i.e. conventional tillage (CT) in rainy and winter seasons, conventional tillage in rainy and zero tillage (ZT) in winter seasons, zero tillage both in rainy and winter seasons, zero tillage in rainy and zero tillage along with crop residue (R) in winter season and zero tillage along with crop residue in rainy and winter seasons and weed control methods in sub plots namely recommended herbicide i.e. atrazine 1.0 kg/ha, integrated weed management containing intercropping with black gram + pre emergence application of pendimethalin 1.0 kg/ha + manual weeding at 30 days after sowing and weedy check..

Results and Discussion

The total weed density under ZT+R-ZT+R at 60 DAS was lower compared to CT-CT to the extent of 23.68 percent during 2014. The weed dry matter accumulation during 2014 reduced under ZT+R-ZT+R to the extent of 13.25 percent compared to mean of rest of the tillage combinations. The weed dry matter accumulation recoded under IWM was significantly lower compared to weedy checks to the extent of 68.57, 75.46 during 2013 and 41.82 and 43.26 percent during 2014 at 30 and 60 DAS respectively.

ZT+R-ZT+R recorded 86.82 percent higher grain (3133 kg/ha) and 97.00 percent straw (6676 kg/ha) yield compared to CT-CT tillage method. The higher net return (Rs. 45652) and B: C ratio (3.19) was recorded under ZT+R-ZT+R which was similar to ZT-ZT and ZT-ZT+R compared to CT-CT and CT-ZT method of tillage. IWM performed in maize crop recorded 16.33; 80.94 and 16.26; 98.93 percent higher gross return (Rs.52429 and Rs. 59497) and 3.33; 107.09 and 5.37; 138.90 percent higher net return (Rs. 31515 and Rs. 38583) compared to application of recommended herbicide and weedy checks during 2013 and 2014. However, application of recommended herbicides in maize recorded significantly higher B: C ratio (1.48) during 2013. Thus it can be concluded that for higher productivity and profitability maize can be grown under zero tillage along with soil cover with crop residue of previous wheat crop.

Table: Effect of conservation tillage and weed control methods on yield attributes and yield of maize

Treatments	Grains/cob		100 seed weight (g)		Grain yield (kg/ha)		Stover yield (kg/ha)	
	2013	2014	2013	2013	2013	2014	2013	2014
Tillage								
CT-CT	294	396.33	28.92	19.68	2415	1677	5530	3389
CT-ZT	299	443.89	31.50	19.41	2043	1872	4946	3997
ZT-ZT	282	457.78	26.91	21.46	1842	2694	4517	5588
ZT-ZT+R	322	414.44	27.48	22.02	2245	2839	4153	5892
ZT+R-ZT+R	286	380.56	26.61	20.45	2104	3133	4762	6676
Sem(Ti)	22.13	21.97	0.72	0.79	177.19	434.68	753.69	807.56
CD	72.14	71.64	2.36	2.58	NS	1417.34	NS	2633
Weed control								
RH	343	433.07	28.83	20.66	2364	2672	4798	5549
IWM	300	442.87	28.22	22.30	2609	3098	5686	6517
WC	247	379.87	27.80	18.86	1417	1559	3860	3260
Sem(W)	22.13	17.66	1.22	1.20	128.66	299.58	605	1093
CD	86.85	69.33	NS	4.72	505	1175.93	2377	4291
Interaction								
Sem	34.72	17.66	1.22	1.20	128.66	300	605.76	1093
CD	104.07	NS	3.66	3.60	NS	NS	1816	3277
CV%	17.29	11.37	6.41	6.22	18.32	25.75	22.41	13.98

64.

Crop Plant Residue Management to Control Weeds in Rice: A Meta-analysis

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Keywords: Rice, residue-incorporation, residue-mulching, residue-burning

Introduction

Rice (*Oryza sativa*) is the most important cereal crop in India, considered as the backbone of Indian food security system. Weeds, the most important biotic stress factor of rice cultivation can reduce its yield from 50 to 90%, depending on the rice ecosystem as well as establishment methods. Chemical control of weed is most common now-a-days but, with gradual shifting weed flora, development of multi-herbicide resistance, and environmental pollution, there is a urgent need to find suitable alternative to mitigate these situation in sustainable manner. Crop plant residue management could be a potential alternative strategy in handling these problems.

Materials and Methods

In this paper we have meta-analyzed the studies regarding weed management in rice using crop plant residues. Crop residues were mostly managed through three methods namely residue mulching, incorporation and residue burning (especially of rice). All these three methods were critically reviewed according to their weed suppressive abilities thereby increasing crop yield.

Results and Discussion

Crop residues suppressed weeds either due to their allelopathic properties or by creating physical hindrance to the growing weed seedling and also by changing the micro climate of weed flora. Different crop residues such as that of rice (*Oryza sativa*), sunflower (*Helianthus annuus*), brassica (*Brassica campestris*) and sorghum (*Sorghum bicolor*) were found to be allelopathic in nature. Incorporation of these allelopathic residues lowered weed dry mater accumulation, density and inhibited germination of problematic weeds in rice such as *Echinochloa colona, Ammania baccifera, Phyllanthus fraternus* and *Convolvulus arvensis*. Crop residue mulching reduced weed density, growth and controlled important rice weeds namely *Amaranthus spinosus*, *Echinochloa colona*, *Eclipta prostrata*, *Eleusine indica*, *Echinochloa crus-galli.* Though residue burning temporarily reduced weed density but in long run, it causes serious environmental hazards and hampers the nutrient recycling in agro-ecosystem.

Table 1: Effect of different crop residue application on weeds

Treatments	Effect on weeds	References
Sorghum + Sunflower + Brassica residues (each incorporated at 2 g kg^{-1} soil)	Inhibited *Echinochloa colona* germination by 22%	Khaliq *et al.*, 2011
Sorghum + Brassica residues (each incorporated at 3 g kg^{-1} soil)	Increased time to start germination of *Echinochloa colona* by 17%	Khaliq *et al.*, 2011
Wheat residue (mulched at 4 t ha^{-1})	Decreased weed density by 54%	Singh *et al.*, 2007
Stylosanthes residue (mulched at 3.2 t ha^{-1})	Decreased weed growth by 70%	Ranaivoson *et al.*, 2015
Maize+ Dolichos residues (mulched at 4.79 t ha^{-1})	Decreased weed growth by 70%	Ranaivoson *et al.*, 2015

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65.

Seasonal Variations in Biomass and Intertidal Distribution of Few Species of Phaeophyceae Seaweed at Narara Coast- Marine National Park, Gujarat

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***Keywords*:** Diversity, seaweeds, Phaeophyceae, biomass, Sargassum johnstonii Narara-Marine National Park.

Introduction

The distribution of marine macro algae is controlled by several factors. The ecology of beach is influenced by two specific environmental requirements. These are the presence of light; sufficient to drive photosynthesis and another important common requirement is to have a firm substrate of attachment. The seaweeds are most commonly found in littoral zone, on rocks and on sandy shore. The commonly occurring marine macro algae as individual species was not studied much for their seasonal distribution in relation to environmental factors at Marine National Park area of Gulf of Kutch. With this as an objective, the commonly occurring species of Phaeophyceae were studied alone the coast of Narara. The Phaeophyceae group algae of the present study are important in research and their utilization in algin industry.

Materials and Methods

The present investigation has been conducted at Narara-Marine National Park, Near Jamnagar (22 15.51 N, 69 30 53 E).

Algal vegetation was surveyed for its quantitative phyto-ecological attributes by monthly sampling survey during low water of the spring tides.

The number of individuals of each species falling in a sampling plot is abundance of the species, from the pool replicate values of the abundance from all the ample plots survey- mean density of a species was calculated. The biomass fraction, thus sorted species-wise were collected into separate polythene bags and brought to the laboratory. The mean value was calculated from the pooled replicates for each species and expressed as gm^{-2}.

The basic seawater parameters such as temperature, salinity, pH, dissolved oxygen, nitrite and phosphate were measured for the month of September- 2013 to March- 2014.

Results and Discussion

Variations in the distribution of all three species occurred at the every belt transect. All the three species was found growing throughout the study period at middle littoral.

Density of Phaeophyceae Variations in the distribution of all three species occurred at the every belt transects. All the three species were found growing throughout the study period at middle littoral. Moderate density of *Sargassum johnstonii* was observed during the months of November to January for Upper littoral, September to January in Middle and lower littoral zones. *Iyengaria stellata* was not at all present during September and October in Upper littoral and February and March in lower littoral zone. On the other hand Middle littoral shows the higher to moderate density of all the three species studied.

After recording the density, the entire biomass falling within each sample plot was harvested right from the base. The mean value was calculated from pooled replicates for each species and expressed as gm^{-2} (Table 2). *Sargassum Johnstonii* exhibited maximum biomass 20.24 and 20.12 gm^{-2} Dry weight in the month of January and March respectively. For *Iyengaria Stellata* it was 18.50 gm^{-2} Dry weight in the month of March, while lowest (4.80 gm^{-2} Dry weight) in the month of October.

Cystoseiraindica was not available in the month of September, while highest biomass 14.50 gm^{-2} Dry weight was observed in the month of March.

Sargassum Johnstonii exhibited maximum biomass 40.50 and 38.80 gm^{-2} Dry weight in the month of December and January respectively. For *Iyengaria Stellata* it was 29.50 gm^{-2} Dry weight in the month of March, while lowest (6.55 gm^{-2} Dry weight) in the month of September.

Cystoseira indica showed maximum biomass in the month of March (33.50 gm^{-2} Dry weight) while lowest (4.80 gm^{-2} Dry weight) in the month of September.

Biomass in lower littoral was dominated by *Sargassum* in the month of January with 16.80 gm^{-2} Dry weight, followed by *Cystosira indica* (14.60 gm^{-2} Dry weight) and *Iyengaria Stellata* (12.60 gm^{-2} Dry weight). However, *Cystosira* and *Iyengaria* were not at all available in the month of February.

Physic-chemical characters viz. temperature, pH, DO, Salinity, Nitrate nitrogen and Phosphate were measured once in a month (Table 3).

Table 1: Density of Phaeophyceae group of species at Narara Intertidal area.

	September	October	November	December	January	February	March
Upper Littoral							
Sargassum johnstonii	+	+	++	++	++	+	+
Iyengariastellata	+	0	+	++	++	+	+
Cystoseira indica	0	0	+	+	+	+	+
Middle Littoral							
Sargassumjohnstonii	+++	+++	+++	+++	+++	+	+
Iyengariastellata	+++	++	++	++	++	+++	+++
Cystoseira indica	+++	+++	+++	++	++	+++	+++
Lower Littoral							
Sargassumjohnstonii	+++	+++	+++	+++	+++	0	0
Iyengariastellata	+++	++	++	++	++	0	0
Cystoseira indica	+++	+++	+++	++	++	0	0

* 0= No species available, + Less density, ++ Moderate density, +++ High density

Table 2: Mean biomass of Phaeophyceae group of species at Narara Intertidal area (g m^{-2} Dry weight)

	September	October	November	December	January	February	March
Upper littoral							
Sargassum johnstonii	4.20	6.30	12.80	15.60	20.24	18.80	20.12
Iyengaria stellata	5.36	4.80	5.12	11.25	14.60	15.80	18.50
Cystoseira indica	0	8.80	10.20	12.16	14.12	12.80	14.40
Middle littoral							
Sargassum johnstonii	12.60	16.90	24.80	40.50	38.80	26.50	21.12
Iyengaria stellata	6.55	10.40	14.60	20.20	22.40	24.40	29.50
Cystoseira indica	4.80	12.80	18.80	24.15	26.12	29.40	33.50
Lower littoral							
Sargassum johnstonii	5.40	7.50	12.65	14.90	16.80	0	0
Iyengaria stellata	6.50	6.80	9.12	11.50	12.60	0	0
Cystoseira indica	6.90	7.12	8.80	9.12	14.60	0	0

Table 3: Physic-chemical characters of seawater

Parameters	**September**	**October**	**November**	**December**	**January**	**February**	**March**
Temperature (°C)	29	30	30	26	27	28	31
pH	8	8.2	8.2	8.1	8.3	8.2	8.3
Dissolved Oxygen (μgl^{-1})	4.5	4.6	5	5.5	5.8	4.8	4.5
Salinity (ppt)	33.4	35.2	34.5	34.5	34.2	36.4	36.7
Nitrate Nitrogen (μgl^{-1})	1.65	1.23	2.23	2.49	3.1	2.24	2.45
Phosphate (μgl^{-1})	0.23	0.57	1.52	2.32	1.58	1.75	2.12

66.

Bio-efficacy of Different Herbicides for Weed Control in Direct-seeded Rice

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Keywords: Direct seeded rice, basmati, yield, weed density

Introduction

With the introduction of direct seeded Basmati (DSR), weeds are the serious constraint due to aerobic soil conditions which favors the germination and growth of more weeds. A weed free period of the first 25-45 days after sowing (DAS) is required to avoid loss in yield in dry direct seeded rice. Use of herbicides is an easy, effective and economically method for controlling weeds in DSR. In Punjab, pre-emergence herbicides like pendimethalin, butachlor, pretilachlor, oxadiargyl and pyrazosulfuron have been recommended in the puddled transplanted. Keeping this in view, experiment was conducted to study the bio-efficacy of these herbicides in direct seeded Basmati.

Materials and Methods

A field experiment was conducted during *kharif* 2015 at Krishi Vigyan Kendra (KVK), Muktsar (Punjab). The field experiment was arranged with split plot design with post emergence herbicides in main plots and pre-emergence herbicides in sub plots with three replications and Basmati variety Pusa 1121 was directly seeded. Among two main plots first treatments was no post emergence herbicide application and second treatment was post emergence application of bispyribac-sodium. However sub plot treatment comprised of pre-emergence application of pendimethalin, pendimethalin + pyrazosulfuron ethyl, pretilachlor, oxadiargyl, butachlor and one treatment kept un-weeded. The data on weed density, yield and contributing character were calculated.

Results and Discussion

Among post emergence herbicides bispyribac-sodium produce significantly superior weed management and dry matter over the non post emergence herbicide application. However, among pre-emergence herbicides lesser weed population was recorded with pendimethalin + pyrazosulfuron herbicide which was statistically at par with oxadiargyl but significant superior over the pendimethalin alone, butachlor, pretilachlor and un-weeded treatment. However, the reduction in dry matter content was also recorded with these treatments.

All the pre and post emergence herbicide treatments failed to produce any significant effect on the plant height and 1000- grain weight of the basmati crop. However, as we considered about the grain yield of the basmati crop, bispyribac sodium produced significantly higher grain yield (43.91 q/ha) from the non application of post emergence herbicide application (39.74 q/ha). Among different pre-emergence herbicides, higher grain yield was obtained with the application of pendimethalin + pyrazosulfuron ethyl herbicide (44.36 q/ha) and which was statistically equal with oxadiargyl (43.76 q/ha) and pedimethalin (43.47 q/ha) but significantly superior from butachlor (41.0 q/ha), pretilachlor (40.64 q/ha) and weedy check (37.73q/ha) of basmati crop. Higher grain yield were due to lesser weed competition during growth period and higher number of effective tillers recorded in these treatments. Whereas, post-emergence herbicide failed to produce any significant affect among grains per panicle. However, all pre-emergence herbicide results in significantly higher number of grains per panicle from control treatment. This indicates that with appropriate weed control in DSR production can be a profitable venture.

Table 1: Effect of different pre and post emergence herbicides on weed density, weed biomass and contributing characters in direct seeded basmati

Treatment	Weed density (no./m^2)	Weed dry matter (g/m^2)	Plant height (cm)	Effective tiller (no./m^2)	No.of grains/ panicle	1000 grain wt. (g)	Grain yield (q/ha)
Post emergence herbicide							
No post emergence	16.72	20.13	110.73	311.33	63.66	24.64	39.74
bispyribac-sodium @ 0.03 kg/ha	4.44	6.77	110.94	348.56	64.53	24.91	43.91
CD(p=0.05)	4.71	4.30	NS	12.24	NS	NS	0.95
Pre-emergence herbicide							
Pendimethalin @0.75 kg/ha	9.00	10.82	111.93	339.67	65.21	25.03	43.47
Pendimethalin 0.68 kg + Pyrazosulfuron ethyl 0.015 kg/ha	3.50	4.97	110.33	353.17	66.39	24.80	44.36
Pretilachlor 0.47 @kg/ha	10.33	13.37	111.60	319.83	64.65	24.83	40.64
Oxadiargyl 0.09 @kg/ha	4.83	7.62	111.43	345.00	66.33	24.87	43.76
Butachlor 1.50 @kg/ha	10.50	14.30	111.23	323.83	63.22	24.82	41.00
Unweeded	25.33	29.42	108.5	298.17	58.78	24.31	37.73
CD (p=0.05)	4.37	4.94	NS	29.40	3.98	NS	3.15
Interaction CD (Pre x Post)	6.18	6.99	NS	NS	NS	NS	NS

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Herbicide Combinations with and Without Manual Weeding for Control of Complex Weed Flora in *Kharif* Maize (*Zea mays* L.)

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Keywords: Manual weeding, atrazine, alachlor

Introduction

Maize is an important rainy season crop of Central Plain Zone of U.P. It is being a widely spaced crop gets infested with a variety of weeds and subjected to heavy weed infestation, which often inflicts huge losses ranging from 28-100%. For effective control of weed flora, a combination of herbicides with and without manual weeding gives a great response in suppression of weed population in maize crop. Since, single application of herbicides in controlling weed is meager, the present investigation was undertaken to overcome this problem.

Materials and Methods

A field experiment was conducted during *kharif* 2014 at students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur. The soil of the experimental site was sandy loam in texture having pH neutral in reaction, low in organic Carbon and nitrogen, medium in available phosphorus and potassium. The N, P and K were applied @ 120, 60 and 60 kg/ha through Urea, DAP and MOP, respectively. Half of nitrogen and full dose of phosphorus and potassium was applied as basal and remaining half of nitrogen applied at 30 DAS. The experiment was laid out in Randomized Block Design with three replications. The twelve treatments

Results and Discussion

The lowest dry weight of grassy weeds were recorded with treatment where, Atrazine followed by 2, 4-D along with one hand weeding at 45 DAS was done. Similar trend was recorded with broad leaf weeds as well as in sedges. The highest grain yield (4.73 t/ha) was recorded with weed free plot and the lowest (2.89 t/ha) was with unweeded control plot. The yield loss due to uncontrolled of weeds as compared to hand weeding was 63.62%. Among the herbicide treatment, the maximum grain yield (4.64 t/ha) was recorded with the treatment where, Atrazine fb 2,4-D + One HW (T_8) followed by treatment where, Alachlor fb 2,4-D + One HW (T_9) were applied (4.47 t/ha). Herbicide treatment resulted into considerably lower cost of cultivation compared with weed free treatment. The B: C ratio was found maximum with treatment T_8. It was concluded that application of Atrazine (1.25 kg ai/ha) fb 2,4-D @ (0.5 kg ai / ha) at 30 DAS + One HW at 45 DAS (T_8) was most effective for control of weeds resulted into higher grain yield and profitability of *kharif* maize.

Treatment	Weed dry weight (g) at 60 DAS			Weed control efficiency (%)			Weed index (%)	Grain yield (q/ha)	B: C Ratio
	Grassy weed	Broad leaf	Sedges	30 DAS	60 DAS	At harvest			
T_1 Atrazine Pre-em. (1.25 kg a.i /ha)	4.76 (21.66)	2.35 (4.70)	3.16 (9.00)	46.10	46.21	47.34	28.08	33.98	2.50
T_2 Alachlor Pre-em. (1.25 kg a.i/ha)	5.10 (25.00)	2.55 (5.70)	3.21 (9.33)	34.23	39.10	28.24	28.11	33.97	2.43
T_3 Pendimethalin Pre-em. (1.0 kg a.i/ ha)	5.23 (26.33)	2.67 (6.33)	3.56 (11.70)	22.36	32.50	18.35	32.28	32.00	2.33
T_4 Atrazine+Alachlor (1.25+1.25 kga.i/ha)	3.74 (13.0)	2.31 (4.33)	3.05 (8.33)	59.35	60.92	61.15	21.69	37.00	2.39
T_5 Atrazin fb 2,4-D Post-em. (1.25+0.5 kg a.i/ha)	2.63 (6.00)	2.07 (3.33)	2.50 (5.33)	68.46	77.67	72.54	14.46	40.42	2.72
T_6 Alachlor fb 2,4-D (1.25+0.5 kg a.i/ha)	2.76 (6.66)	2.07 (3.33)	2.94 (7.70)	61.86	73.12	65.64	19.22	38.17	2.70
T_7 Pendimethalin fb 2,4-D (1.0+0.5 kg a.i/ha)	3.05 (8.33)	2.21 (4.0)	2.99 (8.00)	57.24	69.04	62.62	21.34	37.17	2.58
T_8 Atrazin fb 2,4-D +one HW at 45 DAS	1.38 (1.00)	1.49 (1.33)	1.80 (2.33)	86.85	92.90	90.86	1.80	46.40	3.43
T_9 Alachlor fb 2,4-D +one HW at 45 DAS	2.30 (4.33)	1.71 (2.00)	1.90 (2.70)	80.93	86.31	85.52	5.47	44.67	3.43
T_{10} Pendimethalin fb 2,4-D + one HW at 45 DAS	2.36 (4.66)	1.97 (3.00)	2.37 (4.33)	75.66	81.74	75.58	13.97	40.65	2.99
T_{11} Weed free (2 HW+2 IC) at 15 & 45, 30 & 60 DAS	1.24 (0.66)	1.38 (1.00)	1.63 (1.70)	95.40	94.95	93.13	0.00	47.25	3.47
T_{12} Unweeded control	5.80 (32.66)	4.61 (21.00)	3.60 (12.00)	0.00	0.00	0.00	38.80	28.92	1.96
SE (d)	0.22	0.411	0.21	2.37	2.79	3.99	1.69	3.48	0.42
CD (p=0.05)	0.47	0.86	0.44	4.94	5.83	8.33	3.53	7.27	0.88

68.

The Study on the Domestic and Export Potential of Organic Coconut in Coimbatore District of Tamil Nadu

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Keywords: Organic coconut, cost and returns, domestic potential, export potential

Introduction

Organic farming is gaining gradual movement across the world. Growing awareness of health and environmental issues in agriculture has demanded production of organic food which is emerging as an attractive source of rural income generation. India is bestowed with lot of potential to produce all varieties of organic products because of its various agro climatic regions. Oceania has the largest share of organic agricultural land (37%), followed by Europe (24%) and Latin America (20%). The proportion of organically compared to conventionally managed land, however, is highest in Oceania and in Europe. India ranks last among the top ten countries in terms of cultivable land under organic certification. The certified area includes 10% cultivable area (0.50 million ha) and rest 90% (4.71 million ha) is forest and wild area for collection of minor forest produces. India produced around 1.34 million Metric tonnes of certified organic products which includes all varieties of food products namely sugarcane, cotton, coconut, Basmati rice, pulses, tea, spices, coffee, oil Seeds, fruits and their value added products.

Materials and Methods

Coimbatore district was selected for the study. Within Coimbatore - Pollachi, Udumalapet, and Coimbatore north and Coimbatore south was elected. Reason - large number of farmers are involved in organic crop cultivation in this area. For finding the domestic potential - 30 farmers who got certification from the TNOCD (Tamil Nadu organic seed certification Department) were selected randomly among. To have comparative study 30 inorganic farmers were selected among 85 inorganic farmers to gain knowledge about the cost and income concepts. The cost of cultivation was estimated by using the methodology as used by CACP, GOI. For knowing the export potential, export details were collected from the exporter using the interview schedule. Using the interview schedule the information regarding - quantities of organic produce exported from Tamil Nadu, countries to which it was exported, what were the constrains in organic produce exports were obtained.

Nominal protection coefficient was worked out:

NPC= Pd/Pw= Pw (1+t)/Pw, where Pd is domestic price of a product, Pw is world price of a product, t is tariff rate. If NPC <1, protected that is we can export our organic produce to the foreign countries. If NPC >1, unprotected, it's not profitable to export our produce.

Garrett's scoring technique was employed to rank the constraints:

The respondents were asked to rank the problems in production, processing and marketing. In the Garrett's ranking technique these ranks were converted into percent position by using the formula

$$\text{Percentage position} = \frac{100\,(R_{ij} - 0.5)}{N_j} \qquad \text{.....................} \text{ (i)}$$

Where, R_{ij}= Rank given for i th factor by j th individual
N_j= Number of factors ranked by j th individual

Results and Discussion

Table 1 shows the cost and returns of organic tender coconut. From the table it's clear that the net income from the organic coconut was Rs, 178170.8/ha, the farm business income is Rs, 183171 /ha and the family labour income is Rs, 1, 79,671 / ha respectively. Net income from the organic coconut is 130627/ha, the Farm Business income is Rs, 136787 /ha and the Family labour income is Rs, 132274 / ha respectively.

Farmers ranked that the Price fixing mechanism for organic produce as first constraint, followed by non availability of Procedure for getting organic certification is too long, high cost of organic certification labels, less cost for the produce, and absence of subsidy as second, third, fourth and fifth constraints respectively.

Table 1: The cost and returns of organic tender coconut

Particulars	Organic coconut (Rs / ha)	Inorganic coconut (Rs / ha)
Hired Human labour	5245	10200
Bullock labour	340	125
Hired farm Machinery	507	555
Seedling	1562	1,200
Depreciation	1500	7240
Irrigation	2575	150
Organic Manures	25000	1450
Electricity charges	450	3500
Interest on working Capital	1729	1729
Other expenses (land revenue and other taxes)	1014	1014
Cost A_1 (1to 10)	39922	24463
Interest on value of owned capital asset	1500	1513
Cost 'B1' (11+12)	41422	25976
Rental value of owned land	2000	3000
Cost 'B2' (13+14)	43422	28976
Imputed value of family labour	1500	1647
Cost C_1(13+16)	42922	28976
Cost C_2 (16+ 17)	44922	30623
Gross income	2,23,093 / ha	161250
Net income	Gross income - Cost C_2 = 178170.8/ha	Gross income - Cost C_2 = 130627/ha
Farm Business income	Gross income - Cost A = 183171 /ha	Gross income - Cost A = 136787 /ha
Family labour income	Gross income - Cost B_2 =1,79,671 / ha	Gross income - Cost B_2 =132274 / ha

Table 2: Nominal Protection Coefficient

Countries	Domestic price / Tender Coconut	World price / Tender Coconut	NPC
United State of America	25	250	0.1
Malaysia	25	275	0.090
Singapore	25	260	0.096
United kingdom	25	280	0.089
Dubai	25	290	0.086
Thailand	25	295	0.084

NPC: It is comparatively advantage to export organic coconut to all the six countries like United States, Malaysia, Dubai, Thailand, United Kingdom and Singapore.

Table 3: Constrains faced by organic coconut farmers.

Constrains	Average score	Rank
Procedure for getting organic certification is too long	74.4	2
Absence of subsidy	8.26	5
High cost of organic certification labels	49.6	3
Less cost for the produce	33.06	4
Price fixing mechanism for organic produce is not good	82.66	1

69.

Effect of Altitude and Aspect on Soil Organic Carbon of Shankaracharya Forest

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Keywords: Soil nutrients, Shankaracharya forest

Introduction

The soil and vegetation have a complex inter-relation because they develop together over a long period of time. The vegetation influences the chemical properties of soil to a great extent. The selective absorption of nutrient elements by different tree species and their capacity to return them to the soil brings about changes in soil properties (Singh *et al.*, 1986). Concentration of elements in the soils is a good indicator of their availability to plants. So, the present study is carried out at Shankaracharya forest to study the soil organic carbon development at different altitude and aspect due to plantations.

Materials and Methods

A total of 18 soil samples were collected at two depths of 0-15 and 15-30 cm at each sampling site. A small amount of soil was combined from three randomly located points. The soil samples were air dried and processed through a 2mm sieve whilst twigs, roots and gravel were removed. The sieved fraction of soil was homogenized and used for organic carbon estimation. Organic carbon percentage was estimated by wet combustion method of Walkley and Black (1934).

Results and Discussion

The results on organic carbon content (OC) are summarized in Table 1. The mean values of OC on lower altitudinal gradient of 1575-1705m were 1.9, 2.1 and 0.96% on North West, North East and South East aspects. The OC content along the two soil depths was significantly different ($p \leq 0.05$) with mean values of 1.83 and 1.51 at the depth of 0-15 and 15-30 cm respectively. The OC content on middle altitudinal range of 1705-1835m was in the order of 2.2, 2.3 and 1.09% on North West, North East and South East aspects respectively. The mean values of OC varied significantly ($p \leq 0.05$) from 2.03 to 1.7% along the soil depths 0-15 and 15-30 cm respectively. The soil OC values on the available aspects at the upper altitudinal range of 1837-1967 m were 2.3, 2.5 and 1.7% on North West, North East and South East exposures respectively. The mean values of OC along the soil depth varied significantly ($p \leq 0.05$) and decreased from 2.3 to 2.0% at the soil depth of 0-15 and 15-30 cm respectively. The higher OC content in the soils on Northern slopes can be attributed to higher litter fall due to better tree density and canopy coverage on this aspect [Gupta and Singh, 1990]. OC content is generally higher in the Northern aspects than the South facing slopes and it decreased with increase in soil depth on both the aspects [Bhat, 2010].

Table 1: Soil organic carbon percentage characteristics of Shankaracharya Reserve Forest across the available aspects along an altitudinal gradient

Parameters	Depths (cm)	Altitude (amsl)											
		1575-1705 Aspect				1705-1835 Aspect				1837-1967 Aspect			
		NW	NE	SE	Mean	NW	NE	SE	Mean	NW	NE	SE	Mean
Organic carbon (%)	0-15	2.27	2.3	0.99	**1.83**	2.4	2.5	1.19	**2.03**	2.6	2.7	1.8	**2.3**
	15-30	1.7	1.9	0.94	**1.51**	2.0	2.1	1.0	**1.7**	2.1	2.3	1.60	**2**
	Mean	**1.9**	**2.1**	**0.96**		**2.2**	**2.3**	**1.09**		**2.3**	**2.5**	**1.7**	
CD (P≤0.05), A 0.01B 0.14C 0.11A×B 0.19A×C 0.19B×C0.20													

The results of the present study also reveal that SOC levels decreased from 2.03 to 1.7% in 0-15 and 15-30 cm of soil depth respectively indicating that organic carbon levels were 16.25% higher in upper soil layer as compared to lower depth. These results support the hypothesis that the rate of decomposition gets slower with increase in soil depth [Cole *et al.*, 1977].

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70.

Assessment of Comparative Performance of Safflower Cultivars with Rabi Crops under Limited Irrigation

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Keywords: Safflower, irrigation

Introduction

In Chhattisgarh, agriculture is mainly based on rainwater therefore most of the crops are grown as rainfed or under limited irrigation in *rabi* season. The important *rabi* crops grown in the Chhattisgarh are lathyrus, gram, linseed and safflower. Safflower is one of the most valuable crop with multipurpose usage which is grown for oil, medicinal and industrial uses. Although lathyrus and chickpea occupied maximum area in *rabi* season but they are not remunerative due to market uncertainty, damage of monkeys and theft. The area of linseed is also reducing because of poor yield. Therefore, safflower may be used as an appropriate alternative *rabi* crop in Chhattisgarh.

Materials and Methods

The present study was carried out in Indira Gandhi Krishi Vishwavidayalaya, Raipur, Chhattisgarh during the two consecutive years of *Rabi* 2012-13 and 2013-14. The soil of the experimental field for both the year was same and classified as *Alfisols,* texturally silty clay loam and locally known as "*Dorsa*". The nutrient status of the soil was low in available N (189 kg N ha^{-1}), medium in available P (22 kg P ha^{-1}) and high in available K (345 kg K ha^{-1}). The experiment was laid out in randomized block design with three replications. Treatments comprised three spiny cultivars of safflower (A1, Bhima and NARI-NH-1), two non spiny cultivars (PBNS-40 and NARI-6), Lathyrus (cv. Prateek), Chickpea (cv. JG 226) and linseed (cv. RLC-92). Safflower, chickpea, lathyrus and linseed were sown with a row spacing 45 cm, 30cm, 30cm and 25cm, respectively.

Results and Discussion

The results revealed that maximum and minimum days for 50% flowering and maturity was noted under non spiny safflower cultivar NARI-6 and lathyrus, respectively. Chickpea and lathyrus were being at par and produced significantly higher seed yield than that of other rabi crops. Chickpea was found to be more remunerative crop and spiny safflower cultivar A-1 was next remunerative crop under limited irrigation after the harvest of rice. The finding was also supported by Tambe *et al.* (2012). It is concluded that chickpea is more remunerative crop after harvest of rice under limited irrigation. Spiny cultivar of safflower A-1 found to be next remunerative rabi crop under limited irrigation after the harvest of rice.

Table 1: Days to 50% flowering, seed yield and B: C ratio of safflower cultivars, lathyrus, chickpea and linseed

Treatments	Days to 50% flowering		Seed yield (kg/ha)		B: C ratio	
	2012	2013	2012	2013	2012	2013
Spiny safflower cultivars						
A1	94	93	805.5	954.7	1.5	1.7
Bhima	89	91	607.1	890.2	1.2	1.5
NARI-NH-1	90	91	301.6	394.2	0.3	1.2
Non spiny safflower cultivars						
PBNS-40	81	84	265.9	469.4	0.5	0.9
NARI-6	99	101	304.1	526.2	1.1	1.3
Lathyrus	44	43	1080.0	1108.5	1.1	1.5
Chickpea	67	65	993.8	1088.6	1.8	1.9
Linseed	55	54	396.8	545.0	0.3	0.6
SEm±			46.4	61.8		
CD (P=0.05)			139.1	185.1		

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Impact of Drip Irrigation System on Onion Growers of South Saurashtra Region of Gujarat

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Keywords: Onion, drip irrigation, non-drip irrigation, cost of cultivation, cost of production, MVP, resource use efficiency, decomposition analysis, constraints

Introduction

Looking to the vast consumption in the world of onion and its commercial cultivation, the present investigation was undertaken with a view to examine the economic viability, resource use efficiency, marginal value productivity and decomposition function analysis of the selected onion cultivation practices.

Materials and Methods

The study was restricted to South Saurashtra Region of Gujarat state. Bhavnagar district has the highest onion cultivated area. Mahuva and Talaja talukas of Bhavnagar district of Saurashtra regions of Gujarat state. In all, 160 farm households were selected randomly from two talukas of Bhavnagar district. The primary data on cultivation of onion of drip and non-drip were collected for the year 2011-12 by personal interview. The major analytical tools employed for the study was tabular analysis. The cost of cultivation and return were estimated using various cost concepts viz; Cost-A, Cost-B, Cost-$C_1$and Cost-C_2.

Results and Discussion

The average total cost of cultivation of drip and non-drip practices onion was Rs. 107415/- and Rs. 112987/- per hectare, respectively, while the net return realized per hectare was Rs. 36109/- and Rs. 4453/- in respective systems. The cost of production per quintal in case of drip and non-drip onion was found Rs. 316.64 and Rs. 363.28, respectively, while the average farm harvest prices obtained per quintal were Rs. 423.09 and Rs. 377.60 in respective products. The input-output ratios over Cost C_2 were 1: 1.34 and 1: 1.04 in case of drip and non-drip onion, respectively. Thus, cultivation of onion was found remunerative to the growers.

The MVP of irrigation and plant protection chemicals were found greater than unity in both drip and non-drip onion cultivation. Besides this, MVP of hired human labour, manures, family labour in drip onion and MVP of cost of seeds and cropped area in non-drip were found greater than unity indicating the scope to increase the use of these inputs in respective crops, while bullock labour, other paid out cost and cropped area in drip while hired human labour, manures, fertilizers, family labour and other paid out cost were found less than unity indicating need to curtail the use of these inputs in respective crop practices. The high investment for the drip set and high maintenance cost of drip irrigation system were found the most acute problem faced by drip and non-drip systems onion growers. The highest net return was realized from drip practices. Thus extension efforts are needed to popularize the cultivation of highly remunerative onion crop. The production factors like hired human labour, manures and family labour in drip while cost of seeds and cropped area in non-drip onion were underutilized. Thus, there is need to divert more fund towards these inputs.

Farm business income, family labour income, farm investment income and net profit from onion

Particular	Drip		Overall	Non-drip		Overall
	Mahuva	Talaja		Mahuva	Talaja	
Farm Business Income	78373	62377	70956	35991	45871	41211
Family Labour Income	57273	41832	50114	17238	26858	22320
Farm Investment Income	74158	58110	66717	28253	38404	33616
Net Income (Profit)	43188	27921	36109	-856	9194	4454

72.

Application of Irrigation Management Model under Deficit Irrigation

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Keywords: Deficit irrigation, irrigation management, optimization model

Introduction

Deficit irrigation is an important tool to optimal utilization of irrigation water. Many researchers have provided various optimization models for water resources planning under deficit irrigation but these are few. These models have provided optimal cropping pattern and optimal use of water resources but deficit levels are fixed. Therefore, it may be a possibility to increase the net financial return if the deficit levels are not fixed. Garg and Dadhich (2014) developed an optimization model to get optimal net financial return where the deficit levels are not fixed. In this study, the model is applied to Khairpur West canal command area of the Lower Indus Basin.

Materials and Methods

The study area was Khairpur West Canal Command. The irrigation system for the lower Indus basin has managed by three barrages (namely Gudu, Sukker and Kotri). There are two main cropping system in lower Indus Basin i.e. *Kharif* season (May to October) and *Rabi* season (November to March). In the study, Khairpur West Canal Command is taken which has the left bank canal of the Suukur Barrage in Lower Indus Basin. The non linear programming (NLP) model (Garg and Dadhich, 2014) is applied to the study area. The data of the Sukkur barrage are given by Ali (1995) are presented in Table 1.

Table 1: Climatic data for the Sukkur Barrage

Temperature °C (mean)	14.8	18.3	24.0	30.0	35.1	36.0	35.0	33.6	32.3	28.1	22.0	16.7
Wind Velocity (km/hr)	1.4	1.9	2.5	2.6	2.7	3.4	3.4	2.9	2.1	1.5	0.9	1.0
Relative Humidity (%)	50	47	42	34	34	43	55	60	56	45	46	52
Sunshine (%)	67	70	70	77	78	76	70	74	80	80	78	68
Rainfall (mm)	6.0	8.0	6.0	4.0	4.0	7.0	24.0	22.0	4.0	1.0	1.0	4.0
Reference evapotranspiration (mm/day)	2.39	3.36	5.26	7.00	9.27	9.52	7.42	6.45	6.07	4.42	3.10	2.26

Nonlinear optimization model was developed to obtain the optimal deficit levels for different crops to maximize the net economic returns and to work out the corresponding optimal cropping pattern for the optimal allocation of surface and ground water resources by Garg and Dadhich (2014). The model was formulated for both the approaches, additive and multiplicative, to find out the optimal returns.

Results and Discussion

The NLP model is optimized for the optimal value of deficit level, P_{sc}, for different crops to give the optimal cropping pattern which maximize the net economic return under deficit irrigation for Khairpur West Canal Command. It shows that net economic returns increased by 43.59% and 44.68% under additive and multiplicative approaches respectively by carrying more cropped area under irrigation and thereby increasing the overall crop production and water productivity under deficit irrigation as compared to the existing ones in the command area. It also gave the optimal allocation of surface and ground water resources for Khairpur West Canal Command and further obtained optimum cropping pattern for the command area. Both the approaches, additive and multiplicative, are considered in the study area to find out the yield of the crops under deficit irrigation using corresponding modified crop yield response factors. The results corresponding to deficit irrigation are compared with the existing cropping pattern and show the advantage of deficit irrigation in maximizing the crop production with the available water as shown in Table 2.

Table 2: Overall improvements for Khairpur west canal command

Approach	Existing economic return under full irrigation (MRs)	Existing total cropped area (000'ha)	Optimized net economic return under deficit irrigation (MRs)	Optimal total cropped area (000'ha)	Increased tube well capacity			Percentage maximum increase (%)	
					Percentage increase (%)	Net economic return (MRs)	Optimal cropped area (000'ha)	Net economic return	Total cropped area
Additive	584.62	118.8	839.62	175.6	150.00	1039.21	220.00	77.76	85.08
Multiple	584.62	118.8	845.75	174.4	150.00	1070.82	220.00	83.17	85.08

References

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73.

Influence of Irrigation and Nutrient Schedules on Growth, Biomass Production, Yield and Quality in Coleus (*Plectranthus barbatus* Briq.)

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Keywords: Coleus, Forkolion, fertigation schedule, irrigation regime, yield, quality

Introduction

Coleus botanically known as *Plectranthus barbatus* Briq. belongs to the family 'Lamiaceae' and grows wild in arid and semi-arid regions of India. It is used many in ayurvedic preparations. Irrigation and nutrition are the important factors plant growth, development, yield and quality. If the recommended dose of fertilizers 40: 60: 50 kg N: P_2O_5: K_2O ha^{-1} is applied in 2-3 splits with higher amount during initial growth stages and less amount during lag vegetative period, the effectiveness of the applied fertilizers is reduced considerably. Tuber initiation, tuber bulking and maturity phase are critical stages for nutrients in coleus.

Materials and Methods

A field experiment was conducted for "Standardization of irrigation and nutrient schedule for drip fertigation in coleus" at College of Horticulture University of Horticultural Sciences, Bagalkot, Gandhi Krishi Vignana Kendra, Bengaluru. The experiment was laid out in Factorial concept with randomized block design (RBD) with three replications. Treatments comprising of combination of three drip irrigation namely 0.9 IW/CPE (I_1), 0.7 IW/CPE (I_2) and 0.5 IW/CPE (I_3) ratio regimes and three fertigation schedules Viz., fertigation up to 4 months (F_1), fertigation up to 5 months (F_2), and soil application as per recommended dosage (F_3).

Results and Discussion

Among the irrigation schedules drip irrigation at 0.9 IW/CPE ratio recorded significantly fresh weight of leaves (725.7 g), dry weight of leaves (172.8 g), fresh weight of tubers per plant (395.89 g) and fresh tubers weight (32.99 t ha^{-1}), and it was *on par* with 0.7 IW/CPE ratio(Table 1). Irrigation at 0.7 IW /CPE recorded significantly higher number of tubers per plant (25.0), tubers diameter (3.9 cm), tuber length (21.8 cm), dry tubers weight (4.45 t ha^{-1}), dry tuber yield (4.45 t/ha) and it was *at par* with 0.9 IW/CPE ratio. Drip-fertigation increased the tuber yield and yield attributes compared to soil application of fertilizer in medicinal coleus. Drip irrigation at 0.7 IW/CPE ratio was found optimum. Fertigation of 100% NK up to 5 months (twice in a week) recorded higher tuber yield than fertigation up to 4 months. Fertigation schedules showed significant influence on dry tuber yield (Table 1).

Table 1: Effect of irrigation and nutrient schedule for drip fertigation on yield and quality in coleus

Treatments	No. of tubers per plant	Tuber diameter (cm)	Tuber length (cm)	Fresh tubers weight (t ha^{-1})	Dry tubers weight (t ha^{-1})	Fresh weight of leaves	Dry weight of leaves
Irrigation							
I_1: 0.5 IW/CPE	21.9	3.3	18.0	30.50	3.99	636.0	151.4
I_2: 0.7 IW/CPE	25.0	3.9	21.8	32.81	4.45	694.1	165.2
I_3: 0.9 IW/CPE	24.8	3.7	21.2	32.99	4.29	725.7	172.8
S. Em±	0.6	0.1	0.5	0.64	0.10	23.8	5.7
C.D. at 5%	1.7	0.4	1.4	1.93	0.30	71.3	17.0
Fertilizer levels							
F_1	25.1	3.9	21.1	32.34	4.29	716.7	170.6
F_2	25.5	3.8	21.3	33.23	4.42	734.3	174.8
F_3	21.1	3.2	18.7	30.73	4.03	604.7	144.0
S. Em±	0.6	0.1	0.5	0.64	0.10	23.8	5.7
C.D. at 5%	1.7	0.4	1.4	1.93	0.30	71.3	17.0
Interaction							
I_1F_1	22.1	3.3	18.3	30.78	3.98	664.2	158.1
I_1F_2	23.3	3.4	18.5	31.44	4.19	691.0	164.5
I_1F_3	20.3	3.1	17.3	29.28	3.81	552.7	131.6
I_2F_1	26.2	4.2	22.8	33.08	4.53	703.9	167.6
I_2F_2	27.1	4.3	23.3	33.97	4.57	766.3	182.5
I_2F_3	21.6	3.3	19.4	31.39	4.26	612.0	145.7
I_3F_1	26.9	4.3	22.3	33.17	4.35	781.9	186.2
I_3F_2	26.2	3.8	22.0	34.28	4.49	745.6	177.5
I_3F_3	21.5	3.2	19.4	31.53	4.03	649.4	154.6
S.Em±	1.0	0.2	0.8	1.11	0.17	41.2	9.8
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS

F_1: Fertigation up to 4 months, twice in a week, F_2: Fertigation up to 5 months, twice in a week, F_3: Soil application as per recommended dosage (control)

74.

Response of Capsicum to Deficit Drip Irrigation Scheduling in Sandy Loam Soil

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Keywords: Drip irrigation, capsicum, water scarcity, sandy loam soil

Introduction

Capsicum (*Capsicum annum*, L.) is one of the important vegetables grown in eastern India which is characterized by a long dry season in a year. Cultivation of capsicum with irrigation facility is a common practice in this region. However, limited fresh water availability due to the regional saline aquifer restricts irrigation water supply for the crop. Drip irrigation (DI) has been found as a productive and water saving technique in capsicum. Optimum irrigation scheduling is one of the key options to enhance water use efficiency under any irrigation system. It is, therefore, essential to study the response of capsicum to deficit irrigation under drip system.

Materials and Methods

The experiment was conducted from December 2013 to March 2014 to study the response of capsicum to DI at Deras Research Farm, ICAR-Indian Institute of Water Management, Bhubaneswar, Odisha. The plants were transplanted in paired rows on beds keeping the drip lateral pipes at the centre of the beds. The capsicum seedling (variety Indam Bharat) of 20 days was transplanted for the study. The plant to plant and row to row distances were maintained at 0.4 m on bed. Two lateral layouts were tried with lateral to lateral spacing of 1.4 m and 1.0 m with four DI regimes. DI imposed were at 75% crop water requirement (ET_c), 50% ET_c, 50% ET_c except flowering and fruiting stage (FFS) and compared with full irrigation (FI, 100% ET_c). The irrigation water quantity was estimated using the formula, $ET_c= \{(E_p \times K_p \times K_c) - ER\}/ (IE)$, where ET_c is the crop evapotranspiration (mm day^{-1}); E_p the pan evaporation rate (mm day^{-1}); K_p the pan evaporation co-efficient; K_c the crop coefficient; ER, Effective rainfall (mm day^{-1}) and IE the irrigation efficiency (90%).

Results and Discussion

The mean monthly soil water content (SWC) observed at 30 cm, 60 cm and 90 cm depths during irrigation seasons indicates that FI resulted in significantly higher SWC compared to other treatments. The highest fluctuation in SWC was observed at 0-30 cm depth, which might be due to maximum evaporation coupled with higher root water uptake from this soil layer. The vegetative growth parameters of plants were significantly affected by irrigation treatments and lateral layouts (Table 1). The yield parameters (number of fruits, average fruit weight and yield) observed in various treatments indicates that the maximum number of fruits was harvested from fully-irrigated plants followed by DI_{75}. However, the maximum fruit weight was recorded with DI_{75}. The maximum fruit yield per plant was observed with FI. The fruit yield per hectare decreased with decrease in irrigation regimes. The fruit yield at 75% ET_c was statistically at par with that in FI. The IWP was computed to be highest under DI_{75}, followed by FI. Overall, these results reveal that DI_{75} with drip irrigation is a potential water saving strategy producing higher water productivity in capsicum cultivation.

Table 1: Vegetative growth, yield and WUE of capsicum under different irrigation regimes and lateral layouts

Treatments		Vegetative growth			Yield parameters				WP (kg/m3)
		Plant height (m)	Branches (number)	Canopy diameter (m)	No. fruits/plant	Average fruit weight (g)	Yield (kg/plant)	Yield (t/ha)	
DI100	L1	66.9	7.6	56.2	2.53	97.1	0.246	11.84	4.80
	L2	66.7	7.3	54.1	2.50	97.1	0.241	15.40	4.53
DI75	L1	61.9	6.6	53.3	2.31	98.7	0.228	11.00	5.33
	L2	61.6	6.2	53.0	2.21	98.3	0.218	14.73	5.11
DI50	L1	53.9	5.2	49.8	1.68	68.8	0.116	5.60	3.46
	L2	53.7	5.0	49.5	1.59	68.5	0.109	5.20	3.28
DI50 EFFS	L1	60.1	6.1	54.2	2.04	76.4	0.156	7.52	3.55
	L2	60.0	5.9	54.0	2.00	76.0	0.152	1.25	3.46
CD0.05	I	3.7	0.6	4.2	0.6	0.5	0.02	4.7	----
	L	ns	ns	ns	ns	ns	ns	6.6	
	IxL	2.8	0.4	2.7	0.5	0.3	0.05	7.9	

DI_{100}: Drip irrigation at 100% ET_c; DI_{75}: Drip irrigation at 75% ET_c; DI_{50}: Drip irrigation at 50% ET_c; L_1: 1.4 m lateral distance; L_2: 1.0 m lateral distance

75.

Wheat Genotypes as Affected by Deficit irrigation Regimes

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Keywords: Irrigation regimes, wheat genotypes, yield

Introduction

The Introduction of high-yielding varieties of crops with increased use of fertilizers and irrigation have collectively contributed to green revolution in India. However, the excessive and indiscriminate use of water and fertilizers has often resulted in adverse effect on the soil health, environmental pollution and crop productivity. The issue of water management has been a key factor to bring about steady progress in agricultural production.

Materials and Methods

A field experiment was conducted at experimental Farm of IARI, New Delhi to study the effect of deficit irrigation on productivity and profitability of wheat cultivars during *Rabi* season of 2012-2013 with the objectives to identify most suitable wheat cultivars tolerant to moisture deficits at sensitive stages and to study the influence of deficient water regimes on growth and yield of wheat crop and productivity of water. The experiment was laid out in split-plot design (SPD) replicated thrice with three wheat Cultivars *viz*; HD 2851, HD 2894, HD 2967 and 6 irrigation treatments i.e. I_1- 2 irrigations (CRI & Late jointing), I_2- 3 irrigations (CRI, Booting and Milk), I_3- Recommended irrigations (6 irrigations), I_4- 2 irrigations (with sprinkler), I_5- 3 irrigations (with sprinkler) and I_6- 6 irrigations (with sprinkler). Irrigation under treatments $I_{1,}$ I_2 and I_3 was applied through check basin method of irrigation and in rest of the treatments through sprinkler method of irrigation.

Results and Discussion

Although highest grain yield (4.89t/ha) was recorded in treatment receiving recommended number of irrigations (Check basin method) but it was statistically at par with grain yield (4.79t/ha) obtained by applying recommended irrigation through sprinkler method of irrigation. In addition there was 15-25% saving of irrigation water in sprinkler method without any adverse effect on grain yield. Soil moisture studies showed that there was more retention of water in soil profile (0-30cm) in case of sprinkler method of irrigation. This is because of less percolation losses of water in sprinkler method. Amongst wheat genotypes, HD 2967 recorded the highest grain yield (4.9t/ha) followed by HD2894 (4.7t/ha) and lowest grain yield (4.2t/ha) was recorded in HD2851. HD 2851 matures early and its duration still reduced by 5-6 days under water stressed conditions.

Table 1: Effect of deficit irrigation on grain yield of wheat genotypes

Treatments	Grain Yield (t/ha)	Grains/ear (No's)	1000- grain wt (g)
Irrigation Scheduling			
2 Irrigations (CRI*, LJ**)	4.24	29.67	32.47
3 Irrigations (CRI, Booting & Milk)	4.71	33.67	36.73
Recommended irrigations	4.89	41.67	38.27
2 Irrigations (Sprinkler)	4.27	30.67	32.17
3 Irrigations (Sprinkler)	4.60	32.67	36.53
Recommended irrigations (Sprinkler)	4.79	38.67	37.20
LSD (P=0.05)	0.30	4.11	3.8
Wheat cultivars			
HD 2851	4.2	32.65	32.43
HD 2894	4.7	34.45	34.25
HD 2967	4.9	36.15	37.50
LSD (P=0.05)	0.35	NS	NS

*CRI-Crown root initiation, ** LJ- Late jointing

76.

Agricultural Resource Management Using Optimization Techniques - A Case Study

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Keywords: Optimization, linear programming, consumptive use, net profit.

Introduction

The productivity of any area depends largely upon the timely application of related inputs rather than total quantity of water and fertilizers during the entire growth period of the crop. Agricultural resources management of a particular region would need to include those crops which are locally and economically important. Dantzing (1963) developed the simplex methodology to solve liner programming which is widely used in various fields like industrial, municipal and agricultural management.

Materials and Methods

The project area Kharagpur block-I is located at latitude of 22°22'N and at a longitude of 87°20'E. It is situated at about 8 km in the south of Midnapur (West Bengal). The total geographical area of Kharagpur block-I is 32600 ha the net cultivated area is 18500 ha. The dally rainfall data of 20 years and evaporation data of 15 years were taken from Indian Institute Technology (IIT) Kharagpur observatory and converted on weekly basis to predict the expected weekly rainfall and evaporation at different probability level using Weibull's plotting position formula. Consumptive use of various crops was calculated from pan evaporation data. Twelve crops were considered for land allocation so as to maximization of net benefit within the constraints. Parameters were estimated by taking maximum yields of all crops at optimum levels of water and fertilizer inputs. Only area is taken as the as the decision variable. For optimal resources, the whole block is considered a compact and self-sufficient unit and resources were considered to be transportable within the block. Planning was done keeping in view the farmer's benefit under the constraints of nutrition and food for the socio-economic upliftment of the block. Computer software package QSB+ (Quantitative System for Business Plus) was used to solve the linear programming model.

Results and Discussion

Optimum allocation of land under maximization of net profit strategy was worked out using optimization software (Table 1). Total net benefit from the crops under the model of the block was increased by 42.82% when compared with existing one. It is due to the allocation of more area under high value crops like tomato (*Solanum lycopersicum*), chilli (*Capsicum annuum*) and okra (*Abelmoschus esculentus*) and reducing area under local rice crop. On the contrary area of sugarcane crop was decreased due to high investment towards its cultivation under optimum allocation of agricultural resources strategy.

Table 1: Comparison of optimal land allocation under maximization of net profit strategy

Decision variable	Crop	Area, ha	
		Maximize net benefit	Existing land allocation
A_1	Paddy (K & Rn, local)	4500	15800
A_2	Paddy (K & Rn, HYV)	5500	2000
A_3	Paddy (R & I)	1500	1400
A_4	Wheat (R & I)	400	370
A_5	Mustard (R & I)	300	270
A_6	Groundnut (K & Rn)	410	350
A_7	Greengram (R & I)	700	670
A_8	Greengram (S & Rn)	1150	1050
A_9	Sesamum (S & Rn)	400	380
A_{10}	Sugarcane (S & I)	10	100
A_{11}	Brinjal (R & I)	160	140
A_{12}	Chilli (R & I)	135	125
A_{13}	Potato (R & I)	462.5	380
A_{14}	Tomato (R & I)	7273.13	4000
A_{15}	Lady's finger (K & Rn)	149.73	100

Kharif (K); Rabi (R); Rainfed (Rn); Irrigated (I); Summer (S)

77.

Studying Natural Resource Management Activities in Dry Zone of West Bengal: Sustainability Perspective

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Keywords: Natural resource management, Integrated Wastelands Development Programme, social sustainability, ecological sustainability, institutional sustainability

Introduction

Watershed-based development and management of natural resources has been the strategy for growth and sustainability of agriculture in arid, semi-arid and dry regions in India. Short as well as long-term success of this can only be ensured by taking into consideration specific needs of beneficiaries by ensuring their participation at all stages of decision making and project implementation, through appropriate mix of modern technologies with indigenous technical knowledge and by setting up local institution for planning, implementing and monitoring of whole project and beyond. In West Bengal, one of the most severely affected states by soil erosion, Integrated Wastelands Development Programme (IWDP) was initiated in 2004 to counter the natural resource depletion challenges. This investigation presents a detailed analysis of the programme from sustainability perspective which was measured by considering three dimensions namely social, ecological and institutional separately.

Materials and Methods

Bankura district of west Bengal which was purposively selected as it was the second most drought affected district of the state. Taldangra block was randomly selected from four IWDP project-implementing blocks in which Project VI of IWDP (watershed TSJ/7) was under implementation. A total of 107 respondents were sleeted from project VI of IWDP on a random basis as the beneficiaries of the project. A sustainability index was developed to get a standard score of level of social and ecological sustainability. The indicators under each dimension were selected based on expert judgement. Ratings against each indicator were assigned based on expert as well as respondents views which were combined into a single score by using analytical hierarchy method.

Results and Discussion

Social sustainability was at medium level with index score 49.17, measured by considering people's participation in overall activities of project management, equity for providing benefit and decision making process. Activities were low in participation in planning, post implementation and monitoring evaluation stage (Table 1). Ecological sustainability score 55.75, measured by analyzing technological intervention, environmental effect and increased vegetation in project area, was to some extent higher than social one. Institutional sustainability measured by adequacy and performance of local institutions. In case of village committee and user group, ratio of institution per 100 households was 0.37 for both types of institutions and in case of self help groups (SHGs), it was 2.46. The representation per 100 families in the institution was highest in case of SHGs (61.36%). Bank was found to be the mostly contacted institution followed by co-operative.

Table 1: Distribution of respondents on the basis of extent of participation (n=107)

Stage of project management	Extent of participation(% of respondents)			Weighted mean score
	Full	Partial	Non	
Planning	14.01	84.11	1.86	35.35
Implementation	0.93	98.13	1.86	33.45
Post Implementation	8.41	60.75	30.84	29.59
Monitoring & Evaluation	17.76	21.49	60.75	26.16

78.

Livelihood of *Rohingya* and Their Brunt on Natural Resources: Empirical Evidence from Teknaf of Bangladesh

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Keywords: Livelihood, Rohingya, natural resource, Bangladesh.

Introduction

The *Rohingya* is an ethnic, religious and linguistic minority in Myanmar bordering Bangladesh have been entering and settling in Bangladesh since decades. In order to avert deportation in the recent days, they have been trying to settle in areas where social and physical camouflages can be achieved easily. In this study both the types, the *Rohingya* living in the remote forests and local communities, have been considered. It is assumed that their different locations and strategies of living in Bangladesh will reveal a comprehensive picture of the livelihood mechanisms and its possible impacts on the forest and other natural resources including Teknaf Wildlife Sanctuary (TWS).

Materials and Methods

The study was conducted in Shaplapur village of Teknaf upazila of Cox's Bazar district where cluster of *Rohingya* live in a buffer forest of coastal belt. Randomly selected 125 *Rohingya* household heads (out of 980) were interviewed to assess their livelihood status. Investigation of secondary sources and focus group discussions were also conducted. Livelihood status was measured based on the extent of possession of livelihood assets based on five capitals - *'natural', 'physical', 'financial', 'human', 'social'*. Each of the capitals consisted of several indicators having a definite score. Score for each of the indicators under every capital then made up the final score for each capital. Following similar procedure, data were collected also from 65 *Rohingya* household heads (out of 125) Kerontoli village of Teknaf where they live admixed in the local community. Data were collected in March 2013.

Results and Discussion

As illegal refugees, the overall standard of socio-demographic features of the *Rohingya* was much inferior compared to the people of the locality as the access of all the *Rohingya* were denied to any kind of government services. The possible score of livelihood status could range from 28-84 and the observed score for it was 28 to 34 and the average score was 31.2 (Table 1). All the *Rohingya* belonged to low status of livelihood. About two-thirds of them used to cut trees and twigs in TWS to use as domestic fuel. About 80% of them were engaged in resource depletion either in sea or hills. *Rohingya* adopted desperate livelihood activities due to their *'no means'* situation. They duly realized that their despairing involvement in various activities led to diverse consequences on natural resources and environment. All these cause severe deforestation in TWS leading to habitat loss of wildlife and severe land slide and erosions assisting in polluting environment. Landslides of the hills stand as a major reason of soil deposition on fertile crop filed at downsides of the sanctuary and on the streams. Cutting and selling wood by the *Rohingya*, as a livelihood activity, should not be viewed as the only reason of deforestation. Rather, 86% of *Rohingya* used to cut trees, their branches, twigs, leaves and bushes from hills for household use as biomass fuel and housing materials. Accordingly, desperate livelihood activities of *Rohingya* pose a huge threat to natural resources like forests and aquatic systems although the extent of total effect for the *Rohingya* is much lesser compared to that of the local inhabitants.

Table 1: The overall score for livelihood status of *Rohingya* (n=190)

Status of livelihood (score)	*Rohingya*						Mean score value		
	Buffer forest		Kerontoli		Overall		Buffer forest	Kerontoli	Overall
	No.	%	No.	%	No.	%			
Low (28-47)	125	100	65	100	190	100	32.1	30.3	31.2
Medium (48-65)	0	0	0	0	0	0	0	0	0
High (66-84)	0	0	0	0	0	0	0	0	0

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Promising Agro-interventions to Enhance Farm Productivity and Profitability in Resource Poor Rain-fed Agro-ecosystem of Jammu Region

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Keywords: Rain-fed, alternate land use, productivity, profitability

Introduction

Enhancing farm productivity and profitability in lesser endowed rain-fed areas under the Shivalik foothills is key challenge for researchers and policy makers. Erratic and uneven distribution of rainfall, poor soil fertility, susceptibility to soil erosion, low socio-economic and meager adoption of improved practices characterize the rainfed farming.

Materials and Methods

A study on Aonla (*Emblica officinalis*) based alternate land use system was undertaken at multiple on-farm locations in rainfed areas of Jammu under National Innovations on Climate Resilient Agriculture-All India Coordinated Research Project on Dryland Agriculture (NICRA-AICRPDA) of Advance Centre for Rainfed Agriculture, Rakh Dhiansar to determine the promising agro-interventions to enhance the farm productivity and profitability in comparison with farmers' practice.

Results and Discussion

Aonla + gobhi sarson Brassica Napus (100% RDF) system as improved practice (IP) obtained 43, 34 and 26% higher yield in 2012, 2013 and 2014, respectively in comparison to farmers' practice (FP) (Fig. 1). Higher rain water use efficiency (RWUE) and benefit cost ratio were also recorded under IP in comparison to FP (Fig. 2). The results confirmed the efficacy of aonla based landuse system to enhance farm productivity and profitability in resource poor rainfed areas.

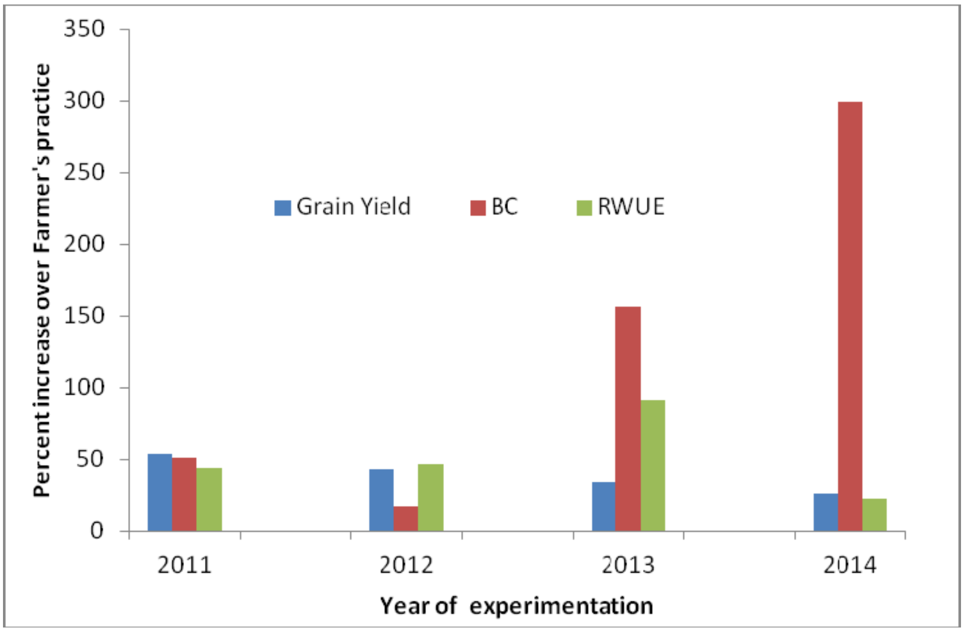

Fig. 1: Percent increase in grain yield, benefit: cost ratio and rain water use efficiency over farmers' practice during the period of experimentation

80.

Traditional Ecological Knowledge Loss and Changes in Agricultural Practices of Highland Mountain Agricultural Systems of Ladakh (India)

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Keywords: Ladakh, traditional ecological knowledge, agricultural practices, land use.

Introduction

Ladakh is a high altitude cold desert of India, constitutes the easternmost part of trans-Himalayan. The region being situated on the rain shadow side of the Himalayas receives less precipitation about 100- 120 mm mostly in the form of snow, the rivers are glacial fed and region have sporadic vegetation. It is characterized by extreme weather conditions like intensive sunlight, cold nights, strong winds and high evaporation rate. The winter temperature drops to -20°C to -30°C. The short vegetation period lasts for 5-6 months during which agricultural practices and other economical activities are carried out and for the rest six months it faces long harsh winters. The traditional practices to live in harmony with the nature have sustained the livelihood of people since centuries.

Materials and Methods

This paper aims to study the changes or loss in the traditional ecological knowledge through personal interviews (especially with aged people of above 70 years) and questionnaire method during monthly field visits of 2014- 15. The methodology for the study was adopted as described by Jain (1991) and Chadwick and Marsh (1994). The villages chosen for study were Tia (3477 m) and Khardong (4182 m) asl. The altitudinal differences of these two villages results farmers choosing different agricultural practices, crops, local vegetables and fruits.

Results and Discussion

It can be well documented that since the past decades there has been intensive change in the traditional agricultural practices due to change in socio economic pattern and government development policies. Most of the traditional agricultural practices like ploughing, threshing and winnowing process which used to involve man and animal power are replacing by technology at the cost of soil and fodder quality degradation. With the change in local knowledge, the traditional wisdom is degrading at the cost of cultural and ecological degradation.

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81.

Effect of Different Rice Establishment Methods on Wheat Productivity at Different Nitrogen Levels

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Keywords: Rice establishment methods, N-levels, rice equivalent yield

Introduction

Rice (*Oryza sativa*) is grown by different techniques for higher productivity. Transplanting of paddy seedlings is common method of crop establishment, but this practice is labour intensive. Puddling alone consumes about 20-40% of the total water requirement and promotes the formation of hard pan. Direct dry seeding offers the potential for water savings, reduced labour demand along with improved soil structure. Zero tillage technology has potential to allow saving in time, energy and water (Piggin *et al.,* 2002) and also helpful in reducing adverse effects of puddling on the soil health (Timsina and Connor 2001). Therefore, the present study was conducted to observe the effects of different establishment methods in rice on wheat (*Triticum aestivum*) productivity under different nitrogen levels.

Materials and Methods

The experiment was conducted at the Regional Research Station, Gurdaspur on clay loam soils during *kharif* season 2014 and *rabi* 2014-15. The experiment was laid out in strip plot design with three rice establishment methods in main plots i.e. Puddle transplanted rice (PTR), zero-till transplanted rice (ZTR) and direct seeded rice (DSR) and four nitrogen levels in wheat crop in sub plots i.e. no nitrogen, 75 kg N/ha, 150 kg N/ha and leaf colour based (LCC -130 kg N/ha) nitrogen application. All the yield attributing characters of rice and wheat crop were recorded at the maturity stage.

Results and Discussion

It is inferred from the study (Table 1) that ZTR and PTR produced statistically similar yields but their yield was significantly higher than DSR. Yield decline in DSR is due to more competition from weeds and also crop coincided with heavy rains at flowering stage. The wheat crop showed similar response to the applied nitrogen ferlizer under different establishment methods and hence wheat yield was not significantly influenced by different methods of establishment. In wheat crop, all the three N-levels produced significantly higher yield than control under different methods of establishment. Application of N at 150 kg N/ha and LCC based N application produced statistically at par wheat yields. Hence, saving in N by using LCC was recorded. Puddled transplanted and transplanted zero tillage gave similar rice equivalent yield which was significantly higher than DSR. Nitrogen application with LCC gave similar rice equivalent yield as recorded in 150 kg N/ha.

Table 1: Grain yields and rice equivalent yield as influenced by different establishment methods and N levels

Nitrogen	Rice grain yield (q/ha)				Wheat grain yield (q/ha)				Rice equivalent yield (q/ha)			
	Establishment methods			Mean	Establishment methods			Mean	Establishment methods			Mean
	PTR	ZT	DSR		PTR	ZT	DSR		PTR	ZT	DSR	
No N (control)	53.67	54.55	33.83	47.35	27.14	23.84	23.63	24.87	80.91	78.48	57.55	72.31
75 kg N/ha	57.43	63.78	36.25	52.49	43.78	41.31	41.94	42.34	101.37	105.24	78.35	94.99
150 kg N/ha	57.95	63.41	36.33	52.56	45.80	44.92	42.77	44.49	103.92	108.50	79.25	97.22
LCC based N	59.81	61.36	38.43	53.20	46.05	45.80	43.22	45.02	106.03	107.33	81.81	98.39
Mean	57.21	60.78	36.21		40.69	38.97	37.89		98.06	99.89		

CD (p=0.05)	Rice	Wheat
Establishment methods	5.23	5.93
Nitrogen levels	6.50	2.71
Interaction	10.53	4.69

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82.

Effect of Seeding Rate of Rice Nursery, Seedling Age and Spacing on Growth Parameters and Productivity of Rice under System of Rice Intensification

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Keywords: Seedling rates, seedling age, spacing, SRI

Introduction

Rice (*Oryza sativa*) forms staple food for more than half of the world population. In India, rice the most important and extremely grown food crop, occupied 42.81 million hectare and produced 143.96 million tonnes paddy (95.97 million tonnes rice) (FAO 2013). Young seedlings prior to the start of the 4th phyllochron of growth (< 15 days) possess higher tillering potential which drastically decreases with advancing age. Transplanting at wider spacing relieves the plant of adverse effects of closer spacing namely- severe competition between plants resulting in poor tillering; square geometry gives room for profuse root and tiller growth through more efficient harvest of solar energy and other growth resources, achieving 'the border effect' throughout the whole field (Satayanarayana *et al.,* 2007).

Materials and Methods

The experiment was conducted at the experimental farm of CSK Himachal Pradesh Krishi Vishvavidyalaya Rice and Wheat Research Centre, Malan *kharif* 2013 to study the effect of seeding rate, seedling age and spacing *vis-a-vis* seeding rates through seedling vigour on rice growth, development and productivity under system of rice intensification. The twenty four treatments comprised of combinations of three seedling ages (10, 17 and 24 days) and two spacing (20 cm x 20 cm and 20 cm x 15 cm) in main plots and four seedling vigour from four seeding rates (25, 30, 35 and 40 g/m^2) evaluated in sub plots.

Results and Discussion

Growth parameters like plant height at all stages, number of tillers and leaves at 70 days after sowing, leaf area index at 40 and 70 days after sowing and dry matter accumulation at all stages except maturity were significantly higher when younger seedlings aged 10 and 17 days were used. The crop raised using 10 days old seedlings matured 3-5 days earlier than 24 days old seedlings. Wider spacing resulted in significant increase in rice plant height at maturity, number of tillers and leaves at 70 days after sowing and dry matter accumulation in shoots at all stages except at maturity. Seedlings from lower seeding rates of rice nursery 25, 30 and 35 g/m^2 resulted in significantly higher dry matter accumulation at 40, 70 and 100 days after sowing and produced significantly taller plants than the check (40g/m^2) at maturity stage. However in the final analysis seeding rates had no effect on rice crop productivity. The seeding rate, seedling age and plant spacing did not influence rice crop productivity significantly thereby permitting flexibility to the rice farmers in the adoption of these factors.

Table 1: Effect of treatments on growth parameters, yield attributes and yield

Treatment	Plant height (cm) (At maturity)	No. of tillers/m^2 (70 DAS)	Leaf area index (70 DAS)	Dry matter accumu-lation (g/m^2) (At maturity)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index
Seedling age (days)							
10	99.9	486.1	6.1	1264.3	5386	7415	0.41
17	100.9	538.3	5.6	1271.6	5408	7528	0.41
24	96.9	475.9	5.2	1223.2	5260	7146	0.42
SE (m±)	0.79	7.96	0.19	37.99	139.5	205.6	0.01
$LSD_{0.05}$	2.48	25.08	0.58	NS	NS	NS	NS
Spacing (cm)							
20 x 20	101.0	524.3	5.6	1268.5	5413	7403	0.41
20 x 15	98.6	490.0	5.7	1239.6	5245	7335	0.41
SE (m±)	0.64	6.50	0.15	31.02	113.9	167.8	0.00
$LSD_{0.05}$	2.03	20.47	NS	NS	NS	NS	NS
Seeding rate (g/m^2)							
25	100.0	486.9	5.62	1235.8	5303	7253	0.42
30	99.2	526.8	5.67	1279.5	5298	7569	0.41
35	100.0	507.9	5.69	1246.8	5387	7283	0.42
40	97.6	478.9	5.52	1250.0	5416	7346	0.42
SE (m±)	0.64	13.89	0.26	25.92	80.8	190.7	0.01
$LSD_{0.05}$	1.82	NS	NS	NS	NS	NS	NS

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83.

Adoption, Knowledge and Satisfaction Level of Happy Seeder Technology in Operational Village under NICRA Project in Bathinda District

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Keywords: Adoption, knowledge, satisfaction and happy seeder technology

Introduction

Rice (*Oryza sativa* L)-wheat (*Triticum aestivum* L.) is the major crop rotation in the state and is responsible for about 40 million tonnes of crop residue waste every year. Wheat straw is mostly used as dry fodder, partly in generating power at biomass thermal plants. High silica content in rice straw does not allow it to be fed to animals. So 20 million tonnes of the rice straw is set on open fire and it creates green house effect by producing the 17.23 mt of CO_2 during the short span of 15-20 days which disturbs the natural climate of the planet. In the rice straw burning process carbon, nitrogen and sulphur elements present in straw are completely burnt and lost to the atmosphere (Singh *et al.*, 2012) A study conducted by the National Remote Sensing Agency indicated that rice straw burning in Punjab contributed 261 giga gram (Gg; 1 Gg=1,000 metric tonne) of carbon monoxide, 19.8 Gg of nitrogen oxide, and other gases to the atmosphere. PAU, Ludhiana has estimated that straw contained 6 mt of carbon, which on burning could produce 22 mt of carbon dioxide. It is further estimated that 25% nitrogen, 30-35% phosphorus, 50% sulphur and 75% potash and microbes are lost and results poor soil health and fertility and which, has to be replenished through organic or inorganic fertilisers and increases the cost of production. To solve the problem of burning of rice straw a machine called happy seeder has been introduced by the PAU Ludhiana.

Materials and Methods

The study was carried out during *kharif* from 2012-13 to 2014-15 (three consecutive years) in operational area of Krishi Vigyan Kendra (KVK), Bathinda (Punjab). KVK, Bathinda has conducted 46 front line demonstrations (FLDs) on 30 hectares of land from 2012-13 to 2014-15 for popularising the happy seeder technology for the management of rice straw in the operational village Killi Nihal Singh under "National Initiative on Climate Resilient Agriculture" (NICRA) project. A sample of 70 respondents was taken comprising 46 beneficiary (Table 1) and 24 non- beneficiary farmers A control group of 24 non beneficiary farmers was selected randomly from the villages adjacent to KVK, where FLDs were not conducted by any institute or organization. The data were collected through personal contact with the help of well structured interview schedule.

Results and Discussion

As revealed in the data that 46% beneficiary farmers has continued the practice after the FLDs. About 70% beneficiary farmers reported that happy seeder technology was easy, economically beneficial, improved environment, improved soil health, required less water, less weed population so less herbicide requirement and resulted in timely sowing of wheat. As indicated from the data that trainings and FLDs resulted in change in the knowledge of the farmers regarding use of happy seeder. There was difference in knowledge of the farmers (beneficiary and non beneficiary) about happy seeder technology like laser land leveler before sowing (85% & 55%), up-liftment of machine while turning or in reverse mode (89% & 21%), soil moisture at sowing time (96% & 29%). The satisfaction level of the beneficiary farmers who used the happy seeder machine was also taken and is given in Table 2 found farmers satisfied with efficiency/ working of machine (55%), weed control management (95%), yield of wheat crop (50%), nutrients saved & pollution check of straw burning (100%).Happy seeder technology is good technology for environment safety and resource conservation and need to replicate it at a greater pace by holding more number of trainings and demonstrations.

Table 1: Extension activity done for promotion of technology and its adoption

Item	2012-13	2013-14	2014-15
Training organized (No. per year)	02	02	03
No. of participants	45	42	38
FLDs conducted (No. per year)	17	21	8
Area of FLDs conducted (ha)	12	14	4
Adoption after the FLDs	08	09	04
Non-adopters	04	04	0

Table 2: FLD farmers' satisfaction level regarding use of happy seeder (%) (n=46)

Particulars	Satisfactory	Un-satisfactory	Not-responded
Efficiency/working of happy seeder	55	40	05
Timely availability of machine	30	70	--
Availability of tractor of required hp	20	75	05
Weed control in the wheat crop	95	05	--
Incentive to end users of happy seeder	--	100	--
Yield obtained from wheat crop	50	40	10
Less water required, saves pre-irrigation	90	10	--
Productivity increase	80	15	05
Nutrients saved	100	--	--
Pollution check of straw burning	100	--	--
Rodent control	10	90	--

Reference

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84.

Genetic Variability Studies for Yield, Yield Attributes and Gum Content in Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.]

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Keywords: *Cyamopsis tetragonoloba*, genetic variability, heritability, genetic advance, seed yield.

Introduction

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.], is commonly known as guar. It is an important leguminous crop grown in arid and semi-arid regions of northwestern India. It is self-pollinated crop belongs to family Leguminosae and sub family paplionaceae. The endosperm of guar seeds contains an important hydrocolloid named galactomannan. Recent rise in demand of guar in international market as a gum is attributed to its use in mining industry and petrochemical, where its use as viscous agent has been revolutionized the petrochemical industry. In the present study, variability and other genetic parameters were studied with the objective of selection of the high yielding genotypes with highly acceptable gum content.

Materials and Methods

The field experiment was carried out at Forage section, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar in *kharif* 2012. The experimental material comprised of thirty-three genotypes grown in a randomized block design (RBD) with three replications. Each genotype was planted in two rows of 4 m length with row-to-row distance of 45cm. Data on individual plants were recorded for twelve quantitative traits. Gum content in the seed was estimated by the method of Das *et al.* (1977) and modified by Joshi (2004). The broad sense heritability (H^2) was performed for all characters using the formula of Hanson *et al.* (1956). The expected genetic advance was calculated for all traits according to by Johnson *et al.* (1955).

Results and Discussion

The coefficient of variation was low for all the traits, which indicates that the local control of experiment was effectively done. Highest genotypic and phenotypic coefficient of variation was observed for number of branches per plant followed by seed yield per plant, number of clusters per plant that indicated the scope of further improvement in these traits (Table 1). It was obvious that for this reason the selection of better genotypes could be done based on their phenotype.

The maximum heritability was observed in days to maturity, plant height and number of branches per plant. The finding indicated presence of large number of fixable additive factors and these traits could be improved by selection. High genetic advance was observed for number of branches per plant followed by seed yield per plant and plant height, it shows that the characters are governed by additive genes and selection will be rewarding for improvement of such traits (Table 1).

High heritability coupled with high genetic advance was observed for number of branches per plant, seed yield per plant and plant height (Table 1). This indicated that in these traits improvement could be made by simple selection. High heritability with medium genetic advance suggests that the character is governed by the dominant and epistatic gene action and for this hybridization is done. To improve yield and its attributes along with gum content, it is necessary to select and isolate genotypes for yield as well as gum content.

Table 1: Mean, range, genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), heritability and genetic advance for seed yield and its component characters in clusterbean

Characters	Mean	Range		GCV	PCV	Heritability (Broad sense)	Genetic advance in % of means
		Minimum	Maximum				
Seed yield /plant (g)	7.94	3.25	13.68	32.86	35.19	87.18	63.20
Days to 50% flowering	47.65	40.67	61.67	12.31	12.36	99.12	25.24
Plant height (cm)	122.97	84.30	227.16	26.56	26.88	97.58	54.03
100 seed weight (g)	3.23	2.71	3.75	7.31	8.57	72.72	12.84
No. of clusters/plant	11.70	6.33	16.00	27.02	28.72	88.49	52.35
No. of pods/cluster	3.89	3.00	4.67	7.29	17.63	17.09	6.21
No. of pods/plant	36.04	17.67	58.00	23.89	25.89	85.16	45.42
No. of seeds/pod	8.68	7.67	10.33	5.96	8.46	49.59	8.64
Pod length (cm)	5.71	5.00	9.33	14.92	17.37	73.73	26.39
Gum content (%)	25.00	18.48	29.45	9.19	12.18	56.92	14.28
Days to maturity	104.38	91.00	127.00	12.77	12.84	99.04	26.19
No. of branches/plant	5.42	000*	9.33	48.98	50.67	93.41	97.51

*Including unbranched genotypes

85.

Enhancing Productivity and Profitability of Castor (*Ricinus communis* L.) based Intercropping Systems in Aridisols

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Keywords: Castor, profitabiltiy, intercropping, clusterbean, mungbean

Introduction

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop. In 2013-14, India produced 1.2 metric tonnes (mt) castor from an area of about 1 million ha with average yields of 1223 kg/ha. Pearlmillet (*Pennisitum glaucum*)/ clusterbean (*Cyamopsis tetragonoloba*)- mustard(*Brassica juncea*) crop rotation is followed on nearly 1.5 lakh ha in Bhiwani district (Haryana). Continuous cultivation of mustard in *rabi* season has invited problem of parasitic weed (*Orobanche)* which reduces mustard yield drastically up to 80% and has emerged as a serious threat to mustard cultivation. Under such situations castor seems to be a suitable alternate for farmers. Although, castor is a frost sensitive crop, yet the risk can be avoided by intercropping with short duration legumes having less water requirement as it is grown under wider row spacing. Therefore, "on farm trials" were conducted on intercropping in castor with clusterbean (*Cyamopsis tetragonoloba*) and mung bean (green gram: *Vigna radiata*).

Materials and Methods

Seven on farm trials (OFTs) were conducted in Bhiwani district (Haryana) in 2012-13 and 2013-14. The soils were light textured and low in available organic carbon (0.22 - 0.37%), low to medium in available phosphorus (6-10 kg ha^{-1}) and medium in available potash (144-210 kg ha^{-1}). Each trial consisted of three treatments namely sole crop of castor, intercropping in castor with mungbean (1: 3) and clusterbean (1: 3). Under sole cropping castor was grown at a spacing of 90 cm X 90 cm, while in intercropping with mungbean and clusterbean it was grown in 150 cm wide row spacing and between two rows of castor three rows of mungbean and clusterbean were grown at a spacing of 30 cm each. The sowing was done in first fortnight of July. Standard package of practices were followed to raise the crops. The yield data of each treatment were recorded from net 10 m^2 area at each location.

Results and Discussion

The perusal of data (Table 1) revealed that clusterbean based intercropping system recorded maximum total yield (Yield of castor + equivalent yield of intercrop) which was 86 and 30% higher than the yield obtained under sole crop of castor and intercropping with mungbean, respectively. Similarly, munbean based intercropping system registered 43% higher total seed yield than sole crop of castor. Intercropping provides substantial yield advantage over sole crop owing to temporal and spatial complementarity and minimizing inter- or intra-specific competition (Chatterjee and Mandal, 1992).

Intercropping in castor with clusterbean and mungbean (both 1: 3) fetched highest net returns of Rs. 97882 per ha. Intercropping in castor with clusterbean and mungbean gave 156 and 78% higher net returns than sole crop of castor. Hence, these intercropping systems resulted into better B: C of 2.77 and 2.33 in comparison to B: C of 1.83 achieved under sole crop of castor. Intercropping of castor with mungbean has been found to be beneficial in achieving higher monetary returns (Singh, 2009). To achieve sustainable crop yield and earn more profit, castor should be intercropped with clusterbean/ mungbean (1: 3) instead of sole cropping.

Table 1: Seed yield and economics of different castor based cropping systems (mean data of 2012-13 and 2013-14)

Treatment	Castor seed yield (kg/ha)	Intercrop seed yield (kg/ha)	Castor equivalent seed yield (kg/ha)	Total seed Yield	Gross Return (Rs./ha)	Net Return (Rs./ha)	B: C
Sole crop of castor	2400	--	--	2400	84600	38242	1.83
Castor + Mungbean (1:3)	2150	900	1272	3422	121000	68031	2.33
Castor + Clusterbean (1:3)	2100	1150	2359	4459	155800	97882	2.77

Note: Rate of castor, mungbean and clusterbean bean were taken as Rs. 3300, 5500 and 10000 per qtl in 2012-13 and Rs. 3900, 4725 and 4500 per qtl in 2013-14, respectively.

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86.

Scope and Opportunities of Medicinal and Aromatic Plants and Spices in Jute Seed Based Cropping System

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Keywords: Ajwain, jute equivalent yield, stevia

Introduction

The conservative estimate for the requirement of certified jute seed is around 5000 tonnes to grow jute crop is around 0.8 million hectares of land (Mahapatra *et al.*, 2012). Jute seed is generally not produced in traditional jute fibre producing area and is mostly grown in Maharashtra, Andhra Pradesh and Karnataka. One of the important bottle necks of low fibre productivity is non availability of good quality seeds among the farmers. Higher price of seed also enhances the cost of cultivation. MAPs and seeds spices are in general high value short duration crops that fit into other cropping system and intercropping and cover cropping for efficient utilization of land and have tolerance to adverse conditions (Rao *et al.*, 2009). So an attempt was made for crop diversification to make jute farming profitable by integrating medicinal and aromatic plants (MAPs) and spices in jute seed based cropping system incorporating autumn rice in rotation.

Materials and Methods

The present experiment was conducted at Experimental Farm of the Indian Council of Agricultural Research-Central Research Institute for Jute and Allied Fibres in 2014-15 to study the production potential of selected seed spices and medicinal crops in jute seed based cropping system. The experimental site is located at 88°26` E longitude and 22°35` N latitude 9m above mean sea level. The experiment was laid out in split plot design with three replications and two fertility levels with recommended dose of fertilizer(RDF) and RDF + 5t Farm Yard Manure respectively. The experimental soil was sandy loam in texture with pH 6.8, medium in organic carbon 0.66%, medium in available nitrogen (290 kg ha^{-1}), high in available P_2O_5 (36 kg ha^{-1}) and potash (234 kg ha^{-1}). Jute was raised for seed and after harvesting of crop, sowing of medicinal and spices crops along with conventional crops as tomato were taken up followed by autumn rice. The jute equivalent yield of fibre cum seed was calculated based on prevailed market price.

Results and Discussion

After harvest of jute (seed crop), MAPs and spices namely ashwagandha (transplanted) (*Withania sominfera*), senna (*Cassia angustifolia)*, stevia (*Stevia rebaudiana)*, isabgol (*Plantago ovata)*, fennel (*Foeniculum vulgare)*, ajwain (*Trachyspermum ammi)*, dill seed (*Anathum graveolens)*, nagella (*Nigella sativa)*, coriander (*Coriandrum sativum)*, fenugreek (*Trigonella foenum-graecum)*, peppermint (*Mentha piperita)* with one traditional crop as tomato (*Solanum lycopersicum)* was raised followed by autumn rice. The highest jute equivalent yield was recorded in stevia (230.68 q ha^{-1}) followed by senna (66.53 q ha^{-1}). Among the spices

Table 1. System economics of medicinal and aromatic plants and spices in jute seed and autumn rice based cropping sequence

Cropping systems	Jute Equivalent Yield (q ha^{-1})	Net returns (Rs. ha^{-1})	B: C Ratio
Jute-fennel-autumn rice	79.15	122379	2.34
Jute-isabgol-autumn rice	63.53	86615	2.02
Jute-ashwagandha-autumn rice	62.24	98607	2.42
Jute-nagella-autumn rice	79.33	123433	2.36
Jute-senna-autumn rice	66.53	110807	2.16
Jute-dill seed-autumn rice	71.23	107224	2.26
Jute-stevia-autumn rice	230.68	366525	2.43
Jute-ajwain-autumn rice	83.75	142991	2.72
Jute-coriander-autumn rice	61.99	94918	2.31
Jute-fenugreek-autumn rice	60.93	92673	2.29
Jute-pipper mint-autumn rice	61.75	92953	2.26
Jute-tomato-autumn rice	77.67	103258	1.97
CD (0.05)	4.23	1450.49	0..002
Fertility Levels			
F1	78.83	127287	2.21
F2	88.45	128641	2.37
CD (0.05)	3.62	2048.99	0.02
Interaction (C x F)			
CD (0.05)	12.55	7097.91	0.077
CV (%)	4.22	0.946	0.150

highest jute equivalent yield of 83.75 q ha^{-1} was recorded in ajwain followed by nagella (79.33 q ha^{-1}) and fennel (79.15 q ha^{-1}) whereas traditional crop tomato registered jute equivalent yield of 77.67 q ha^{-1}. Considering the system as whole, the B: C ratio was highest with ajwain (2.72) followed by nagella (2.36) and fennel (2.34). However the yield was highest in stevia with 230.68 q ha^{-1} with an B: C ratio of 2.43 and for the aromatic plants peppermint the yield is recorded as 61.75 q ha^{-1} of oil with BC ratio of 2.26. Among the seed spices ajwain MAP crops such as stevia and peppermint can be grown in jute seed-rice cropping sequence for higher income to farmers.

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87.

Optimum Size and Shape of Plots Based on Data from a Uniformity Trial on Indian Mustard in Haryana

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Keywords: Coefficient of variation, heterogeneity, optimum plot size and shape, variability, uniformity trial

Introduction

The most obvious use of uniformity trial data is to provide information on the most suitable size and shape of plots, in which the field was planted to a single variety and harvested as small plots. The objectives of the study were to estimate the optimum plot size and shape for field research experiments on mustard yield trial; to determine the effect of plot size on variability in yield and to study the coefficients of variation of different plot sizes and shapes.

Materials and Methods

Indian mustard (*Brassica juncea* L.) cultivar RH-749 was grown using uniform crop improvement practices during rabi season of 2013-14 at Research Farm of Oilseed section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, Haryana state, India, to estimate optimum plot size and shape using yield data of the 48m × 48m (2304 basic units) recorded separately from each basic unit of 1m × 1m. The variability among plots of different sizes and shapes was determined by calculating coefficient of variation.

Results and Discussion

It was observed that the coefficient of variation decreases as the plot size increases in case of both the directions i.e. when plots were elongated in N-S direction (88 per cent decrease) or elongated in E-W direction (93 per cent decrease). Further it was observed that long and narrow plots elongated in E-W direction were more useful than the compact and square plots in controlling the soil heterogeneity. Based on the maximum curvature method the optimum plot size for yield trial was estimated to be 5m^2 with rectangular shape.

Table 1: Coefficient of variation for various plot sizes

No. of units in N-S direction	No. of units in E-W direction								
	1	2	3	4	6	8	12	24	48
1	20.07	14.12	11.81	10.22	8.24	7.42	5.44	3.28	1.44
2	14.78	10.50	8.82	7.93	6.31	5.95	4.34	2.67	-
3	12.68	9.11	7.93	6.92	5.52	5.25	4.09	-	-
4	11.00	7.89	6.82	6.24	4.83	4.64	3.52	-	-
6	9.05	6.79	5.84	5.47	4.31	3.99	-	-	-
8	7.71	5.67	4.95	4.77	3.78	-	-	-	-
12	6.10	4.80	4.03	4.11	-	-	-	-	-
24	4.08	3.47	-	-	-	-	-	-	-
48	2.34	-	-	-	-	-	-	-	-

To compare the efficiencies of plots of various sizes, the relative efficiencies were computed using the formula suggested by Agarwal and Deshpande in 1967. For this purpose, efficiency of the smallest plot was taken as unity as the smallest plot was the most efficient of all the plot sizes. It was observed that the smallest plot has the maximum efficiency but as the plot size increases the efficiency goes on decreases due to the presence of soil variability.

The results from Smith's method were inappropriate for the estimation of optimum plot size, where as maximum curvature technique revealed significant results. Accordingly plot size of 5m^2 was found optimum for field experiment on Indian mustard using the maximum curvature technique. It was observed that long and narrow plots elongated in E-W direction were more useful than the compact and square plots. Plot size of 5m^2 with rectangle shape was found optimum for field experiment on Indian mustard using the maximum curvature technique. Researchers of the relevant area may use the estimated plot size in the study to have better control over the variability of the field experiment.

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88.

Intercropping Patterns of Maize and Cowpea: Impact on Nodulation and Maize Yielding Ability

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Keywords: Intercropping, nodulation, yield

Introduction

Intercropping is one of the avenues to increase the productivity per unit area of land under the supply of limited resources. This system not only provides certain insurance against biotic and abiotic stresses but also helps in the maximization of productivity and profit by efficient utilization of natural resources (Tsubo *et al.*, 2005). Cereal-legume intercropping plays an important role in subsistence food production in both undeveloped and developing countries, especially in situations of limited water resources. The present investigation was carried out to ascertain the influence of different intercropping schemes on nodulation and yield of black cowpea (*Vigna unguiculata*) and harvest index of maize (*Zea mays*).

Materials and Methods

The investigation was conducted at the Experimental farm of Division of Agronomy at main Campus of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar. The experiment was laid out with seven methods of maize and cowpea planting (sole crops and different row ratios) in a randomized block design with four replications. Number of nodules of black cowpea crop was counted on the roots of sampled plants at flowering stage of crop and average number of nodules per plant was worked out. The other parameters recorded include biological yield (q ha^{-1}), grain yield (q ha^{-1}), stover yield (by deducing grain yield from biological yield) and harvest index (%) of maize.

Results and Discussion

Among various intercropping patterns, sole crop of cowpea (18.27) and 2: 2 maize + cowpea (16.24) yielded maximum number of nodules per plant. Sole cropping of black cowpea accumulated higher amount of fresh weight (0.235 g) of nodules per plant followed by 2: 2 maize + black cowpea intercrop at flowering stage of the crop. Significantly higher grain yields were recovered in sole cropping (50.62 q ha^{-1}), 2: 1 (49.20 q ha^{-1}), 2: 2 (48.60 q ha^{-1}) and 1: 1 (47.66 q ha^{-1}) row ratios of maize + black cowpea. Stove yield and biological yield were also significantly superior in sole cropping followed by 2: 1 and 2: 2 row ratios of maize + black cowpea intercropping patterns. However, harvest index exhibited no significant differences (Table 1).

Conclusively, the present investigation revealed that it will be desirable to harness higher yields of maize by utilizing 1: 1, 2: 1 or 2: 2 maize + cowpea intercropping patterns. In any case, we should avoid the higher number of rows of cowpea as compared to number of rows of maize like 2: 3 as they decrease the yielding ability of maize crop. Padhi (2001) also envisaged the similar trend in maize yields under different intercropping patterns with cowpea.

Table 1: Yield and harvest index of maize under various intercropping planting patterns

Treatment	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Maize sole	50.62	189.90	240.53	21.02
Black Cowpea sole	-	-	-	-
Maize + Black Cowpea (Broadcast)	43.47	187.33	230.83	18.83
Maize + Black Cowpea (1: 1)	47.03	185.88	232.91	20.18
Maize + Black Cowpea(2: 1)	49.20	189.29	238.49	20.61
Maize + Black Cowpea(2: 2)	48.60	188.69	237.29	20.46
Maize + Black Cowpea(2: 3)	46.17	187.33	233.50	19.95
S.E(m)±	1.32	0.84	1.44	0.47
C.D.($P \leq 0.05$)	3.98	2.54	4.36	NS

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89.

Evaporation Estimation by Two Different Learning Algorithms of Multi-layer Perception Based Artificial Neural Network and Multiple-linear Regression Techniques

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Keywords: Activation functions, ANN, learning algorithm, meteorological parameters, MLR

Introduction

Evaporation is the process by which water changes from liquid state to vapour state. The prediction of evaporation amount is of crucial importance in the management of water resources, irrigation, soil conservations and water balance. Accurate estimation of evaporation is essential for the balancing of irrigation water use in arid and semiarid regions. Water resource managers are confronted with the great challenge of scarcity, over thirty arid and semi-arid countries are likely to having water scarcity in 2025. The present study evaluated the following objectives; (1) To develop the ANN based evaporation estimation models with two different learning algorithms, (2) To estimate the evaporation by multiple linear regressions and (3) To evaluate performance and adequacy of the developed models.

Materials and Methods

For study area the dataset formulation was taken as standard meteorological weather data of; mean of maximum and minimum temperature, mean of relative humidity, sunshine hours and wind velocity as input and remaining evaporation data was used for output. Total number of data for each year's period comes out to be 52. Then the whole numbers of data of 39 year are 2028. Data of years 1976 to 2005 (1560) were used for training of the models and remaining data 2006 to 2014 (468) were used for testing of the models. Artificial neural network and multiple-linear regressions were applied for the model; the results of training and testing are shown in figures. In this present study learning rule delta bar delta (DBD) and Levenberg-Marquardt (L-M), activation function TanhAxon was used for artificial neural networks. The following formula used for evaluation:

Coefficient of determination (R^2)

$$R^2 = \frac{\sum_{i=1}^{n}(Yij - Yej)(Yie - Yme)}{\sqrt{\sum_{i=1}^{n}(Yij - Yme)^2} \sum_{i=1}^{n}(Yie - Yme)^2} \qquad \text{.......... (1)}$$

Where,

Yij= observed value at the i^{th} time step, Yie= corresponding simulated values,
n= number of time steps, Yej= mean of observational values and Yme= mean value of the simulations.

Coefficient of efficiency (CE)

$$CE = \left(1 - \frac{\sum_{i=1}^{n}(Yj - Yej)^2}{\sum_{i=1}^{n}(Yj - \bar{Y})^2}\right) \text{ x } 100 \qquad \text{.......... (2)}$$

Where,

Y_j =observed values, Y_{ej} = estimated values and $\bar{Y}$=mean of observed values

Multiple linear regressions (MLR)

$$Y = b_0 + b_1 X_1 + b_2 X_2 + \dots \dots\dots + b_n X_n \qquad \text{.......... (3)}$$

Where,

Y is the dependent variable (evaporation), b_0, b_1, b_2......b_n are the regression coefficient for the linear equation, and X_1,X_2,..….. X_n are the independent variables (relative humidity, wind velocity, sunshine hour and temperature).

Results and Discussion

Performance of the Delta Bar Delta and TanhAxon based evaporation estimation model was also assessed independently on the evaluation data sets (Table 1). Various networks of single and two hidden layers were trained for a maximum iteration of 1000, step size 1, additive 1, multiplicative 0.10 and smoothing 0.50 with different hidden neurons to choose best suited networks was selected based on the minimum value of root mean square error (RMSE), maximum value of coefficient of determination (R^2) and coefficient of efficiency (CE) by trial and error method.

Table 1: Performance indices of ANN and MLR based weekly evaporation estimation models

Model Name	Networks	Training			Testing		
		RMSE	CE (%)	R^2	RMSE	C (%)	R^2
Delta Bar Delta and TanhAxon	4-5-5-1	0.8561	97.91	0.9246	1.0322	96.03	0.9046
Levenberg-Marquardt and TanhAxon	4-9-1	0.8166	98.10	0.9300	1.0062	96.25	0.8975
Multiple-linear regression	-	1.0500	96.73	0.8795	1.1250	94.18	0.8658

Different ANN architectures were tried using these inputs and the appropriate model structures were determined for each input combination. Then, the ANN and MLR models were tested and the results were compared by means of coefficient of determination, coefficient of efficiency and root mean square error statistics. Artificial neural network (ANNs) gives better performance over multi- linear regression. Observed and estimated evaporation of ANN and MLR are shown in Fig. 1 to 6.

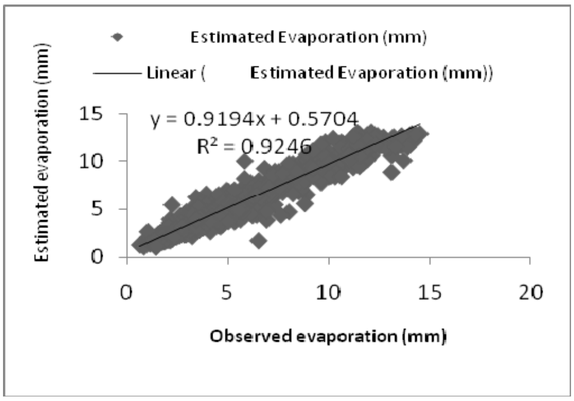

Fig. 1: Observed and estimated evaporation for Delta Bar Delta TanhAxon and combination of ANN model (4-5-5-1) during training period

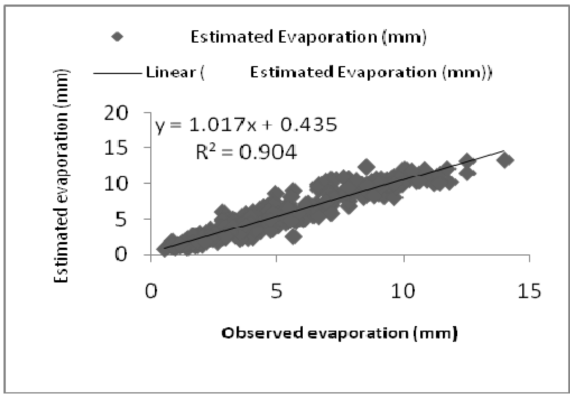

Fig. 2: Observed and estimated evaporation for Delta Bar Delta TanhAxon and combination of ANN model (4-5-5-1) during training period

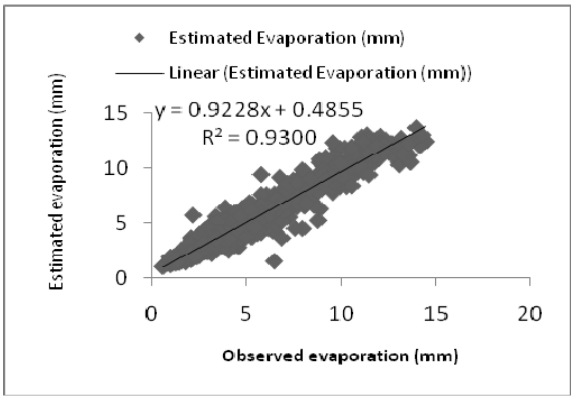

Fig. 3: Observed and estimated evaporation for Levenberg-Marquardt TanhAxon And combination of ANN model (4-9-1) during training period

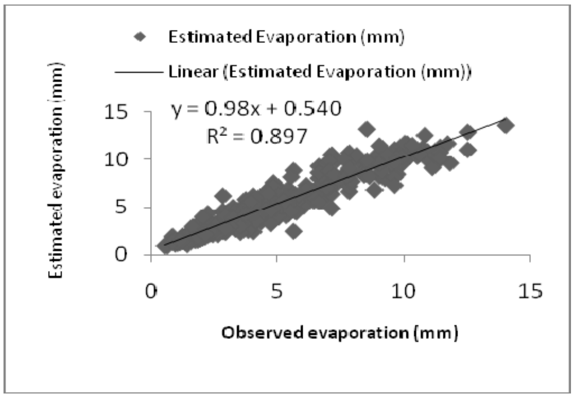

Fig. 4: Observed and estimated evaporation for Levenberg-Marquardt TanhAxon And combination of ANN model (4-9-1) during testing period

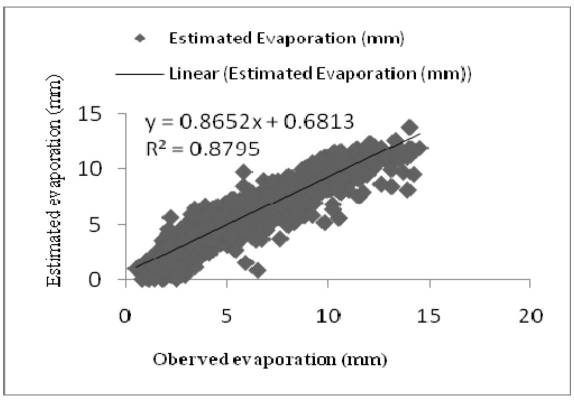

Fig. 5: Observed and estimated evaporation of MLR during training period

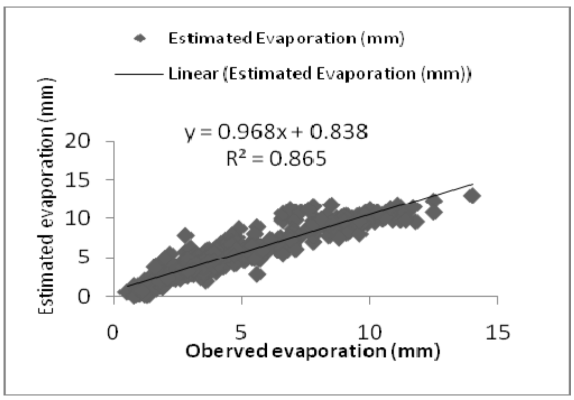

Fig. 6: Observed and estimated evaporation of MLR during testing period

90.

Least Square Support Vector Machine and Back Propagation Neural Network Models for Flood Prediction

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Keywords: Flood prediction; regression models; back propagation neural network; least square support vector machine; correlation co-efficient; RMSE.

Introduction

Water is the most precious and replenishes natural resource. The development and management of water resource is main concern for countries like India. Flood is the phenomenon of influx of water beyond its normal level confines to an area [Yarrakula, 2010]. To reduce damage caused by flood, forecasting of flood is useful. To analyze the pattern of the discharge, Auto Regression (AR), Auto Regressive Integrated Moving Average, Back Propagation Neural Network (BPNN) and Least Square Support Vector Machine (LSSVM) is applied to predict the flood values. The accuracy of prediction for various models are examined using correlation co-efficient (r), RMSE, Nash-Sutcliffe Co-efficient. LS-SVM shows better results as compared to all other models.

Materials and Methods

The daily water level and discharge values of Krishna River at Vijayawada gauging station is collected from Central Water Commission (CWC) for 46 years (1965-2010). The yearly mean discharge value is calculated and is used for prediction of flood. To analyze the pattern of the discharge, AR, ARIMA, BPNN and Least Square Support Vector Machine (LSSVM) is applied to predict the flood values. In the present research work, root mean square error (RMSE) and Nash-Sutcliffe co- efficient have been used as performance evaluation metrics as these are very sensitive to even small errors, it is better to compare the small differences in the model's performance.

Results and Discussion

The predictive capability of AR (2), ARIMA, BPNN and LS-SVM models for Krishna River is compared. The RMSE, Nash correlation co-efficient and correlation co-efficient (r) are used to evaluate the performance of these models. The statistical results of different models are summarized in Table 1.

It was observed that the LS-SVM model has the best performance with the lowest RMSE and highest correlation co-efficient for both training and testing data. The BPNN is the second best model, followed by ARIMA. As specified in Table 1, AR is having moderate prediction accuracy with less correlation co-efficient.

The LS-SVM model performance is improved with 47.95% in correlation co-efficient and reduction in RMSE with 86.27% as compared to the performance of AR (2). LS-SVM also produced some improvement over ARIMA with about a 20% and 22.85% improvement in *r* and Nash co-efficient respectively. The RMSE value of LS-SVM is reduced with 83.3% when compared to ARIMA. As with BPNN, the LS-SVM model resulted in some improvement over BPNN as well, with about an 11% and 13% for r value and Nash co-efficient respectively.

Table 1: Performance evaluation of Auto Regression, Auto Regressive Integrated Moving Average, Back Propagation Neural Network and Least Square Support Vector Machine

Method	Correlation co-efficient	Root mean square error	Nash-Sutcliffe Co- efficient
Auto Regression (2)	0.513	0.51	0.645
ARIMA	0.78	0.42	0.766
BPNN	Test: 0.94	0.065	0.985271
	Train: 0.88		
LSSVM	Test: 0.98	0.07	0.861716
	Train: 0.99		

Reference

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91.

Correlation Studies and Statistical Yield Forecasting Model for *Sorghum bicolor* (L.)

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Keywords: *Kharif* sorghum, growth stages, correlation, statistical model.

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is an important food crop in India and it is cultivated in tropical and subtropical climates, especially in the semi-arid tropics. The success or failure of dryland rainfed crops depends mostly on the pattern of monsoon rains. The distribution of rainfall in monsoon decides the yield of rainfed crops. The findings of the experiments may be useful for sorghum grower as well as agricultural policy maker because this paper may gives clear idea about correlation between weather and crop as well as help in yield forecasting before one and half month of harvesting.

Materials and Methods

Field experiment was conducted under FASAL project at Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during 2012-13 in split plot design with three replications and four sowing dates as main treatment namely D_1 (24^{th} MW), D_2 (25^{th} MW), D_3 (26^{th} MW) and D_4 (27^{th} MW) and four different varieties as sub treatment with spacing 45x15 cm. The gross plot size was 3.60 x 2.25 m^2 and net plot size was 2.25x 1.8 m^2. The recorded data was analyzed by using statistical computerized programme based on technique of analysis of variance and significance for every phenophase of sorghum crop. Regression equation was developed on the basis of crop data (phenological stage wise data) and weather data.

Results and Discussion

Highest grain yield (1482.10 kg ha^{-1}) was recorded in 24^{th} MW sowing and it was at par with 25^{th} MW sowing (1442.2 kg ha^{-1}); while, lowest grain yield (1119.31 kg ha^{-1}) was recorded in 27^{th} MW. Twenty fifth MW recorded significantly highest fodder yield (7310.5 kg ha^{-1}) and lowest in 27^{th} MW (6541.1 kg ha^{-1}). Amongst the four varieties highest grain yield (1451.31 kg ha^{-1}) and fodder yield (7228.2 kg ha^{-1}) was observed in variety PSH-71). Weather parameters found highly and significantly correlated with sorghum grain yield at different growth stages. The multiple linear regression coefficients (R^2) at each stage showed a high degree of goodness of fit as indicated by as high as 0.79 to 0.88. The multiple regression model at flag leaf to boot stage and physiological maturity stage is ($Y= -33190.0 + 359.92 X_1 -5560.80 X_2 -505.49 X_3 + 32.90 X_4 + 333.05 X_5 + 256.66 X_6 + 3241.52 X_7 --1469.99 X_8 + 137.25 X_9$) and ($Y= 4280.19 + 7.59 X_1 + 18.23 X_2 -119.45 X_3 - 125.19 X_4 + 25.87 X_5 + 10.51 X_6 + 56.29 X_7 + 113.66 X_8 - 263.93 X_9$) significant and it may be used to yield forecast of *kharif* sorghum in advance two to two and half months and 15 days before harvesting at Parbhani location. The observed yield was compared with estimated yield.

Table 5: Predicted and observed grain yield (kg ha^{-1}) of sorghum by multiple regression at various phenophases

Phenophase	Predicted Yield (kg ha^{-1}) (P)	Observed Yield (kg ha^{-1}) (O)	Difference (kg) (P-O)	Error (%)
P_2	1334.90	1335.85	-0.95	0.07
P_4	1319.68	1335.85	-16.17	1.21
P_6	1328.79	1335.85	-7.06	0.52
P_7	1325.05	1335.85	-10.76	0.80
P_8	1396.80	1335.85	60.95	4.62
P_9	1363.11	1335.85	27.26	2.04

P_2 - Emergence to panicle initiation; P_4 - Flag leaf to boot stage; P_6 -Heading to 50% flowering; P_7 - Flowering to milk stage; P_8- Dough stage; P_9- Physiological maturity

92.

Tensiometer Adoption among Rice Cultivators in Punjab: An Assessment Using the Probit Model

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Keywords: Tensiometer, paddy cultivation, groundwater depletion, adoption

Introduction

The groundwater depletion in Punjab has become a serious concern for more than a decade, with net water availability turning out to be negative. The dominance of paddy, intensive production pattern and low water use efficiency are the major reasons for such depletion (Sidhu *et al.*, 2010). The Centers for International Projects Trust (CIPT), New Delhi, promoted the use of tensiometer device for scheduling irrigation in paddy crop. The device records the matrix potential of the soil and has the potential to save 370mm of irrigation water through irrigation scheduling without any adverse effect on productivity (World Bank, 2010). The present study examines the factors influencing the adoption of this water saving technology in Punjab.

Materials and Methods

This study pertain to the sample of 838 farmers (467 adopters and 371 non-adopters) with whom the tensiometer was promoted in 2014 across four districts in the central Punjab (Amritsar, Kapurthala, Patiala and Sangrur), where groundwater was depleting at the highest rate. Within the sample, 500 farmers were provided innovative technology insurance with a nominal premium which covered the loss of productivity owing to the use of tensiometer. Rest of the farmers were treated as a control group. The data were also collected on water, electricity use and other socio-economic variables through regular visits to the farmers and probit regression analysis was carried out using the statistical package STATA 14.

Results and Discussion

The Probit regression model was estimated with adoption of the technology as dependent variable (adoption= 1 and not adopted=0), we estimated probit regressions for adoption of technology (Table 1). Even if a farmer installed the device and did not use it later for irrigation scheduling, he was classified as non-adopter. In the first model (Model 1), only two variables are significant i.e. insurance and soil type at 1% level of significance. In the second model (Model 2), variables such as soil type, insurance, education and education^2 are

Table 1: Marginal effects of Probit regression (Dependent variable: Adopted=1 and Not adopted=0)

Independent Variables	Model 1	Model 2	Model 3
Age (years)	0.0009 (0.0004)	-0.0146 (0.0253)	-0.0070 (0.0296)
Education (years)	-0.0075 (0.0129)	-0.1069*** (0.0358)	-0.1663*** (0.0443)
Soil type	-0.1811*** (0.0645)	-0.1617** (0.0653)	-0.1519** (0.0710)
Laser levelled (1= if land is laser levelled and 0=if not)	0.004 (0.0995)	-0.0213 (0.1006)	0.0551 (0.1105)
Yield (kg/acre)	-0.0068 (0.0069)	-0.0075 (0.0069)	-0.0027 (0.0081)
Motors owned	-0.0273 (0.0571)	-0.0211 (0.0574)	-0.0184 (0.0625)
Insurance (1= insurance taken and 0 if not)	0.9749*** (0.0955)	1.0040*** (0.0961)	-0.7340 (0.5859)
Motor horsepower/operational area	-0.1182 (0.0957)	-0.1252 (0.0961)	-0.0737 (0.1036)
Motor horsepower/area under paddy	0.1012 (0.0801)	0.1051 (0.0808)	0.0346 (0.0870)
Variety_1 (1= Basmati Variety, 0= others)	-0.0559 (0.1948)	-0.0354 (0.1969)	-0.0009 (0.2243)
Variety_2 (1= Hybrid Variety, 0= others)	0.1513 (0.1713)	0.2001 (0.1740)	0.2943 (0.1988)
Age^2		0.0002 (0.0003)	0.0003 (0.0003)
Education^2		0.0069*** (0.0024)	0.0008 (0.0031)
Age_insurance			-0.031*** (0.0097)
Education_insurance			0.3402*** (0.0322)
Constant	0.2556 (0.4334)	0.6957 (0.6233)	0.9442 (0.7874)
Observations	838	838	838
Log Likelihood	-515.6587	-510.6407	-408.6104
Pseudo-R2	0.1037	0.1125	0.2898

Source: Authors estimates
Note: Standard errors in parenthesis
*** & ** represents statistical significance at 1% and 5% level, respectively

significant. The third model (Model 3), soil type, education and interactions between age-insurance and education-insurance appeared significant. The findings revealed that insurance is a variable which is highly significant, since the marginal effect of insurance (1.004) ensures that farmers with insurance have higher adoption rates for the technology. A positive and statistically significant marginal effect of education-insurance confirms that more educated farmers with insurance are better adopters of the Tensiometer technology. The young and educated farmers have higher awareness level on inefficient water use and depletion of water resources and thus are willing to adopt the water-saving technology. The marginal effect of age-insurance indicates that younger farmers have taken insurance and have high rates of adoption. With respect to the ecological parameters, soil type is another variable which is statistically significant. The negative sign indicates that if the soil type is sandy or medium the adoption of technology is lower. The provision of technology use insurance and relative more focus on young and educated farmers can help in boosting the adoption of resource conservation technologies in Punjab.

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93.

Adoption of Hybrid Rice Cultivation in Jammu District, Jammu and Kashmir, India

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Keywords: Hybrid rice, attributes, rate of adoption

Introduction

Rice (*Oryza sativa*) is the staple food of about 65% of Indian population. Its production and productivity has increased with the development of dwarf and input responsive varieties. But our rice requirement by the year 2020 is estimated to be around 122 million tonnes as against the present production of about 106.65 million tonnes (Anonymous, 2014).Hybrid rice can be one of the drivers for accelerating the rice production and productivity to meet the growing consumption requirement of ever increasing population. Under National Food Security Mission (NFSM) major thrust is also being given on the production of hybrid seed for bridging the demand supply gap of rice in the country. At present area under hybrid varieties of rice in India is about 1.8 mha. In Jammu & Kashmir (J&K), area under hybrid varieties of rice is 5000 ha (FAO Stat, 2014). Various factors affect the adoption of hybrid rice cultivation that include technology attributes which includes relative advantage, compatibility, complexity, trialability and observability. Keeping in view the importance of hybrid varieties of rice in increasing the overall production a study was undertaken to access the present status of hybrid rice cultivation in Jammu district.

Materials and Methods

The study was undertaken in R.S. Pura block of Jammu district. A list of villages growing hybrid varieties of rice was obtained from Sub-Divisional Agricultural Office, Miran Sahib, Jammu. From these villages, Kirpind village was selected purposively. A list of about 150 farm families growing hybrid varieties of rice was prepared with the assistance of village panch (a panchayat representative).Out of this, 50 farm families growing hybrid rice, 10 farm families who had discontinued cultivation of hybrid rice and 10 non-adopter who never cultivated hybrid rice were selected. Thus making a total sample of 70 respondents. The data was collected through personal interview technique.

Results and Discussion

Attributes of hybrid varieties such as relative advantage, compatibility, complexity, trialability and observability were mainly studied as factors affecting its rate of adoption. The rate of adoption of an innovation is also affected by the socio-personal characteristics of farmers, efforts of change agents, concentration of opinion leaders &communication behavior of the farmers. The relative advantages as reported by the farmers were higher yield (100%), non-lodging (80%) and high fertilizer responsiveness (85%). Farmers reported that average yield of hybrid varieties was 64 q/ha in the study area. Farmers further reported that with present slump in market price of Basmati rice, hybrid varieties were more profitable than Basmati. The hybrid varieties were fully compatible with their socio-economic conditions as reported by 100% sampled farmers whereas 84% farmers reported non-compatible with their food habits as farmers did not like its taste of hybrid rice but cultivate hybrid varieties only for marketing. Difficulty in threshing of hybrid varieties was main complexity as reported by 100% sampled farmers. Further 100% sampled farmers reported that they first grew hybrid varieties on small scale as a trial. After observing trial results they decided to grow it on large scale. Farmers reported that better results of hybrid varieties such as higher yields, non-lodging and high fertilizer responsiveness were clearly visible from fellow farmer's fields which were augmenting its adoption rate in the study area. The cumulative frequency graph so obtained was S-shaped curve (Rogers, 2003) which indicates that rate of adoption of hybrid rice was slow initially but with passage of time the rate increased and was the maximum in the year 2010 and thereafter it decreased and became almost static in the succeeding years in the study area.

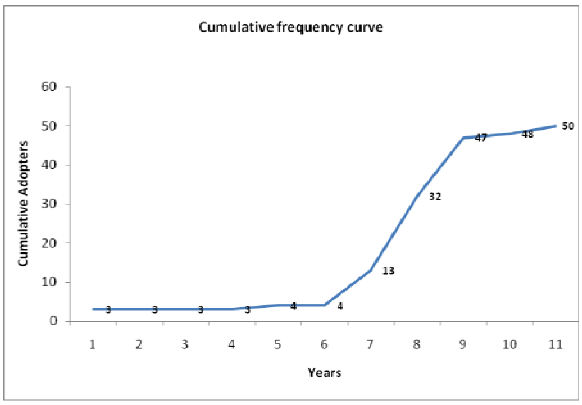

Figure showing S-Shape rate of adoption curve

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94.

Popularization of Wheat (HD-2967) in Kathua District through Farmers' Participatory Mode

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Keywords: Wheat, HD-2967, participatory mode

Introduction

Wheat is the second most important staple food after rice consumed by 65% of the population in India. The total area under the crop is about 29.8 million hectares in the country. The production of wheat in the country has increased significantly from 75.81 million tonnes in 2006-07 to 94.88 million tones in 2011-12. The productivity of wheat which was 2602 kg/hectare in 2004-05 has also tremendously increased to 3140 kg/hectare. The major wheat basket of the country is represented by North Western Plains Zone (NWPZ) covering an area of approx. 11.55 million hectare. In J&K, Kathua, Samba and Jammu districts are represented by North Western Plains Zone (NWPZ).

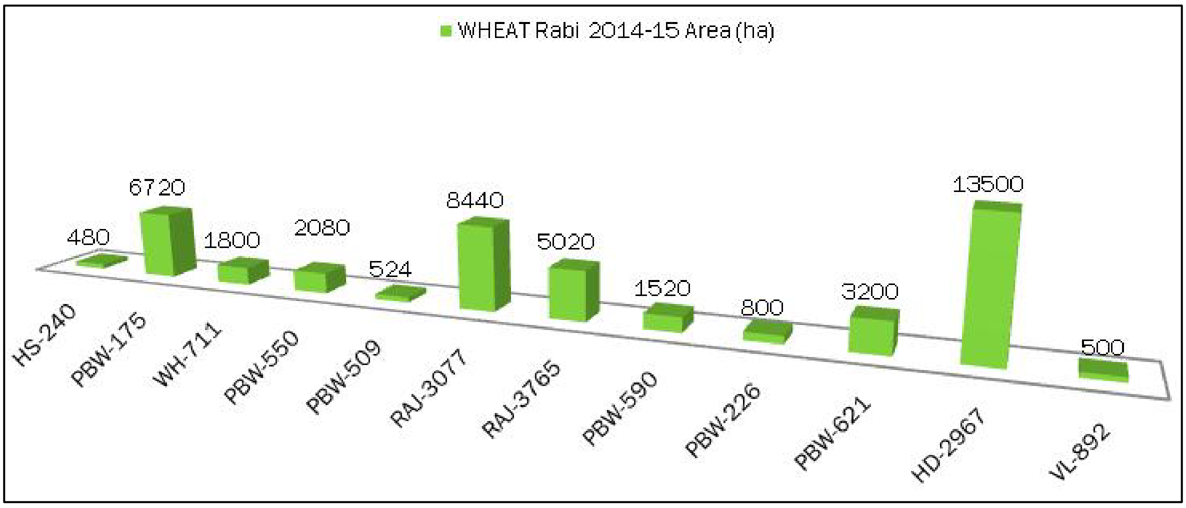
The variety HD-2967 was released in the year 2010 for North Western and North Eastern Plain Zone. It is suitable for timely sown irrigated conditions with average potential yield in NWPZ is 50.4 q/ha. It has wide adaptability and has very high plant resistance against yellow rust disease and leaf blight.

Materials and Methods

The Krishi Vigyan Kendra(KVK) Kathua procured the seed of HD-2967 from Indian Agricultural Research Institute, New Delhi under technology demonstration component *in rabi* 2011. The multi-location on-farm testing was conducted at twelve locations in Kathua and Hiranagar tehsil, respectively in *rabi* 2011 and *rabi* 2012 to identify the location specific yield, its performance and resistance to yellow rust. After, the successful results in OFT's, KVK Kathua conducted frontline demonstrations to establish its production potential on the farmers' fields during 2013 onwards.

Results and Discussion

The result of on farm trials (OFTs) conducted on HD-2967 at twelve different locations showed highest yield of 43.5 q/ha and lowest yield of 40.25 q/ha with an overall average of 41.0 q/ha as compared to 32.5 q/ha of PBW-550 which was the most popular variety among the people during the period of study (local check an increase of 32.30% yield over its local check. After the successful results of OFTs, HD-2967 was taken in frontline demonstration (FLD) programme through farmers' participatory mode. FLDs were provided to 50 farmers covering an area of 20 ha and to 92 farmers covering an area of 35 ha, respectively for 2013-14 and 2014-15. The major impact of this programme was that the total area under HD-2967 during 2012-13, 2013-14 and 2014-15 was 89 ha, 1983 ha and 13,500 ha, respectively. The total area under wheat in the district during 2014-15 was 44584 ha and nearly 30% (13500 ha) was recorded under HD-2967 followed by RAJ-3077 (8440 ha) and PBW-175 (6720 ha) with sizeable reduction in the yield losses due to yellow rust. Therefore, HD-2967 was successfully popularized among the farmers using the participatory mode which has covered a sizeable area in Kathua district.



Horizontal spread of HD-2967 in Kathua during 2014-15

95.

Women Participation in Decision Making of Punjab Agriculture

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Keywords: Decision making, Punjab agriculture, women participation

Introduction

Contribution of women in agriculture is considerable. Rural women are extensively involved in agricultural activities. However, nature and extent of their participation varies with different agro-production system. The participation tasks done on farm by men and women have certain common patterns. In general, men undertake the heavy physical labour work and jobs which are specific to distant locations, such as live stock herding and those activities which are located close to home such as care of the kitchen garden. Further, contribution of women in farm operation decision also depends on the region and crops, women produce half of the world food, hunt their work remains for the most part invisible, and unaccounted in production and employment statistics 2.

Materials and Methods

The study was conducted in eight blocks of Ludhiana-Moga-Faridkot and Moga - Faridkot - Ferozpur zone of Centeral Plain (Zone IV) from 2000-01 to 2003-04 and 12 blocks of Fatehgard Sahib -Nawashare districts of Centeral Plain (Zone III) in Punjab (India) from 2004-05 to 2008-09 under All India Coordinated Research Project on Cropping System (on farm research), Modipurum, Meerut, U P (India). In each block four villages were randomly selected and total 1718 farming families were interviewed in both the zones during study period. The data were collected with the help of well structured questionnaire supplied by Directorate of Cropping System Research, Modipuram, Meerut (India). Questions were asked to the main or primary operator/owner of the farm (the person most active in running the operation) with respect to different areas of decision making in agriculture and extend of women participation was separated into four categories namely, nil, only consulted, opinion considered and final decision taken by women in their family

Results and Discussion

Women have always played a key role in agricultural production, their importance both worker and as manager of farm have been growing. Yet, when we look more direct participation of females in farm production and decision making, the finding have been less promising. In spite of the significant women participation in agriculture activities, however, their access to decision making regarding cultural operations is limited. Table 1 depicts that 92.81, 79.17, 92.16 and 90.48% of farmers in zone IV and 97.71, 85.04, 89.61 and 91.20% of surveyed farmers in zone III did not even consult women while making decisions regarding preparation of land, time and method of sowing, mean of irrigation and manures and fertilizers to be used, respectively. Further, the results showed that farmers who considered women opinion regarding these activities were very few, less than two per cent in zone IV while, around six percent farmers in zone III considered women opinion. The lesser participation of women in these areas of decision making is due to less physical involvement of women in these operations. Earlier studies reported that the role of women in ploughing of field, application of manure and fertilizers was found to be very low (Choudhary and Singh, 2003).

Table 1: Participation (%) of women in decision making in farm operations

Decision making areas	Extent of participation							
	Nil		Only consulted		Opinion considered		Final decision	
	Zone IV	Zone III	Zone IV	Zone III	Zone IV	Zone III	Zone IV	Zone III
Preparation of land	92.81	97.71	6.19	1.76	0.94	0.53	0.00	0.00
Proper time and method of sowing	79.17	85.04	19.69	9.86	1.07	5.11	0.00	0.00
Means and fertilizers	92.16	89.61	6.91	7.92	0.87	2.46	0.00	0.00
Manures and fertilizers	90.48	91.20	8.29	6.16	1.17	2.64	0.00	0.00
Numbers of hired labourers and kind of wages	43.25	53.44	44.8	33.45	11.83	12.52	0.00	0.71

The women can help in improving the livelihood security of marginal and small farmers by helping the farmers family in agriculture and its allied enterprises.

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96.

Mushrooms: A Potential Tool for Bioremediation

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Keywords: Bioremediation, mushroom, contaminated soils

Introduction

Biological approaches based on industrial and environmental biotechnology focus on development of clean technologies which focuses on treatment and conversion of waste in some useful form. These clean technologies focus on biological methods for remediation of wastes or bioremediation. It is now becoming apparent that fungi play an important role in degrading organic materials in the ecosystem and that they have the potential for remediating contaminated soils and water. Fungi, particularly mushrooms in basidiomycetes are among nature's most powerful decomposers, secreting strong enzymes. The great potential of fungi in bioremediation is by virtue of their aggressive growth, great biomass production and extensive hyphae reach in the environment. They use a variety of mechanisms to accomplish the degradation of lignin and a wide variety of other environmental pollutants.

Meta-analysis

Meta analysis of literature (Olusola and Anslem, 2010; Adenipekun and Lawal, 2012; Christopher, 2014; Sadiq *et al.* 2015) regarding potential of fungi with special reference to mushrooms was done so as to get an insight into the areas in which this unique group of fungi can act and the methods along with the processes mushrooms employ to act as useful and effective tools of bioremediation.

Discussion

Fungi feature among nature's most vigorous agents for the decomposition of waste matter and are an essential component of the soil food web providing nourishment for the other biota that live in the soil. Mushroom forming fungi are amongst nature's most powerful decomposers, secreting strong extra cellular enzymes due to their aggressive growth and biomass production. These enzymes include lignin peroxidases (LiP), manganese peroxidase (MnP) and laccase, etc. (Christopher, 2014). White rot fungi have been used for biotransformation of pesticides (Sadiq *et al.* 2015), degradation of petroleum hydrocarbons (Olusola and Anslem, 2010) and lignocellulolytic wastes in the pulp and paper industry. *Phanerochaete chrysosporium*, *Agaricus bisporus*, *Trametes versicolor* and *Pleurotus ostreatus* amongst many mushrooms have been reported in the decontamination of polluted sites (Adenipekun and Lawal, 2012).

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97.

Knowledge Gap of Silkworm Rearers of Jammu Division of Jammu and Kashmir State

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Keywords: Knowledge, silkworm, mulberry

Introduction

Silk, a way of life in India has become an inseparable part of Indian culture and tradition. India is the second largest producer of silk in the world with an annual silk of around 18500 tonnes. India has distinction of being the only country producing all four kinds of silk namely Mulberry, Tasar, Eri and Muga (Giridhar *et al.,* 2010). However mulberry silk contributes more than 87% of the c Due to favourable climatic conditions, mulberry is cultivated mainly in five states of India, namely Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal and J&K. These five states collectively account for 97% of the total area under mulberry cultivation and 95% of raw silk production in the country (Gangopadhyay, 2008).

Sericulture plays a vital role in the rural development in Jammu and Kashmir, as it integrates well with the farming systems and has potential to generate attractive income. Sericulture is a subsidiary occupation for about 25000 rural families in the state. Annually about 850 tones of cocoons are produced generating an income of about Rs 1100 lakh for these silkworm rearers coupled with annual employment generation to the tune of 6 lakh man days (Department of Sericulture report 2010-11).

Materials and Methods

The present study was conducted in the Jammu division of J&K state. The Jammu division comprises of ten districts. The silk worm rearers are found in all these districts. On the basis of number of silkworm rearers in each districts, the districts were categorized into three categories with i) less than 500 rearers ii) 500-1000 rearers iii) above 1000 rearers. Three districts namely Poonch, Reasi and Rajouri were selected from these categories for the purpose of study. Based on the number of silkworm rearers in a block, two blocks having maximum silk worm rearers from each district was selected purposively. From each selected block four villages having maximum number of silkworm rearers were selected purposively. The descriptive cum diagnostic research design was employed for conducting the study. The respondents were selected by proportionate random sampling with a sample size of 240 respondents. Data were collected from the selected respondents with the help of semi- structured interview schedule method.

Results and Discussion

The data presented in the Table 1 depicts the knowledge gap related to mulberry and its management, management of young age worms, disinfection and disinfectant, management of late age rearing and disease and insect pest management of silkworm. There was significant difference between the desired knowledge scores of respondents. The knowledge gap was quantified by subtracting the actual knowledge score from the desired knowledge score. In Rajouri, Poonch and Reasi districts the maximum mean knowledge score related to mulberry and its management was 4.14, 4.60 and 4.79 and minimum mean knowledge score related to disinfection and disinfectant were 2.42, 2.30 and 2.30, respectively. Overall maximum mean knowledge score was 4.30 related to mulberry and its management and overall minimum mean knowledge score was 2.39 related to disinfection and disinfectant. The overall maximum difference was in case of disinfection and disinfectant which was 40% followed by 39% about mulberry and its management and 38% respondents about management of late age rearing.

About 31% respondents had knowledge about management of young age rearing and the lowest difference was in case of disease and insect pest management.

Table 1: Knowledge gap of silkworm rearers in different practices of sericulture management.

Practices	District wise mean knowledge Score			Overall mean knowledge score	Maximum obtainable	Knowledge gap (%)
	Rajouri (n=170)	Poonch (n=36)	Reasi (n=34)			
Mulberry and its management	4.14	4.60	4.79	4.30	7.00	38.57
Management of Young age worms	2.82	2.57	2.82	2.78	4.00	30.50
Disinfection and disinfectant	2.42	2.30	2.29	2.39	4.00	40.25
Management of late age rearing	2.66	2.44	2.58	2.50	4.00	37.50
Disease and insect pest management	3.24	3.72	2.99	3.39	4.00	15.25

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98.

Quality of Bajra Fodder Harvested By Impact Type Forage Harvester

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Keywords: Forage harvester, flails, nutrition, moisture, crude protein

Introduction

Bajra (pearl millet, *Pennisetum glaucum*) is an important fodder crop grown during kharif season and is hardy which withstands adverse agro-climatic conditions. The harvesting of forage crop is one of the most important farm operations. The critical period of forage growth, when the nutritive value and dry matter of the fodder maximize, is very limited and any delay in its harvest results in tremendous loss in terms of its feeding value. Moreover, the genetic potentialities of high yielding animals can only be realized if they are fed with quality fodder. This is particularly true in the case of dairy animals. Hence to meet the requirements of fast developing dairy industry, fodders of good quality will have to be produced in sufficient quantity to replace the concentrates. Keeping this in view, it is prudent to mechanize the time and labour consuming operation of fodder harvesting not only to overcome labour shortages but to remove drudgery, hard labour and to enhance labour productivity. It was therefore, decided to evaluate the performance of the self- propelled forage harvester for bajra fodder from nutrition point of view.

Materials and Methods

A self-propelled forage harvester was used in the experimentation for evaluating its performance. The treatments consisted of three levels of forward speed of the machine (a) 1.5 km/h (b) 2.25 km/h and (c) 3.00 km/h, three levels of flail speed (a) 26.86 m/s (b) 32.51 m/s and (c) 40.26 m/s and three levels of rake angles (a) 25° (b) 35° and (c) 45°. Bajra was sown as per the standard package of practices and was harvested at the optimum stage of harvesting. The parameters evaluated for fodder nutrition were loss of moisture, crude protein, neutral detergent fibre, acid detergent fibre and total ash. These observations were recorded for three replications for each treatment combination.

Results and Discussion

Experimental data for the loss of moisture, crude protein, neutral detergent fibre, acid detergent fibre and total ash for the bajra fodder as affected by different independent parameters namely forward speed of the prototype, flail speed and rake angle have been presented in Table 1. The minimum loss of moisture (%), maximum crude protein (%) and minimum neutral and acid detergent fibre (%) were obtained with the forward speed of 3.00 km/h, flail speed of 26.86 m/s and a rake angle of 45°. The corresponding values of loss of moisture (%), crude protein (%) and neutral and acid detergent fibre (%) were 0.60%, 8.35%, 57.27% and 30.75%, respectively.

Table 1: Effect of forward speed, rake angle and flail speed on loss of moisture, Crude protein, neutral detergent fibre, acid detergent fibre and total ash for bajra fodder

Forward speed (km/h)	Flail speed (m/s)	Loss of moisture (%)	Crude protein (%)	Neutral detergent fibre (%)	Acid detergent fibre (%)	Total ash (%)
Rake Angle 25 degrees						
1.50	26.86	1.67	7.29	58.863	32.06	9.41
	32.51	2.02	7.14	59.02	32.53	9.66
	40.26	2.32	7.02	59.21	32.88	9.89
2.25	26.86	1.07	7.65	58.33	31.54	9.38
	32.51	1.23	7.34	58.48	31.89	9.69
	40.26	1.42	7.18	58.62	32.06	9.87
3.00	26.86	0.87	8.11	57.74	31.07	9.39
	32.51	1.01	7.99	57.93	31.21	9.64
	40.26	1.17	7.88	58.04	31.35	9.87
Rake Angle 35 degrees						
1.50	26.86	1.21	7.51	58.64	31.84	9.38
	32.51	1.47	7.38	58.83	32.10	9.66
	40.26	1.69	7.20	59.04	32.35	9.88
2.25	26.86	0.92	7.82	58.08	31.25	9.35
	32.51	1.09	7.54	58.27	31.62	9.70
	40.26	1.22	7.44	58.43	31.84	9.90
3.00	26.86	0.73	8.25	57.52	30.93	9.40
	32.51	0.88	8.14	57.71	31.09	9.65
	40.26	1.07	8.01	57.86	31.24	9.89
Rake Angle 45 degrees						
1.50	26.86	0.99	7.69	58.39	31.56	9.41
	32.51	1.13	7.52	58.62	31.78	9.62
	40.26	1.38	7.32	58.82	31.94	9.86
2.25	26.86	0.79	7.91	57.89	31.08	9.38
	32.51	0.86	7.71	58.03	31.37	9.66
	40.26	1.11	7.55	58.24	31.57	9.86
3.00	26.86	0.60	8.35	57.27	30.75	9.41
	32.51	0.75	8.23	57.50	30.96	9.64
	40.26	0.96	8.12	57.67	31.10	9.87

99.

Fresh Herb, Essential Oil Yield and Net Returns from O*cimum* spp. Grown under Teak (*Tectona grandis* L.f.) based Silvi-medicinal Systems in South Gujarat, India

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Keywords: Agroforestry, Silvi-medicinal, *Ocimum* spp. essential oil, net returns.

Introduction

According to world teak (*Tectona grandis*) conference the total area under commercial teak plantation in India is 2561000 ha. Teak is recognized for its durable timber. In Gujarat, teak is the main timber tree species planted as block plantations, under social forestry, farm forestry as well as mixed plantation with fruit trees. Many species of *Ocimum* contain economically important essential oils used in perfumery and cosmetics industries. Owing to the importance of teak and *Ocimum* spp. present investigation was carried out to evaluate the herbage and essential oil yield and financial flows accrued from four species of *Ocimum* intercropped under middle aged teak plantations.

Materials and Methods

Three *Ocimum* species namely *O. tenuiflorum*, *O. gratissimum* and *O. basilicum* were intercropped under teak (*Tectona grandis*). The agroforestry systems so formed were named as silvi-medicinal systems (*Tectona grandis*+*Ocimum* spp.) and sole cropping system. Fresh herbage yield was recorded after harvesting the intercrops. Oil recovery was estimated by hydro distillation method using Clevenger Apparatus. The total oil yield obtained was converted to kilogram per hectare multiplying litter per hectare. The net returns on account of essential oil yield were calculated using prevailing market price of inputs and outputs. The data generated were subjected to the statistical analysis using factorial randomized block design.

Results and Discussion

The results evinced that land use systems significantly affected the fresh herbage yield of *Ocimum* spp. Maximum fresh above (5.90 tonnes/ha) and below ground 1.30 tonnes/ha and total herbage yield (7.20 tonnes/ha) of *Ocimum* spp. was recorded in sole cropping system compare to silvi-medicinal system. Among intercrops, *O. gratissimum* gave higher fresh yield above ground (6.00 tonnes/ha) and total herbage yield (7.04 tonnes/ha). Whereas, *O. basilicum* produced higher below ground fresh yield (1.24 tonnes/ha). Maximum essential oil recovery was recorded under sole cropping as compare to silvi-medicinal systems. Among *Ocimum* species, maximum essential oil recovery (0.69%) was recorded from *O. gratissimum*. Oil yield of *Ocimum* species, intercropped under teak and as sole crop, differed significantly. Maximum oil yield (38.43 kg/ha) from *Ocimum* species was obtained from sole cropping system as compared to teak based silvi-medicinal system (30.25 kg/ha). Among intercrops, significantly maximum oil yield (46.57 and 35.78 kg/ha, under sole cropping and sivi-medicinal system) was obtained from *O. gratissimum,* followed by *O. basilicum* (35.39 and 28.02 kg/ha). Among *Ocimum* species, the highest net returns of Rs. 103327.00 per hectare from essential oil were accrued from *O. basilicum* grown under sole cropping system with highest benefit cost ratio (2.56). Although, the fresh herbage and oil yield of *Ocimum* spp. under silvi-medicinal systems was lesser as compared to sole cropping system, nonetheless intercropping may provide handsome income, from of sale of essential oil, until teak trees have not attained merchantable size.

Table 1: Fresh herbage yield (tonnes/ha), essential oil yield (kg/ha) and net returns (Rs./ha) of *Ocimum* species grown under *Tectona grandis* based silvi-medicinal and sole cropping systems

Land use systems	Fresh herb yield (*Panchang*) (t/ha)			Mean	Oil yield (kg/ha) and net returns (Rs./ha)			Mean
	O$_1$	O$_2$	O$_3$		O$_1$	O$_2$	O$_3$	
LU$_1$	5.52	6.24	5.73	5.83	26.94 (73220)*	35.78 (33397) *	28.02 (76940) *	30.25
LU$_2$	6.72	7.84	7.03	7.20	33.33 (95943) *	46.57 (50576) *	35.39 (103327) *	38.43
Mean	6.12	7.04	6.38		30.14	41.17	31.71	
Sources	**SE±**	**C.D. (5%)**		**C. V. (%)**	**SE±**	**C. D. (5%)**		**C. V. (%)**
LU	0.14	0.44			0.88	2.65		
Ocimum spp.	0.18	0.53		7.68	1.08	3.24		8.86
LU x *Ocimum* spp.	0.25	NS			1.52	NS		

LU= Land use; LU$_1$= Teak + *Ocimum* species, LU$_2$= sole crops, O$_1$= *Ocimum tenuiflorum*, O$_2$= *O. gratissimum* and O$_3$= *O. basilicum*; *net returns

100.

Performance of Dual Purpose Forage Crops under Different Cutting Management System

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Keywords: Dual purpose forage crops, cutting management system, green forage yield, quality parameters and economics.

Introduction

Barley (*Hordeum vulgare* L.), oat (*Avena sativa* L.) and wheat (*Triticum aestivum*) are being used as a grain crop for human consumption and animal feed in India. It is grown in the winter season. In recent years it has been observed that, animal husbandry occupies an important role and there is a big gap between demand and supply of forage. Since both the green forage and grain can be utilized for animal fodder purpose, the crops are advantageous due to faster early growth. For dual purpose crops, stage for forage cutting is most important on which both forage and grain yield depends. If cut is given early, forage yield will be reduced and if delayed plant regeneration and the grain yield will be adversely affected. Considering these views, present field experiment was conducted to evaluate the effect of different cutting management system on dual purpose forage crops.

Materials and Methods

The field experiment was conducted during 2012-13 to 2014-2015 at All India Coordinator Research Project on Forage Crop and Utilization, Mahatma Phule Agricultural University, Rahuri. The experiment was laid out in split plot design with three replications. The treatments comprised of three main plot treatments of various forage crops namely, oat (RO-19), barley (RD-2552) and wheat (VL-829) and three subplot treatments of cutting management systems namely, no cutting for fodder and left for seed only, cut at 50 days after sowing (DAS) for fodder and left for seed, cut at 60 DAS for fodder and left for seed, and cut at 70 DAS for fodder and left for seed. The gross plot size was 4.00 x 3.00 m^2 and net plot size was 3.40 x 2.40 m^2. Recommended dose of fertilizer 120: 50: 40 NPK/ha was applied to all the crops. Nitrogen was applied in 3 equal splits as basal, 25 DAS and after harvest of first cut. The full dose of P_2O_5 and K_2O was applied at the time of sowing.

Results and Discussion

Among the forage crops under study, oat (RO-19) recorded the significantly higher green forage yield (54.30 t/ha) and dry matter yield (9.14 t/ha), straw yield (10.01 t/ha) and crude protein yield (0.92 t/ ha) than the rest of the crops. However, seed yield was recorded significantly higher in the wheat crop (2.47 t/ha). The cutting at 70 DAS for fodder recorded significantly higher green forage yield (39.02 t/ha), dry matter yield (7.11 t/ha) and crude protein yield (0.76 t/ha) than rest of the cutting management. However, seed yield (2.47 t/ha) and straw yield (9.39 t /ha) was recorded significantly higher in the no cutting for fodder and left for seed only (Table 1). The results are in collaboration with Ahmad *et al.* (2014).

Crude protein content in fodder (12.51%) and grains (14.41%) was recorded significantly higher in the barley crop. The cutting of fodder at 60 DAS for fodder recorded significantly higher crude protein content (11.50%) in the fodder, while in grain (14.55%) crude protein was recorded in the no cutting for fodder and left for seed only (Table 1).

The Oat crop (RO-19) recorded significantly higher gross monetary returns (Rs. 62645 /ha), net monetary returns (Rs. 31644/ha) and B: C ratio (2.10) than rest of the crops. The gross monetary returns (Rs. 63561/ha) and net monetary returns (Rs. 31921/ha) with B: C ratio (2.07) was recorded significantly higher in cut at 50 DAS for fodder and left for seed only (Table 1).

Oat variety RO-19 recorded the higher green forage, dry matter, straw and crude protein yield, while wheat variety VL-829 recorded higher seed yield, gross and net monetary returns and B: C ratio. As regards the cutting management, cutting at 70 DAS for fodder recorded higher green forage, dry matter and crude protein yield. The higher seed yield was obtained with no cutting for fodder and left for seed only. While with cutting at 50 DAS for fodder and left for seed recorded higher gross and net monetary returns and B: C ratio.

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Table 1: Effect of dual purpose forage crops under different cutting management system on green forage yield, dry matter, seed and straw yield, quality of fodder and economics of different treatments. (Pooled mean of three years)

Treatment	Yield (t/ha)					Crude protein content (%)		Economics			
	Green forage	Dry matter	Seed	Straw	Crude protein	Fodder	Grain	Gross returns (Rs./ ha)	Cost of cultivation (Rs./ ha)	Net returns (Rs./ha)	Benefit: Cost ratio
A) Main plot (Forage crops-3)											
V_1 - Oat (RO-19)	54.30	9.14	0.97	10.01	0.92	10.14	12.81	62645	30999	31644	2.10
V_2 - Barley (RD-2552)	31.57	6.22	1.17	3.96	0.77	12.51	14.41	49728	30368	19361	1.66
V_3- Wheat (VL-829)	18.08	3.38	2.47	5.33	0.36	11.02	13.33	62229	31583	30646	2.01
S.E.m±	1.10	0.24	0.06	0.37	0.03	0.21	0.17	1880	--	1880	0.07
C.D. at 5%	3.40	0.75	0.20	1.16	0.11	0.66	0.53	5793	--	5793	0.22
B) Sub plots (Cutting management-4)											
C_1 - No cutting for fodder and left for seed only	0.00	0.00	2.47	9.39	0.00	0.00	14.55	60298	31190	29108	1.98
C_2 - Cut at 50 DAS for fodder and left for seed	30.00	5.30	1.62	6.75	0.58	11.28	13.82	63561	31641	31921	2.07
C_3 - Cut at 60 DAS for fodder and left for seed	34.92	6.34	1.21	5.52	0.71	11.50	13.26	57223	30990	26333	1.89
C_4 - Cut at 70 DAS for fodder and left for seed	39.02	7.11	0.84	4.07	0.76	10.90	12.43	51721	--	21609	1.76
S.E. m±	0.53	0.11	0.04	0.26	0.02	0.22	0.13	1109	--	1109	0.04
C.D. at 5%	1.52	0.32	0.12	0.76	0.05	NS	0.36	3145	--	3145	0.11
C) Interaction											
V X C											
S.E. m±	0.92	0.19	0.07	0.46	0.03	0.39	0.22	1921	--	1921	0.07
C.D. at 5%	NS	NS	0.20	1.31	NS	NS	NS	5448	--	5448	0.20
C X V											
S.E. m±	1.34	0.29	0.09	0.55	0.04	0.38	0.26	2511	--	2511	0.09
C.D. at 5%	NS	NS	0.27	1.62	NS	NS	NS	7464	--	7464	0.28

DAS: Days after sowing

101.

Effect of Methanolic Extract of *Acorus calamus* L. (Sweet Flag) on Dimensional Stabilization of Wood

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Keywords: Swelling, shrinkage, wood moisture, *Acorus calamus.*

Introduction

Wood is an important natural renewable resource. It is a porous three-dimensional, hydroscopic, viscoelastic, anisotropic biopolymer composite, composed of an interconnecting matrix of cellulose, hemicelluloses and lignin, with minor amounts of inorganic elements and organic extractives. Wood moisture tends to attain equilibrium with relative humidity of surrounding air which leads to imbalance in the wood dimensions and restrict its potential use. Dimensions of wood can be stabilized by different means. In the present work *Acorus calamus* rhizome extract has been tested to see its effect on dimensional stability in *Pinus roxburghii* Sargent, *Celtis australis* L. and *Bombax ceiba* L. wood.

Materials and Methods

The rhizomes of *Acorus calamus* were washed, dried, and finely powdered. After oven drying the material was extracted with methanol and 2.5 liters stock solution (10%) was prepared by dissolving the extract in 5% methanol and different concentrations were prepared (Fig. 1). The wood specimens of *Pinus roxburghii, Celtis australis* and *Bombax ceiba* were dipped in 0.25%, 0.5%, 1%, 1.5% and 2% extract solution for 72 hours then dried at 105±2°C to constant weight. The dimensions were measured with digital calliper and weights were recorded in grams. The difference in weights and dimensions before and after treatment was recorded.

Fig. 1: Extraction of A. calamus Rhizome with methanol

Results and Discussion

Wood specimens dipped in different concentrations of *Acorus calamus* rhizome extract were analyzed for variation of specific gravity, % weight gain of treated and untreated wood on dry weight basis (swelling), % weight gain of treated and untreated wood on wet weight basis (shrinkage), % oven dry weight gain before and after treatment, volumetric swelling coefficient, volumetric shrinkage coefficient, swelling and shrinkage of wood in three different planes. The maximum value for specific gravity was recorded in *Celtis australis* (0.586) and minimum in *Bombax ceiba* (0.465) showing significant difference. Swelling and shrinkage of wood were recorded maximum in *Pinus roxburghii* in longitudinal plane, radial and tangential plane. The minimum swelling and shrinkage were recorded in *Bombax ceiba* in longitudinal plane, radial and tangential plane. Maximum volumetric swelling and shrinkage coefficient was recorded in *Pinus roxburghii* in control and minimum in *Bombax ceiba* at 1.50%. The maximum per cent variation of treated and untreated wood on dry and wet weight basis had been recorded in *Pinus roxburghii* and minimum in *Celtis australis*. The results show that the extract has direct relation with wood specific gravity for all species. *Celtis australis* has recorded maximum specific gravity with increase in concentration thereby indicating higher strength. The main conclusions drawn from the study indicates that highly non durable wood species *Bombax ceiba* has lowest swelling in all planes after treatment which was inverse without treatment. Maximum swelling and shrinkage were observed in tangential plane followed by radial and longitudinal plane, respectively.

102.

Effect of Planting Material and Growth Regulators on Turmeric (*Curcuma longa* L.) Emergence

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Keywords: Turmeric, planting material, growth regulators, water soaking

Introduction

Turmeric (*C. longa* L.) takes long time for germination and has slow initial growth. The planting material in terms of rhizome size play important role in determining the growth and yield of turmeric. The crop grown from mother rhizomes gives higher yield and healthy crop stand as compared to the crop grown through primary and secondary rhizomes. However, mother rhizomes being heavier than primary and secondary rhizomes increase the seed requirements and involve higher cost of cultivation. Generally, mother rhizome are preferred and used as planting material, however if the yield of the crop grown from the primary or secondary rhizomes (fingers) by treating with growth regulators would be comparable to that grown from mother rhizomes then input cost on seed in terms of weight can be decreased. Keeping all these points in view, the present investigation was planned to study the effect of rhizome size and different growth regulators on emergence of turmeric.

Materials and Methods

The present study entitled, "Effect of rhizome size and growth regulators on emergence of Turmeric (*Curcuma longa* L.)" was conducted at the Students' Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana, in 2013-14. The average annual rainfall lies between 500-750 mm. The soil of the experimental field was categorized as loamy-sand. It was low in organic carbon, available nitrogen but the available phosphorus and potassium status was medium. The soil pH and electrical conductivity values were within the normal range. Field experiment was conducted in factorial randomized block design with all possible combinations of three planting material (Mother rhizome, Primary rhizome and secondary rhizome) and five dipping treatments viz., dipping in NAA (40 ppm), GA3 (50 ppm), Kinetin (30 ppm), water for 4 hours and control (neither water nor growth regulator dipping).

Results and Discussion

The data on the emergence count was recorded at 30, 45 and 60 days after planting (DAP) and summarised in Table 1. Mother rhizomes showed significant difference in emergence count at 30 and 45 DAP, whereas differences were non-significant at 60 DAP. Thus mother rhizomes resulted in 71.6 and 25% more emergence count than secondary rhizomes at 30 and 45 DAP, respectively. Similarly primary rhizomes showed significantly better emergence count than secondary rhizomes at 30 and 45 DAP, which resulted 52.9% and 19.6% more emergence count than secondary rhizomes at 45 DAP, whereas mother and primary rhizomes were statistically at par with each other. Early emergence thus gives the plants a head-start to perform better than the rest. Balashanmugan and Vanangamudi (1988) also reported that planting of full mother rhizomes gave maximum germination of 94.8% as compared to the minimum of 67.4% due to planting of tertiary rhizomes.

Data presented in Table 1 revealed that at 30 DAP, NAA (40 ppm) recorded significantly better emergence count than all other treatments, but at 45 DAP all other treatments were at par except GA3 (50 ppm) and control treatments. At 60 DAP all other treatments were at par but significantly better than GA3 (50m ppm). At 30 and 45 days after planting stage the water soaked rhizomes showed significantly more emergence count over control, however at 60 days after planting stage both water soaked and control treatments were at par.

Table 1: Effect of different treatments on the emergence count (%) of turmeric

Treatments	Emergence count (%)		
	30 DAP	45 DAP	60 DAP
Planting material			
Mother rhizomes	40.26	75.20	89.33
Primary rhizomes	35.86	71.73	87.73
Secondary rhizomes	23.46	60.00	82.66
CD (p=0.05)	10.06	6.25	NS
Growth regulators			
GA3 (50 ppm)	11.55	18.22	57.33
NAA (40 ppm)	56.88	86.66	94.66
Kinetin (30 ppm)	39.55	82.22	92.44
Water soaked	35.55	82.66	94.55
control	22.44	75.11	92.88
CD (p=0.05)	12.99	7.07	13.93

The interaction effect was non-significant. Geetharani and Ponnuswamy (2007) reported that application of NAA (100 ppm) resulted in maximum germination (93%) in onion. The water soaking of turmeric rhizomes for four hours improved emergence and helped to produce vigrous plants and ultimately higher turmeric yield and net returns. The use of growth regulators was found at par with water soaking.

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103.

Effect of Different Sources and Combination of Nitrogen on Chilli (*Capsicum annuum L.*)

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Keywords: Chilli, flowering, growth, nitrogen, quality and yield

Introduction

Chilli *(Capsicum annuum L.*) is an important crop of West Bengal growing throughout the state. It is predominantly popular for its green pungent fruits, which is used for culinary purpose. The excessive use of inorganic source of nutrients for its cultivation creates health hazards. Therefore, inclusion of organic manures with inorganic sources of nutrient is essential. Several scientists found that integrated nutrient management with vermicompost, green manures and application of biofertilizers showed a significant positive response on chillies.

Materials and Methods

The present investigation was carried out at Horticultural Research Station, Mondouri, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal in consecutive two seasons during 2010-11 and 2011-12 in chilli cv. Bulet with soil pH 6.7.

The plants were manured with six organic manures like cowdung, neem cake, poultry manure, vermicompost, phosphocompost and mustard cake along with inorganic source of nitrogen *viz.* urea. Full dose of organic manure including recommended dose (N: 80Kg,P: 60Kg and K: 60 Kg per Ha) of P (single super phosphate) and K (muriate of potash) and 50% dose of urea was applied as basal. Rest amount was applied after one month of transplanting. The seedlings were planted in the plots measuring 4.5m x 1.5m with a spacing of 60 cm (row to row) x 45 cm (plant to plant) following randomised block designith 19 treatments and 3 replications. The plants in the control plot were grown only with P and K, but without any N. Observations were recorded on different growth, flowering behaviour and quality parameters and analyzed statistically (Gomez and Gomez, 1984). Capsaicin and Ascorbic acid content of chilli were estimated following Standard biochemical method (Sadasivam and Manickam, 1996).

Results and Discussion

The average plant height of chilli was found maximum with 50% N from vermicompost + 50% N from Urea. Plant height increases with increase in the level of inorganic nitrogen (25 to 75%) and with reduced level of organic manure. The reverse effect was found with neem cake, poultry manure, and phosphocompost

Application of N at the rate of 25% through cow dung manure and rest from urea induced advanced flowering in plants as compared to control (without N). On the other hand, flowering was delayed, when plants were treated with 25% N from cow dung manure + 75% N from urea (T_1).

With application of 50% N from vermicompost + 50% N from urea, highest number of fruits of individual plant (136.37) and fruit yield per ha was recorded over other treatments. Whereas, cow dung manure, poultry manure and phosphocompost when used with urea in different combinations showed very poor performance compare to Neem cake and Mustard Cake.

From the result it may be concluded that application of organic manure specially vermicompost may replace up to 50% of inorganic nitrogen fertilizers requirement of the crop to produce the maximum fruit yield. Qualitative characters like ascorbic acid and capsaicin content in fruit may be improved to a maximum extent with addition of neem cake in soil at the rate of 75% of total N requirement of the crop.

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104.

Integrated Farming System Approach for Income Enhancement of Marginal and Small Farmers

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Keywords: Integrated farming systems, dairy, vegetables, crops, fruits, fishery

Introduction

Farming system approach is considered as backbone of the farming community because majority of the farmers are having more than one enterprise. Numerous investigations conducted at different locations clearly elucidate the beneficial effects of integrated farming towards income generation, rational use of resources, increasing per unit productivity and above all making the agriculture eco-friendly. In true sense, the farmers are working in very diverse, risk prone and location specific environment which many a time enforce them not to follow the improved knowledge as such, because the technologies developed under resource enriched conditions does not suit them. Therefore, farming system approach have the potential to integrate different combinations of enterprises and to study their interaction effect with resources available to the farmers and the environment without dislocating the ecological and socio-economic balance in one hand and attempts to meet the national goals on the other.

Materials and Methods

An integrated farming system model has been developed on one hectare land area under irrigated conditions at the Department of Agronomy, Punjab Agricultural University, Ludhiana. The soil of experimental site is loamy sand in texture with low organic carbon content (0.28%), low in available nitrogen (138 kg/ha), medium in available phosphorus (21.0 kg/ha) and low in available potassium (126.4 kg/ha). The one hectare land area is distributed as crops-6400 sq m, horticulture crops-1900 sq m, agro-forestry-300 sq m, fishery- 1000 sq m, cattle shed+ Vermicompost unit-400 sq m, respectively.

Results and Discussion

A net returns of Rs 1,07,020 was obtained from rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L.) cropping system. Moreover, the returns were obtained two times in a year after the sale of rice and wheat grains in the market. However, in integrated farming system approach, net returns of Rs 3,29,834/ ha were obtained (Table 1). The dairy unit provides regular income on daily basis and the profitability further increases from the sale of young calves. Vegetable and fruit component provides balanced nutrition to the family members. The crops component included the diversified crops *viz.,* maize, oil seeds, pulses, vegetables and fodder crops etc so that all the domestic needs can be met from the own farm. The per cent contribution of net returns of different components of integrated farming system model in terms of dairy, crop, horticulture crops (including vegetables intercropped in between fruit plants), fishery, agro-forestry (income generated from turmeric-wheat crops), bee-keeping were to the tune of 49.2, 32.6, 12.2, 2.8, 1.0 and 0.3% respectively. Gill *et al* (2005) reported 48.6% more gain from fishery + piggery + poultry integrated farming system than rice-wheat system in a case study at Ludhiana.

In the rice-wheat system Rs 293/ha/day net returns can be obtained where as from integrated farming system the net returns were Rs 904/ha/day i.e. Rs 611/ha/day extra over rice-wheat cropping system.

Table 1: Relative efficacy of different farm enterprises of integrated farming system model

Farm Enterprises	Size of the unit (area/number)	Gross returns (Rs/year)	Cost of production (Rs/year)	Net returns (Rs/year)
Field Crops (Cereals/pulses/oilseeds/ green fodders etc.)	6400 m^2	167648	60774	106874
Horticulture	1900 m^2	54838	14873	39965
Guava		4200		4200
Lemon		1875		1875
Galgal		825		825
Agro-forestry	300 m^2	Turmeric 3725 Wheat 1428	2120	3193
Dairy	400 m^2	329842	168353	161489
Aquaculture (Fresh water fish production)	1000 m^2	10930	1900	9030
Apairy		1200	300	900
IFS model -total allocated land (m^2)	10000 sq m	576511	248320	328191

Thus integrated farming system approach seems to be the only option to make the agriculture sector more profitable and sustainable. This concept is holistic in nature involving the synergistic effect of one component over the other, which enables to create employment opportunities, avoid wastage of bi-products, and making the environment eco-friendly.

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105.

Evaluation of Maize-Based Cropping Sequences on Cultivators' Fields in Submontane Low Hills Subtropical Zone of Himachal Pradesh

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Keywords: Production efficiency, economics, yield, cropping sequences, maize based

Introduction

Of the 30 major cropping systems identified in India (Yadav and Prasad, 1998)**,** maize based cropping system is the most predominant in rain fed hilly areas. As maize based cropping systems in general and maize-wheat system in particular are remunerative, farmers are not ready to give up. Despite enormous growth of maize-wheat system, reports of stagnation in the productivity, with possible decline in production in future, have raised doubts on its sustainability.

The farmers realize much of their food security from this cropping system and the low production level need immediately attention for the efforts to be geared in strengthening it. Besides food security, the low production levels jeopardize farmers' economic security to a considerable extent. To strengthen the economic security, it is imperative to intensify and diversify the existing maize-wheat system. Therefore, it is essential to diversify the system with maize as the base crop with more productive and profitable crops in place of wheat on cultivators' fields on participatory mode.

Materials and Methods

Field experiments to evaluate the production potential of maize- based cropping sequences were conducted under the On-Farm Research Programme of 'All India Coordinated Research Project on Integrated Farming Systems', Project Directorate of Farming System Research, Modipuram (ICAR) for six years (2007-08 to 2012-13). Ninety field experiments were conducted on cultivators' fields for six years (2007-08 to 2012-13) in districts Una, Hamirpur and Kangra within NARP Zone I of Himachal Pradesh. The experimental trials were conducted at five OFR centres during 2007-08 to 2009-10 and six OFR centres during subsequent years. Two locations (farmers) at each centre in each year (except in Rangas & Kohla centres during 2007-08 to 2008-09, and in Dehrian and Silh- Dehri centres during 2009-10 to 2012-13 where there were four locations) were randomly selected and considered as replications.

Five maize-based cropping sequences *viz.* maize-wheat, maize + soybean - wheat, maize - gram, maize - gobhi sarson + toria and maize - potato -onion were evaluated at farmers' fields. The soils of the zone were inceptisols, having texture from loamy sand to silty clay loam and pH varying from6.1 to 7.8 and 5.1 to 7.4 in Farming Situation I (Una, Hamirpur and Kangra) & Farming Situation II (Kangra), respectively. The crops in each cropping sequence were raised in accordance with the recommended package of practices.

Results and Discussion

Five maize-based cropping sequences *viz.* maize-wheat, maize + soybean - wheat, maize - gram, maize - gobhi sarson + toria and maize - potato -onion were evaluated on cultivators' fields for their production potential and economic feasibility in the low hills of Una, Hamirpur and Kangra districts of Himachal Pradesh. Six years' (2007-08 to 2012-13) results revealed that maize-potato-onion cropping sequence resulted in highest maize equivalent yield (28170 kg /ha/annum), net return (Rs 142640/ha/annum), productivity (77.2 kg/ha/day in terms of maize equivalent) and profitability (Rs 390/ha/day).

The extent of maize equivalent yield and net returns increase under maize-potato-onion was 288.9 and 188.4%, respectively, over the conventional maize-wheat cropping sequence. Maize + soybean - wheat and maize - gobhi sarson + toria were also superior to conventional maize - wheat cropping sequence in influencing maize equivalent yield, net returns, B: C ratio and productivity and profitability. Only maize - potato - onion and maize + soybean - wheat cropping sequences could excel over the maize-wheat sequence in terms of total calories of the main product. Total calories under maize - gram and maize - gobhi sarson + toria sequences were 69.2 and 76.0%, respectively of maize - wheat cropping sequence. Conventional maize - wheat cropping system was superior to all the new cropping systems in terms of energy intensity both in physical as well as economic terms. Land use efficiency ranged between 66.5 (maize-wheat) and 86.8% (maize-potato-onion) under different cropping systems.

Thus, it is concluded that farmers of low hills of HP can adopt maize - potato - onion cropping sequences for higher net income as an alternative to maize-wheat cropping system. However, complete replacement is not advisable.

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106.

Economics and Yield as Influenced by Different Weed Management Practices in Soybean

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Keywords: Soybean, weed, yield, economics

Introduction

Soybean (*Glycine max* L) is one of the most important oilseeds crops grown in India. It ranks second after groundnut in term of production contributing 28% of total oilseed production in India. The economics of the soybean is very important aspect for farmers to shift from already existing rice (*Oryza sativa*)-wheat (*Triticum astivum*) cropping system. Keeping in view, the present investigation was taken to find the economics and yield as influenced by different weed management practices in soybean.

Materials and Method

An investigation was conducted during *kharif* 2011 at Research Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha-Jammu. The soybean variety SL-525 was planted at a row spacing of 45 cm. The experiment comprised of twelve treatments in randomized block design with three replications. All the post-emergence herbicides were applied at 15 days after sowing. The herbicide fluchloralin was applied as pre-plant incorporation 2 days before sowing and pendimethalin as pre-emergence one day after sowing.

Results and Discussion

The maximum seed yield was obtained in weed free treatment followed by hand-weeding at 15 & 35 days after sowing. Among various herbicidal treatments, imazethapyr at the rate of 75 g a.i ha^{-1}+ hoeing (35 days after sowing) recorded maximum seed yield (Table 1) which was found to be at par with quizalofop-ethyl (40 g a.i ha^{-1}+ hoeing 35 days after sowing). These herbicides when applied as post-emergence suppresses the weed growth efficiently which is supplemented by hoeing at the crucial stage of crop growth which checked weed growth and resulted in higher yield. Similar findings have been reported by Wadafale *et al.* (2011). Highest net returns were obtained with imazethapyr 75 g a.iha^{-1} + hoeing (35 DAS) followed by quizalofop-ethyl 40 ga.iha^{-1} + hoeing (35 DAS) due to higher returns obtained from seed yield and highest B: C ratio was obtained with quizalofop-ethyl (40 g a.iha^{-1} + hoeing 35 DAS).

Table 1: Effect of different weed treatments on yield and economics of soybean

Treatments	Seed yield (q ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
Weedy check	9.03	10198.00	0.69
Weed free	15.52	22106.33	1.06
Hand weeding at 15 & 35 DAS	15.28	23093.10	1.20
Hoeing at 15 & 35 DAS	13.44	20149.30	1.18
Fluchloralin @ 1.0 kg a.i ha^{-1} (PPI)	11.61	16650.43	1.08
Pendimethalin @ 1.0 kg a.i ha^{-1} (PE)	11.30	15015.70	0.92
Imazethapyr @ 100 g a.i ha^{-1} (PoE)	11.18	14447.87	0.88
Quizalofop-ethyl @ 50 g a.i ha^{-1} (PoE)	12.02	17372.83	1.09
Fluchloralin @ 0.75 kg a.i ha^{-1} (PPI) + hoeing at 35 DAS	13.27	20344.60	1.24
Pendimethalin @ 0.75 kg a.i ha^{-1} (PE) + hoeing at 35 DAS	13.13	19366.80	1.14
Quizalofop-ethyl @ 40 g a.i ha^{-1} (PoE) + hoeing at 35 DAS	14.76	24074.70	1.44
Imazethapyr @ 75 g a.i ha^{-1} (PoE) + hoeing at 35 DAS	15.08	24565.17	1.43
SEm±	0.65	-	-
CD at 5%	1.9	-	-

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3

Crop Environment Interactions

107.

Ecological Effect of Protected Environment on Growth and Yield Performance of Bacterial Wilt Resistant Tomato (*Solanum lycopersicum* L.) Hybrids

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Keywords: Protected environment, hybrid, bacterial wilt, tomato

Introduction

Vegetable production is highly seasonal and mostly weather dependent in hilly states of India and the extents available have been fully exploited. As a result there is a glut during favorable season and scarcity during unfavorable seasons. This has created unrealistic high prices of these commodities in unfavorable seasons. Meanwhile the expanding export demand for quality vegetables is another aspect to be considered. There is a great potential in Himachal Pradesh to adopt protected cultivation for high value vegetables. According to the available records, total land area in Himachal Pradesh under protected environment is approximately 350 ha. Mostly the land holdings with the farmer's are small and farmers are cultivating tomato, bell pepper, salad cucumber under the protected environment.

Materials and Methods

The experiment was carried out at the experimental farm of Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during 2012 and 2013 in randomized block design (RBD) replicated thrice inside the modified naturally ventilated polyhouse of the size 25m X 10m. The experimental material used for the present study comprised of 15 diverse hybrids of tomato developed at CSK Himachal Pradesh Krishi Vishvavidyalaya (CSKHPKV) Palampur with one check hybrid from private sector. Besides the application of vermin compost at the rate of 5 tonnes per hectare, chemical fertilizers were applied as per ad-hoc recommendation of CSKHPKV for protected cultivation (50 kg each of N, P and K per ha) through straight fertilizers. Whole of the vermin-compost and chemical fertilizers were applied in pits before transplanting. The fertigation was given twice a week by applying liquid fertilizer (19: 19: 19) @ 2.2 g/m^2 of the effective area of polyhouse after third week of transplanting and was stopped 15 days before final harvest.

Results and Discussion

Hybrid 15-2(H/R) x Palam Pride took significantly minimum days to 50% flowering after transplanting followed by 15-2(H/R) x 16-B), BWR-5(F/R) x 16-B, BL 333-1 x 16-B and BBWR-21-3-16 x Palam Pride which were at par with each other (Table 1). In both as well as pooled over environments hybrid 15-2(H/R) x Palam Pride took minimum days to first harvest. Hybrid 15-2 (H/R) x Palam Pride produced significantly highest marketable yield per plant followed by 15-2(H/R) x 16-B, BWR-5(F/R) x Palam Pride and CLN 1314G x Palam Pride and were at par with each other. In case of Env.II 15-2 (H/R) x Palam Pride had significantly highest marketable yield followed by 15-2 (H/R) x 16-B and BWR-5(F/R) x Palam Pride and were also at par with each other. Over the environments, same results were obtained like Env.II, in which 15-2 (H/R) x Palam Pride showed significantly highest marketable yield. In both the environments hybrid 15-2 (H/R) x Palam Pride produced significantly maximum number of marketable fruits per plant. Over environments hybrid 15-2(H/R) x 16-B had significantly highest fruit weight followed by BWR-5(F/R) x Palam Pride, 1-2 x 16-B, BL 333-1 x 16-B and CLN 1314G x Palam Pride, which were at par with each other. Hybrid 15-2(H/R) x Palam Pride had significantly minimum internodal length over as well as in both environments. Significantly maximum plant height was recorded in 15-2(H/R) x Palam Pride in all environments.

Table 1: Pooled over mean performance of tomato hybrids in relation to different quantitative traits

Genotypes	Plant survival	Days to 50% flowering	Days to first harvest	Gross yield per plant (kg)	Number of marketable fruits per plant	Total no. of fruits per plant	Average fruit weight (g)	Plant height (cm)	Inter-nodal length (cm)	Marketable yield per plant (kg)
BWR-5(F/R) x CLN 1314G	100.00	35.50	85.33	1.77	26.25	28.71	59.88	257.22	8.18	1.75
BWR-5(F/R) x Palam Pride	100.00	34.17	80.00	2.13	35.53	37.44	64.79	288.30	7.73	2.09
BWR-5(F/R) x 16-B	100.00	34.33	84.33	1.53	29.22	31.65	51.59	274.48	7.80	1.48
CLN 1314G x Palam Pride	100.00	34.83	82.33	2.09	33.06	35.37	63.12	276.03	7.82	1.96
1-2 x 16-B	100.00	34.50	81.17	2.06	33.82	36.23	63.51	278.61	7.79	1.97
1-2 x BBWR-21-3-16	100.00	34.33	84.33	1.86	32.47	34.52	58.02	200.96	7.87	1.84
12-1 x Palam Pride	100.00	37.50	86.17	1.74	28.65	30.98	62.04	215.22	7.85	1.72
15-2(H/R) x Palam Pride	100.00	31.00	77.17	2.27	39.46	42.22	60.52	310.06	7.50	2.25
15-2(H/R) x 16-B	100.00	32.83	78.33	2.23	37.94	39.58	66.97	302.96	7.70	2.19
15-2(H/R) x Hawaii-7998	100.00	36.17	83.17	1.89	28.52	30.80	61.73	268.14	8.27	1.75
BL 333-1 x 16-B	100.00	34.33	84.50	1.83	26.95	29.07	63.48	230.00	7.91	1.82
Hawaii-7998 x Palam Pride	100.00	35.83	84.33	1.74	28.35	30.63	56.49	236.45	8.00	1.69
Hawaii-7998 x Palam Pink	100.00	35.67	84.00	1.96	29.69	32.44	58.53	215.86	8.32	1.87
BBWR-11-1 x BBWR-21-3-16 BBWR-21-3-16 x Palam Pride	100.00 100.00	35.17 35.33	86.83 86.83	1.78 1.68	32.69 26.49	34.42 29.27	62.04 59.34	258.56 255.55 214.62	8.11 8.60 8.16	1.76 1.67 1.68
Avtar	100.00	36.00	88.83	1.70	26.51	29.64	59.26	200.96	7.49-8.59	1.48-2.25
CD (5%)	-	1.91	2.18	0.06	1.69	0.67	3.90	2.31	5.76	7.52

108.

Farmers Perception on Climate Change: A Study in West Tripura

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Keywords: Farmers perception, climate change, adaptation, information sources

Introduction

The likely consequences of climate change on the water front in Tripura are decrease in total annual rainfall, change in rainfall pattern resulting in crop failure for not getting the rain when required and sudden bursts of rain over a small period of time which may cause floods. Drought normally occurs in the state of Tripura due to delayed rainfall in the months of April-May. Climate variability and climate change could impact agriculture, water resources and forest sectors in Tripura. Under this backdrop present research was conducted i) to assess the farmers extension exposure, ii) to study the farmers observation on climate change, iii) to identify the farmers' climate change adjustment factors, and iv) to find out the farmers' adaptation barriers under changing climate.

Materials and Methods

West Tripura district was purposively selected among eight districts of Tripura state. From six blocks of West Tripura district, Mohanpur and Lefunga blocks were selected randomly. Sample size was 150 with farming experience not less than 15 years. The data was collected during March, 2014 to August, 2014. The questionnaire developed by Gbetibouo (2009) with some modification were employed for the study. The statistical tools included were mean, percentage, standard deviation, rank and Pearson's correlation coefficient. For analysis of data IBM SPSS 21 was employed.

Results and Discussion

The farmers' perception on climate change is ranged from bad to very bad, and the diseases of crop and human were inclined in trend. It was also noted that frequency of dry days in monsoon period had increased in last 10 years, number of hot days and sun's heat had also increased (Table 1). It was interesting to note that 100 per cent farmers perceived that temperature had increased in last 15 years. Reduced use of irrigation water was the most appropriate agronomic practice that might help in climate change adjustment and it was ranked first by the farmers. Change in planting dates of crops was the second most important practices as perceived the respondents. Find off-farm employment and alternative livestock feed supplements were third and fourth ranked perceived adjustment factors to the farmers (Table 2). So, it can be concluded that farmers of West Tripura district perceived there is a change in climate and they are adjusting their farming in changing context, however, agricultural scientists' intervention is imperative.

Table 1: Farmers observation on climate change n=150

Perception on climate change	Level of perception (% farmers)			
	Increased	Decreased	Constant	Unsure
1. Wind speed last 15 years	15	12	37	36
2. Frequency of dry days in monsoon period last 10 years	69	17	2	12
3. Incidence of crop diseases last 10 years	83	5	5	7
4. Incidence of animal disease last 10 years	52	29	12	7
5. Incidence of human diseases last 15 years	80	5	5	10
6. Number of hot days last 15 years	95	5	0	-
7. Sun's heat last 15 years	83	5	12	-
8. Number of rainfall days last 15 years	12	79	9	-
9. Rainfall last 15 years	14	77	9	-
10. Temperature last 15 years	100	0	0	-
11. Current perception on climate	**Good**	**Bad**	**Very bad**	**Constant**
	23	47	25	5

Source: Survey Data

Table 2: Farmers perception on climate change adjustment practices and factors

(From agreement to disagreement) n=150

Climate change Adjustment factors	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	Weighted mean	Rank
Decrease use of irrigation water	3	6	5	36	50	4.32	I
Change of planting date	12	60	19	5	4	4	II
Finding off-farm employment	33	40	7	12	8	3.74	III
Alternative livestock feed supplements	16	53	21	5	5	3.72	IV

Source: Survey Data

Reference

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109.

Effect of Rising Temperature on Certain Plantation and Spice crops- A GIS Analysis

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***Keywords*: Climate change, GIS analysis, plantation**

Introduction

Most climate change scenarios project that greenhouse gas concentrations will increase through 2100 with a continued increase in average global temperatures (IPCC 2007). How much and how quickly the Earth's temperature will increase remains unknown given the uncertainty of future greenhouse gas, aerosol emissions and the Earth's response to changing conditions. In recent time crop simulation models have been used extensively to study the impact of climate on agricultural production and food security. The output provided by the simulation models can be used to make appropriate crop management decision and to provide the farmers and others with alternative options for their farming systems. Crop growth simulation models are research tools usually applied in assessing the relationship between crop productivity and environmental factors. The eco-crop model of DIVA GIS is a universal model which can be used for the crops of any region by adjusting the required climatic parameters. DIVA-GIS implement Eco-crop to predict the adaptation of a crop over geographic areas (Hijmans *et al.,* 2005).

According to several recent studies, even if the composition of today's atmosphere was fixed (which would imply a dramatic reduction in current emissions), surface air temperatures would continue to warm (by up to 1.6°F or 0.9°C) (NRC2008).Based on the above facts this study prepared Eco-crop models of site suitability maps of coconut, Black pepper, and ginger with the present temperature conditions and the future by increasing the temperature by 2°C.

Materials and Methods

The suitability maps were drawn with the help of eco-crop model of DIVA GIS. In Eco-crop, the growing period is defined in days as between Gmin and Gmax (expressed in days). 12 possible growing seasons are considered, starting at the first of each month. To determine the suitability of a growing season, the temperature parameters used were-; KTmp: absolute temperature that will kill the plant, Tmin: minimum average temperature by which the plant will grow, TOPmn: minimum average temperature by which the plant will grow optimally, TOPmx: maximum average absolute temperature by which the plant will grow optimally and Tmax: maximum average temperature by which the plant will cease to grow for all the crops under consideration like Ginger, Pepper and Coconut. In the same way the rainfall parameters were also considered for the different crops.

Results and Discussion

In the present situation eco-crop suitability model for ginger, black pepper and coconut were drawn and compared with latest state wise area and production data (2013-2014). In case of ginger it indicates that Assam, Orissa, West Bengal, Mizoram and Kerala parts of Karnataka are very highly suitable while North western states like Gujarat, Rajasthan, Uttar Pradesh, parts of Madhya Pradesh are marginally suitable or unsuitable. North eastern and South western states are ideally high suitable for ginger cultivation. It shows that the area possessing suitability involuntarily is having high area under ginger cultivation. Productivity is a comparative term, which consists the effect of area, production as well as some other related terms like soil and environmental conditions, socio economic infrastructure and so on. Utpala *et al.* (2007 & 2008) reported that 30 years area, production and productivity data of ginger and turmeric has a close relation with the environmental suitability.

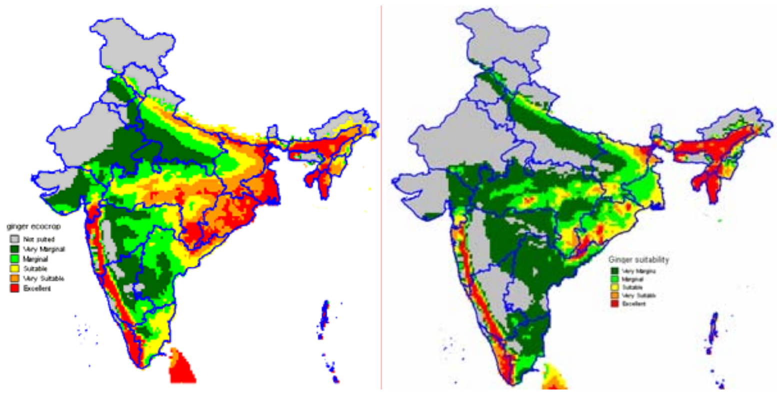

Fig. 1: Ginger Site suitability map for India (Present &Future)

In case of suitability map of black pepper it shows that pepper shows that eastern and northern part of Kerala is excellent to highly suitable for black pepper cultivation (Kollam, Idukki, Wayanad, Calicut and Kannur). South eastern part of Karnataka is highly suitable while North eastern part is marginally suitable and in case of Tamil Nadu only a patch of south western part is highly suitable. Though there are no reliable estimates of total area under cultivation of black pepper in Assam, Tripura, Meghalaya Mizoram and Arunachal Pradesh, the eco-crop model shows these areas are very suitable for pepper cultivation.

The coconut suitability model shows that Kerala as a whole and Eastern coast of Tamil Nadu, Western parts of Karnataka and Maharashtra are very suitable for coconut cultivation. West Bengal, Orissa, Parts of Andhra Pradesh, Madhya Pradesh and Gujarat are suitable to very suitable, while Assam, Bihar and parts of Madhya Pradesh are marginally suitable.

The future prediction of eco-crop model indicates that if the temperature increases by 2°C the suitability for ginger in Orissa and West Bengal will reduce drastically from high suitability to marginally suitable, indicating the effect of climate change. Again in case of black pepper the model for the future prediction shows that the suitability of Western ghats will reduce while that of the Eastern Himalaya's foot hills will turn to be more suitable.

The map prepared with increased temperature by 2°C shows West Bengal, Orissa, Assam will become totally unsuitable for coconut cultivation. According to Naresh Kumar (2008) coconut productivity will increase by 10% by 2020, 16% by 2050 and 36% by 2080, only due to climate change in the west coast. But there will be a decline of 2%, 8% and 31% respectively in the eastern coast in 2020, 2050 and 2085. This study was made on the basis of climate change model. But the Eco-crop model which is prepared by altering temperature parameters also shows a decline in the eastern coast as West Bengal and Orissa which will become unsuitable for coconut cultivation.

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110.

Influence of Pretreatments and Different Drying Methods on Lycopene Content of Dried Tomato

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Keywords: Drying, lycopene, pretreatments, tomato.

Introduction

The preservation of fruits and vegetables by dehydration offers a unique challenge. Due to the structural configuration of these products, the removal of moisture must be accomplished in a manner that will be least detrimental to the product quality. Tomato (*Lycopersicum esculantum* L.) has a limited shelf life at ambient conditions and is highly perishable. It creates glut during production season and becomes scanty during off-season. Over the past few years, consumers have increasingly demanded food products providing both good sensorial quality and specific nutritional properties. Thus, there exists a need to develop suitable technology for processing and preservation of this valuable product in a way that will not only check losses but also generate additional revenue for the country.

Tomato as other fruits and vegetables can be dried using various methods. The quality of dehydrated tomato depends on many parameters such as tomato variety, total soluble solid content (°Brix) of the fresh product, the size of the tomato segments and the air temperature.

Materials and Methods

Two varieties of fresh tomato (Shalimar I and Punjab Chuhra) were purchased from the division of Vegetable Science (SKUAST-K). The fruits were sorted and washed with water to remove dirt and soil and finally they were cut into slices of 15mm thickness. Following pretreatment methods were applied to tomatoes before drying:

- **T_1:** Firstly whole tomatoes were dipped in 2% ethyl oleate + 4% potassium carbonate solution for one minute and the 1% ascorbic acid +1% citric acid dipping solution was applied to sliced tomato samples for 2 minutes.
- **T_2:** Firstly whole tomatoes were dipped in 2% ethyl oleate + 4% potassium carbonate solution for one minute and then 2% sodium metabisulfite dipping solution was applied to sliced tomato slices for 2 minutes.
- **T_3:** Tomato slices were treated with 1% calcium chloride +.25% sodium chloride solution for 2 minutes.
- **T_4:** Tomato slices were treated with 1% sodium chloride solution for 2 minutes.
- **Control T_0:** Non- pretreated samples were used as control samples.

The Pretreated samples were dried by drying methods namely, Sun Drying (SD)**,** Solar Tunnel Drying (ST) and Cabinet Drying (C) at 45°C (D_1), 55°C (D_2) and 65°C (D_3).

Analysis of lycopene content of fresh and dried tomatoes was performed by following procedure:

Weigh 5-10g of the fresh and dried tomato sample and extract repeatedly with acetone in a pestle and mortar until the residue is colourless. Acetone extract was transferred to a separating funnel containing 10-15 ml of petroleum ether and mix gently and the carotenoid pigments were transferred into the petroleum ether by diluting the acetone (lower phase) with water or water containing 5% Na_2SO_4. Thelower phase was then transferred to another separating funnel and the petroleum ether extract containing the carotenoid pigments to an amber coloured bottle. The extraction of the acetone was repeated similarly with petroleum ether until it turns colourless and acetone phase was discarded. Small quantity of anhydrous Na_2SO_4 was added to petroleum ether extract and then transferred to a 50 ml volumetric flask and diluted to mark with petroleum ether. Calculations were made by following formula:

$$\text{mg of lycopene per 100g} = \frac{3.1206 \times \text{OD of sample} \times \text{volume made up} \times \text{Dilution} \times 100}{1 \times \text{weight of sample} \times 1000}$$

Results and Discussion

As it can be observed from the Table 1, the lycopene content increased upon drying. Effects of drying methods & pretreatments on the Lycopene values were found statistically significant ($P<0.05$).

Among both the varieties the highest Lycopene content of 95.76 was observed in variety II in T_1 pretreated sample dried in cabinet (55°C) & Lowest of 60.41 in T_0 pretreated sample dried in sun (variety I). Ethyl oleate, potassium carbonate and ascorbic acid and citric acid treated samples had significant protective effect on lycopene degradation and it was more effective than any other treatment applied. Similar results have been observed by Sharma *et al.* (1996).

Table 1: Influence of Drying Methods and Pretreatments on Lycopene Content mg/100gm

Treatments/ Drying	Variety I (Shalimar I)	Variety II (Punjab Chuhra)	Sub Mean (Treatment* Drying)
T_OSD	60.41	65.50	62.95
T_1SD	62.94	67.25	65.09
T_2SD	68.86	68.75	68.80
T_3SD	66.40	66.47	66.43
T_4SD	63.45	62.47	62.96
Sub mean	64.41	66.14	65.25
T_0ST	85.21	83.25	83.73
T_1ST	90.32	91.26	90.79
T_2ST	94.16	92.17	93.66
T_3ST	92.95	94.03	93.49
T_4ST	86.11	89.09	87.60
Sub mean	89.75	89.96	89.85
T_0D1	90.43	84.04	86.73
T_1D1	92.29	92.26	92.27
T_2D1	94.42	92.88	94.15
T_3D1	93.47	95.02	94.24
T_4D1	87.01	93.37	90.19
Sub mean	91.52	90.91	91.51
T_0D2	89.43	84.75	87.15
T_1D2	92.87	95.76	92.84
T_2D2	93.81	95.17	94.23
T_3D2	93.85	93.27	94.56
T_4D2	90.10	91.03	89.42
Sub mean	92.13	91.59	91.64
T_0D3	91.04	84.47	87.39
T_1D3	92.84	95.07	93.00
T_2D3	95.03	92.81	94.65
T_3D3	94.02	92.65	94.89
T_4D3	88.36	90.74	89.69
Sub mean	92.42	91.14	91.92
Grand mean	86.04	85.95	

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Sharma, S.K. and Maguer, M.L. 1996. Kinetics of Lycopene degradation in Tomato pulp under different processing and storage conditions, *Food Research International.* **29**: 309-315.

111.

Analysis of Rainfall and Temperature Trends in Haryana, India

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Keywords: Rainfall, maximum temperature, minimum temperature, Modified Mann Kendall test, Haryana.

Introduction

Agriculture sector has been adversely affected due to changing climatic conditions. Besides this, scarcity of agricultural facilities, lack of scientific approach in small scale farming, lack of water harvesting and other infrastructures in our country coupled with changing climate will adversely affect the agricultural production. Timely availability of water is the most prominent factor in agriculture which in India needs immediate attention due to decreasing ground water level and spatio-temporal variation of rainfall. Trend analysis of climatic parameters assists in statistical corroboration of changing climate scenarios of a region and also for their future projections. Such studies play a significant role in investigation of its probable impacts on crop yield at regional scales and development of mitigation strategies for attaining agricultural sustainability. Climatic variability and change greatly affects the economy and food security of a country. Therefore, such studies in the Indo Gangetic plain of India assume importance due to over-exploitation of natural resources and to devise strategies for sustaining agricultural production in the region. In this context, the present study was undertaken to analyse the long term trend using the 41 years data from 1969 to 2009 pertaining to rainfall depth, minimum and maximum temperature of different districts of Haryana using Modified Man-Kendall test.

Materials and Methods

In this study climatic parameters namely average maximum, minimum temperature and rainfall have been used for identifying the trends. The Modified Mann-Kendall (MMK) test was undertaken on time series data of annual rainfall depth, average maximum and minimum temperature for six districts of Haryana (Kaithal, Bhiwani, Fatehabad, Rohtak, Palwal and Sirsa) for a period from 1969 to 2009 using a developed interface in Matrix Laboratory (MATLAB) software run at 5% significance level. The Mann-Kendall test is a non-parametric test for identifying trends in time series data. The resultant MMK test statistic indicates how strong the trend in rainfall as well as in maximum and minimum temperature is and whether it is increasing or decreasing significantly.

Results and Discussion

Climatic parameters, namely temperature (maximum and minimum) and rainfall depths of six districts were analysed using the trend test interface in MATLAB. In the MMK test, different parameters *namely* Kendall's tau, Sen's slope, S statistics and the Z-value were analysed to identify the increasing or decreasing trend in the time series of climatic parameters.

Table 1: Trend test statistics and interpretation of annual rainfall, average maximum and minimum temperature in different districts of Haryana using MMKT

Districts (Haryana)	Rainfall		Maximum Temperature		Minimum Temperature	
	Z-value	p-value	Z-value	p-value	Z-value	p-value
Kaithal	2.59	0.01	-0.348	0.72	4.91	<0.0001
Bhiwani	-0.168	0.86	1.471	0.003	4.73	<0.0001
Fatehabad	-0.887	0.37	0.303	0.76	4.53	<0.0001
Rohtak	-0.651	0.51	1.123	0.26	4.24	<0.0001
Palwal	0.000	0.99	0.640	0.52	4.68	<0.0001
Sirsa	-0.033	0.97	0.326	0.74	4.28	<0.0001

It was observed that the rainfall depth, maximum and minimum temperature in six districts of Haryana depicted spatio-temporal variability during 1969 to 2009. Trend analysis of rainfall showed increasing trend for Kaithal and Palwal district of Haryana but for Kaithal there was significant increase with z-value of 2.59. The S statistics, Kendall's tau and Sen's slope were 220, 0.27 and 5.8, respectively for Kaithal district. However, non-significant decreasing trend was observed for other districts of Haryana. Further, trend analysis for maximum temperature showed an increasing trend for all districts except for Kaithal but it was observed that the trend was statistically significant only for Bhiwani district. The S statistics, Z-value, Kendall's tau and Sens' slope were 132, 1.47, 0.16 and 0.01, respectively and the positive value of Kendall's tau and S statistics showed an increasing trend of maximum temperature for Bhiwani district. Moreover, the Z-value showed that the trend was statistically significant. Contrastingly, it was observed that the trend of minimum temperature increased significantly for all districts of Haryana. The results indicated that Significant increasing trend was observed for only one district each pertaining to rainfall depth (Kaithal) and maximum temperature (Bhiwani), whereas for minimum temperature, all six district showed significant increasing trend. Therefore, it can be concluded that the trend test need to be undertaken for long term time series data of different climatic parameters to ascertain whether there was climate variability or climate change besides its magnitude at a given level of significance. Nonetheless, based on the results of trend analysis, judicious agricultural management activities would be recommended based on regional variations in Haryana State.

112.

Effect of Growing Environments and Chlorophyll Meter Based Nitrogen Management on Productivity and Profitability of Maize Cultivars in Alluvial Plains of North-India

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Keywords: PEEHM 5, Pusa Composite 3, planting dates, SPAD meter, precision nitrogen

Introduction

Maize is adapted to a wide range of environmental and climatic conditions with large variations in yield. This nutrient exhaustive crop requires heavy nitrogen (N) fertilization that poses stiff challenge to the producers like low N-use efficiency and environmental pollution. Precision N management using chlorophyll meter, also known as Soil and Plant Analysis Development (SPAD) meter, offers important solution to address such issues (Dass *et al.*, 2014, 2015). However, response of maize cultivars to N management may differ with growing environments. Thus, current investigation was carried out to assess the effect of planting dates and chlorophyll meter based N application on productivity, economics and agronomic efficiency of two maize cultivars.

Materials and Methods

The three-time replicated, split-plot designed experiment had 24 treatments, 2 maize cultivars (Hybrid PEEHM 5, PC 3), 3 planting dates (July 9, July 24, August 7) in main-plots, and 4 N-rates, no-N, chlorophyll meter based N (CMB): 30 kg N/ha basal + 30 kg/ha N top-dressed each time at SPAD value ≤ 37.5 (150 kg/ha), chlorophyll meter based N application stage-wise (CMBSW): 30 kg N/ha N + 30 kg N/ha top-dressed each at knee high, pre-tasseling and silking stages at SPAD value ≤37.5 (120 kg N/ha), and STCR based application (160 kg/ha), in sub-plots.

Results and Discussion

The maize hybrid PEEHM 5 produced 5% higher grain yield, whereas biological yield was 5.4% higher in PC 3. Both grain and biological yields of both cultivars decreased with successive 15-day delay in planting from July 9 to August 7, but the decrease was more drastic in PEEHM 5. CMB N application increased grain yield by 8.5% and biological yield by 7.63% and also saved 10 kg N/ha compared to STCRB N application. CMB N resulted in higher agronomic efficiency (AE) over STCRB N application, across both cultivars and planting dates due to higher yield with less input of N. The highest gross return, net return and B: C ratio, were recorded with the earliest planting (July 9) and CMB N application. Further, cultivar PEEHM 5 was more profitable for early planting (July 9) condition and for later planting dates (August 7), PC 3 showed greater promise. Thus, in northern plain zone of India, sowing of maize should not be delayed beyond second week of July; however, if sowing gets delayed use cultivars like Pusa Composite 3 and N application scheduling may be done using a chlorophyll meter.

Table 1: Effect of varieties, planting dates and chlorophyll meter based N application on grain and biological yields of maize

Treatment	Yield (t/ ha)	
	Grain	Biological
Cultivars		
PEEHM 5	4.62	12.99
Pusa Composite 3	4.39	13.73
CD (P=0.05)	0.213	0.571
Planting dates		
July 9	4.87	14.32
July 24	4.58	13.55
August 7	4.06	12.21
CD (P=0.05)	0.261	0.699
Nitrogen management		
Control	3.03	9.22
CMB	5.31	15.58
CMBSW	4.82	14.24
STCRB	4.86	14.39
CD (P=0.05)	0.213	0.570

CMB: Chlorophyll meter based N application up to silking i.e. 30 kg/ ha N basal + 30 kg/ha N top-dressed each time leaf SPAD value falls to ≤ 37.5; CMBSW: Chlorophyll meter based N application stage-wise i.e. 30 kg/ha N basal + 30 kg N top-dressed each at knee high, pre-tasseling and silking stages when SPAD value falls to ≤ 37.5; STCRB: Soil test crop response based N application

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113.

Functional Behavior of Lotus Rhizome Harvested From High Altitude Dal Lake of Kashmir

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Keywords: Lotus, rhizome, swelling capacity, least gelation concentration, foaming stability, foaming capacity, emulsifying activity, emulsifying stability.

Introduction

Lotus, botanically known as *Nelumbo nucifera,* is a rhizomatus aquatic, ornamental, edible and medicinal plant which is grown as a non-conventional vegetable commonly in China, India, Japan and Australia. In India lotus plant reportedly grows in almost all lakes and other water bodies, both at high altitudes of 1400 m above mean sea level e.g., Kashmir (North India) and low altitudes of 0.30 m above mean sea level e.g., Kanyakumari (Southern India). However the lotus from the Kashmir valley is of prime importance owing to the geographic location and climate in which it grows. Biochemically, lotus rhizomes are composed of proteins, fats, carbohydrates and minerals and are good source of energy. Therefore lotus rhizome can be well exploited for the development of value added products, for which the critical evaluation of its functional behavior needs to be done. Therefore the present study was planned.

Materials and Methods

The lotus rhizomes harvested from Dal Lake, Kashmir were sliced and dried in cabinet drier at 50°C for 8 hours. The slices were ground to flour and analyzed for various physico-chemical, functional and pasting properties. The proximate compositions i.e. moisture content, crude protein, crude fibre, ash and starch content of the raw material were determined using (AACC, 2000) methods. The crude fat and carbohydrate content were determined by using Soxtec 2045 (Foss instrument, Sweden) and difference method respectively.

The solubility and swelling capacity (SC) were determined by the method described by Leach *et al.* (1959) with slight modifications. The water absorption capacity (WAC) of the flour was determined using the methods suggested by Beuchat (1977). The gelation properties of the flour were determined by the method described by Coffman and Garcia (1977). The procedure of Akpapunam and Markakis (1981) was used to determine the pre weighed (W_1) bulk density of the flour. Foaming capacity (FC) of the flour was determined by the method described by Coffman and Garcia (1977). In order to determine the foaming stability, the foam was allowed to stand for 8 hours at room temperature and the foaming stability (FS) was expressed as the percentage retention of the initial foam volume. Emulsifying activity (EA) and emulsion stability (ES) were determined by following the method of Neto *et al.* (2001). The emulsion stability (ES) was determined by heating the emulsion at 80°C for 30 minutes followed by centrifugation at 1100 × g for 5 minutes. The pasting properties were determined using Rapid Visco-Analyser (RVA).

Results and Discussion

The physico- chemical and functional properties of lotus rhizome are depicted in table I. The moisture content, protein, fat, ash, fibre, carbohydrate and starch content in lotus rhizome were recorded as 5.90, 8.24, 2.72, 1.33, 10.80, 71.01 and 53.37% respectively (Table I). Some differences were found between the physico-chemical properties of the present study and those reported by Muhammad *et al.* (2011) which can be due to differences in geographical locations and altitude of the water bodies.

The water solubility, swelling capacity, water absorption capacity, least gelation concentration, bulk density, foaming capacity, foaming stability, emulsifying activity and emulsifying stability of lotus rhizome flour were recorded as 97.10, 2.90, 245.9, 17.60, 0.77, 5.43, 4.78, 46.60, and 88.40% respectively. The data given in the table I indicates that lotus rhizome from Dal lake of Kashmir region possess appreciable functional behavior and can be very well utilized for the development of bakery and extruded food products.

Pasting is the phenomenon following gelatinization in the dissolution of starch. It involves granular, swelling, exudation of molecular components from starch granules and eventually total disruption of the granules. The pasting profile of flour is important for different industrial food uses. The pasting properties of the lotus rhizome are summarized in Table 1. The pasting temperature, peak viscosity, hold viscosity, final viscosity, breakdown viscosity and setback viscosity of lotus rhizome flour were found as 89.75°C, 2075, 1614, 2456, 461 and 842 centipoises (cp) respectively. The peak viscosity of the lotus rhizome flour was little lower (2075cp) than most common flours (i.e rice and wheat flour) used in food industries which indicates its structural rigidity than these flours. However the other pasting properties (like hold, final, and bulk and setback viscosities) were found on the lower side except the pasting temperature. The higher pasting temperature of the lotus rhizome flour demonstrates its higher gelatinization temperature than flours like rice and wheat.

The present data on proximate composition, functional and pasting behavior of lotus rhizome of Dal Lake, Kashmir may provide a guide line for its use in development of food products through baking, extrusion and other processes.

Table 1: **Proximate composition of Lotus Stem flour**

Parameters	Lotus stem flour
Moisture%	5.90
Protein%	8.24
Fat%	2.72
Ash%	1.33
Fibre%	10.80
Carbohydrate%	71.01
Starch%	53.37
Water solubility (%)	97.10
Swelling capacity (%)	2.90
Water absorption capacity (%)	245.9
Least gelation concentration (%)	17.60
Bulk density (g/cm^3)	0.77
Foaming capacity (%)	5.43
Foaming stability (%)	4.78
Emulsifying activity (%)	46.60
Emulsifying stability (%)	88.40
Pasting temperature (°C)	89.75
Peak viscosity (cp)	2075
Hold viscosity (cp)	1614
Final viscosity (cp)	2456
Breakdown viscosity (cp)	461
Setback viscosity (cp)	842

*values expressed are means of 3 replicates.

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114.

Cultural, Morphological and Pathogenic Diversity Analysis of *Sclerotinia sclerotiorum* Causing Sclerotinia Rot in Indian Mustard

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Introduction

Sclerotinia sclerotiorum (Lib.) de Bary, the causal agent of Sclerotinia stem rot is a necrotrophic pathogen infect over 400 species of plants. Wide host range, high degree of variability in cultural and morphological characteristics observed among different isolates of *S. sclerotiorum*. The available reports related to the variability in pathogen infecting *Brassica* throughout the world indicates that in spite of wide host range and reported homothallism in this fungus, the variability do exist in this pathogen in the form of clonal variation within different crop species in different geographical regions. In this context the present study was carried out to find out the diversity among Indian populations of *S. sclerotiorum* infecting Indian mustard.

Materials and Methods

In this context the present study was carried out to find out the variability among Indian populations of *S. sclerotiorum* infecting Indian mustard in relation to variability in cultural, morphological and pathogenic characteristics. The collected isolated were purified through hyphal tip culture method and identified using ITS primers. All isolates were incubated at 21±1°C in BOD incubator and observed the cultural and morphological characteristics. Pathogenic variability of isolates were observed on different rapeseed-mustard genotypes on the basis of wide phenotypic and genotypic variations. Pathogens were artificially inoculated under screen house conditions and lesion phenotype index were recorded according to 0-4 scale (Zhao *et al.,* 2004) and PDI was calculated following the formula of Wheeler (1969).

Results and Discussion

The present study was conducted to ascertain the variability among fourteen isolates of *Sclerotinia sclerotiorum* collected from Indian mustard (*Brassica juncea*) from different mustard growing regions of India. Variation in cultural characteristics were observed among the isolates, particularly in colony colour *i.e.* dirty white to whitish; while, the mycelial growth varied from sparse and regular, fluffy and regular to fluffy and irregular. The morphological features like number of sclerotia, size of sclerotia and pattern of sclerotia formation varied among the isolates. Significant variation was observed in the host-pathogen interaction as the average disease intensity of isolates varied from 29.5 to 60.8 per cent. Four isolates *viz*., HSR, FTH, SRS, and DBW recorded were more virulent and showed average disease intensity of more than 50%, while ALW isolate caused less than 30% disease intensity. The disease reaction studied for the pathogenic variability on Varuna albino cv. showed moderately resistant reaction, while genotypes viz., Varuna, Domo 4 and Midas showed highly susceptible reaction to all the isolates (Table 1). The identification of the pathogen as isolates of *S. sclerotiorum* were confirmed at the molecular level by using ITS primers.

In conclusion, no comprehensive study has been conducted for variability in this pathogen in Indian mustard. Significant differences in pathogenicity among different isolates across genetically diverse rapeseed-mustard genotypes in the present study, suggest existence of a form of physiological specialization in *S. sclerotiorum* population in India. Furthermore, genotypes such as Varuna albino which has shown consistent moderate resistant reaction to all the isolates could be used as source of resistance in mustard breeding programmes in the country.

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Table 1: Per cent Disease intensity and disease reaction of *S. sclerotiorum* isolates in rapeseed- mustard genotypes under screen house conditions

Genotypes/ Varieties	Isolates of *S. sclerotiorum*														
	HSR	FTH	SRS	DBW	SWN	BWL	MHR	BHR	ALW	BKN	GNG	JLN	LDN	MRN	Mean
Brassica 1	41.8 (S)	34.2 (S)	34.2 (S)	21.1 (MR)	28.3 (S)	20.6 (MR)	33.4 (S)	22.5 (MR)	18.4 (MR)	23.4 (MR)	35.1 (S)	21.4 (MR)	28.5 (S)	23.2 (MR)	27.6
Domo 4	85.4 (HS)	81.2 (HS)	84.1 (HS)	80.7 (HS)	79.5 (HS)	58.4 (HS)	68.1 (HS)	63.7 (HS)	51.6 (HS)	70.3 (HS)	53.4 (HS)	68.7 (HS)	76.4 (HS)	68.2 (HS)	70.7
GSL 01	74.5 (HS)	68.3 (HS)	70.3 (HS)	42.4 (HS)	43.6 (HS)	23.3 (MR)	38.4 (S)	64.2 (HS)	21.1 (MR)	37.6 (S)	43.8 (S)	32.1 (S)	43.1 (S)	43.2 (S)	46.1
HC 0212	78.3 (HS)	76.5 (HS)	72.8 (HS)	46.2 (S)	42.5 (S)	21.3 (MR)	37.2 (S)	40.6 (S)	20.4 (MR)	33.8 (S)	52.1 (HS)	42.1 (S)	45.2 (S)	43.1 (S)	46.6
HNS 9605	78.2 (HS)	72.3 (HS)	74.4 (HS)	68.3 (HS)	65.2 (HS)	54.3 (HS)	64.7 (HS)	62.5 (HS)	26.1 (S)	44.7 (S)	58.2 (HS)	58.2 (HS)	52.4 (HS)	46.4 (S)	59.0
JN 031	44.1 (S)	34.4 (S)	37.2 (S)	32.0 (S)	20.2 (MR)	22.8 (MR)	34.4 (S)	22.5 (MR)	20.2 (MR)	23.1 (MR)	36.3 (S)	37.4 (S)	35.1 (S)	24.1 (MR)	30.3
JN 032	23.8 (MR)	21.3 (MR)	21.6 (MR)	37.1 (S)	35.4 (S)	34.6 (S)	48.5 (S)	39.3 (S)	30.3 (S)	40.3 (S)	42.6 (S)	38.3 (S)	41.8 (S)	37.1 (S)	35.1
Kiran	66.5 (HS)	70.5 (HS)	58.4 (HS)	53.1 (HS)	37.8 (S)	38.4 (S)	37.2 (S)	41.3 (S)	24.4 (MR)	35.7 (S)	63.1 (HS)	31.7 (S)	61.5 (HS)	32.7 (S)	46.6
Midas	84.1 (HS)	78.7 (HS)	82.1 (HS)	80.2 (HS)	81.6 (HS)	63.4 (HS)	58.2 (HS)	61.3 (HS)	53.2 (HS)	76.2 (HS)	53.4 (HS)	52.2 (HS)	57.6 (HS)	72.3 (HS)	68.2
RH 30	73.2 (HS)	68.6 (HS)	62.3 (HS)	60.2 (HS)	40.6 (S)	48.6 (S)	35.8 (S)	44.4 (S)	30.2 (S)	41.7 (S)	52.5 (HS)	34.4 (S)	52.4 (HS)	35.7 (S)	48.6
Varuna	88.5 (HS)	83.2 (HS)	86.6 (HS)	85.8 (HS)	82.5 (HS)	54.2 (HS)	65.2 (HS)	65.5 (HS)	54.2 (HS)	78.5 (HS)	64.1 (HS)	78.4 (HS)	62.3 (HS)	77.1 (HS)	73.3
Varuna albino	21.2 (MR)	24.2 (MR)	24.4 (MR)	16.7 (MR)	18.2 (MR)	12.5 (MR)	14.8 (MR)	16.2 (MR)	10.2 (MR)	14.2 (MR)	22.1 (MR)	18.6 (MR)	22.4 (MR)	22.1 (MR)	18.4
ZEM 1	43.3 (S)	34.2 (S)	28.7 (S)	34.7 (S)	27.1 (S)	22.2 (MR)	36.7 (S)	45.5 (S)	26.5 (S)	43.6 (S)	36.6 (S)	42.3 (S)	45.5 (S)	43.1 (S)	36.4
ZEM 2	48.1 (S)	42.3 (S)	43.0 (S)	48.4 (S)	42.3 (S)	23.8 (MR)	42.8 (S)	45.8 (S)	26.3 (S)	42.1 (S)	35.3 (S)	21.3 (MR)	23.3 (MR)	45.3 (S)	37.9
Mean	60.8	56.4	55.7	50.5	46.1	35.6	44.0	45.4	29.5	43.3	46.3	41.2	46.3	43.8	46.1

Per cent Disease Intensity (PDI) <25%=Moderate Resistant (MR), 26-50%= Susceptible (S), >50% Highly susceptible (HS)

Factors	C.D. 5%	SE(d)	SE(m)
Isolates (A)	0.46	0.23	0.16
Genotypes (B)	0.65	0.33	0.23
(A X B)	1.74	0.88	0.63

115.

Climate Change and its Impact on Apple Farming in High Hill Dry Temperate Zone of Himachal Pradesh-Farmers Perception and Responses

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Introduction

Climate change is a global environmental issue as it relates to global common atmosphere. The impacts of climate change are most seriously felt in the Himalayan region because it belongs to the most vulnerable ecosystems and most of the population is dependent on the agriculture and horticulture for sustaining the livelihood. The present study was conducted during 2014-15 in Kinnaur district of Himachal Pradesh, located between 31°-05'-50" to 32°-05'-15" North latitude and 77°-00'-35" East longitude at an altitude range of 2500-3000 m a.m.s.l. and aimed at understanding the farmer's awareness on climate change and its impacts on apple crop.

Materials and Methods

Seven Panchayats of Kinnaur district of Himachal Pradesh namely Kalpa, Dooni, Kothi, Roghi, Bathseri, Sangla and Rakchham representing altitudinal ranges between 2500-3000 m amsl and dominated by the apple cultivation were selected purposely to examine the perceptions of farmers about climate change and apple cultivations with reference to climate change.

Results and Discussion

The study revealed that about 72% of farmers noticed a decrease in the irrigation water sources to their apple orchards and as per farmers perception the main reasons for decrease in irrigation water sources were reduced snowfall (51%), increased temperature (16%) and both (33%). Farmer's perceptions on the factors affecting apple cultivation (Fig. 1) showed that change in snowfall pattern (71%), increase in atmospheric temperature (63%), pollination problems (62%), and change in rain fall pattern (58%), less proportion of pollinizer varieties (53%) and insect-pest disease incidence (52%) were the major factor affecting apple cultivation in the region. Under high temperature and moisture stress, damage by shot hole borers, wooly apple aphid, San Jose Scale, blossom thrips and premature leaf fall is more prominent (Sharma *et al.*, 2004).

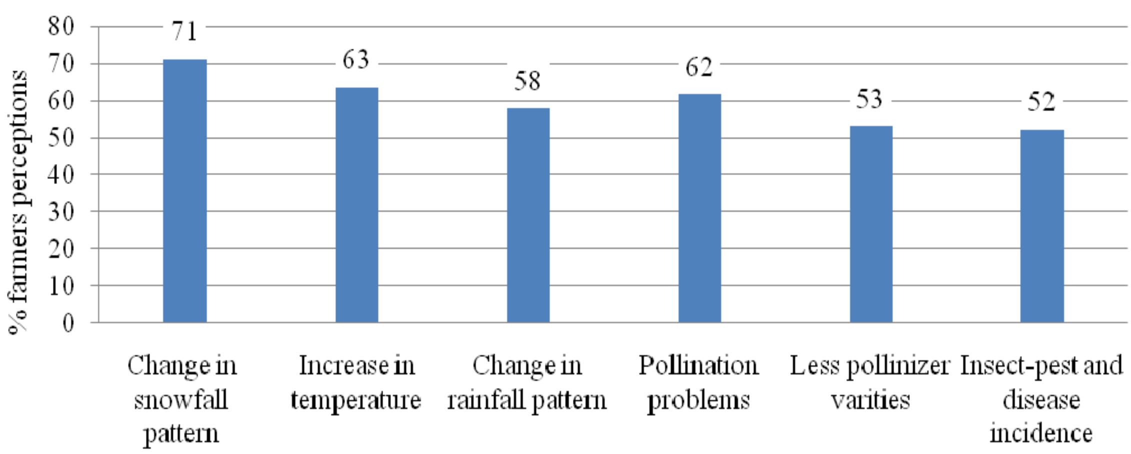

Fig 1. Major factor affecting apple cultivation in the Kinnaur district of Himachal Pradesh

Reference

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116.

Isolation and Screening of Thermo tolerant Isolates of Microalgae for Biodiesel Production

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Keywords: Biodiesel, thermotolerant, microalgae, BG-11 medium, lipid.

Introduction

Microalgae have been taken into consideration as a residual biomass ready to be used for energy purposes. Oil content of microalgae is usually between 20 to 50% on dry weight basis, while some strains may contain as high as 80%. Utilizing thermophilic microalgae would minimize the amount of energy expended on cooling, thereby contributing to the overall efficiency. The temperature in northern region of India reaches upto 48°C during summer. Therefore, microalgae that are adapted to high temperature are desirable. Selecting right and robust strain is the key to success for commercialization of potential microalgae in terms of biodiesel production.

Materials and Methods

Samples were collected from different locations of Haryana state during summer months. Isolation of microalgal isolates was made on Bold's Basal Medium (BBM) (Bischoff and Bold, 1963) and BG-11 medium at 40°C. Algal isolates were screened on the basis of lipid and biomass accumulation. The colonies of microalgae isolates were picked, purified by streaking and restreaking and designated as TMD-1, TMD-2, TMD-3, TMD-28 etc. The isolates were maintained on slants. The pH of different isolates from different locations was measured by pH-meter. Lipid extraction was done by Bligh and Dyer method (1959).

Results and Discussion

A total of 28 thermotolerant microalgal isolates were obtained on Bold's Basal medium and BG-11 medium. These were categorized into three groups. Out of 28 isolates, 16 isolates showed poor lipid accumulation whereas one isolate was highest lipid producer and rest were average lipid producers

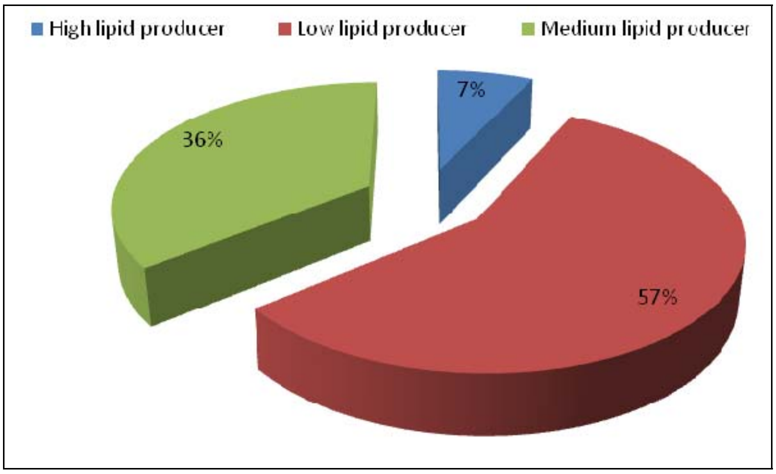

Fig. 1: Categorization of growth of thermotolerant microalgal isolates on the basis of lipid production

The lipid production was studied at 40°C in BG-11 and Bold's Basal Medium. The lipid production by low producer isolates varied from 0.021 to 0.037g/l whereas it was 0.063 to 0.098g/l at 40°C by average lipid producers, respectively. However, high lipid producing isolate TMD-9, showed maximum lipid production 0.160g/l at 40°C. Further, the growth of isolate TMD-9 was more at elevated temperature i.e. 40°C. The temperature in northern region of India goes very high even upto 48°C during summer. Out of 28 isolates obtained from different locations, one microalgal isolate TMD-9 accumulated maximum biomass and lipid production at elevated temperature i.e., 40°C. This isolate produced highest amount of biomass and lipid at high temperature. Thus thermotolerant microalgal isolate can be a potent biodiesel producer and can be exploited for production of biodiesel on mass scale for its commercialization.

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117.

Effects of High Temperature Stress on Physiological Processes and Yield Attributes of Different Mungbean (*Vigna radiata* L.) Genotypes

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Keywords: Transpiration cooling, proline, SPAD

Introduction

Atmospheric temperatures are expected to increase in future due to potential climatic changes. The current estimates of global warming predict an increase of temperature from 1.8°C to 4.0°^{C} by the end of the century (IPCC 2007). One of the greatest dangers is the vulnerability of agriculture to climate change, especially in developing countries. Heat stress is one of the primary stresses limiting the performance of plants over the globe (Mansoor and Naqvi 2013). The rise in temperatures is drastically affecting the growth and production potential of crops, especially for those being grown in the tropical conditions (Hall 2001).

Materials and Methods

The present study was carried out to understand the tolerance mechanism to high temperature stress in three Mungbean [*Vigna radiata* (L.) Wilczek] genotypes namely MH-421, MH-318, and Basanti. The seeds of MH-421, MH-318 and Basanti were obtained from Pulses Section, Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar- 125004, India.

Transpiration cooling *i.e.* canopy temperature depression (CTD°C) measured by using infra-red thermometer (Model AG-42 Tele-temp Corp. CA) which was focused on 1 m distance of crop canopy level and at late morning to early afternoon cloudless periods in between 10.00 a.m and 12: 00 a.m. The data for each slab were the mean of three readings, taken from the same side of each slab at an angle of approximately 45° to the horizontal in a range of directions such that they covered different regions of the slab and integrated many leaves. Proline content was estimated by using the method of Bates *et al.* (1973).

Two ml of supernatant was taken in a tests tube and 2 ml reagent acid ninhydrin was added. This mixture was then kept in boiling water bath for 1 h at 100°C, and thereafter reaction was terminated by keeping tubes in ice-bath. Then 4 ml of toluene was added. After vigorous shaking, the upper coloured organic phase was taken after attainment of room temperature and absorbance was recorded at 520 nm by using toluene as blank. Standard curve was prepared by using graded concentration of proline in 3% sulphosalicylic acid. The proline content was expressed as μ mol g^{-1} DW.

The mean of three readings from a portable Minolta chlorophyll meter SPAD-502 (Spectrum Technologies, Inc., Plainfield, IL, U.S.) was obtained for each leaf disc from individual leaves (10 leaves per tree) and pooled to obtain one SPAD measurement per disc. The leaf disc used to obtain a SPAD value provided sufficient tissue for total chlorophyll content.

Results and Discussion

SPAD readings and canopy temperature depression (CTD) was negative and significant with increasing high temperature, at 7 DAE maximum SPAD and less CTD *i.e.* (48.72, -4.37) respectively was recorded in MH 421 followed by MH 318 (0.568, 45.63, -3.73) and minimum SPAD and high CTD *i.e.* (45.53, -3.40) respectively was recorded in Basanti genotype over to their control. High temperature stress significantly reduced the duration of reproductive phase and number of pods plant^{-1} The maximum reduction in number of pods plant^{-1} was found in Basanti (10.64%) followed by MH 318 (8.13%) and minimum in MH 421 (6.70%) and 100 seed weight. The maximum reduction in 100 seed weight was found in Basanti (23.3%) followed by MH 318 (17.4%) and minimum in MH 421 (16.3%) in both normal and late sown conditions and there was reduction was observed in seed yield plant^{-1} and yield components in late sown compared to that of normal sown. Based on mean performance of mungbean genotypes for various morpho-physiological traits as well as yield and its components, the genotype MH 421 was found to have high values than MH 318 and Basanti under environment of both normal and late sown conditions. It also showed low value of HSI, high value of YS in MH 421 compared to MH 318 and Basanti genotype.

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Table 1: Changes in SPAD chlorophyll content of leaves in mungbean genotypes as affected by high temperature

Genotypes	SPAD							
	Normal sown				Late sown			
	Control < 35°	>35°C, Days of exposure (DAE)			>35°C, Days of exposure (DAE)			
	Control	3	7	Mean	Control	3	7	Mean
MH 421	54.27	52.30	49.60	52.06	51.40	47.87	46.90	48.72
MH 318	47.13	46.13	44.37	45.88	47.17	46.67	45.63	46.49
Basanti	48.90	47.70	46.73	47.78	47.37	46.47	45.53	46.46
Mean	50.10	48.71	46.90		48.64	47.00	46.02	
C.D. at 5%	Genotypes=2.44 Temperature=2.44 Genotypes X Temperature=NS				Genotypes=1.58 Temperature=1.58 Genotypes X Temperature= NS			

118.

Influence of Weather on the Incidence of Wax Moth (*Galleria mellonela*) and Hive Beetle (*Aethina tumida*) in the Pests of *Apis mellifera* L. Apiaries in Gird Zone of Morena District

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Keywords: *Apis mellifera L.,* residential, migratory, apiaries, gird zone, incidence etc.

Introduction

Gird zone is in northern part of Madhya Pradesh lies between latitude 24° to 26° north and longitude 76° to 79° east. The climate of the zone is characterized as semi arid being extremely hot during May -June (maximum temperature 47°C) and extremely cold in January (minimum temperature 1°C). Gird zone is highly suitable for beekeeping. Good quality of bee flora coupled with large acreage under mustard (*Brassica compestris)* cultivation, sown from October to December provides bee flora from November to February and coriander (*Coriendrum sativum L.),*Berseem (*Trifolium alexandrinum* L.) in March and April. Beekeepers of this zone are adopted the stationary beekeeping, they place their apiaries in orchards and in vegetable growing areas. Occurrence of pests and predators in residential apiaries as well as in migratory apiaries may be different. If so than this may be hazardous and leads exposure of residential and migratory apiaries vice versa. The high infestation of (*Galleria mellonella L.)* occurs during August to October generally this pest feeds on empty combs and under heavy infestations the colony strength is declined drastically

Materials and Methods

Study on pests and predators of *(Apis mellifera L.)* was carried out block of Morena district. The beekeepers from the adjoining states regularly migrate their apiaries in the month of October -November and remains till the end of April. Situation prompted us to work on the status of pests and predators, their spread and adoption of beekeeping by the local farmers. Five blocks namely Ambah, Morena, Jaura, Kailaras and Sabalgarh were selected for the study. The wax moth (*Galleria mellonela* L.) larvae and pupae/hive was recorded by observing the silicon galleries and silk covered comb cell at fortnightly interval. Hive beetle *(Aethina tumida* Murray*)* adult population and larval population were examined by using observation frame, population per centimeter square /hive.

Results and Discussion

Incidence of wax moth in migratory apiaries at all the location was significantly higher in migratory apiaries as compared to residential apiaries. Incidences of wax moth larvae in residential apiaries in different blocks were nearly uniform. But the low or high incidence in migratory apiaries determined the level of significance in different blocks of Morena district (Table 1). Out of five blocks of Morena district seasonal activity of wax moth in bee boxes (correlation coefficient) with weather factor in only Morena location In residential apiaries the population of hive beetle differed significantly in Joura t= 3.50 Sabalgarh t= 2.49. Small hive beetles are more abundant in warmer than cooler regions (De Guzman *et al., 2010)*. Activity of hive beetle were highly influenced by the maximum and minimum temperature. The population of hive beetle was significantly low in Joura and Sabalgarh (Table 2). While in Kailarash,Morena, and Ambah the differences in population of hive beetle in residential and migratory apiaries was not significant. Activity of hive beetles was highly influenced by the fluctuation in maximum and minimum temperature.

Table 1: Occurrence of wax moth *(Gallaria mellonella L.)* in residential and migratory and migratory apiaries in different blocks of Morena district.

Observation period fortnightly	Mean population per frame									
	Kailarash		Morena		Joura		Sabalgarh		Ambah	
	R	M	R	M	R	M	R	M	R	M
First fortnight Nov	0.76	16	1.12	0	0	2.49	0	17.1	0.73	24.9
Second fortnight Nov	0.94	8	0.65	0	0	1.26	1.43	58.06	0.65	59.29
First fortnight Dec	0.94	12.25	0.65	0	1.08	1.21	1.51	12.25	0	12.25
Second fortnight Dec	1.28	0.69	0.73	0	1.48	1.22	1.3	0.12	0.86	0.14
First fortnight Jan	0	1.69	0.65	0.94	1.46	2.49	1.25	1.69	0.65	1.69
Second fortnight Jan	1.04	1.51	0.81	0.86	1.48	1.29	1.13	1.51	0.65	1.25
First fortnight Feb	0.69	8.07	0.86	0	1.48	1.33	0	8.07	0.65	8.07
Second fortnight Feb	1.69	2.5	0.94	1.28	1.12	1.26	0.86	2.5	0.94	2.5
First fortnight Mar	0	1.44	1.12	1.72	1.12	2.49	0	1.44	0	0.49
Second fortnight Mar	1.59	1.93	0.86	1.21	1.53	1.26	0	1.37	0	0.76
First fortnight April	2.5	1.77	1.04	1.21	1.25	2.49	0	2.28	1.36	0.76
Second fortnight April	1.59	1.8	0.86	1.21	0	0.8	0	1.8	0.65	0.49
"t" value	2.50*		4.13**		2.51*		2.30*		2.79*	

R=Residential, M=Migratory

Table 2: Occurrence of hive beetle *(Aethina tumida Murray)* in residential and migratory and migratory apiaries in different blocks of Morena district.

Observation period fortnightly	Mean population per frame									
	Kailarash		Morena		Joura		Sabalgarh		Ambah	
	R	M	R	M	R	M	R	M	R	M
First fortnight Nov	0.73	0	0.73	0.94	0	0	1.69	1.36	0	0.65
Second fortnight Nov	0.82	1.12	0.82	1.12	0	0.75	1.21	1.69	0.81	0.86
First fortnight Dec	0.73	0.86	0.73	0.86	0	0.75	0.86	1.12	0	0.86
Second fortnight Dec	0.92	8.46	0.92	8.46	0	0.57	0.81	0.86	0.65	0.86
First fortnight Jan	0.81	0.94	0.81	0.94	0	0.75	0.81	1.21	0.65	0.81
Second fortnight Jan	0.94	0.94	0.94	0.94	0	0.75	0	1.58	0.65	0.94
First fortnight Feb	1.48	0.86	1.48	0.86	0	0	0.65	1.27	0.86	1.21
Second fortnight Feb	0.73	1.18	0.73	1.18	0	1.12	0	1.27	1.12	0.94
First fortnight Mar	0	1.12	0	1.12	0	0	0.82	0.73	0.81	0.81
Second fortnight Mar	0.81	0.94	0.81	0.94	0	0	0	1.58	0.81	0.73
First fortnight April	0.57	0.81	0.57	0.81	0	1.48	0	1.58	1.26	0.65
Second fortnight April	0	0.73	0	0.73	0	0	0.65	0	1.12	0.94
"t" value	-0.092* NS		1.39 NS		3.50**		2.49*		1.62NS	

R=Residential, M=Migratory

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119.

Influence of Climatic Factor on Population Dynamics of Mustard Aphid *(Liphaphis Erysimi* Kalt.) On Brasica Cultivars in Madhya Pradesh

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Keywords: *Liphaphis erysimi L.*, aphid, weather, brassica sp. temperature, mustard

Introduction

Brassica Varieties is the most important oilseed crop of Morena district in Madhya Pradesh India. It is grown rain fed as well as irrigated condition. The mustard aphid (*Liphaphis erysimi* Kalt.) is one major limiting factor for low yield. Aphid present throughout the year in the field and its population reached to peak during December to February. It infests mustard at vegetative, flowering and poding stage. Weather factor such as temperature, relative humidity, rainfall and total sunshine usually influence the insect population. Therefore the present study was undertaken to observe the population dynamics of mustard aphid in relation to weather.

Materials and Methods

The climate of the experimental area Morena is characterized as semi arid with extreme hot and cold period during May- June (49-50°C max. and 26°C min.). The field experiment was conducted on seven different cultivars of brassica varieties. The variety namely JM-4, Rohini, NRCDR-2 belong to *Brassica juncea L.* and Bhavani, JT-1, PT 303 belong to *Brassica compestris L.* and local cultivars represented *Brassica compestris L.* variety and sowing was done last week of October and first week of November during experiment period in 4x3 m^2 plot at a spacing of 30x10 cm in randomized block design with three replication.

Results and Discussion

The aphid infestation on *Brassica compestris L.* and *Brassica juncea L.* was recorded on (Standard Meteorological Week) SMW 52th. In case of Indian mustard such as NRCDR-2(38.2) and JM-4 (45.0) population of aphid reached the peak level of SMW 8th and 9th. Data indicated that the population dynamics of mustard aphid (*Liphaphis erysimi* Kalt*)* on five genotype of mustard in relation to weather parameters was studied. Aphid infestation was noticed during first week of January. Data revealed that the highest aphid population 65.2 and 64.0 *Brassica compestris L.* was observed in the third week of February SMW 6 th. The ambient minimum and maximum temperature 12.71°C and 25.14°C and relative humidity 91.28% might be favorable for increasing aphid population (*Rasid et al., 2007).* In Indian mustard such as NRCDR-2, JM-4, aphid population reached its peak on SMW 9th, 10th but *Brassica compestris L* aphid population reached its peak level on SMW 7th while in early peak was noticed on SMW 4th in local cultivars. Temperature is not positively correlated with aphid population. So that *Brassica compestris* L attain peak population earlier than *Brassica juncea* L. Variety JT-1(72.2) harboured highest population during both season followed by PT-303(64.0) and local variety (50.2) SMW 6th to 8th.It is concluded that *Brassica compestris* L are not suitable in late sown condition compared to *Brassica juncea* Lin Morena district of Madhya Pradesh. Aphid population positively associated with maximum temperature as well as minimum temperature and negatively correlated with relative humidity. The aphid population highly significant negatively correlated with maximum and minimum temperature relative humidity was negatively correlated (Pawar *et al*., 2010).

Table 1: Population of *Liphaphis erysimi (Kalt*) on Brassica cultivars during experiment period

Standard meteorological week	NRCDR-2	JM-4	Rohini	JT-I	PT-303	Local	Temperature		Relative Humidity (%)		Rainfall (mm)
							Max.	Min.	Morning	Evening	
52	0.30	0.58	0.2	1.25	3.20	6.60	26.5	5.8	86.2	72.6	0
1	15.32	18.71	39.0	12.20	16.6	5.78	17.3	5.4	83.6	73.0	0
2	14.25	8.95	25.62	8.45	12.0	6.20	20.1	5.4	90.8	75.3	1.0
3	7.01	0.34	18.92	6.40	3.45	14.0	21.2	5.4	90.2	73.0	0
4	2.50	0.37	6.95	48.2	10.20	50.2	21.5	5.7	83.1	63.7	0
5	0.56	7.25	11.95	63.02	26.9	31.2	22.6	6.5	83.4	65.8	0
6	5.92	5.23	7.93	65.2	52.20	20.8	21.8	7.7	77.5	65.0	3.0
7	6.93	13.02	10.98	72.0	63.0	9.79	23.3	8.8	78.2	60.0	0
8	13.92	44.2	9.52	18.6	64.0	7.23	25.8	10.9	73.9	60.1	0
9	38.20	42.1	26.0	27.1	32.90	0.6	29.8	11.3	75.3	58.8	0
10	18.94	19.0	10.30	0	15.0	0	30.2	12.6	75.4	60.1	0
11	12.96	8.50		0	0		32.9	13.4	79.2	65.0	0

*SMW: Standard meteorological week

Table 2: Correlation coefficient between aphid population and weather parameters (2010-11 and 2011-12)

Brassica cultivars	Weather Parameters				
	Temperature		Relative humidity %		Rainfall (mm)
	Maximum	Minimum	Maximum	Minimum	
NRCDR-2	0.568	0.580	0.241	-0.503	0.035
JM-1	0.758*	0.745	0.345	-0.523	0.582
Rohini	0.145	0.280	0. 035	-0.112	0.054
Bhawani	0.843*	0.421	0.305	-0.491	-
JT-1	0.902*	0.504	0.25	-0.630	--
PT-303	0.860*	0.575	0.341	-0.694	-
Local	0.220	0.575	0.091	-208	-

*Significant at 5% level ** Significant at 1% level

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120.

Study the Effect of Different Weather Parameters on Sugar Recovery in Sugarcane in Subtropical India

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Keywords: Temperature, rainfall, sugar content, sugarcane, correlation etc.

Introduction

Sugarcane (*Saccharum officinarum* L.) a C_4 plant, is being grown in two distinct sugarcane growing zones in India- the tropical zone comprising of the southern region below the Tropic of Cancer and the sub-tropical zone comprising of the northern states (26°N to 32°N latitude). The sugar recovery is hovering around 10.5% for the past decade with a maximum recovery of 12.4% in southern Maharashtra. For ripening process, the temperature below 20°C slows down sugarcane growth rates and increase sucrose accumulation in stalks (Scarpari and Beauclair, 2009). Due to industrialization and concentration of population all along the coastal strip and wide spread anxiety about global warming, it is hypothesized that there is change in weather parameters which is causing physiological and morphological changes in sugarcane. Thus, objective of the study was to find out the effect of weather parameters on the sugar content in sugarcane. Any decrease in amount of available water to sugarcane will cause water stress which is likely to alter physiological processes like photosynthesis, stomatal conductance, respiration and photo-assimilate partitioning (Gardener *et al.*, 1984).

Materials and Methods

The data of sugar recovery were collected for the study from crop improvement experimental plots at Indian Institute of Sugarcane Research Farm, Lucknow (26°56'N, 80°52'E and 111 m), from 2008-09 to 2012-13. Five cultivars comprising, early (CoS 8436, CoJ64 and CoPant 84211) and mid late (CoS 767 and Co 1148) cultivars of sugarcane were taken in this study. The mean meteorological data on maximum and minimum temperature (Tmax and Tmin, °C), temperature range (Trange, °C), mean relative humidity (RHmean, %), sunshine hours (BSS, h), pan evaporation (mm), wind speed (km/h) and rainfall (mm) were collected from Agrometeorology observatory of IISR, Lucknow and analyzed. The correlation analysis was computed for the sugar content with different weather parameters for the month of October to January of 2008-09 to 2012-13. Comparative analysis of five years average weather data with sugar content were carried out. The crop was planted on second fortnight of October (early) and first fortnight of February (mid-late) months of study period.

Results and Discussion

Results revealed (Fig. 1) that the highest sugar content was recorded for the early cultivars as compare to late in all the years. Among the early cultivars Cos 8436 recorded the highest sugar content followed by CoJ 64 and least for the Co Pant 84211, in all the five years. The Cultivar Cos 767 recorded the highest compare to Co 1148 during year 2009-2010 and for 2008-09, 2011-12 and 2012-13; Co 1148 recorded higher sugar content compare to Cos 767 between mind-late varieties.

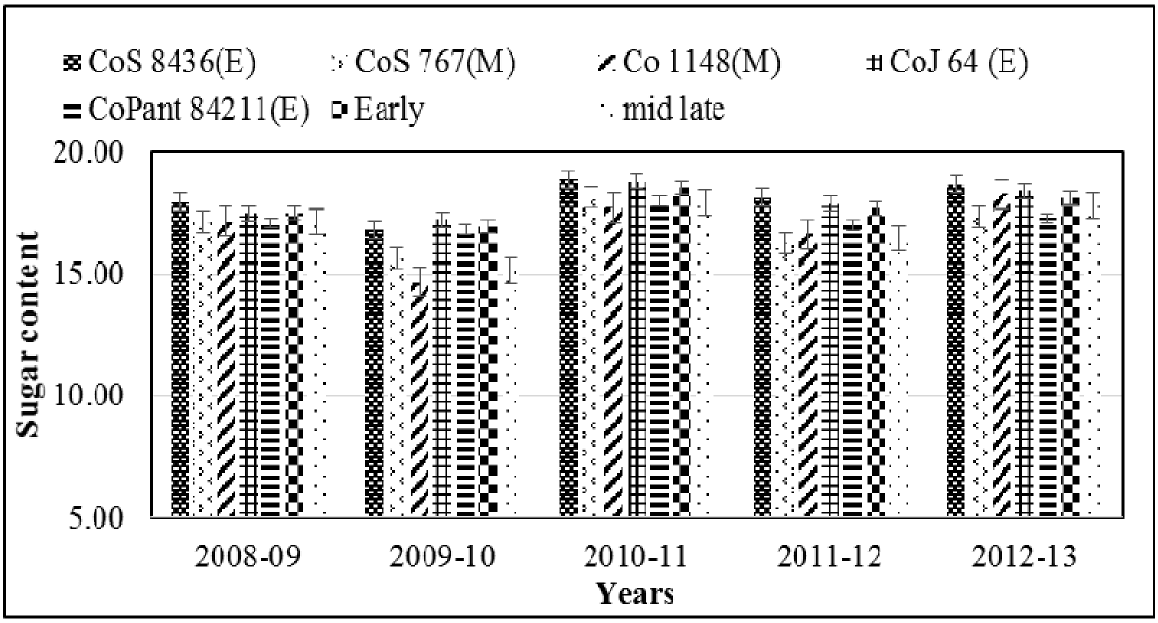

Fig. 1: Sugar content of different early and mid-late cultivars of sugarcane during 2008-09 to 2012-13

Table 1: Correlation coefficient between weather variables and pol % during 2008-09 to 2012-13

Variety	Tmax	Tmin	Trange	RHmean	BSS	EVP	Wind	R.F.
CoS 8436(E)	0.277	-0.020	0.425	-0.518	0.147	0.563	-0.098	-0.770
CoS 767(M)	0.369	0.068	0.647	-0.648	-0.212	0.383	-0.049	-0.516
Co 1148(M)	0.193	-0.162	0.607	-0.224	0.128	0.033	-0.256	-0.328
CoJ 64 (E)	0.005	-0.155	0.247	-0.754	0.217	0.832	0.179	-0.990
CoPant 84211(E)	0.268	0.184	0.089	-0.840	-0.186	0.856	0.284	-0.426
Early	0.191	-0.017	0.297	-0.703	0.095	0.754	0.090	-0.618
Mid Late	0.274	-0.069	0.643	-0.411	-0.012	0.183	-0.176	-0.418

The correlation analysis was done for the sugar content with different weather parameters, the results revealed that Tmax, Trange and pan evaporation has positive correlation with sugar content among all the cultivars during all the five years. The Tmin has shown negative relationship with sugar contents in cultivars CoS 8436, Co 1148, CoJ 64 but it was positively correlated with in cv. CoS 767 and CoPant 84211. The BSS was positively correlated with the CoS 8436, Co 1148, CoJ 64 and negatively for the rest of the cultivars. The rainfall was found to be negatively correlated with sugar contents in all the cultivars, whereas wind speed expressed the positive relationship only for cv. CoJ 64 and CoPant 84211.

Conclusion

Climatic aberrations especially rainfall and maximum temperature affect sugar recovery. The study revealed that climatic deviations like uneven distribution of rainfall during monsoon followed by variations in relative humidity results in sugar content in certain varieties of sugarcane. It was also found that rainfall is negatively correlated with sugar recovery.

Acknowledgment: This work was conducted under the NICRA project.

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121.

Assessment of Eggshell Thickness Variation and Calcium Carbonate Content in Red Wattled Lapwing (*Vanellus indicus*) in Agricultural Landscape of Punjab

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Keywords: Calcium carbonate content, eggshell thickness, red wattled lapwing

Introduction

Lapwing (*Vanellina*e) is a terrestrial bird of the agriculture fields, often seen in pairs and in groups of 10-20 and more. Studies on varied aspects on avian ecology in recent past have been extensively carried out by Gupta *et al.* (2010) and many others. However, gathering information on calcium content and eggshell thickness in case of red wattled lapwing are the first in Punjab. Eggshell quality and reproduction of bird species is greatly affected by levels of calcium availability. Thus, eggshells can be used to monitor health of populations over long periods.

Materials and Methods

We collected freshly laid eggs within 12 hours of laying of red wattled lapwing in the fields of Punjab Agricultural University, Ludhiana (Punjab, India) during April to June 2013. Three little egg shell pieces were taken for the measurement. These were air-dried. On all three pieces of the eggshell three measurements were taken using a travelling microscope. The three measurements (cm) were averaged to get a mean figure for the egg. The mass and percent composition of calcium carbonate was calculated using Butcher and Miles method.

Results and Discussion

Variation in egg shell thickness and calcium carbonate content has not been reported to our knowledge for any lapwing species in the wild. It was observed that the egg shell thickness was ranged from 0.022 cm to 0.054 cm. Average shell thickness of red wattled lapwing eggs was 0.035±0.004 cm. The $CaCO_3$ weight and proportion were ranged from 0.404 gm to 0.864 gm and 36.49% to 54.97%, respectively. Average $CaCO_3$ weight and proportion of red wattled lapwing eggs was 0.594±0.065 gm and 43.77±3.49%, respectively. It was also observed that egg shells with lower calcium content showed less thickness, while eggshells with higher calcium content showed more thickness. Variation in thickness of shell among clutches probably depends on: differences in the stages of incubation, differences related to clutch size, genetic and physiological differences between females, differences in diet among females within and between local populations, differences in gene pools between local populations, differences in environmental conditions between years, and other unknown factors.

Table 1: Eggshell Thickness (cm) and $CaCO_3$ (%) content of eggs of red wattled lapwing in different areas

Area (PAU)	Thickness (cm)	$CaCO_3$ (gm)	$CaCO_3$ (%)
Museum of Rural Life of Punjab	0.026	0.497	34.12
Soil Department Fields	0.040	0.645	48.80
Area around orchard	0.049	0.768	50.89
Area around Gate No. 8	0.031	0.563	49.0
Area around New Orchard	0.022	0.404	32.01
Floriculture	0.054	0.864	54.97
Area around Meteorology Observatory	0.025	0.421	36.30
Mean±S.E	0.035±0.004	0.594±0.065	43.77±3.49

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122.

Climate Change Perceptions and Adaptations among Smallholder Coffee Farmers from Central Veracruz, Mexico

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Keywords: Agroforestry, ecology, climate, coffee plantation management

Introduction

Changing climate conditions represent a significant threat to production and livelihoods in the coffee industry throughout the world. However, options available to smallholder coffee farmers in Central Veracruz, Mexico to adapt to climate change are limited and little is known about adaptation activity at farm-level (Gay *et al.*, 2006). This study aims to establish which activities are being undertaken, and determine whether the type of agroforestry structure of the coffee plantation, ranging from rustic to sun-grown (no shade), is significant in decision-making. Modifications to crop management as well as the biophysical environmental variables of shade, soil and water were examined.

Materials and Methods

The study was conducted in three regions of Central Veracruz, representing smallholder farmers with no more than 2 hectares of land from peri-urban, rural and rural-indigenous areas. The sample contained 32 farmers and data was collected between May and June 2015. The questionnaire was combined with open-ended interview questions, conducted on a one-to-one basis. The interview focused on four sections: perceptions of climate change, effects of climate change, plantation management and socio-economic indicators. Pearson's chi-squared test, administered by SPSS software (version 21), was used to demonstrate the significance of plantation structure in crop modifications and shade, soil and water adaptations.

Results and Discussion

The most common crop adaptation was the planting of 13 different varieties, with 31% of farmers opting exclusively for this strategy, while 47% did not adapt in this area. The remaining 22% used a combination of different varieties, planting in different dates and sites. Modifications to the biophysical environment saw 63% making changes to the shade structure including the introduction of new trees such as vanilla, while 56% had made changes to soil practices such as weeding with machete and abstaining from chemical-based inputs. However, only 16% adapted their water management strategies. With regards to the significance of the plantation structure in crop adaptation, the values obtained were superior to 0.05, the critical value of x^2, hence: 0.522>0.05. Similarly, the values obtained with respect to modifications to the shade canopy, soil practices and water management were 0.465, 0.433 and 0.196 respectively. Therefore the structure of the plantation is not related to any changes made directly to the crop nor to the biophysical variables. It appears to be related to farmers' perception of climate change.

Table 1: Climate change adaptions to coffee crop, shade cover, soil and water management

Adaptations to crop	
New varieties	31%
Planting in different dates	13%
New varieties + Planting in different dates	6%
New varieties + Planting in different dates + Planting in different locations	3%
No adaptations	47%
Shade	
Increase shade cover	47%
Pruning trees	9%
Thinning shade cover	6%
No adaptations	38%
Soil	
Use of machete only for weeding	38%
Avoid use of hoe	6%
Reduction of agrochemicals	6%
Use of organic fertilizers	3%
Creation of ditches or terraces	3%
No adaptation	44%
Water	
Use of recipients to capture rainwater	13%
Irrigation	3%
No adaptation	84%

Given that historical climate trends and future projections indicate increasing temperatures and declining rainfall are highly probable for the region (Gay *et al.*, 2006), optimal shade management is crucial for temperature regulation. Water management techniques such as rainwater capture and weather information services should be evaluated. Furthermore, the selection of alternative varieties and the changes to the shade canopy will require careful performance monitoring in terms of yield, quality and plant health in the years ahead.

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123.

Productivity of Wheat (*Triticum aestivum* L.) Crop as Influenced by Different Weather Parameters in Mid Hill Conditions of Himachal Pradesh

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Keywords: Weather parameters, growth, yield, wheat

Introduction

Wheat (*Triticum aestivum* L.) is the staple food for over ten billion people of the world. India is second largest producer of wheat in the world after China with about 12% share in total world wheat production. It alone contributes about 33% to the total food grain production of the country. A major constraint limiting wheat production in mid hills of Himachal Pradesh, India is its late planting, which ultimately results in exposure of plants to high temperature at grain- development stage. Among the factors affecting productivity of any region is climate with its principal weather components i.e. rainfall, temperature, sunshine duration and solar radiation. Wheat crop is especially vulnerable to thermal stress particularly in reproductive phase and differential response of temperature change to various crops has been noticed under different production environments (Kalra 2008).

Materials and Methods

A field experiment was conducted at Research farm of Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur in the winter (*rabi*) season of 2010-11. The treatments consisted of four dates of sowing, and five varieties. Dates of sowing were taken as main plot treatments and varieties as subplot treatments in split plot design. The crop was sown in furrows opened with the help of a hand plough and other packages of practices were followed as per recommendation for wheat crop.

Results and Discussion

Among varieties, the number of effective tillers was significantly higher in variety HS-490 as compared to other varieties. Variety VL-829 produced significantly lesser number of effective tillers as compared to HS-490 and VL-892 but remained at par with VL-804 and VL-907. Among varieties, VL-892 produced significantly more number of grains/spike as compared to other varieties; however it was at par with VL-907. Among varieties, HS-490 and VL-829 behaving statistically alike resulted in significantly higher grain weight as compared to other varieties. The grain development and maturity keep a favourable balance with the steady rise in temperature afterwards, which is clearly indicated by the 1000-grain weight and number of grains per spike. Sowing of crop on 20th November produced significantly higher grain yield as compared to 5th December and 20th December sowing but remained at par with 5th November sown crop (Table 1). Among varieties, HS-490 produced significantly higher grain yield as compared to all other varieties (Table 1). High temperature during later part of the crop growth in delayed sowing caused forced early maturity of the crop and resulted in lower test weight, less number of filled grains per ear and ultimately the lower grain yield.

Table 1: Yield contributing characters and yield of wheat

Treatments	Effective tillers (m-2)	Grains per spike	1000-grain weight (g)	Grain yield (t ha-1)
Dates of sowing				
5th Nov.	231.30	47.30	47.60	4.18
20th Nov.	287.60	51.90	49.60	4.20
5th Dec.	230.30	46.20	46.70	3.66
20th Dec.	222.10	46.80	46.50	3.25
CD (P=0.05)	15.10	3.60	NS	0.21
Varieties				
HS-490	263.30	46.70	52.70	4.21
VL-804	239.80	45.90	41.20	3.72
VL-829	225.40	47.50	50.80	3.43
VL-892	249.90	51.70	46.10	4.08
VL-907	235.60	48.40	47.20	3.67
CD (P=0.05)	16.00	3.80	2.20	0.13

Reference

Kalra N. 2008. Effect of increasing temperature on yield of some winter crops in North West India. *Current Science* 94(1): 82-88.

124.

Effect of Storage on Biochemical Constituents of Grain Amaranth under Mid-hill Conditions of Himachal Pradesh

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Keywords: Biochemical constituents, Amaranthus.

Introduction

Amaranthus spp. collectively known as amaranth is a cosmopolitan genus or short-lived perennial plant; approximately 60 species have been recognized. Amaranth grain is considered to have a unique composition of protein, carbohydrates and lipids. Amaranth grains contain lysine, an essential amino acid, limited in other grains or plant sources. However, literature revealed inadequate information on nutritional quality characteristics of stored grain amaranth under Himachal Pradesh conditions. Hence, the study was undertaken to follow the changes in biochemical constituents during storage period to help further crop improvement and storage of grains for longer duration.

Materials and Methods

Dry mature samples of one of the locally available amaranth genotype PRA-2 and one market sample (MS) procured from Palampur, were cleaned and freed of any extraneous substances, and then stored in triplicate at room temperature for six months from December, 2009 to May, 2010 in different storage structures namely gunny bags, polythene bags and metallic bins. The samples were evaluated at an intervals of two months. Moisture and crude protein were analysed by the method described in (AOAC 1990) while total sugars and total free amino acid content were estimated as described by Dubois *et al.* (1956) and Jayaraman (1981) respectively.

Results and Discussion

Amongst different storage structures used for storage of amaranth genotype (PRA-2) and market sample, metallic bin was found to be best packaging material for storage, since it appeared to be facilitate retention of nutritional attributes of the grains stored at room temperature followed by polythene bags and gunny bags.

Storage of amaranth grains at room temperature for six months resulted in relatively marginal alterations in biochemical constituents of interest i.e. moisture, protein, total sugars and total free amino acids content and, hence, amaranth grains might be safely stored for further human consumption upto this time frame of storage. Amongst different storage containers used for storage of amaranth samples, metallic bins followed by polythene bags were found to be best packaging material for storage as compared to gunny bags with regard to retention of nutrients in amaranth grains stored at room temperature. In Table 1 the % moisture content in market and PRA-2 Increases Rapidly and % protein content decreases in gunny bags. where as in polythene and metallic content % moisture and %protein does not show much change.

Table 2 shows increase in %total sugar content in market and PRA-2 kept in Gunny bag and Decrease in total amino content. Where as in polythene and metallic content %total sugar and total amino content does not show much change.

Table 1: Effect of storage on percent moisture and protein content of grain amaranth samples stored at room temperature

Genotype/ Market sample	Storage containers	Moisture (%)* [Storage time (months)]				Protein (%)** [Storage time (months)]			
		0	2	4	6	0	2	4	6
Market Sample	Gunny bag	10.06	10.22	10.33	10.41	10.48	10.44	10.37	10.33
	Polythene bag	10.06	10.07	10.08	10.09	10.48	10.50	10.48	10.48
	Metallic bin	10.06	10.06	10.07	10.07	10.48	10.48	10.47	10.47
PRA-2	Gunny bag	9.94	10.19	10.29	10.36	11.35	11.32	11.27	11.23
	Polythene bag	9.94	9.96	9.98	9.99	11.35	11.38	11.37	11.36
	Metallic bin	9.94	9.95	9.95	9.96	11.35	11.37	11.37	11.36

*CD (P=0.05) for storage time (A)= 0.006
CD (P=0.05) for genotype/ market sample (B)= 0.005
CD (P=0.05) for storage structure (C)= 0.006
CD (P=0.05) for A X B= 0.008
CD (P=0.05) for A X C= 0.010
CD (P=0.05) for B X C= 0.008

**CD (P=0.05) for storage time (A)= 0.006
CD (P=0.05) for genotype/ market sample (B)= 0.005
CD (P=0.05) for storage structure (C)= 0.006
CD (P=0.05) for A X B= 0.008
CD (P=0.05) for A X C= 0.010
CD (P=0.05) for B X C= 0.008

Table 2: Effect of storage on total sugars (%) and free amino acids (mg/100g) content of grain amaranth samples stored at room temperature

Genotype/ Market sample	Storage containers	Total sugars (%)* [Storage time (months)]				Total free amino acids (mg/100)** [Storage time (months)]			
		0	2	4	6	0	2	4	6
Market sample	Gunny bag	3.46	3.51	3.62	3.70	636.40	628.45	624.69	618.03
	Polythene bag	3.46	3.48	3.51	3.52	636.40	636.21	635.28	635.28
	Metallic bin	3.46	3.46	3.48	3.49	636.40	636.07	635.96	635.89
PRA-2	Gunny bag	3.16	3.20	3.34	3.41	558.56	551.13	545.19	538.49
	Polythene bag	3.16	3.17	3.18	3.20	558.56	557.67	557.56	557.38
	Metallic bin	3.16	3.16	3.17	3.18	558.56	557.34	557.27	557.13

*CD (P=0.05) for storage time (A)= 0.010
CD (P=0.05) for genotype/ market sample (B)= 0.009
CD (P=0.05) for storage structure (C)= 0.010
CD (P=0.05) for A X B= 0.015
CD (P=0.05) for A X C= 0.018
CD (P=0.05) for B X C= 0.015

**CD (P=0.05) for storage time (A)= 0.351
CD (P=0.05) for genotype/ market sample (B)= 0.429
CD (P=0.05) for storage structure (C)= 0.351
CD (P=0.05) for A X B= 0.249
CD (P=0.05) for A X C= 0.202
CD (P=0.05) for B X C= 0.247

Reference

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125.

Influence of Microclimate on Population Dynamics of Brinjal Shoot and Fruit Borer, *Leucinodes orbonalis* Guen. at Gangetic Plains of West Bengal

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Keywords: *Leucinodes orbonalis,* population dynamics, canopy temperature, canopy humidity

Introduction

In India, brinjal (*Solanum melongena* L.) is considered as one of the most common, popular and principal vegetable crops. The crop suffers heavily at fruiting stage due to attack of shoot and fruit borer (SFB), *Leucinodes orbonalis* Guen. causing 70% loss to the crop. The population was positively correlated with average temperature, mean RH and rainfall. In the present investigation multiple correlation and regression were analyzed to study the impact of microclimatic factors on the population density of SFB so that proper management strategies can be planned.

Materials and Methods

Brinjal variety Muktakeshi was sown in a plot of 6m x 4m with three spacing 100cm x 80cm, 100cm x 60cm and 80cm x 60cm and each having seven replications. Canopy temperature and canopy humidity were taken from three different regions of plant height i.e. top, middle and bottom portion of the canopy from three randomly selected plants of each plot at 8.00 am, 10.00 am and 12.00 noon. For FSB the total and affected shoots and affected and healthy fruits were counted from the tagged plants. The experiment was conducted in 2013-2014 and 2014-2015 at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal.

Results and Discussion

In 2013-2014, the population density of brinjal shoot and fruit borer was positively associated with canopy temperature at all three observed times but significantly negative association was noticed with canopy humidity at 10: .00 am and 12: 00 noon. About 69 to 73.9 per cent variation in population density was contributed by both the microclimatic factors. In 2014-2015 the population of SFB showed significantly positive association with canopy temperature at 8: 00 am and 10: 00 am but significantly negative correlation with canopy humidity. About 70 to 74 per cent variation in incidence of SFB was noticed due to canopy temperature and canopy humidity. On the basis of the regression equation the incidence of SFB can be forecasted and accordingly suitable control measures for this pest can be employed.

Table 1: Influence of canopy temperature and canopy humidity on the incidence of brinjal shoot and fruit borer during 2013-2014 and 2014-2015

Year	Different time	Canopy Temperature (r)	Canopy Humidity (r)	R^2	Regression equation
2013-2014	8.00 am	.095	-.208	0.690	$Y= -19.09 + 4.75X_1 - 1.43X_2$
	10.00 am	-.503	-.997*	0.715	$Y= 11.72 + 0.10X_1 - 0.26X_2$
	12.00 noon	.912	-.769*	0.739	$Y= 5.82 + 0.52X_1 - 0.87X_2$
2014-2015	8.00 am	-.978*	-.019	0.703	$Y= -1.09 + 2.05X_1 - 1.85X_2$
	10.00 am	-.539*	-.887**	0.725	$Y= -11.02 + 0.15X_1 - 0.29X_2$
	12.00 noon	.955	.850	0.747	$Y= 4.88 + 0.59X_1 + 0.98X_2$

* significant at the 0.05 level (2-tailed), ** significant at the 0.01 level (2-tailed).
X_1= Canopy Temperature; X_2= Canopy Humidity

126.

Agronomic Management of Terminal Climatic Stress in Wheat (*Triticum aestivum*)

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Keywords: Benzyl amino purine, climate stress, potassium nitrate, sprinkler irrigation, wheat

Introduction

Wheat (*Triticum aestivum* L.) is the most widely grown cereal crop, constituting basic food for 35% of global population. High temperature affects wheat development, growth and causes yield loss; occurrence of terminal heat stress after anthesis is immensely detrimental (Bala *et al.,* 2014).Wheat crop in north-western and central India frequently experiences high temperatures at reproductive stages, which cause 15–20% reduction in its yield. This problem is expected to exacerbate in future due to climate change, and calls up for devising heat stress mitigation and adaptation strategies to sustain wheat productivity at a higher level.

Materials and Methods

A 3-year field experiment was conducted during *rabi* seasons of 2011-12 to 2013-14 at Indian Agricultural Research Institute New Delhi to determine to what extent heat stress reduces wheat yield and how effective are agronomic management practices in maintaining wheat yields under heat-stressed environment. Treatments included 4-heat stress environments created through staggered sowing dates- 15th Nov., 30th Nov, 15th Dec., and 30th Dec, 2-irrigation methods-surface and sprinkler, 2-two foliar-applied growth enhancing chemicals-NO_3 (1%) and Cytokinin (N-6 benzyl amino purine (BAP), 6 ppm and 2-control treatments- farmers' practice for normal date of sowing and complete stress (30th Dec sowing).

Results and Discussion

Wheat ('HD 2967') yield consistently decreased with every 15-day delay in sowing from 15th November to 30th December. Water productivity also followed the same trend. On an average, sprinkle irrigation improved wheat yield by 14.5% and water productivity by 21.5% over surface method of irrigation. A foliar application of (N-6 benzyl amino purine (BAP) (6 ppm) at anthesis resulted in 5-7% higher grain yield than KNO_3. Crop subjected to heat stress by sowing on 30th December without application of any chemical or sprinkler irrigation (control 2) reduced to wheat grain yield to half of the yields obtained with sowing during Nov. 15 or 30 and irrigated with sprinkler method and also sprayed with BAP (6 ppm). Combination of sprinkler irrigation and 6-BAP (6 ppm foliar application at anthesis) enhanced wheat yield by about 22.8% over timely sown wheat (control 1), hence appears to be a promising option to manage terminal heat stress in wheat. Beneficial effects in terms of enhancement in yield and water productivity has been reported by Yasmeen *et al.* (2013) for BAP and by Kumar *et al.* (2015) for sprinkler irrigation.

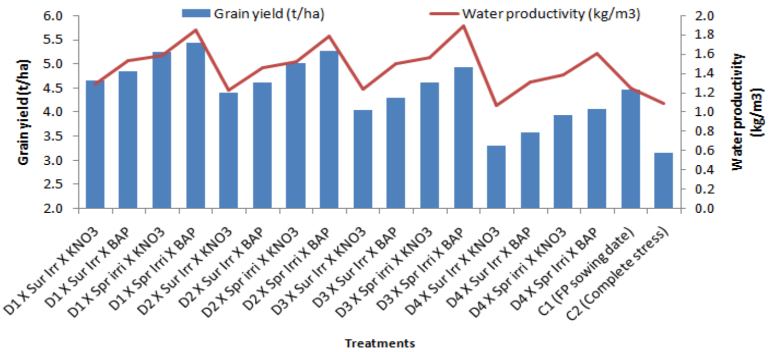

Fig. 1: Effect of planting dates, irrigation methods and growth enhancing chemicals on yield and water productivity of wheat (mean of 3 years). *[Note: D_1, D_2, D_3 and D_4 are planting dates, 15th November, 30th November, 15th December and 30 December, respectively. Sur means surface irrigation; Spr means sprinkler irrigation.]*

This research clearly demonstrates that adverse effects of terminal heat-stress can be minimized, and yield & water productivity of wheat can be improved to a significant extent by employing sprinkler irrigation method and foliar application of (N-6 benzyl amino purine (BAP) (6 ppm) at anthesis stage in semiarid western India.

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127.

Boosting Rice Productivity through Direct Seeded Rice- An Mitigation Option in Changing Climatic Scenario of Jharkhand, India

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Keywords: DSR, drought, brown manuring, rainfed, *Sesbania*

Introduction

Rice (*Oryza sativa* L.) is life for more than half of humanity in globe. It is one of the most important food crops of India, being grown in 44.0 million ha and produces about 105.31 million tonnes, with an average productivity of 2.4 t/ha which is very low as compared with average global productivity. Climate change is projected to have significant impacts on changing of precipitation patterns, erratic rainfall, long dry spell and reduced rainy days. Frequent droughts are being observed and have become the major constraints to rice production in rainfed areas, resulting in large yield losses and limiting the average yield increase of India. Drought is the most serious constraint to rice production since most of the farmers' preferred rice varieties are susceptible to drought stress (Serraj *et al.,* 2009). Transplanting of rice is more water demanding, laborious, time consuming and entails a lot of expenditure on raising nursery, uprooting, and transplanting. Thus, Direct Seeding Rice (DSR) is gaining popularity among farmers of Jharkhand, India. Screening of suitable cultivar and weeds management are major concerns for success of DSR.

Materials and Methods

The present study was carried out by Krishi Vigyan Kendra, Koderma under Indian Council of Agricultural research - Central Rice Research Institute, Cuttack in 2012-13 to 2014-15 on farmers' field in Koderma district of Jharkhand, India. On Farm Trails (OFT) were formulated and implemented by farmers to get the solution of low yield of rice in DSR under upland condition. Two OFTs entitled, "Evaluation of newly released short duration variety for DSR" with four treatments: T_1 -farmers' practice - FP (rice local variety); T_2 - rice Cv. Sahbhagi Dhan; T_3 - rice Cv. CR Dhan 40 and T_4- rice Cv. Vandana with 6 replications, and second OFT entitled "Evaluation of suitable weed management for DSR" with four treatments *namely* T_1 - farmers practice; T_2 - application of pedamithaline at the rate of 1kg active ingredient (a.i)/ha; T_3 - application of bispyribac sodium at 30 g ai /ha and T_4- brown manuring with 6 replications, the test variety was Sahbhagidhan.

Results and Discussion

Result revealed in varietal trail that the increase in grain yield was to the tune of 34.16, 20.92 and 15.62% with Sahbhagi Dhan, C R Dhan-40 and Vandana, respectively over farmers' practice (23.42 q/ha). Same trend were recorded in number of panicles and grains/m^2, number of effective tillers/m^2 etc. In weed management trail, result revealed that number of tillers, height of plant and number of panicles m^{-1} was maximum with T_4 followed by T_3, T_2 and T_1. The increase in grain yield was to the tune of 35.60, 21.87 and 4.24% with T4, T3 and T2, respectively over farmers' practice (27.08 q/ha). Benefit: cost ratio was calculated, which showed that T_4 was economically the most feasible (B/C- 2.21) followed by T_3 (B/C-2.03), T_2 (B/C-1.71) and T_1 (farmers, practice- B/C= 1.640). Application of brown manuring recorded maximum suppression of weed biomass followed by application of post-emergence and pre-emergence herbicides. Same trends were recorded during both the years. Aslam *et al.*, (2008) found that direct seeding with *Sesbania* co-culture as a brown manuring recorded significantly higher rice grain yield than direct seeding without brown manuring. Rapid growth of *Sesbania* helps to suppress weed by covering of soil surface and create a live mulch to conserve the soil moisture and reduce weed competition for nutrients, moisture and sun light. Adopting DSR with short duration drought tolerant rice variety Sahbhagidhan and brown manuring for effective weed management is the only option to boost the rice productivity in rain-fed condition of Jharkhand in changing climatic scenario.

Table 1: Weed biomass, Weed control efficiency %, Number of Panicle, Number of grains, Grain yield, Harvest Index and B: C ratio as influenced by different cultivars

Treatments	Weed biomass (g/s m)	Weed control efficiency %	No. of Panicle/m^2	No. of grains/ panicle	Grain yield (q/ha)	B: C ratio
T_1: Farmers Practice	185	-	130	84	23.42	1.98
T_2: Rice Cv. Sahbhagi dhan	122.45	33.85	173	119	31.42	2.64
T_3: Rice Cv. CR Dhan-40	84.25	54.49	162	114	27.27	2.26
T_4: Rice Cv. Vandana	80.82	56.34	146	98	26.09	2.15

Table 2: Number of Panicle, Number of grains, Grain yield, Harvest Index and B: C ratio as influenced by method of weed control

Treatments	Number of Panicle/m^2	No. of grains /panicle	Grain yield (q/ha)	Harvest Index %	B: C ratio
T_1: Farmers Practice	127	81	26.15	46.21	1.64
T_2: Pendimethalinn @1kg ai /ha	146	96	27.26	40.1	1.71
T_3: Bispyribac sodium @ 30 g ai /ha	158	102	31.87	38.6	2.03
T_4: Brown manuring	171	108	35.46	36.2	2.21

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128.

Biofloc Technology for Improving Health, Growth and Reducing Environmental Impacts on Freshwater Prawn, *Macrobrachium rosenbergii*

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Keywords: Biofloc technology, *Macrobrachium rosenbergii*, immune response, digestive enzyme activity

Introduction

Aquaculture maintains steady growth as an alternative to open sea fisheries. Techniques to provide sustainable alternatives that would reduce environmental impact without affecting the health and growth of the aquatic organisms are essential. One option for the development of sustainable practices in aquaculture is biofloc technology (BFT). BFT has been reported to confer many beneficial effects on fish/prawn culture, including: i) improving water quality; ii) increasing feed utilization and growth performance; and iii) enhancing biosecurity and health management. To the best of our information, the present study is the first to evaluate the potential of biofloc technology in commercially important crustacean *Macrobrachium rosenbergii.*

Materials and Methods

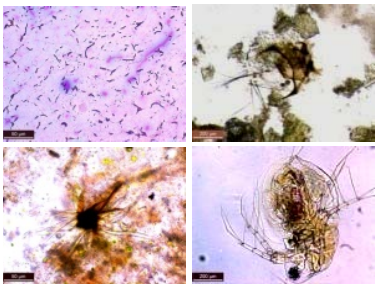
Live specimens of healthy freshwater prawn *M. rosenbergii* were provided by the College of Fisheries, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana (Punjab), India and the experiment was conducted at the same place. Twelve experimental fibreglass tanks of 500 L capacity were prepared before stocking of prawn. Biofloc production was carried out in two fiberglass reinforced plastic (FRP) tanks (500 L capacity; bottom area 1.3 m^2). Tanks were filled with freshwater from tube-well. The fined meshed filter bag was used to prevent entry of unwanted materials and suspended particles in to the biofloc production tanks. Two aeration pipes with air stones were provided in each tank to meet oxygen demand and proper mixing of floc. For biofloc production, each tank was manured to develop micro flora and fauna. Bacterial inoculum of *Bacillus coagulans* was inoculated for the development of microbial community in the tanks. An inoculum, 10 liters water with bacterial floc (developed in a separate biofloc production tank) was added to experimental tank. The C: N ratio was maintained at 15: 1 using dextrose, sucrose and starch as carbon source.

Manuring of tanks

Inoculation of bacteria

Biofloc development in FRP tank

Estimation of biofloc sediment



Biofloc consists of bacteria, diatoms, macroalgae, dead organisms, invertebrates, etc.

Harvest of prawn at the end of experimental trial

Showing method of biofloc production and harvest of prawn

Water quality analysis tested as per standard procedures. At the end of experiment, the final body weight, weight gain, specific growth rate, survival, feed conversion ratio (FCR) and protein efficiency ratio (PER) were calculated. Enzymatic extracts were prepared and analysed as described by Gupta *et al.* (2014). Enzyme activities were measured as the change in absorbance using spectrophotometer and expressed as specific activity (U mg^{-1} protein). Haemolymph (50-100 µL) was withdrawn from the ventral sinus at the base of the first abdominal segment of each prawn into a 26 G needle and a 1 mL syringe containing an anticoagulant solution. The lysozyme activity, respiratory burstassay, total myeloperoxidase content, superoxide dismutase activity and catalase activity were estimated following the method described in Gupta *et al.* (2014).After termination of experiment trial, an experimental infection was induced in prawn with the pathogenic bacterium, *Vibrio harveyi*. The mortality was monitored daily for up to 7 days.

Results and Discussion

Biofloc is macro-aggregates consists of diatoms, macroalgae, fecal pellets, remains of dead organisms, bacteria, invertebrates, etc and acts as natural feed and water quality enhancer. Carbon sources used are dextrose, sucrose and starch with C: N ratio of 15: 1. The result indicates that addition of sucrose as additional carbon source results in better growth, survival and innate immunity of freshwater prawn (Fig. 1, 2, 3). BFT also resulted in improvement of water quality parameters.

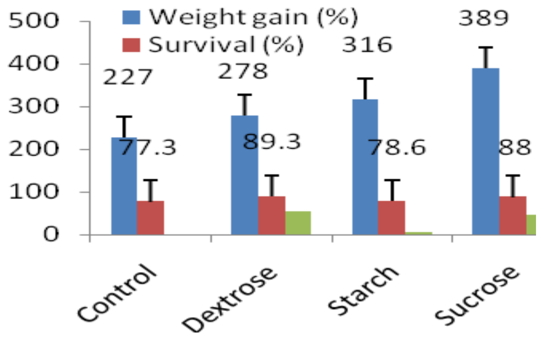


Fig. 1: Effect of BFT on growth and survival of freshwater prawn.

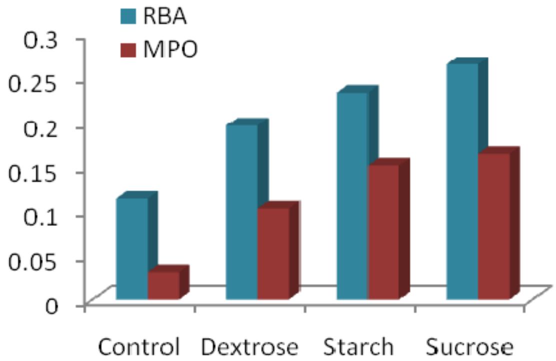


Fig. 2: Effect of BFT on innate immune parameters such as RBA and MPO.

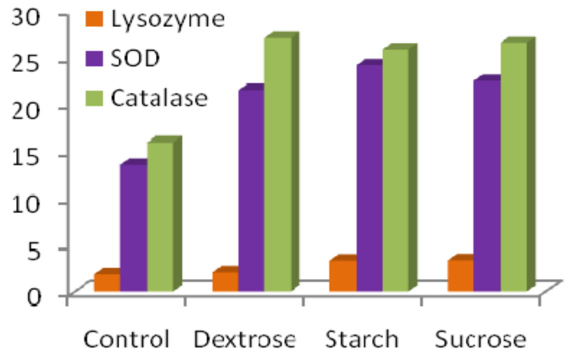


Fig. 3: Effect of BFT on innate immune parameters.

From the results of present study, it may be concluded that the application of biofloc technology could reduce feeding cost, increase growth performance by improving digestive enzyme activity and increase survival by elevating innate immunity of freshwater prawn, *M. rosenbergii*.

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129.

Methane and Nitrous Oxide Emission from Rice-Wheat Rotation as Influenced by Plant Nutrient Sources

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Keywords: Methane, nitrous oxide, rice-wheat, plant nutrients

Introduction

Rice and wheat are two major staple foods and rice-wheat rotation is widely adopted by the farmers. Its area in India is 10.5 m ha which contribute 40% of country's total food grain. Rice is considered to emit remarkable amount of methane and wheat may emit nitrous oxide up to some extent. Farmers also use different organic and inorganic sources to provide nutrients to their crops which have variable green house gas emission potential. Therefore, a field experiment was conducted at crop research centre of the university during 2003-04 under randomized block design with four replications to assess the methane and nitrous oxide emission from rice-wheat rotation through plant nutrient source.

Materials and Methods

In this experiment, influence of ten treatments namely; T_1 control without crop, T_2 control with crop, T_3 100% NPK-S, T_4 100% NPK + *Azotobacter,* T_5 100% NPK + FYM, T_6 100% NPK + green manure, T_7 100% NPK + biogas slurry, T_8 100% NPK + wheat straw, T_9 100% NPK+ S and T_{10} vermicompost alone on yields of rice (Pant Dhan 4) and wheat (UP 2425) and methane and nitrous oxide emission was assessed. 100% NPK dose was 150, 60 and 40 kg ha^{-1} N, P_2O_5 and K_2O, respectively for each crop. *Azotobacter* culture was added @ 2 kg ha^{-1}. FYM, green manure, biogas slurry and wheat straw were added @ 10 ton ha^{-1} and dose of vermicompost was 2 ton ha^{-1}. Nitrogen was applied in three split doses. Other plant nutrient sources were applied as basal dressing before the final preparation of the land. Proper measures for plant protection and irrigation were taken well in time. Fig. 2 and 3 depict views of rice and wheat crops. Air samples drawn from closed chambers placed on channels (Fig. 3) were analyzed for methane and nitrous oxide gases by a gas chromatograph and emission was calculated by using cross sectional area of chamber, height of head space, volume of head space and concentration of CH_4 or N_2O. The gas concentration at zero time was subtracted from the gas concentration at one hour to get the amount of gas emitted during one hour time period.

Results and Discussion

The influence of various plant nutrient sources on rice and wheat grain yields was statistically significant (Table 1). The rice grain yield varied from 33.12 to 68.92 q ha^{-1} and wheat grain yield ranged from 24.09 to 60.34 q ha^{-1} in treatment control (T_2) and 100% NPK + S (T_9, ammonium sulphate, single super phosphate, potassium sulphate, zinc sulphate), respectively. Other plant nutrient sources recorded significantly higher yields over control and comparable to each. However, rice and wheat grain yields were 45.65 and 29.69 q ha^{-1}, respectively in T_{10} (vermicompost alone). The cost of vermicompost is about Rupees 5000 ton $^{-1}$.

Table 1: Rice and Wheat Grain Yield and Methane and Nitrous Oxide Emission

Treatment	Rice			Wheat		
	Grain yield	CH_4	N_20	Grain yield	CH_4	N_2O
T_1 Control without crop	-	0.76	0.20	-	-0.21	0.36
T_2 Control with crop	33.12	2.18	0.54	24.09	-0.92	0.62
T_3 100% NPK - S	61.60	3.07	1.37	51.41	-0.23	1.92
T_4 100% NPK + *Azotobacter*	61.74	3.67	0.90	45.88	-0.15	1.16
T_5 100% NPK + FYM	64.28	7.32	1.80	59.43	-0.19	1.85
T_6 100% NPK + Green Manure	62.75	7.47	2.33	55.34	-0.10	1.58
T_7 100% NPK + Biogas slurry	61.87	3.18	1.43	28.52	-0.18	1.26
T_8 100% NPK + Wheat straw	61.07	7.52	3.80	56.94	-0.08	1.60
T_9 100% NPK+ S	68.92	3.01	1.25	60.34	-0.30	1.44
T_{10} Vermicompost	45.65	3.12	0.72	26.95	-0.20	0.65

F test	Sig - -	Sig - -
Sem±	0.472	1.335
CD at 5%	1.380	3.897

Average of treatments and number of observations were taken to know total and periodic methane and nitrous oxide emissions which were quite different from rice (4.13 and 1.44 mg m^{-2} h^{-1}) and wheat (-0.18 and 1.24 mg m^{-2} h^{-1}) indicating that rice emit the methane and wheat absorb it, while nitrous oxide emission was quite comparable for both crops. In general, the treatments with 100% NPK and straw, GM or FYM recorded higher gaseous emission as compared to 100% NPK+S and vermicompost alone. Partly substitution of inorganic nitrogen by *Azotobacter* was also beneficial to reduce the emission. Therefore, it is recommended that all organic sources of nutrients should be first converted in to vermicompost and then apply in the field. This will increase grain yields, build up soil fertility and reduce the methane and nitrous oxide emission. Vermicompost will be a good option for farmers, organic farming and eco-friendly agriculture as it is a cheaper source of plant nutrients.

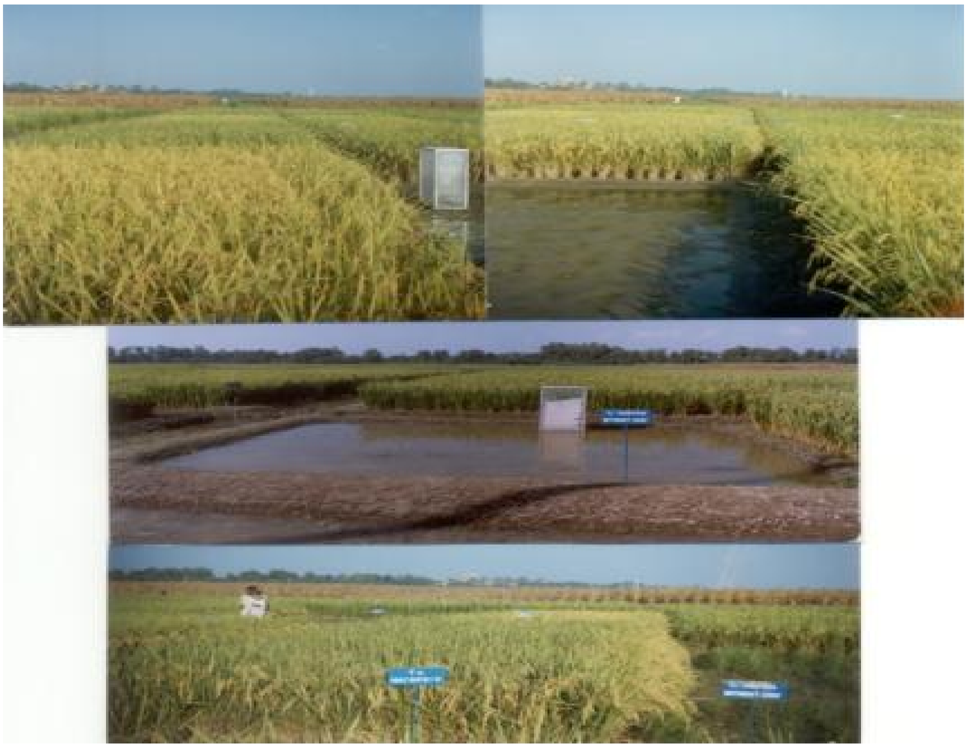

Fig. 1: Experimental view of rice crop

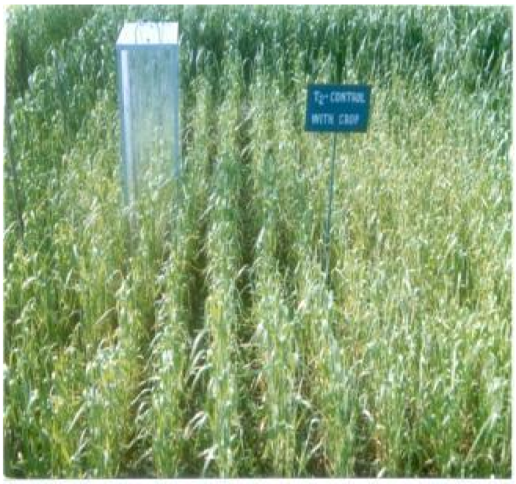

Fig. 2: A treatment of wheat crop Fig. 3: Air collecting channel and chamber

130.

Women's Participation in Conservation of Homestead Plant Biodiversity in Selected Areas of Comilla District

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Keywords: Women, role, biodiversity, homestead plant

Introduction

Biodiversity is crucial for survival, health and well-being of humans giving greater resilience to ecosystems and organisms. But increased human population and associated development activities in the last few decades has resulted directly and indirectly in depletion of the natural vegetation which in turn increase the pressure on the homestead forest specially in the developing countries to meet various needs of the human beings. Rural women are playing a vital role in the conservation of homestead plant biodiversity. Therefore, the present study aimed at to assess the women's participation in homestead plant biodiversity conservation.

Materials and Methods

The study was conducted in five selected villages of Homnaupazila under Comilla district. A total of 120 respondent women were selected using proportionate random sampling technique. Data were collected from September to October, 2014 and were coded, compiled, tabulated and analyzed in accordance with the objectives of the study. Statistics such as range, mean, number, percentage, standard deviation were employed throughout the study. Status of homestead plant diversity was measured in term of total number of recorded plants, mean and relative prevalence of each plant category and the species diversity index of different types of plants in the homesteads were measured by Simpson's Index (D).Extent of women's participation in homestead plant biodiversity conservation activities was measured in terms of extent of their involvement with the different selected decision making matters and operations as well. To measure this, each respondent was asked to indicate her extent of participation in each activity which was calculated in percent.

Results and Discussion

Findings reveal that majority of the respondents (59.2%) possessed moderate knowledge on homestead plant cultivation. Out of 93 different types of plants recorded in the study area, ladies finger (*Abelmoschus esculentus* with relative prevalence of 4.92) was the most dominant among the vegetables while mango (*M. indica*,with relative prevalence of 4.72)among the fruit trees, mahogany (*Swietenia mahogany,* with relative prevalence of 1.72) among the timber trees, chilies (*C. annum L.,* with relative prevalence of 2.52) among the spices, basil (*Ocimum sanctum*, with relative prevalence of 0.68) among the medicinal plants, henna (*Lawsenia ineromis*, with relative prevalence of 0.22) among the ornamental plants. The findings presented in Table 1 depict that among all types of homestead plants, highest diversity index was found in fruit plants (12.52) followed by timber (6.21), vegetable (5.33), medicinal (4.32), spices (3.22) and ornamental (3.29) plants. It indicates that the relative prevalence and species richness of different fruit trees were higher than other types of plants.

Table 1: Diversity index of different plants in the homestead

Different type of plants	P_{i2} for different plant types	*D
Vegetable	0.018	5.33
Fruit	0.079	12.52
Timber	0.160	6.21
Medicinal	0.231	4.32
Spices	0.310	3.22
Ornamental	0.303	3.29

*D= Simpson's diversity index

The diversity index of fruit trees (12.52) was found higher than other type of homestead plants. It was also found that participation of the respondents in homestead plants biodiversity conservation activities was 59.0 percent which was higher than their husband's participation (41.0%) (Table 2). More than half of the respondents spent 2-3 hour/day in homestead plants cultivation activities.

Table 2: Overall comparative participation of men and women in different homestead plant biodiversity conservation activities

Extent of participation by men (%)		Extent of participation by women (%)	
Decision	Operation	Decision	Operation
49	41	51	59

131.

Genetic Divergence Analysis in Newly Developed Genotypes of Soybean [*Glycine max* (L.) Merril]

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Keywords: D^2, genetic diversity, soybean, new breeding genotypes

Introduction

Soybean [*Glycine max* (L.) Merill] is the chief oilseed crop in India contributes 43% oilseeds and 29% edible oil production in the country. Madhya Pradesh contribution has always been largest and substantial in respect of area and production of country's total. In recent years soybean productivity has been declining due to impact of environmental fluctuations and lack of appropriate breeding strategies. According to Shrivastava *et al.* (2011) there is a possibility of increasing soybean yield potential up to 27% through developing four seeded plant ideotype. Efficient plant ideotype requires diverse genotypes and broad genetic base. For improved breeding approach correct exploitation of genetic diversity among population is a prerequisite. Thus, Mahalanobis's D^2 statistics is a powerful tool to measure genetic divergence within a set of genotypes. Present study aims to analyze the genetic diversity of fifty new breeding genotypes of soybean for identifying promising parents.

Materials and Methods

The investigation consisting of fifty newly developed breeding genotypes of soybean (Table 1) conducted during *Kharif* 2013 in RBD with three replications. Observations were recorded for phenological traits and morphological traits. The replicated data of all traits were subjected to genetic divergence analysis using Mahalanobis's D^2 statistic as suggested by Rao (1952)**.** All the soybean genotypes were grouped into respective clusters on the basis of values following Toucher's method.

Table 1: Distribution of 50 genotypes into different clusters

Cluster	No of genotypes	Genotypes
Cluster I	13	JS 20-50, JS 20-65, JS 20-71, JS 20-97, JS 20-86, JS 20-53, JS 20-99, JS 20-96, RVS 2007-4, JS 20-94, JS 20-79, JS 20-88, JS 20-41
Cluster II	13	NRC 37, Bragg, JSM 146, JSM 283, JSM 126, JS 335, JS 20-95, JSM 230, JS 20-80, JSM 207, JSM 242, JS 20-64, JSM 20-85
Cluster III	1	JS 20-70
Cluster IV	4	JS 20-29, JS 20-98, JSM 127, JS 20-89
Cluster V	9	JS 20-73, JS 20-82, JS 20-59, JS 20-69, JS 97-52, JS 20-91, JS 20-93, JSM 302, JSM 20-90
Cluster VI	1	JS 20-92
Cluster VII	3	JSM 7, JSM 271, JSM 20
Cluster VIII	1	JSM 175
Cluster IX	1	JS 20-75
Cluster X	3	JS 95-60, JS 20-34, JS 93-05
Cluster XI	1	JS 20-74

Results and Discussion

The percentage contribution towards genetic divergence by all the traits is presented in Table 1. Number of pods per plant (30.18%) contributed most towards genetic divergence. The average intra and inter-cluster D^2 values estimated as per the procedure given by Singh and Choudhary (1979). For the determination of genetic divergence among 50 new breeding genotypes of soybean Wilk's Λ criterion value (28073.292) was found highly significant. The estimation of 'Λ' (Wilk's criterion) was done using the following relationship.

'Λ'= (E)/ (E+V), Where, (E)= Determination of error sum of squares and sum of products matrix. (E+V)= Determination of error + Varieties sum of squares a sum of products matrix

The V statistics value (2794.063) was found highly significant at 588 degrees of freedom. The results revealed significant differences among genotypes for all studied traits. Fifty genotypes were grouped into eleven clusters. Cluster I and cluster II were polygenotypic found to be the largest cluster each comprising of 13 genotypes. Cluster X showed maximum intra cluster D^2 value (D^2= 64.02) followed with cluster V (D^2= 53.07), cluster IV (D^2= 43.20), cluster II (D^2= 39.52), cluster VII (D^2= 34.78) and cluster I (D^2= 32.53).Entries from cluster I, II, IV, V and X can be utilize in crossing programme for development of advance breeding lines presented in Table 2. The potential genotypes based on the D^2 statistics was found to be JS 20-69, JS 95-60, JS 20-29, JS 20-34, JS 20-50, JS 20-65, JS 20-71, JS 20-97, JS 20-86, JS 20-53, JS 20-98, JS 20-96, RVS 2007-4, JS 20-89, JS 20-29, JS 20-88, JS 20-41, JSM 230.

Table 2: Mean values for eleven clusters based on twelve quantitative traits of 50 soybean genotypes

Cluster Means: *Tocher's Method

Cluster	Vegetative phase (days)	Repro-ductive phase (days)	Plant height (cm)	No. of pod cluster per plant	No. of branches plant	Number of pods per plant	Number of nodes per plant	Number of seeds per plant	Biological yield per plant(g)	100 seed weight (g)	Harvest Index (%)	Seed yield (g)
Cluster I	35.69	54.51	46.84	20.53	2.93	49.38	11.61	92.28	20.12	7.37	34.98	5.18
Cluster II	35.10	55.13	40.12	13.55	2.19	28.77	11.19	53.77	11.72	7.65	36.56	5.01
Cluster III	35.33	55.33	46.03	18.10	2.73	37.00	12.47	69.15	15.08	8.11	35.08	5.29
Cluster IV	36.08	54.93	48.26	19.85	2.52	60.58	11.48	113.22	24.69	8.12	35.67	8.66
Cluster V	35.56	54.88	42.21	15.66	2.47	50.70	11.11	92.88	22.25	7.23	34.57	6.88
Cluster VI	35.00	58.67	36.07	12.07	2.01	35.67	11.00	66.66	14.54	7.10	35.07	5.92
Cluster VII	33.78	55.78	30.80	14.52	1.98	18.33	10.71	34.26	8.40	6.25	24.54	3.04
Cluster VIII	33.33	52.33	48.47	20.33	3.00	45.00	12.67	84.10	20.62	7.18	31.19	7.40
Cluster IX	38.67	60.00	49.83	14.23	2.47	46.00	12.60	85.97	21.08	7.10	31.20	7.56
Cluster X	26.78	54.56	41.51	16.66	2.12	30.78	10.28	57.52	14.11	7.52	30.12	5.06
Cluster XI	32.67	55.33	43.50	23.17	2.93	36.00	10.60	67.28	16.50	7.04	31.01	5.32

*Tocher's method as described by Rao, 1952

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132.

Genetic Diversity of Chilli (*Capsicum annuum* L.) Genotypes using RAPD Markers

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Keywords: Genetic diversity, RAPD, PCR, *Capsicum*, dendrogram

Introduction

Chilli (*Capsicum annuum* L.) is indispensible spice essentially used in every Indian cuisine due to its pungency, taste, appealing colour and flavor and also used worldwide as spice, condiment, vegetables and medicine. Indian productivity (1.5 t/ha) is low and there is need to improve the same by developing of high yielding varieties and hybrids by planning appropriate crop improvement programs. Previously genetic diversity in *Capsicum* was studied using morphological, cytological and biochemical markers (Kaur and Kapoor, 2001). Recent developments in deoxy ribo nucleic acid (DNA) based technologies have revolutionized the utilization of molecular markers in Genetics and Breeding studies (Paterson *et al.*, 1999).

Assessment of genetic polymorphism is more meaningful than studying phenotypic character, as morphological traits are environmental dependent. So the study of variations at the level of nucleotide bases is the primary source of all biological information. Hence, Random Amplified Polymorphic DNA (RAPD) is one such molecular marker method (Williams *et al.*, 1990) which helps in identifying polymorphism that can be used to elicit information on genetic differences among individuals of a population between lines or germplasm accessions

Materials and Methods

Seventeen advanced breeding line of chilli were collected from HRS (Horticulture Research Station, Devihosur and COH (College of horticulture), Bagalkot, Karnataka, India. All Genomic DNA was extracted from leaves of the different chilli accessions by the CTAB method, according to Sambrok and Russel (2001) with some modifications. For quantification of genomic DNA, the absorbance of the DNA samples was measured at 260 nm in a Nano Drop. After quantification, the quality of the purified DNA was analysed in a 0.8% (w/v) agarose gel.

A total of 34 RAPD primers were used for polymorphism survey. The RAPD assay was carried out using PCR (polymophic chain reaction) vials containing 1× PCR reaction buffer, 0.2 mM dNTPs mix, 20 p mole primer, 50 ng DNA template, 0.25 U Taq DNA polymerase and sterile distilled water to a final volume of 20 µl. Amplification was performed with thermal cycler. PCR amplified products of all the primers were subjected to gel electrophoresis using 1.8% agarose gel in 1x TAE (Tris Acetate EDTA) buffer and visualized by staining with ethidium bromide followed by image capturing using a gel documentation system.

Amplified DNA fragments were scored as 1 for presence of bands and 0 for absence of bands. Pair-wise similarity matrices were generated using simple matching similarity coefficient by means of SIMQUAL procedure of NTSYS-pc version 2.1 (Rohlf, 2000) statistical package).

Cluster analysis was performed by means of SAHN procedure of NTSYSpc via unweighted pair-group method using arithmetic average (UPGMA) to develop dendrograms.

Polymorphism information content (PIC*i*) of a band was calculated according to Anderson *et al.* (1993) as follow:

$$PIC_i = 1 - \sum_j f^2_{ij}$$

Where, f_{ij} is the frequency of the j^{th} pattern of the i^{th} band

Percent polymorphisms were calculated for each primer combination according to the formula: % Polymorphism= p/ (m + p)

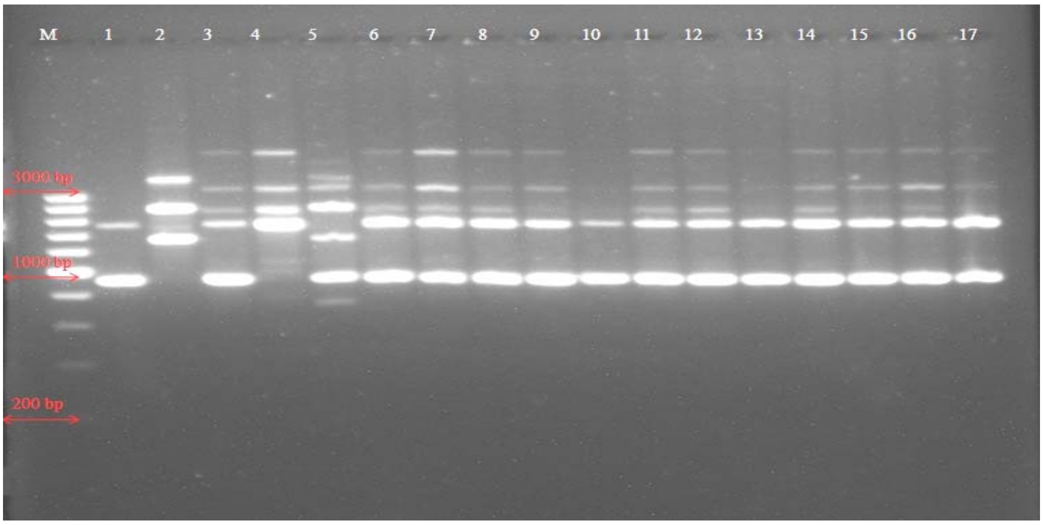
Where, p is total number of polymorphic bands

m is the total number of monomorphic bands of the primer combination used.

Results and Discussion

The 34 RAPD primers amplified a total of 1962 bands across the 17 genotypes. The sizes of amplified product ranged from 150 to 9000bp and the number of bands per primer ranged from 18 (OPJ-04) to 125 (RAPD10) with an average of 57.70 per primer. Out of the 1962 bands, 1418 were polymorphic with 71.25% polymorphism. There was a lot of variation in per cent of polymorphic bands produced by the primer screened among which primers RAPD1, RAPD2, RAPD5, RAPD7 (Fig. 1), AV-08, OPA-07, OPB-04, OPB-17, OPERON-AC07, OPA-14, OPB-07, OPC-06, OPJ-04 and C-16 were the most polymorphic generating 100 (%)

polymorphism while the primer OPA-07 did not exhibited polymorphism (0.00%). The polymorphic information content (PIC) which is a measure of informativeness of a marker were found in the range from 0.20 (OPD-16) to 0.88 (RAPD5) with a mean of 0.71 (average heterozygosity).



(a)RAPD-7

Fig. 1: Banding profile of 17 chilli genotypes 1 DCA-136, 2DAC-192, 3DCA-199, 4DCA-233-1, 5Assam chilli, 6 Byadagi chilli, 7EC-28-DPS-06-07-01, 8GC-07-01, 9CH-1, 10HC-07-05, 11GC-07-02, 12HC-0714, 13HC-0702, 14GPC-82, 15Pusa jwala, 16Byadagi dabbi, 17 IS-25-30 by RAPD-7

Bivariate (1-0) data obtained by amplification of RAPD markers were used for construction of dendrogram (Fig. 2). Seventeen chilli genotypes studied were grouped into two major clusters using a Jaccard's similarity coefficient of 0.20. The genotype G2 (DCA-192) was individually grouped into cluster 1 forming a solitary genotype cluster. Whereas, rest of the 16 genotypes was grouped together in cluster 2. Further, cluster 2 was again grouped in to two sub- clusters using a Jaccard's similarity coefficient of 0.52. Sub cluster 2A comprises only one genotypes i.e. G5 (Assam chilli) whereas sub-cluster 2B comprises remaining all 15 genotypes. Sub-cluster 2A further grouped in to two sub-sub clusters using a Jaccard's similarity coefficient of 0.65. Sub-sub cluster 2B1 comprises of G1 (DCA-136) genotype and sub-sub cluster 2B2 comprises of remaining all 14 genotypes. In sub-sub cluster 2B2 G7 and G8 were most similar (0.85) which were closely related with G6, G3 and G4. Further, G10 and G13 were similar (0.80) which were closely related with G9, G14 and G11. Similarly G15 and G17 were similar which were closely related with G16. The genotype G12 formed separate cluster with a similarity coefficient of 0.73. Thus the RAPD analysis revealed high level of genetic variability among the genotypes studied. The genotypes G2 and G5 were distantly related with G1 which can be use for further improvement of chilli through hybridization programme.

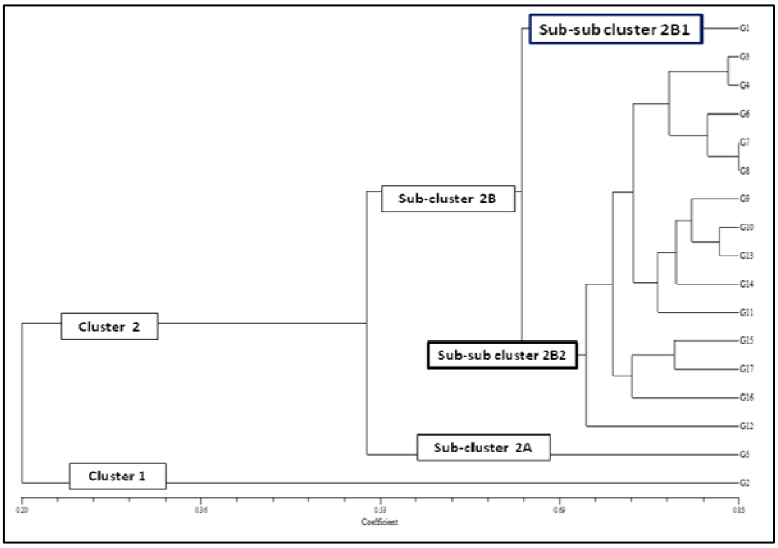


Fig. 2: UPGMA cluster analysis showing the relationship and diversity among 17 genotypes of Chilli (Capsicum annuum) produced by RAPD.

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133.

Effect of Altitude and Aspect on Vegetation Structure of Trees in Shankaracharya Forest

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Keywords: Shankaracharya, community structure, aspect, altitude

Introduction

The structure of forest is affected by a variety of factors ranging from spatial position of the nearest trees and stand density and the arrangement of branches on trees. Forest structure is thus both a product of forest dynamics and a template for biodiversity and ecosystem functioning and the future of a forest ecosystem (Puumalainen *et al.*, 2003). In all the studies till date, the vegetation characteristics of Shankaracharya hillock; which is largely characterized by a typical topographic physiognomy, is poorly cited. Therefore, the present study was undertaken to acquire knowledge about the vegetation of this unique man made reserved forest grove's which now comprises many plant species.

Materials and Methods

Phyto-sociological status of the entire reserve forest grove was worked out at three different aspects along the altitudinal range. The vegetation sampling was done by quadrat method in 2011-2012, and the sample quadrats were located by systematic random sampling procedure. Altogether ninety nine quadrats were laid and sampled. Various community attributes (importance value index, species frequency, density, abundance to frequency ratio were analyzed as per standard procedures and the formulas used for calculation of various attributes (Misra, 1968) for tree layer.

Results and Discussion

The data on community structure of trees is presented in Table 1. The frequency values recorded varied on all the aspects along an altitudinal gradient. At the lower altitudinal gradient, *Cupressus torulosa* and *Morus alba* recorded the maximum frequency of 100% on North Eastern aspect and North Western aspects respectively. *Pinus helpensis*, *Cedrus deodara*, *Pinus roxburghii* and *Pinus canariensis* were most frequent tree species on middle and upper altitudes with respective frequency of 100% on North Eastern aspect as described by (Chen *et al.*, 2008). With increasing altitude there is often a change in environmental stress including climatic factors such as temperature, disturbance, competition for resources and geographic factors associated with isolation (Korner, 2002). The data on phyto-sociological status recorded in the present study (Table 1) manifests that among the tree species, the respective maximum of 280 individuals ha^{-1} was exhibited by *Cupressus torulosa* on North Eastern and South Eastern aspects at lower altitudinal range of 1575-1705 m. At the middle altitude (1705-1835 m), the maximum density of 388 individuals ha^{-1} was exhibited by *Cedrus deodara* on North East aspect and the minimum density of 25 individuals ha^{-1} was recorded for *Robinia pseudoacacia*, *Quercus ilex*, *Morus alba* and *Aesculus indica* on North Western aspect. At higher altitude (1835-1967m) while maximum density of 610 individuals ha^{-1} was recorded for *Cedrus deodara* (Table 1). The values of tree density recorded in the present study are well within the range of 3.2 to 20.8 individuals 100 per m^2 documented for several temperate forests (Saxena and Singh, 1982). The concept of Importance Value Index has been developed to express the dominance and ecological success of any species within a single value (Mishra, 1968). Considering importance value index as an indicator of dominance, IVI at different aspects varied across the altitudinal gradients (Table 1). Maximum IVI of 72.1 was exhibited by *Cupressus torulosa* on North East aspect, the minimum IVI of 18.1 was recorded for *Populus alba* on North Western aspect at lower altitude. At middle altitude, the maximum and minimum IVI of 70.4 and 3.8 was exhibited by *Cedrus deodara* and *Aesculus indica* on North Eastern and North Western slopes respectively. At upper altitudinal gradient, the maximum and minimum IVI of 131.8 and 47.1 was recorded for *Cedrus deodara* at North Eastern aspect and *Quercus ilex* on North Western aspect respectively.

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Table 1: Phyto-sociological attributes of tree species on available aspects along an altitudinal gradient at Shankarachrya Reserve Forest

Aspect → Altitude ↓	North West			North East			South East		
	F	**D**	**IVI**	**F**	**D**	**IVI**	**F**	**D**	**IVI**
1574-1705 m asl									
Cupressus torulosa	66.60	270.00	54.60	100.00	280.0	72.10	77.80	18..0	59.10
Juglans regia	16.60	30.00	19.80	-	-	-	-	-	-
Populus alba	16.60	16.00	18.10	-	-	-	-	-	-
Morus alba	100.00	130.00	54.7	57.10	71.0	45.50	88.90	117.00	63.80
Populus nigra	66.60	160.00	45.3	-	-	-	-	-	-
Prunus cerasifera	50.00	83.00	35.41	-	-	-	-	-	-
Prunus armenica	33.30	50.00	30.60	78.50	52.00	51.20	-	-	-
Salix fragilis	16.60	30.00	19.20	-	-	-	-	-	-
Celtis australis	33.30	40.00	22.30	-	-	-	-	-	-
Aesculus indica	-	-	-	92.80	128.00	68.10	88.90	113.00	64.160
Robinia pseud acacia	-	-	-	57.10	120.00	63.10	66.60	117.0	62.530
Pyrus cumminis	-	-	-	-	-	-	55.00	112.0	50.58
Total		**809**	**300**		**651**	**300**		**477**	**300**
1705-1835 m asl									
Cupressus torulosa	100.00	95.00	36.30	98.00	113.00	470	58.1	78.00	44.62
Pinus helpensis	100.00	345.00	52.40	100.00	363.00	64.40	100	270.00	64.55
Cedrus deodara	100.00	360.00	66.20	100.00	388.00	70.40	-	-	-
Pinus roxburghii	100.00	75.00	44.70	100.00	75.00	48.40	66.6	110.00	49.69
Pinus canariensis	75.00	75.00	36.30	100.00	83.00	46.50	-	-	-
Robinia psedacacia	37.50	25.00	23.10	90.00	33.00	23.30	45.5	60.00	44.70
Quercus ilex	25.00	25.00	22.54	-	-	-	-	-	-
Morus alba	12.50	25.00	14.70	-	-	-	-	-	-
Aesculus indica	12.50	25.00	3.80	-	-	-	57.14	64.00	47.68
Pyrus cumminis	-	-	-	-	-	-	70.2	110.00	48.60
Total		**1050**	**300**		**1055**	**300**		**692**	**300**
1835 to 1967 m asl									
Cedrus deodara	93.40	540.00	127.8	100.00	610.00	131.80	80.80	200.00	126.10
Pinus wallichiana	93.40	210.00	71.9	66.60	330.00	93.10	22.30	86.00	69.30
Celtis australis	26.60	160.00	53.34	100.00	100.00	75.13	-	-	-
Quercus ilex	53.30	60.00	47.1	-	-	-	66.60	100.00	104.60
Total		**970**	**300**		**1040**	**300**		**386**	**300**

F= Frequency (%); D= Density ha$^{-1.}$ IVI= Importance Value Index

134.

Microbial Cataloguing from Wetlands of North Bihar with Special Reference to Some of the Selected Microbes as Effective Biomineralizers

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Keywords: Microbial diversity, taxonomy, MTCC, consortia, FAME analysis, phylogenetic characterization.

Introduction

Of all form of life, micro-organisms are much more diverse. Micro-organisms are abundant, and ubiquitous in our environment. They are found in a diverse habitat and show a great diversity in their morphology, growth requirements and biochemical characteristics. Wetlands are among the most important ecosystems of the earth, dominated by anaerobic conditions including soil saturation and flooding. The biodiversity found in wetlands is very large. These wetlands are the habitat of a large number of microorganisms, algae, flowering plants, crustaceans, molluscs, fishes, turtles, birds and animals. In North Bihar, the wetlands are known as *chaurs* or *mauns.*

Materials and Methods

An investigation was undertaken with the objectives i) to isolate different strains of bacteria and actinomycetes from soil and water samples, during pre and post monsoon period using dilution plate method, ii) to examine the test isolates on the basis of their morphology, physico-chemical and biochemical characteristics including acid production from carbohydrates, iii) to assess only the selected strains of bacteria and actinomycetes as potential biofertilizer either alone or in the form of consortia's on some selected paddies as well as pulses, to identify these strains from a reputed culture collection centre (Institute of Microbial Technology, Chandigarh) for getting the microbial type culture collection number), and iv)to catalogue and preserve these strains in culture collection centers, for further study and to characterize the strains phylogenetically. Several different techniques were applied to isolate and study the microbes in pure culture. For isolation, several medias were used. Soil and water samples were collected in sterile polythene bags and bottles and were cultured on Nutrient Agar (NA) media, Starch Casein Agar (SCA) media & Azotobacter (Ashby's) media using spread plate technique and serial dilution method. Culture characteristics of the isolates were also studied in detail. Among so many isolates, only 5 selected test isolates were undertaken for further investigation for their assessment as potential biofertilizers/biomineralizers on some selected paddies and pulses.

Results and Discussion

Bacteria as well as actinomycetes are ubiquitous in nature and form an extremely large group of prokaryotes. They have the property of phosphate solubilization and henceforth can work as suitable bioefrtilizers. The current investigation was carried out with the objective to isolate, characterize, identify and catalogue the bacteria from some selected wetlands of North Bihar and also to assess their potential as suitable biofertilizers on some selected rice and pulse crops grown in that region. Among a large number of test isolates, most of them were mesophilic and showed luxuriant growth on NA media at 37°C. All of the isolates showed growth on NaCl at a range of 0.87-7%. Also, they showed growth at pH range of 5.2-11.0. Most of the isolates were bacillus, but also a few coccus shaped were also observed. Colony morphology was also studied in detail. It was confirmed that NA media was the most important media for the growth and sporulation of all isolates. Screening of the selected isolates was done to test their potential as suitable biofertilizers on the basis of their phosphate solubilizing activity. On the basis of phosphate solubilizing activity of microorganisms on Pikovaskay's medium, among so many isolates, only 5 strains were undertaken from the different wetland sites of North Bihar. Out of these, 20 test isolates showed good results for phosphatase test. Finally, 9 strains were tested individually as well as in various consortia's. Only 5 isolates gave good results. Successful potting experiments were conducted on some paddies and pulses such as *Triticum aestivum, Zea mays* and *Vicia faba;* it was concluded that microbes can be used as biofertilizers for better growth of plants. It will be economically a better option to get better yield. Use of these biofertilizers will be eco friendly option and will definitely replace the use of chemical fertilizers in future. The MTCC number allotted to isolates are given in Table 1.

Table 1: MTCC number allotted to isolates

Strain Designation	Isolate Identified	MTCC No
SM8	*Nocardiopsis flava*	MTCC 9525
SM10	*Bacillus species*	MTCC 9524
SM2A	*Virgibacillus pantothenticus*	MTCC 9524
SM18A	*Lysinibacillus sphaericus*	MTCC 9523
BC7A	*Lysinibacillus sphaericus*	MTCC 9526

Acknowledgement: Financial grant from DBT is greatly acknowledged.

135.

Aprostocetus purpureus, a Major Parasitoid of Indian Lac Insect, *Kerria lacca* (Coccoidea: Tachardiidae)

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Keywords: *Kerria lacca*, parasitoids, *Aprostocetus purpureus*

Introduction

The lac production of the country can be viewed as summation of the contribution of four crops, contributed by two crops each of *rangeeni* and *kusmi* strains. In recent years the contribution of summer *rangeeni* (*baisakhi*) crop has shown drastic decline in production, which used to be the major lac crop. Lac insect sucks the sap from specific plants known as lac hosts and being of sedentary nature is more vulnerable to be attacked by number of pests and diseases. There are several parasitoids and predators of lac insects which causes considerable loss in lac production. Among them *Aprostocetus purpureus* is the most dominant in the composition of lac associated fauna particularly in *baisakhi* crop and causes major damage to the lac crop during critical crop growth period. The present investigation was aimed to study the emergence profile of *A. purpureus* and its correlation with weather parameters at Ranchi, Jharkhand on *ber* and *palas.*

Materials and Methods

The *rangeeni* strain broodlac was cultured on *ber*, *Ziziphus mauritiana* and *palas, Butea monosperma* during *baisakhi* crop at Institute Research Farm, Ranchi, Jharkhand. Lac insect samples (one meter length of encrustation) were collected randomly from inoculated trees one month after inoculation at every 15 days interval till harvest under three replications. The samples were caged in parasitoid emergence cage (20×20×30cm), fitted with glass tubes to collect parasitoids by exploiting their phototropic behaviour. Lac associated parasitoids and predators were collected from cage every day continuously upto one month. Among them, *A. purpureus* were morphologically identified and population abundance was recorded and correlated with weather parameters. Per cent lac insect (male and female) parasitization was observed through microscope by pricking method in the month of March 2014 during summer crop 2013-14. The data was analyzed using statistical package AGRES and SPSS version 11.5.

Results and Discussion

Relative abundance of lac associated fauna was analyzed during *baisakhi* crops for two consecutive years, which revealed that, parasitoids alone constitute 93 and 89% population among lac associated fauna, followed by predators and hyper parasitoid on *ber*, respectively during 2011-12 and 2012-13. Similar trends were also observed on *palas* for both the years. Among them, *A. purpureus* was significantly more abundant which constitute 71, 56% on *ber* and 74, 47% on *palas*, respectively during 2011-12 and 2012-13 (Table 1). In recent years 538% increase in *A. purpureus* population was observed when compared with four decade backs (Table 2). The per cent population of *A. purpureus* was mainly observed more during the critical period (17 to 22 Week After Inoculation) of the summer season crop on *ber* 78 & 66 and *palas* 62 & 49, respectively during 2011-12 and 2012-13. Interestingly, male lac insect was more vulnerable towards parasitization than female. A significant negative correlation with relative humidity was observed during critical period of *baisakhi* crop. The observations indicate the resurgence of *A. purpureus* as the most serious pest of lac insect causing huge economic losses. Parasitization at an early development stage of lac insect by *A. purpureus* leads to complete mortality of lac insect thus leading to failure of the lac crop.

Table 1: Per cent composition of lac associated fauna summer *rangeeni* (*baisakhi*) crops

Lac associated fauna	*Ber*		*Palas*	
	2011-12	**2012-13**	**2011-12**	**2012-13**
Tachardiaephagus tachardiae	20.61	13.73	15.54	25.91
Aprostocetus purpureus	71.47	55.71	73.86	46.92
Parechthrodryinus clavicornis	1.06	17.99	1.65	2.54
Eupelmus tachardiae	-	-	0.00	0.18
Erencyrtus dewitzi	-	-	0.00	0.18
Marietta javensis	0.00	1.16	0.37	0.36
Eublemma amabillis	3.17	3.09	2.74	16.30
Pseudohypatopa pulverea	1.06	4.45	0.00	3.80
Coleopteran	-	-	0.55	0.36
Bracon greeni	2.64	0.19	5.30	0.18
Apanteles tachardiae	0.00	3.68	0.00	3.26
CD (P= 0.05)	14.79	9.00	7.83	7.64

Table 2: Comparative analysis of lac associated parasitoids population (Number per kg broodlac sample)

Year	Total parasitoid population (nos./Kg)	*Aprostocetus purpureus* (nos./Kg)	*Tachardiaephagus tachardiae* (nos./Kg)	*Parechthrodryinus clavicornis* (nos./Kg)	Other parasitoids population (nos./Kg)
1972-73 to 1973-74	28.4	17.0	9.1	1.7	0.56
2011-12 to 2012-13	130.7 (361.0)	108.4 (537.7)	19.9 (119.9)	1.8 (5.2)	0.53 (-4.71)

Figures in parentheses is per cent increase over initial population

136.

Estimation of Genetic Components Affecting Inheritance of Yield Contributing Traits in Linseed (*Linum usitatissimum* L.)

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Keywords: Linseed, heritability and genetic inheritance.

Introduction

Linseed (*Linum usitatissimum* L.) is annual self-pollinated diploid (2x=2n=30) oilseed crop belonging to *Linaceae* family. Qualitative characters controlled by one or a few major genes are more readily manipulated in a breeding programme as compared to quantitative traits controlled by many genes. Nevertheless, the breeder is concerned mainly with quantitative characteristics which could be of use in both formulating and performing the breeding programme. Hence, the present investigation has been carried out to study the nature of gene action for yield and its contributing traits in this crop.

Materials and Methods

The experimental material for present investigation comprised of 28 F'_1s (developed by crossing eight parental lines viz., NDL 2004-05, R-552, TL-11, TL-27, EC-1392, A.95.B, GS-234 and Shekhar) in half diallel fashion design during *rabi* 2011-12. The test genotype Shekhar was used as check. A total of 36 treatments (28 F1's + 8 parents) were evaluated in randomized block design with three replication at N.D. University of Agriculture and Technology, Faizabad, India.

Results and Discussion

Genetic components of variation namely D, H_1, H_2, F, h^2 and E for eleven characters in F_1s generation are presented in Table 3. Analysis of variance reveals that additive and dominance genetic variances were significant for most of the characters. Additive component (D) was highly significant and positive for most of the characters studied, indicated that additive gene actions condition the above characters. The estimates of dominance component H_1 and H_2 showed highly significant values for all the characters. This indicated that dominant gene actions condition the above characters. Significant value of D and H revealed the importance of additive and dominant genetic effects. The value of dominant components was higher than additive components for all the characters studied except plant height, indicating that genes showing dominant genetic effects for such traits were more important than additive genetic effects. The significant of positive value of h^2 indicated presence of dominance. The proportion of positive and negative alleles in the parent ($H_2/4H_1$) was less than unity for all the characters, which indicated that the positive and negative alleles were distributed asymmetrically. The proportion of the dominant and recessive genes in the F_1s (KD/KR) was recorded more than unity for all the characters, indicated that the dominant genes were frequently distributed as compared to their recessive genes. High heritability coupled with moderate genetic advance in per cent of mean was recorded for harvest index, seed yield per plant and number of capsules per plant.

Table 1: Estimates of genetic components of variance in respect to eleven characters in diallel cross in Linseed

Characters	D	H_1	H_2	h^2	F	E	$H_1/D^{0.5}$	$H_2/4H_1$	KD/ KR	'r'	h^2/H_2
Days to 50 per cent blooming	20.90**	45.16**	33.60**	50.40**	6.77	1.86	1.47	0.86	1.25	0.82*	1.50
Days to maturity	9.84**	24.70**	17.37**	12.68**	5.74	2.09*	1.58	0.17	1.45	0.75*	0.73
Plant height (cm)	86.42**	84.02**	51.30**	14.58	103.21 **	1.07	9.9	0.15	4.07	0.93**	0.28
No. of primary branches per plant	0.207*	1.59**	1.23**	0.61**	0.41	0.05	2.78	0.19	2.11	-0.02	0.50
No. of secondary branches per plant	34.85**	124.76**	104.79**	72.28**	51.52*	2.12	1.89	0.21	2.28	0.72*	0.70
Number of capsule per plant	686.37**	2493.30**	1968.03**	1346.27**	987.94 **	18.56	1.91	0.20	2.21	0.62	0.68
Number of seeds per capsule	0.16	0.90**	0.68**	-0.01	0.32	0.08*	2.34	0.19	2.48	-0.01	-0.01
1000 Seed weight (g)	1.01**	1.31**	1.12**	0.27	0.21	0.01	1.14	0.21	1.20	0.77*	0.24
Biological yield / plant(g)	6.62*	34.53**	31.61**	40.57**	6.84	0.34	2.28	0.23	1.59	-0.09	1.28
Seed yield per plant (g)	0.60*	4.60**	4.39**	4.54**	0.35	0.05	2.76	0.24	1.23	0.22	1.03
Harvest index (%)	21.23	105.25**	94.45**	3.74	25.67	2.38	2.23	0.22	1.75	-0.22	0.04

* Significant at 5 per cent level; ** Significant at 1 per cent level.

137.

Genetic Divergence Studies in Chilli (*Capsicum annuum* L.)

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Keywords: Chilli, genetic divergence, cluster analysis, D^2 statistics

Introduction

Eighteen genotypes of chilli (*Capsicum annuum* L.) representing different part of a country were studied for sixteen yield and quality traits at Vegetable Research Farm, Division of Vegetable Science & Floriculture, Chatha, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, India. The aim of the research was to assess the genetic diversity among germplasm collected using Mahalanobis D^2 (Mahalanobis, 1936) clustering and identifying the most diverse lines based on inter and intra cluster distance which will act as parental lines in future heterosis breeding programme for development of hybrids in crop improvement programme.

Materials and Methods

The experiment materials comprised of eighteen genotypes and were evaluated in a Randomised Block Design design with three replicates. Observations on sixteen yield traits were taken from five randomly selected plants from each plot in each replicates and quality traits namely capsaicin and ascorbic acid were determined by the titration procedure (Sadasivam and Theymoli, 1987) and spectrophotometric method (Sadasivam and Manickam, 1992), respectively. The mean data obtained was subjected to determine the clustering pattern among the genotypes and Mahalanobis (1936) D^2 statistics was employed to measure the genetic distance between genotypes and grouping was done by Touchers's method as described by Rao (1952).

Results and Discussion

The analysis of variance revealed significant differences among the genotypes for all the characters studied indicating considerable amount of genetic variability for all the characters and thereafter the diversity study was carried out. Based on the D^2 statistics, eighteen genotypes of chilli were grouped into five clusters (Table 1) in which cluster II had maximum number of genotypes (5) namely Punjab Surkh, Selection-1, SJC-02, G-4 and LCA -334 followed by cluster III (Selection-2, Selection-3, LCA-305 and LCA-960) and cluster IV (DKC-8, Cherry pepper, LCA-206 and G-3) with 4 genotypes each and cluster I with minimum two genotypes viz. SJPC and SJC-01. The mean values obtained for varying number of genotypes in each cluster, although, cannot be compared statistically, but to get a relative idea of diversity among the clusters they are compared. In the present investigations Cluster I had the highest mean value for total number of fruits per plant, fruit diameter, number of primary branches per plant, fruit yield per plant. Cluster IV gave the maximum mean value for capsaicin percentage and ascorbic acid and recorded the minimum value for days to 50% flowering, days to fruiting. Maximum intra cluster distance (Table 1) was observed in cluster IV including DKC-8, Cherry Pepper, LCA-206 and G-3 while the maximum inter cluster distance was recorded between cluster IV (DKC-8, Cherry Pepper, LCA-206 and G-3) and I (SJPC, SJC-01) revealing that sufficient genetic diversity for selecting superior and diverse parents were present and can be further exploited for any chilli improvement programme.

Table 1: Average intra (bold) and inter cluster (D^2 Values) distance values.

Cluster	Genotypes	I	II	III	IV	V
I	SJPC, SJC-01	**(1.040)**	30.130	22.193	48.889	21.902
II	Selection-2, Selection-3, LCA-305 and LCA-960		**(7.469)**	19.088	10.667	13.286
III	Selection-2, Selection-3, LCA-305 and LCA-960			**(5.683)**	22.677	18.430
IV	DKC-8, Cherry pepper, LCA-206 and G-3				**(9.278)**	26.092
V	CCH-05-01, LCA-353 and Jammu Local Selection					**(4.423)**

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138.

Assessment of Genetic Diversity of *Ajuga* Using Molecular Markers

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Keywords: Molecular markers, genetic diversity, *Ajuga*

Introduction

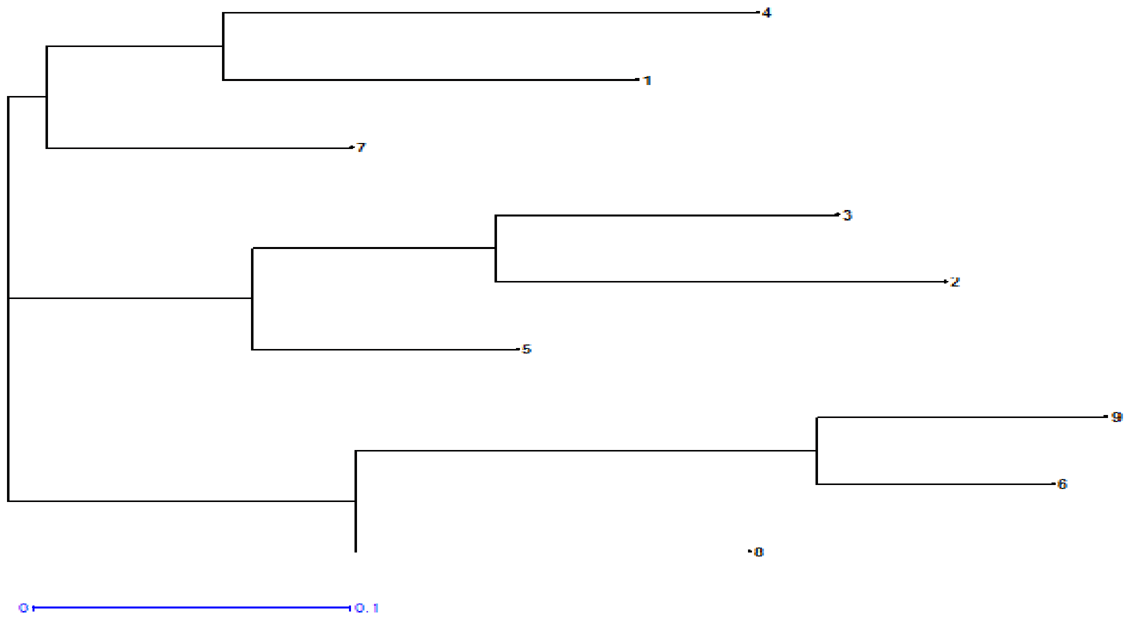
Ajuga bracteosa (Labiatae) is a low herb covered with soft hairs, with erect, ascending stems which arise from the rootstock, branching usually diffusely from the base and measuring 10 to 20 centimeters in length. Genetic diversity is a key factor to study genetic variability present in the germplasm. *Ajuga bracteosa* is distributed in subtropical and temperate regions from Kashmir to Pakistan, Afghanistan, China and Malaysia. It contains withanolids (bracteosin A, B) and yields glycosides, tannin, ceryl alcohol, ß-sitosterol, y-sitosterol, cerotic acid, palmitic acid, oleic and linoleic acid, glucose, arabinose, phenolic compounds. It is considered stimulant, diuretic, depuratives, and aperients, aromatic, astringent and tonic. RAPD analysis has been performed for evaluation of genetic diversity and clonal identification of this genus. The objective of the present study was to assess the genetic diversity among *Ajuga* using RAPD primers with the aim of utilizing them for their parent selection and to assess the genetic variability for the management of genetic resources inbreeding programs.

Materials and Methods

Genetic diversity was studied in nine *Ajuga* samples. Leaf samples of nine *Ajuga* plants were collected from different regions of northern India Jammu and Kashmir (JK), Punjab (PB) and Himachal Pradesh (HP). The genomic DNA was isolated from sample using the CTAB Method (*Saghai-Maroof et al)*. In vitro amplification of DNA was performed using polymerase chain reaction (PCR) with nine different RAPD primers. The amplified products were electrophoretically resolved on a 1.5% agarose gel.

Results and Discussion

9 RAPD primers amplified a total of 55 bands of which 30 bands were polymorphic and 25 were monomorphic. Maximum numbers of 10 bands were generated with primer OPH-20 of which 4 were polymorphic and 6 were monomorphic. Primer OPH-03 showed highest level of polymorphism which was 75% followed by primer OPH-15 showing polymorphism level of 55.5%. The genetic dissimilarity index calculated varied from 0.16 to 0.64. The generated dendrogram was based on neighbor-joining approaches and it showed the presence of three distinct clusters. The study demonstrates the utility of RAPD markers to characterize interspecific relationships and to evaluate germplasm diversity in plants collected from three different regions, and that this material could be exploited in the future for breeding programs to develop new varieties.



UPGMA based dendrogram on nine samples

Reference

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139.

Intra- and Inter-specific Genetic Diversity in Grain Amaranth (*Amaranthus hypochondriacus* L.)

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Keywords: Intra-and inter-specific genetic diversity, grain amaranth, *Amaranthus hypochondriacus* L., clusters, canonical roots.

Introduction

Grain amaranths (*Amaranthus hypochondriacus* L.) of the genus *Amaranthus* is the most important subsidiary food crop of the people inhabiting to the tropical and subtropical highlands of Central and South Americas. The genus contains more than 60 species of which *Amaranthus hypochondriacus* and its hybrids are widely cultivated as ornamental, pseudo-cereal, and fodder crops in many tropical to warm-temperate regions of the world. In India the species is extensively cultivated as subsidiary food crop from Kashmir to Arunachal Pradesh. There are many methods like Mahalanobis D^2 statistics described by Rao (1952) to represent variation.

Materials and Methods

The present investigations were undertaken in 2012-13 in 33 of *A. hypochondriacus*. These were grown in completely randomised design with three replications in the experimental field of Birsa Agricultural University, Ranchi, Jharkhand (India). Spacing between rows were 45 cm and plant-to-plant distance was 15 cm. Ten plants of each genotype of each replication were selected randomly for gathering observations on seven characters Table 1. Genetic divergence between genotypes was worked out using Mahalanobis (1936) D^2 statistics and the clustering of genotypes were done following Tocher's method as described by Rao (1952).

Table 1: Genotypes groups into 16 clusters in grain amaranth.

Cluster number	Genotype(s)
Cluster I	BGA9, BGA20, BGA14, BGA11 (Bhubaneshwar)
Cluster II	BGA7-1 (Bhubaneshwar), RGA6 (Ranchi)
Cluster III	AmbikaGA12-1 (Ambikapur), KBJ3 (Bangalore)
Cluster IV	MGA16 (Mettupalayam), BGA 5-1 (Bhubaneshwar)
Cluster V	BGA3 (Bhubaneshwar), IC35370 (Akola)
Cluster VI	SKNA403 (S.K. Nagar)
Cluster VII	RMA45 (Mandor), BGA 21 (Bhubaneshwar), IC35482 (Akola)
Cluster VIII	BGA11-1 (Bhubaneshwar), RGA5 (Ranchi)
Cluster IX	MGA507 (Rahuri), SKNA808 (S.K. Nagar)
Cluster X	Suvarna (Bangalore)
Cluster XI	RMA43, RMA42 (Mandor), BGA4 (Bhubaneshwar), SKNA809 (S.K. Nagar)
Cluster XII	SKNA401 (S.K. Nagar)
Cluster XIII	BGA12 (Bhubaneshwar), KBJ3-1 (Bangalore)
Cluster XIV	RMA51 (Mandor), MGA15 (Mettupalayam)
Cluster XV	GA2 (S.K. Nagar)
Cluster XVI	BGA 2 (Bhubaneshwar), AmbikaGA12-2 (Ambikapur)

Results and Discussion

With Wilk's criteria (V state=1847.44 at d.f 224) the distribution pattern of 33 genotypes revealed that there were 16 clusters and the distribution of genotypes from different eco-geographical region was apparently random Table 1. The genetic contribution towards diversity was made by number of branches (21.9697), days to 50% flowering (17.0455), inflorescence length (15.7197), plant height (12.6894), days to maturity (12.3106), seed yield kg/ha (10.9848), 10ml volume weight (9.2803). The highest positive canonical vector value for seed yield (0.7594) in 3rd vector, days to maturity (0.8390) in 5th vector, days to 50% flowering (0.8252) in 6th vector, plant height (0.4216) in 1st vector, number of branches (0.5291) in 1st vector, inflorescence length (0.6138) in 7th vector and 10ml volume weight (0.5798) in 7th vector. Cluster I (BGA 9, BGA 20, BGA 14 and BGA 11) and cluster XI (RMA 42, RMA 43, BGA 4 and SKNA 809) contained maximum number of genotypes (4), Cluster II, III, IV, V, VIII, IX, XIII, XIV and XVI (2 in each case) and in cluster VII (RMA45, BGA 21 and IC35482) 3 genotypes. Cluster VI (SKNA 403), X (Suvarna), XII (SKNA 401) and XV (GA 2) have one genotype. Intra cluster values ranged from 0.00 to 23.194 and cluster XIII is most diverse group. The inter cluster values ranged from 20.3 to 26809. Maximum divergence was noticed between clusters III (AmbikaGA12-1 and KBJ3) and XII (SKNA401) (26809) followed by clusters X (Suvarna) and XVI (AmbikaGA12-2 and BGA 2) (20017). The mean values for seed yield varied from 426.5 (Cluster IX) to 1191.667 (Cluster III). Days to maturity ranged from 148.17 (Cluster II) to 173.333 (Cluster XII and Cluster XV). Days to 50% flowering varied from 58.83 (Cluster II) to 94.5 (Cluster IX). Plant height ranged from 74.817 (Cluster VIII) to 104.525 (Cluster IX). Number of branches varied from 1.667 (Cluster X) to 3.2 (Cluster VI). Inflorescence length ranged from 20.167 (Cluster X) to 29.067 (Cluster XIII). 10ml Vol. Weight varied from 7.367 (Cluster IV) to 10.233 (Cluster X). Genotypes SKNA401, AmbikaGA12-1, KBJ3, Suvarna RMA51 and MGA15 being genetically diverse from rest of the genotypes could be used in hybridization with all the clusters.

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140.

Distribution of Arbuscular Mycorrhizal Fungi in Apple (*Malus Domestica* Borkh)

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Keywords: AMF, Apple, *Acaulospora, Scutellospora*, *Gigaspora, Glomus*

Introduction

Apple (*Malus domestica* Borkh) is considered as one of the most important and widely grown fruits in temperate zones of the world with regard to its acreage, production, economic returns and high nutritive value. Apple is the fourth widely produced fruit in the world after Banana, Orange and grape Mycorrhiza is a mutualistic association between fungi and roots of higher plants.Frank (1885) was the first to coin the term "mycorrhiza" (literally meaning the fungal roots) for designating a symbiotic relationship between fungi and plant roots. The important genera of endomycorrhizal fungi reported so far are *Acaulospora, Entrophosphora, Gigaspora, Glomus, Sclerocystis* and *Scutellospora*.

Materials and Methods

The present investigation was carried out in 2013-15 at Regional Research Station and Faculty of Agriculture, Sher-e-Kashmir University of Agriculture Sciences and Technology of Kashmir, Wadura, Sopore. The area of study was district Pulwama, villages selected were ten. From each village three orchards were selected with one representative sample from each orchard. Rhizosphere soil samples were collected from the apple field/orchard for isolation, enumeration, identification and root colonization studies of of arbuscular mycorrhizal fungal propagules/spores.

Results and Discussion

The data presented in Table 1 indicates that *Glomus* spores were more predominant with highest number from Gungoo (4/gram) followed by *Acaulospora* which was higher in number from Tikkin, Pinglin and Puhoo (3/gram).Spores of *Scutellospora* were rarely found with least number from Drubgam and Gungoo (1/gram). Highest number of unidentified genera was found from Pinglin (6/gram).Four Arbuscular mycorrhizal fungi genera were identified during the present investigation. There was no evidence of any ectomycorrhizal association with apple roots, and this corroborates with the findings of Greene *et al.* (1982). *Glomus* sp. was common and made up for more than 75% of total isolates followed by *Acaulospora, Gigaspora and Scutellospora.* The predominance of *Glomus* sp. under varying soil conditions might be due to the fact that they are widely adaptable to the varied soil conditions and survive in acidic as well as in alkaline soils.

Table 1: Isolation of arbuscular mycorrhizal spores from rhizospheric soil of apple from different locations of District Pulwama

Locations	Spore count per gram of soil (Identified Genera)				
	Acaulospora	*Scutellospora*	*Gigaspora*	*Glomus*	Unidentified Genera
Rajpora	-	-	1	2	4
Shadimarg	2	-	3	3	4
Nikas	1	2	-	-	4
Drubgam	-	1	1	2	3
Shiekar	2	-	1	-	5
Tikkin	3	-	-	3	4
Sunsomil	-	-	2	2	4
Pinglin	3	2	1	-	6
Gungoo	-	1	-	4	3
Puhoo	3	-	-	-	5

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141.

Morphological Characterisation and Diversity Analysis for Exploitation of Indigenous Landraces of Pulse Crops for Yield Improvement under Andaman & Nicobar Island Agro-ecosystem

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Keywords: Mungbean, urdbean, pigeonpea, landraces, Bay Islands

Introduction

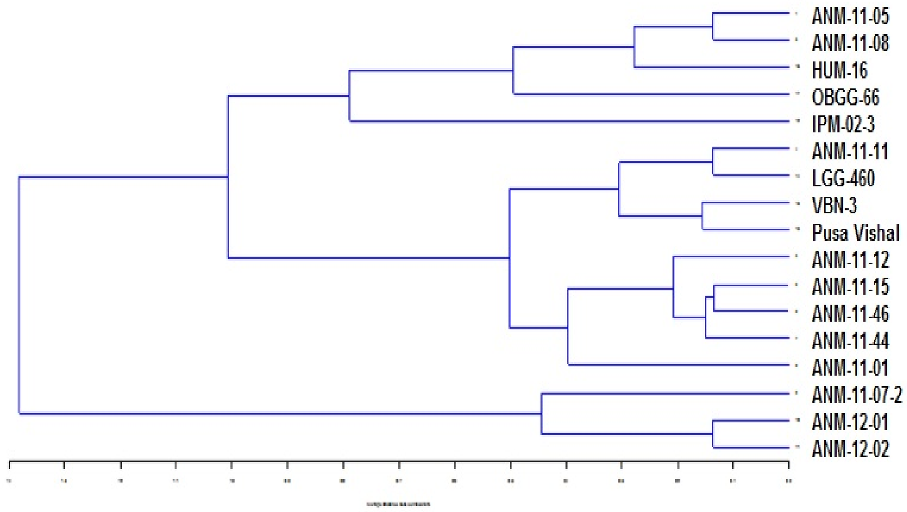
Pulse crops have great potential in alleviating protein hunger and malnutrition among vegetarian population in most of the developing countries. Besides, pulses have an ability to fix atmospheric nitrogen in to the soil through symbiotic nitrogen fixing bacteria, thereby reducing the cost of nitrogen inputs of the farmers. Major grain legumes, including mungbean, urdbean and pigeonpea occupy considerable area under cultivation in these islands and form an important constituent of diets for both vegetarian and non-vegetarian people. The mungbean, urdbean and pigeonpea in general were domesticated in these islands by the settlers or from different parts of India and Bangladesh.

Materials and Methods

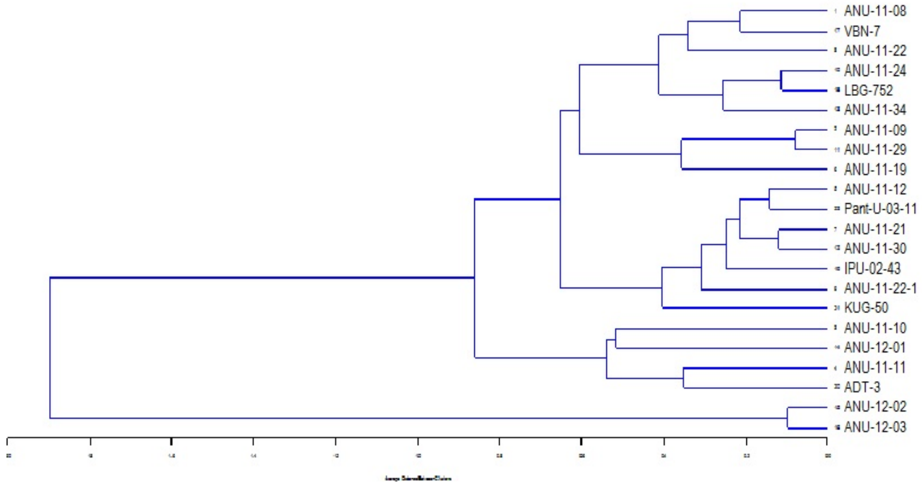
Pulse crops genetic resources of cultivated landraces are present in the form of farm saved seeds of mungbean (*Vigna radiate* L. Wilczeck); urdbean (*Vigna mungo* L. Hepper) and pigeonpea (*Cajanus cajan* L.) landraces were collected from different parts of the Andaman and Nicobar of Islands of India and some advanced cultivars from the different parts of India. The collected indigenous landraces and advanced lines or cultivars were analysed to determine genetic variability for plant ideotypes and morphological attributes, to understand the genetic basis of diversity and to study the genetic response for adaptation to islands conditions. These were evaluated in different seasons at Research Farm, CIARI, Port Blair for various agro-morphological markers and biotic resistance to determine the genetic diversity present among the indigenous landrace

Results and Discussion

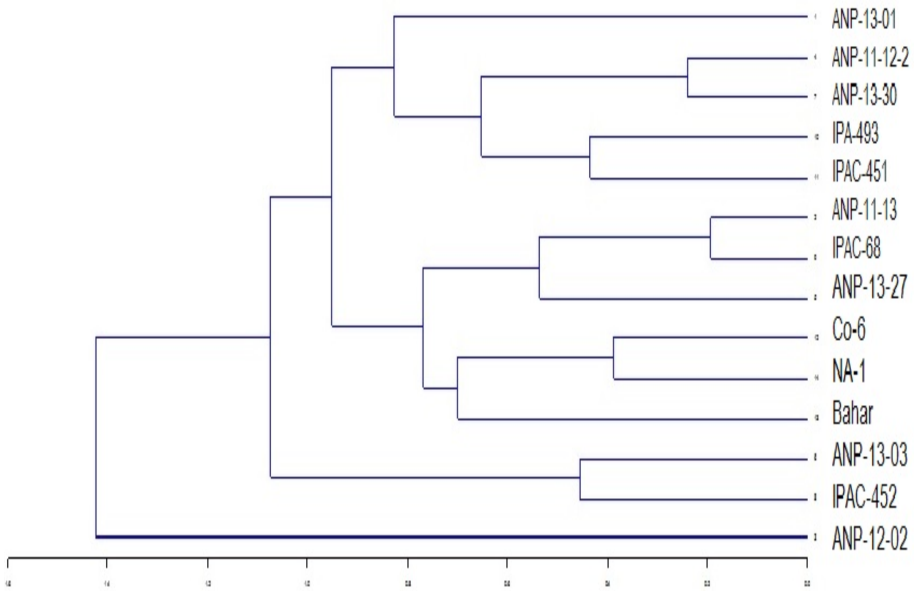
Eleven promising landraces in mungbean, 16 in urdbean and 7 in pigeonpea were identified as the potential genetic resources derived with wider genetic variability for the traits of economic importance and major biotic stress. Some genotypes in both crops also showed resistance to aphids under natural field conditions. There were significant genetic variability were recorded for all the three pulse crops for most of the agro-morphological markers namely, days to 50% flowering, days to maturity, plant height and seed yield per plant. The clustering separated variability among the accessions according to seed yield per plant. There was close clustering within and between accessions collected from the North and Middle Andaman Islands distinctly separated with advanced breeding lines. A total of 2 major groups were defined through cluster analysis and significant variation among the landraces, genotypes and established cultivars were observed. Agro-morphological profiling of using cluster analysis by unweighted pair group method with arithmetic mean method, all genotypes were grouped into 2 major groups and one minor group. The landraces ANM-11-02, ANM-11-12, ANM- 12-01, ANM-11-05, ANM-11-08, ANM-11-15, ANM-11-46 and ANM-11-07-2 in mungbean whereas, ANU-11-19, ANU-11-10, ANU-11-29, ANU-11-34 and ANU-11-09 in urdbean and ANP-12-02, ANP-11-12-2, ANP-13-01, ANP-13-03, ANP-11-13, ANP-13-27 and ANP-13-30 exhibited superiority to standard checks for seed yield and other secondary traits. Thus these landraces can be used for release as varieties for local cultivation. These can also serve as donors to increase number of improve cultivated varieties by transferring in them the economically valuable traits like pods per plant, length of pods, number of seeds per pod, 100-seed weight and disease resistance.



a. (Mungbean Advanced breeding Lines)



b. (Urdbean Advanced breeding Lines)



c. (Pigeonpea Advanced Lines)

Genetic diversity assessment among advanced breeding lines of mungbean (a), urdbean (b) and pigeonpea (c) landraces under AVT-II

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Andrographis paniculata and *Dicoma tomentosa*: Medicinally important weeds

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Keywords: *Andrographis paniculata* and *Dicoma tomentosa* as medicinally useful weed, natural product

Introduction

Some weeds are cause of detriments in natural ecosystem. On the other hand there are also a number of desirable weeds having prominent medicinal value for human health or have other environmental benefits. A number of such plants are traditionally used among many tribal communities. *Andrographis paniculata* belongs to family Acanthaceae. It is a cold property herb and is used to get rid of body heat. *Dicoma tomentosa* from Asteraceae family has antibacterial property. Due to multiple pharmacological properties these plants were explored for identification of their active natural products.

Materials and Methods

Biomass of *Andrographis paniculata* and *Dicoma tomentosa* were procured from the fields of Jammu district and Amer (Jaipur) respectively. Air dried plant material was extracted first with hexane followed by a polar solvent. By different chromatographic techniques viz. column, TLC, HPLC a number of natural products were isolated and identified for further studies.

Results and Discussion

Andrographis paniculata has diterpenoid lactones with multiple pharmacological activities such as anti cancer, antipyretic, hepatoprotective, anti hyperglycemic, anti oxidant, antimicrobial etc. *Dicoma tomentosa* has sesquiterpene lactones with anti-plasmodial activity. The leaves are used as febrifuge, as a local application to putrescent wounds. By exploring the folkloric knowledge and proper identification several significant weed plants can be distinguished and phytochemically investigated for new compounds.

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143.

Ecological Characteristics of *Sterculia urens*

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Keywords: *Sterculia urens,* stand structure, regeneration, conservation

Introduction

Sterculia urens Roxb., Gum Kadayo, is one of the commercial important Non-timber Forest Producing (NTFP) species and used in food, pharmaceutical industries and medicine purpose. Karaya is a native of dry deciduous forests of dry rocky hills having tropical climate. There is a great demand for gum of Karaya; in fact, it is one of the major sources of income to the tribal/rural people in the country. Presently, raw materials are procuring from the natural source. Thus, domestication is very important for tapping large quantity of gum in this species. Study of ecological aspect may help in large scale plantations and for further management in their native habitat.

Materials and Methods

Present study was undertaken to study ecological structure of *S. urens* in Vansda National Park (Lat: 20°46' N; Long: 73°28' E) of Navsari district. This species is also found in Dharampur Forests (Lat: 20°45' N; Long: 73°21' E) of Valsad district in Southern Gujarat and the same was also used in the study. Ecological characteristics such as stand growth, species association, phenology and natural regeneration were assessed as per standard procedures.

Results and Discussion

In Vansda National Park (VNP), the trees occurred mainly in the slope of rocky hills along the river side, whereas in Dharampur Forest (DF), the trees were found in diverse topographical conditions like near river bank, plain area, along roadside, top of rocky hills and also in the slopes of rocky hills. Tree dispersion pattern was random in both the location. In a patch, number of trees varied from 2-3 and rarely it was 5 trees in a clump. Total > 30 trees were recorded. Tree growth was more in DF than VNP sites (Table 1). Flowering phenology showed that many trees flowered during Dec to Mid Feb and fruited in Mar to Apr at VNP. Crow and common Myna were noticed as common flower visitors and monkey and squirrel are visited for the nuts. *Tectona grandis, Dendrocalamus strictus*, *Wrightia tinctoria, Oroxylum indicum, Garuga pinnata* and *Ougeinia oojeinensis* were recorded as associated species in VNP; whereas in DF, stand was dominated by *Tectona grandis* and *Carissa carandas*. Girth distribution ranged from 14 to 330 cm in VNP, 59 to 253 cm in DF (Table 1). There was a lack of regeneration in studied sites indicating there is threat and it needs conservation attention. Result of stand structure is line with Gujarat Forest Department report showing less of young trees in different stand of Gujarat (GFD, 2008). Artificial regeneration varied greatly among VNP (53.3 to 100%) and DF seed sources (0 to 66.67%). It is concluded that there was a good growth having lack of regeneration of *S. urns* in studied sites. Information presented here may be useful for conservation of *S. urnens.*

Table 1: Growth structure of *Sterculia urens* in studied sites (VNP and DF) in Southern Gujarat

Location		Tree height (m)	Girth at Breast height (GBH in cm)	Clear bole height (m)	Crown Diameter (m)
Vansda National Park (VNP)	Min.	2.50	14.00	1.20	0.55
	Max	22.00	330.00	13.10	11.5
	Mean	10.68	96.71	5.88	5.42
Dharmpur Forest (DF)	Min.	7.00	59.00	3.00	4.05
	Max	24.00	253.00	18.00	17.25
	Mean	14.07	140.42	8.62	8.63

Reference

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144.

Breeding Biology of *Milvus mirgans* in Different Type of Agricultural Areas of Punjab

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Keywords: Breeding biology, agricultural transects, mating, nesting

Introduction

Eagles are excellent biological indicators of ecosystem health. They act as predators and scavengers in nature. *Milvus mirgans* are distributed in Europe, Asia, Africa and Australia. Major decline in population of raptors has been reported in recent time due to agricultural practices, habitat destructions and modifications. *M. migrans* is an important avifaunal component of agro-ecosystem which has survived the change of greatly reduced tree density and diversity over the years in the state of Punjab. Plantations of eucalyptus and poplar have today replaced the indigenous trees of the state. A study was conducted to understand if there is any effect on the breeding biology of *M. migrans* in the changed scenario of Punjab.

Materials and Methods

Breeding biology was studied in three different agricultural transects of Punjab Agricultural University as given in Table 1. The study was conducted for two breeding seasons. Line transect method was used to study the success of nesting, breeding, egg laying, incubation period and hatching in all transects. Preferred area for breeding and preferred tree for breeding was studied during the study period.

Table 1: Transect and there tree density, diversity and predominant tree species

Transect	Tree Density/ Ha	Tree Diversity/ ha	Predominant trees in transect
1 Agricultural Field	0-2	0-2	Poplar, Neem
2 Forestry Field	3-15	2-10	Silveroak, Neem, Sapt Parni, Eucalyptus
3Commercial Tree plantation	15-40	1	Poplar

Results and Discussion

The breeding season of *M. migrans* begins in winter. Nesting starts in December and mating started when the nest was partially built. The nest was a rough platform of twigs and rags placed with the main branch of tree. After pairing, the male frequently copulates with the female. Both the male and female take part in nest building, incubation and care of chicks. Egg laying occurred in January. The typical clutch size was 2 or sometimes 3. The incubation period varies from 30-34 days. The preferred breeding area was observed in transect area 2 as given in Table 2. Breeding success was considered when nesting, egg laying and hatching was found successful in nest.

Table 2: Transect with breeding success in two seasons

Transect	Breeding success in season 1	Breeding success in season 2
Agricultural Field	0	0
Forestry Field	20	27
Commercial Tree plantation	0	0

No nest was observed in transect 1 and 3, which inferred that the *M. migrans* prefer areas with high tree diversity and density. No nest was found in poplar trees which advocate that *M. migrans* does not prefer nesting and breeding in Poplar plantation so the increase in Poplar plantation in Punjab may adversely effect the population of *M. migrans.* Maximum breeding was observed on Silver Oak followed by Sapt Parni and Eucalyptus. The study indicates that the breeding of *M. migrans* is tree specific and also depends upon tree diversity.

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Plant Specific Transcription Factors Associated With Diverse Phenomena Unique to Plants

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Keywords: Dof domain, transcription factor, transcriptional regulation

Introduction

Dof (DNA-binding with one finger) domain proteins are plant-specific transcription factors with a highly conserved DNA-binding domain, which presumably includes a single C2-C2 zinc finger. Each member of these families interacts with closely related DNA sequence motifs controlled by different regulatory signals. It has been proposed that the combination of different cis elements and trans-acting factors may produce the diversity and specificity required for the regulation of gene expression. Although, it has been shown that several plant DNA binding proteins containing well known motifs can activate transcription, however knowledge of the functions and physiological roles of most plant DNA binding proteins is still limited.

Materials and Methods

Meta analysis of the literature (Amado *et al.*, 2012; Cai *et al.*, 2013; Xia *et al.*, 2013) on dof was done to get an insight on Dof proteins which functions as a transcriptional activator or a repressor involved in diverse plant-specific biological processes of domain proteins play critical roles as transcriptional regulators in plant growth and development.

Results and Discussion

Analysis of literature revealed that many biological processes are strictly regulated through transcriptional control of particular genes in plants. There by, plants appear to need a large number of transcription factors governing proper and strict transcriptional regulation in response to developmental programs and environmental changes (Cai *et al.*, 2013). Plant genome sequences reveal that approximately 7% of all genes encode putative TFs. Dof (DNA binding with one finger) family, a particular class of zinc finger domain TFs is characterized by a conserved region of 50 amino acids with a C2-C2 finger structure, associated to a basic region, that binds specifically to DNA sequences with a 5'-T/AAAAG-3' core. Dof proteins have been reported to participate in the regulation of gene expression in processes such as seed storage protein synthesis in developing endosperm, light regulation of genes involved in carbohydrate metabolism, plant defense mechanisms, seed germination, gibberellin response in post-germinating aleurone, auxin response and stomata guard cell specific gene regulation (Amado *et al.*, 2012) The zinc finger of Dof protein is distinct from other known zinc fingers in terms of its amino acid sequence and arrangement of cystein residues for the co-ordination of zinc essential for DNA binding (Xia *et al.*, 2013) During the past decade, numerous Dof domain proteins have been identified in both monocots and dicots including maize, barley, wheat, rice, tobacco, *Arabidopsis*, pumpkin, potato, and pea.

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146.

Response of Different Cultivars of Blackgram (*Vigna mungo* L.) to Dates of Sowing as Influenced by Growth and Yield Attributes in Spring Season in Central Region of Uttar Pradesh (India)

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Keywords: Date of sowing, cultivars, blackgram and grain yield.

Introduction

Among pulses, blackgram/ mashbean/ urdbean (*Vigna mungo* L.) is highly nutritious with high digestible dietary protein (20-24%), carbohydrate, minerals and vitamins. Besides it improves the soil productivity on account of biological nitrogen fixation and in addition of organic matter. Being the most critical non-monetary input, date of sowing is highly influenced by the agro-climatic effect during the grain formation period because of that delayed planting would not be realized by agro-techniques. Delayed planting invariably reduces the yield, whereas early planting in the season may also not be advantageous, as the crop does not receive favorable environment at various physiological stages.

Materials and Methods

A field experiment was conducted during the spring seasons in 2012 and 2013 at the Oilseeds Research Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, India. The experiment was carried out with three sowing dates, 25th February, 10th March and 25th March and five high-yielding varieties of blackgram, namely, Azad-1, Azad-2, Shekhar-1, Shekhar-2, and Etawah local in RBD in tree replications. The number of pods per plant, number of grains per pod, 100-seed weight (g), and seed yield per plant (g) were recorded for the purpose.

Results and Discussion

Among the varieties, Shekhar-1 gave maximum mean yield (967.00 kg/ha) on 25th February followed by and Shekhar-2 (610.00 kg/ha) 10th March in 2012 (Table 2). In 2013 and Shekhar-2 was given maximum grain yield on 25 Feb. (1250.00 kg/ha) and 10th March (1135.00 kg/ha). The heavy reduction in yield was recorded in the later sowing on 25th March in both the experimental years in each of cultivars, may be due to lowest number of pods per plant, grain per pod, yield per plant and 100-seed weight. Therefore, it is concluded that early sowing of urd Shakhar-2 in spring season produces higher grain yield than any other cultivar of urd in central region of Uttar Pradesh.

Table 2: Interaction effect of sowing dates and varieties on grain yield of blackgram (kg/ha).

Date of sowing	2012				2013			
Varieties	25 Feb.	10 March	25 March	Mean	25 Feb.	10 March	25 March	Mean
Azad-1	491.00	475.00	301.00	422.33	1126.00	950.00	875.00	983.67
Azad-2	444.00	523.00	285.00	417.33	958.00	850.00	850.00	886.00
Shekhar-1	967.00	586.00	269.00	607.33	1060.00	1058.00	735.00	951.00
Shekhar-2	571.00	610.00	270.00	483.67	1250.00	1135.00	791.00	1058.67
Etawah local	491.00	530.00	360.00	460.33	750.00	800.00	810.00	786.67
Mean	592.80	544.80	297.00		1028.80	958.60	812.20	
SEm+	63.06				51.42			
C.D. at 5%	120.14				106.73			

147.

Performance of Malt Barley under Different Seeding Rate and Row Spacing on Yield, Quality and its Economics

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Keywords: Effect of seed rate and row spacing, quality, yield, economics

Introduction

The experiment was conducted at research farm of Department of Agronomy, CCS Haryana Agricultural University, Hisar (Haryana). Seeding rate, as well as the row spacing, is considered an important factor to optimize plant population. Whereas excessively high protein level is commonly associated with lower soluble substance content and malt extract quality, resulting in unacceptable malt quality. So, this study was conducted to investigate the effect of row spacing and seeding rates on mainly quality, yield traits and economics of the cultivar BH-885.

Materials and Methods

The geographical location of Hisar is 29°10' N latitude and 75°46' E longitude with an elevation of 215.2 m above the mean sea level. The experiment was carried out in a split- plot design with four different seed rate treatments *viz*. 75 kg/ha, 87.5 kg/ha, 100 kg/ha and 112.5 kg/ha as main plot treatment and three row-spacing *viz*. 18 cm, 20 cm and 22.5 cm as sub plot treatment with four replications. The total number of treatment was forty eight.

Results and Discussion

There was significant increase in grain yield of barley with the increasing levels of seed rate up to 100 kg/ha. However with seed rate of 112.5 kg/ha, there was an increase in the yield but, it was found to be non-significant when compared with the treatment where seed rate of 100 kg/ha was applied. Application of 100 kg/ha produced 19.24 and 7.0% higher grain yield over 75.0 and 87.5 kg/ha seed rate, respectively. Quality parameters including protein content and beta-glucan were highest recorded in 112.5 kg/ha seed rate followed by with the seed rate of 100 kg/ha. Higher malt content was recorded in the treatment where seed rate of 75 kg/ha was applied. All quality parameters were recorded highest with row spacing of 18 cm and highest grain yield was recorded at 20 cm of row spacing but it was found to be statistically at par with spacing of 18 cm showed in Table 1. Net return (Rs/ha) was also recorded highest with seed rate of 112.5 kg/ha followed by 100 kg/ha and row spacing of 20 cm as discussed in Table 2.

Table 1: Effect of seed rate and row spacing on yield and quality of two- rowed barley

Treatments	Grain yield (kg/ha)	Malt yield (%)	Protein content (%)	Beta- glucan (%)
Seed rate (kg/ha)				
75.0	4314	87.04	8.70	3.19
87.5	4970	85.99	8.83	3.45
100.0	5342	84.90	9.10	3.90
112.5	5542	83.67	9.34	3.98
SE (m)±	64	0.06	0.09	0.02
C.D at 5%	206	0.20	0.30	0.06
Row spacing (cm)				
18.0	5109	85.78	9.44	3.62
20.0	5116	85.50	8.88	3.55
22.5	4906	84.92	8.68	3.64
SE (m)±	29	0.04	0.12	0.02
C.D at 5%	84	0.13	0.35	0.06

Table 2: Effect of seed rate and row spacing on economics of two- rowed barley

Treatment	Cost of cultivation (Rs./ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B: C
Seed rate (kg/ha)				
75.0	26866	53229	26363	1.98
87.5	26989	61106	34117	2.26
100.0	27111	65183	38072	2.40
112.5	27234	67094	39860	2.46
Row spacing (cm)				
18.0	27234	62348	35114	2.29
20.0	27111	62350	35239	2.30
22.5	26989	60173	33184	2.23

148.

Comparative Response of Different Genotypes of *Brassica Juncea* to Anther Culture

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Keywords: Anther culture, haploids, *Brassica napus, Brassica juncea,* embryogenesis.

Introduction

Indian mustard is an important oilseed crop of the *Brassicaceae* family. The family *Brassicaceae* (= *Cruciferae*) contains over 338 genera and 3709 species. With the advent of biotechnology tools, plant tissue culture techniques have been refined and protocols have been developed to supplement the conventional crop improvement approaches. Anther culture is an efficient way of producing doubled haploid plants in *Brassica* species. Compared with the traditional production of genetically stable homozygous lines, microspore culture dramatically speeds up breeding process and facilitates the selection of recessive traits. In the present paper, we used different genotypes of *Brassica Juncea* and their crosses with Ogura restorer as background to evaluate the effect of anther culture response for haploid production.

Materials and Methods

Experimental material comprised of anthers (explant) got from four varieties of *B. juncea* (RH 406, RH 555, RH 749 and RH 832). In addition, crosses were attempted to get F_1 using Ogura restorer line as a female parent with the four genotypes**.** Different culture media were used to culture anthers. B5 medium (Gamborg *et al.*, 1968) and Murashige and Skoog medium (Murashige and Skoog, 1962) with growth additives like serine, glutamine, glutathione and silver nitrate were used to enhance embryogenesis. Growth regulators, 6-Benzyl aminopurine (BAP) and α- Napthalene acetic acid (NAA) were used alone or in various combinations with basal medium for callus induction.

Results and Discussion

In order to access the effect of anther culture response in different genotypes *of Brassica Juncea,* four different genotypes (RH 406, RH 555, RH 749 and RH 832) and their F_1's with Ogura Restorer (OR) as the background were evaluated with in two different media viz., MS and B5 with different concentrations of phytohormone from uninucleate stage anthers and subsequent plant regeneration in MS media with different concentrations and combinations phytohormone. Maximum callusing (%) response of anthers was observed in F_1 OR x RH 749 (20.37±1.44) while maximum percent embryogenic calli were obtained in genotype OR x RH 749 (20.35±2.68) on medium supplemented with B5 as basal medium with 100 mg/l sucrose, 30 mg/l glutathione, 100 mg/l serine, 0.05 mg/l BAP, 0.5 mg/l NAA and 10 mg/l silver nitrate. Rooting and hardening of plantlet was done on MS medium supplemented with different concentration of NAA and IBA. Among Out of sixteen anther culture media combinations tried, the best media were found to be ACM15 and ACM16 (containing B5 as basal medium with 100 mg/l sucrose, 30 mg/l glutathione, 100 mg/l serine, 0.05 mg/l BAP, 0.5 mg/l NAA and 10 mg/l silver nitrate in ACM15 and 20 mg/l silver nitrate in ACM 16) for all parents and F_1's.

Table 1: Response of anthers (%) of four hybrids of *B. juncea* cultured on different media combinations

Media code	RH 406		RH 555		RH 749		RH 832	
	Explants response (%)	Days to response	Explants response (%)	Days to response	Explants response (%)	Days to response	Explants response (%)	Days to response
ACM6	0	0	0	0	0	0	10.04±0.42	28.04±0.22
ACM7	0	0	10.04±0.42	31.58±0.25	0	0	0	0
ACM9	9.30±1.08	42.80±1.5	18.42±1.23	31.79±0.21	0	0	16.23±0.43	32.16±0.11
ACM12	05.03±1.23	23.03±1.23	0	0	0	0	13.21±1.20	31.13±1.15
ACM13	0	0	14.26±1.4	34.12±1.13	4.01±1.22	33.21±2.11	0	0
ACM15	27.17±1.40	29.04±1.04	21.51±1.29	33.42±2.43	14.45±1.40	33.12±2.14	22.13±0.24	36.70±3.11
ACM16	20.27±0.31	36.25±2.37	18.18±1.22	35.40±2.44	25.09±1.12	41.46±2.11	28.20±0.21	36.43±2.30
	OR x RH 406		OR x RH 555		OR x RH 749		OR x RH 832	
ACM6	0	0	0	0	0	0	7.94±0.76	25.32±0.97
ACM7	0	0	9.05±4.64	25.58±0.65	0	0	0	0
ACM9	6.30±3.20	33.80±1.28	11.08±1.07	26.79±0.48	0	0	12.04±0.33	27.26±0.41
ACM12	0	0	0	0	0	0	6.91±3.69	26.25±3.37
ACM13	0	0	10.66±5.92	25.24±1.93	0	0	0	0
ACM15	17.87±1.30	25.01±1.73	16.91±1.89	29.47±3.73	9.37±1.40	29.75±3.34	17.47±0.84	29.00±3.93
ACM16	14.97±0.62	28.85±3.37	13.18±1.82	32.40±4.74	20.08±1.32	32.76±6.17	20.80±0.34	31.53±5.90

ACM: Anther Culture Media;±: Mean Std. Error

149.

Evaluation and Identification of Potential Bivoltine Silkworm Hybrids of *Bombyx mori* L.

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Keywords: Adaptable, high yielding, diallel, evaluation index

Introduction

India is the second largest producer of raw silk in world after China with an annual production of 20,000 metric tonnes (MT). India being predominantly a tropical country with marginal sub-tropical and temperate sericulture zones. Mostly multivoltine breeds or multi x bivoltine hybrids are reared in tropical areas which is not so superior and hence, do not meet the international standards As a result, more emphasis needs to be given to bivoltine sericulture, which is the need of the hour to produce international grade silk. Realizing the importance of bivoltine sericulture, efforts are being made by breeders of the country to evolve high yielding bivoltine breeds/hybrids for commercial purpose.

Materials and Methods

With the objective of identifying adaptable, high yielding bi x bivoltine potential silkworm hybrids, the study was undertaken at Division of Sericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. For this purpose, four hypersericigenous (PO_1, PO_3, ND_2 and ND_5) and four thermotolerent (Udhey-1, Udhey-3, Udhey-4 and Udhey-6) breeds were crossed by employing full diallel method and studied along with ruling bivoltine hybrid, SH_6 x NB_4D_2. These hybrids along with the control were reared in the completely randomized block design with three replications each as per the standard rearing techniques. Data was recorded replication-wise and analyzed using multiple trait index (Evaluation index: EI) method.

Results and Discussion

Out of the fifty six hybrids evaluated, twenty two hybrids scored the average EI of >50 for the traits that contribute positively for silk yield ranging from 67.61-51.13 (Table 1), whereas, the control hybrid scored EI of 49.21 only. Evaluation index is one such method that increases the precision of selection of breeds/hybrids. By considering the average EI value of all the traits, PO_3 x ND_5 (67.61), ND_5 x PO_1 (63.35), PO_1 x PO_3 (61.34), Udhey-6 x ND_2 (61.25), Udhey -6 x ND_5 (60.65), Udhey -4 x ND_2 (60.19) and ND_2 x Udhey -6 (60.11) emerged as a potential hybrids. Hence, these hybrids could be further exploited for better prospects of sericulture

Table 1: Evaluation Index values of superior cross combinations or heterotic hybrids for commercial traits

Hybrids	Traits								
	Larval weight (g)	Crop weight (kg)	Single cocoon weight (g)	Single shell weight (g)	Shell ratio (%)	Average filament length (m)	Non-breakable filament length (m)	Denier (d)	Average E.I
SH_6 x NB_4D_2 (control)	50.83	45.11	64.82	49.66	31.90	45.62	44.87	60.89	49.21
PO_3 x ND_5	68.55	59.00	62.50	66.71	61.78	75.79	76.59	70.00	67.61
ND_5 x PO_1	59.26	64.66	66.92	68.00	56.26	67.22	66.17	58.27	63.35
PO_1 x PO_3	64.40	59.72	55.00	57.87	56.66	66.12	67.89	63.07	61.34
U*-6 x ND_2	61.44	60.16	60.83	67.27	65.35	66.22	67.98	40.76	61.25
U*-6 x ND_5	67.36	68.10	63.33	63.03	55.00	62.43	48.25	57.56	60.65
U* -4 x ND_2	53.75	61.60	59.16	63.93	61.78	57.25	51.74	72.30	60.19
ND_2 x U*-6	64.46	57.79	60.00	62.33	56.37	66.72	57.07	56.17	60.11
ND_5 x U*-3	50.05	56.89	55.08	58.66	57.00	62.20	69.88	64.03	59.22
ND_5 x U*-6	55.40	57.49	56.92	61.33	58.75	64.88	55.48	61.93	59.02
PO_1x ND_5	58.49	68.34	70.00	62.72	47.38	48.17	51.74	56. 92	58.12
ND_2 x PO3	63.44	39.53	44.12	59.33	73.39	62.95	61.49	60.36	58.07
U*-6x PO_1	57.30	55.52	54.16	56.36	56.19	64.72	66.63	47.69	57.32
ND_2 x U*-1	48.63	52.13	65.17	62.00	49.60	64.38	55.04	59.31	57.03
ND_5 x U*-4	50.12	57.41	52.10	59.00	61.46	54.75	53.53	62.98	56.42
U*-3 x ND_2	55.53	62.81	62.50	61.51	53.33	48.17	51.74	51.53	55.89
PO_1 x ND_2	59.67	57.40	60.83	60.90	55.00	53.56	56.59	41.53	55.68
PO_1 x U*-6	47.84	65.56	59.82	59.00	51.55	53.07	51.94	53.03	55.23
ND_2 x U*-4	68.64	50.09	55.61	59.00	56.84	51.06	43.28	55.65	55.02
PO_3 x ND_2	56.71	57.12	51.66	54.24	55.00	52.36	55.51	40.76	52.92
U*-3 x U-6	47.84	53.31	43.33	45.45	49.88	54.85	57.75	63.07	51.93
ND_2 x PO_1	54.77	48.06	56.75	59.00	55.38	44.78	45.14	45.18	51.13
U*-3 x PO_1	42.51	51.54	56.66	53.63	48.21	52.96	56.05	43.84	50.67

*Udhey

150.

Studies on Evaluation of Varieties and Transplanting Time for *Kharif* Onion Production

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Keywords: *Kharif* onion, varieties, transplanting dates, bulb yield

Introduction

Onion (*Alliun cepa* L.) is the most important alliums grown in India. It occupies an area of 10,52,000 ha with a total production of 1,68,13,000 metric tonnes (MT) and an average yield of 16.0 MT/ha (NHB, 2013). There has been a steady increase in area and production of onions in the last decade. India exports 4,16,000 MT of onion valued at Rs. 1630.6 million which accounted for about 75% of total foreign exchange earning among fresh vegetables. Besides the traditional *rabi* crop (winter season), the *kharif* crop (rainy season) is now being grown successfully in the north and eastern parts of the country which has revolutionized the onion production and marketing in the country. The *rabi* crop harvested in April-May is stored all over the country and slowly made available for domestic supply as well as export up to September-October. There is critical gap in supply of onion in the country from October to March and as a result the prices shoot up. A good harvest in *kharif* season can bridge the gap between demand and supply of onion during this dearth period. Further, production of onion during kharif season offers a good alternative to the farmers for obtaining higher returns. Therefore, an experiment was conducted during 2014-15 to assess the effect of varieties and planting time on *kharif* onion production under subtropical conditions of Chamba district.

Materials and Methods

Four cultivars of onion namely N-53, Nasik Red, Agrifound Dark Red (AFDR) and Agrifound Light Red (AFLR) were transplanted on five dates separated by ten days interval starting from 15th July to 25th August in 2014. The experiment was laid out in randomized block design with three replications for each treatment. Healthy seedlings were transplanted on raised beds at a spacing of 15 x 10 cm in plots of 3.0 x 3.0 m^2. All the observations pertaining to traits were; plant height (cm), neck thickness (cm), bulb diameter (cm), weight of bulb(g), days for harvesting, TSS and yield (q/ha) were taken by randomly selecting twenty healthy plants from each plot. Standard package and practices were followed for raising the crop as per the recommendations of the University.

Results and Discussion

There was a significant impact of varieties, transplanting dates and their interaction on bulb diameter, bulb weight and yield. The maximum bulb diameter (5.52 cm) and highest bulb weight (58.65 g) among cultivars was noticed in cultivar Agrifound Dark Red. The yield of onion was significantly affected both by varieties and transplanting dates. The highest average yield (197.98 q/ha) was observed in cultivar AFDR. The highest bulb yield (189.92 q/ha) among transplanting dates was noted on fourth transplanting date D_4 (15th August) followed by third transplanting date D_3 i.e. 5th August with yield 180.25 q/ha. Therefore it can be summarized that among the cultivars under study, Agrifound Dark Red is the best suited cultivar for kharif onion production under subtropical conditions of Himachal Pradesh and it should be transplanted around second fortnight of August for maximization of bulb yield.

Table: Effect of varieties and date of transplanting on total yield (q/ha) in onion

Varieties		Transplanting dates				
	D_1 (15th July)	D_2 (25th July)	D_3 (5th Aug)	D_4 (15th Aug)	D_5 (25th Aug)	Mean
V_1 (AFLR)	142.2	153.3	160.1	169.7	154.2	155.90
V_2 (N-53)	169.7	177.5	186.3	195.5	183.9	182.58
V_3 (AFDR)	187.8	193.4	200.3	210.6	197.8	197.98
V_4 (Nasik Red)	160.1	169.4	174.3	183.9	172.2	171.97
	164.95	173.40	180.25	189.92	177.05	
CD $_{(0.05\%)}$	Variety Date Variety x Date		8.45 18.55 29.48			

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Effects of Different Doses of Lead on Morphological and Biochemical Parameters of Chickpea (*Cicer arietinum* L.)

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Keywords: Chickpea, lead, germination, chlorophyll

Introduction

Chickpea (*Cicer arietinum* L.) is an important pulse crop grown and consumed all over the world. India is the largest chickpea producing country accounting for 66% of global chickpea production. Heavy metal ions present in the soil can be taken up alongside nutrients with. Plants are the target of a wide range of pollutants that vary in concentration, speciation and toxicity. Among common pollutants that affect plants, lead is one of the most toxic and frequently encountered (Shahid *et al.*, 2011) and is known to induce a broad range of toxic effects to living organism, including those that are morphological, physiological, and biochemical in origin. (Sharma and Dubey, 2005)

Materials and Methods

The healthy seeds of two varieties of chickpea (*Cicer arietinum* L.) NBeG13 and PBc161 were surface sterilized with to prevent any fungal contamination. Petri dishes were sterilized in oven at 80°C for 1 hour. Ten seeds were sown in each petridish Metal treatment of lead was prepared using lead oxide (Pbo2) with concentrations of 5ppm, 10ppm, 20ppm, 40ppm, 80ppm and 160ppm At the start of each experiment 5ml of respective treatment was given to each petridish. The control received only 5ml of double distilled water. There were three replicates per treatment and the petridishes were kept at room temperature.

Results and Discussion

From the experimental study it was observed that in both the varieties the growth parameters like germination percentage radical length, plumule length, number of lateral roots, tolerance indices, moisture percentage, fresh and dry weight and biochemical parameters like chlorophyll-a, chlorophyll-b total chlorophyll, total carotenoids and protein content showed a significant decrease with increasing concentration of lead (0-160 ppm). The data regarding germination percentage, chlorophyll-a and chlorophyll-b presented in the table showed that there was no significant effect in germination percentage upto 5ppm lead concentration in NBeG-13 after this germination percentage showed gradual reduction while as in PBC-161 germination percentage decreased after 0 ppm concentration. The Chlorophyll-a showed marked decline with increase in concentration of lead. The maximum reduction was observed at 160ppm in both the varieties. Chlorophyll -b was found significantly effected by lead. The chlorophyll -b showed marked reduction with the increasing concentration of lead. Based on these observations it was concluded that the PBC-161 variety of chickpea (*Cicer arietinum* L.) is less tolerant to lead than NBeG-13.

Table 1: **Effect of different concentration of lead on germination percentage, chlorophyll-a and chlorophyll-b on two different varieties of chickpea**.

Treatments	Germination %		Chlorophyll a		Chlorophyll b	
	NBeG-13	PBC-161	NBeG-13	PBC-161	NBeG-13	PBC-161
0ppm	96.67	100	0.85	0.74	0.54	0.5
5ppm	98	95.33	0.84	0.73	0.52	0.49
10ppm	99.67	90.33	0.8	0.69	0.5	0.47
20ppm	90.33	97.67	0.7	0.63	0.47	0.43
40ppm	82.33	82.33	0.64	0.6	0.42	0.39
80ppm	72.33	75.67	0.6	0.53	0.37	0.31
160ppm	61	61	0.5	0.44	0.3	0.28

References

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152.

Morphological Characterization of *Imperata cylindrica* and Gene Action for Different Haploid Induction Parameters in Wheat x *I. cylindrica* System

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Keywords: Wheat, *Imperata cylindrica,* haploid induction parameters

Introduction

Doubled haploidy breeding is an important biotechnological tool to fix desirable characters of recombinants instantly within one generation, thereby saving four to five generations of varietal development programmes. The wheat (*Triticum aestivum*) x *Imperata cylindrica* approach is an efficient alternative to the wheat x maize system for obtaining the high frequency of haploid and doubled haploids in wheat and triticale. The present investigation was carried out to characterize different *I. cylindrica* genotypes at morphological level and estimate different components of variance to elucidate the gene action for haploid induction parameters.

Materials and Methods

The materials included five diverse *I. cylindrica* genotypes *viz.,* Ic-Pbr, Ic-Pye, Ic-Aru, Ic-Sri and Ic-Jp from different geographical locations which were used to pollinate the wheat F_1s for induction of haploids. The diversity among these genotypes was recorded on different morphological characters. Twenty one different wheat F_1s were pollinated with various *I. cylindrica* genotypes and the haploids were produced as per the protocol given by Chaudhary *et al.* (2005). The haploid embryos were rescued on artificial Murashige and Skoog (MS) medium from the fluid filled pseudoseeds lacking endosperm. The data obtained on haploid induction parameters was used to compute different genetic variance components to calculate variance due to general combining ability (σ^2gca) and specific combining ability (σ^2sca).

Results and Discussion

The *I. cylindrica* genotypes showed differences for plant height, leaf length, leaf width, flowering time (initiation and duration) spike length and anther colour. The genotype Ic-Aru was taller (81.20 cm) as compared to other genotypes, where as leaf length-width ratio was higher for the genotype Ic-Pye (38.67). For all the haploid induction parameters, the magnitude of dominance variance component (σ^2_D) was higher than the additive variance component (σ^2_A) as a result of which the degree of dominance $((\sigma^2_D/\sigma^2_A)^{1/2})$ was found to be more than one. These results reveal that the relative magnitude of σ^2_{sca} is higher than σ^2_{gca}, indicating the predominant role of SCA for all the haploid induction parameters.

Table 1: Estimates of genetic components of variance for various haploid induction parameters

Genetic parameters	Haploid induction parameters			
	Pseudoseed formation	Embryo formation	Haploid regeneration	Haploid formation
σ^2 gca	0.22	0.26	0.08	0.16
σ^2 sca	21.50	8.25	11.03	6.91
σ^2 A	0.45	0.52	0.17	0.33
σ^2 D	21.50	8.25	11.03	6.91
$(\sigma^2 D/\sigma^2 A)^{1/2}$	6.87	3.97	7.94	4.53

σ^2A= Additive genetic variance; σ^2D= Dominance variance

Conclusively, it can be stated that in order to induce haploids at higher frequency through *I. cylindrica-mediated* approach, it may be advantageous to use the early segregating generations (F_2 or F_3) when the amount heterozygosity is higher than the late segregating generations. In addition, the diversity present among the *I. cylindrica* genotypes suggests that there may be variations for haploid inducing efficiency of various *I. cylindrica* genotypes when crossed with wheat. So, the further studies must be conducted in order to identify the most efficient *I. cylindrica* genotypes as pollen source for enhancing frequency of haploid production in wheat.

Reference

Chaudhary H K, Sethi G S, Singh S, Pratap A and Sharma S 2005. Efficient haploid induction in wheat by using pollen of *Imperata cylindrica*. *Plant Breeding* **124**: 96-98.

153.

Crop Environment Interaction Assessment in *Brassica rapa* var. Brown Sarson under Kashmir Conditions

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Keywords: Brown sarson, stability, G x E interaction, Eberhert and Russel model

Introduction

Brassicas have been very important as food crops in the form of vegetables, feed and fodder, green manure and oilseeds. *Brassica rapa* (A genome, n=10) belongs to the *Cruciferae* (Brassicaceae) family. In the state of J&K, it is the major oilseed crop grown on a large scale on stored moisture regimes of winter snowfall. In addition to this, the constraints for achieving higher productivity of the crop include cultivation under sub-marginal conditions, non-availability of adequate quantities of quality seed together with low adoption of management practices recommended for realizing higher yields. So in order to diversify the varietal profile of brown sarson in the valley, it is necessary to identify and evolve more number of genotypes possessing high production potential and better quality through the application of sound breeding programme.

Materials and Methods

The study was conducted during rabi 2013-2014 in three districts of the state J&K namely Anantnag, Pulwama and Kulgam. The basic material for the study comprised 10 genotypes of brown sarson (*Brassica rapa* L.). Each genotype was grown in a 3-row experimental plot of 3 metre length with inter and intra row spacing of 30 and 10 cm, respectively. The experimental fields were well prepared and all the recommended packages were adopted to raise a good crop. The data for following quantitative traits was recorded from ten competitive plants from each replication for various morphological, agronomical, yield and yield attributing traits. Each selected plant were taken at random from each experimental plot in a replication and tagged for recording bio-metrical observations. Mean value of all characters and median values for days to flowering and days to maturity were worked out. The data generated from was analyzed through ANOVA.

Results and Discussion

Mean squares arising due to genotypes x environments (G ×E interaction) revealed significant differences for all the traits, revealing that the genotypes were having, by and large, significant differential response to the changing environments. Component analysis of the environments + (genotype × environment) interaction [E + (G × E)] was significant for all the traits (Table 1). Genotypes KBS-49 and KBS-33 were also identified as most stable based on stability analysis across all the test environments/locations for yield and other desirable traits put emphasis on the role of further evaluation both spatially and temporally so that the recommendation of the said genotypes can be suggested with authenticity. Non-linear component of S^2d_i (representing deviation from the regression slope) was non- significant in most of the cases and thus the prediction of stability was more or less accurate. Highest mean performance for seed yield plant^{-1} was observed to be higher in KBS-49 (6.68 g) which was surpassing both the checks KS-101 (3.67 g) and SBS-1 (3.52 g).Stability parameters for oil content revealed that the genotypes KBS-33 and KBS-49 were having 25% more oil content as compared to the check varieties.

Table 1: Analysis of variance for stability of different traits in *Brassica rapa* var. brown sarson genotypes over environments

Source of Variation	d.f	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches/ plant	Length of main raceme	No. of siliquae on main raceme	No. of siliqua/ plant	No. of seeds/ siliqua	Seed yield/ plant (g)	1000 - seed weight (g)	Oil content (%)
Genotypes	9	10.231*	40.285**	71.006**	0.203**	35.723*	38.512**	101.217*	7.722**	0.725**	0.032**	5.139**
Environment + (Genotypes × Environment)	20	1.166*	0.246**	0.218**	0.002**	0.127**	0.192**	0.230**	0.244**	0.001**	0.010**	0.124**
Environment	2	0.514**	2.178**	1.821**	0.012**	2.227*	2.816**	3.126**	3.021**	0.018**	0.023**	1.241**
Genotypes × Environment	18	0.124*	0.206*	0.102*	0.013**	0.022*	0.016*	0.016*	0.014*	0.010*	0.002**	0.013*
Environment (linear)	1	1.132**	3.243**	3.414**	0.015**	3.021**	4.123**	4.433**	4.002**	0.024**	0.052**	2.622**
Genotype × Environment (linear)	9	0.114*	0.127*	0.421*	0.002*	0.014**	0.013*	0.032**	0.024**	0.012**	0.011**	0.021**
Pooled deviation (non-linear)	10	0.030**	0.023*	0.118**	0.014*	0.034*	0.024*	0.037*	0.025*	0.018*	0.023*	0.049*
Pooled error	54	0.011	0.025	0.021	0.031	0.017	0.028	0.024	0.016	0.003	0.006	0.023

*Significant at p=0.05; **Significant at p=0.01

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Crop Environment Interaction Assessment Using Advanced Technologies Impact of Rainfall Pattern on Mango and Sweet Orange Productivity in Marathwada (MS)

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Keywords: Variability, annual rainfall, linear trend, mango and citrus species.

Introduction

Marathwada region of Maharashtra state comprised of 8 districts, lies between 17°35′ to 20°40′ N latitude and 74°40′ to 78°16′ E longitude. The altitude ranges between 300 to 900 meters above sea level. The monsoon commences from June and terminates at September end. Around 82.19% of annual rainfall is concentrated in these months. The main fruit crops grown commercially in Marathwada are Mango (*Mangifera indica*) (21,247.61 ha), Sweet Orange (*Citrus sinensis*) (49,669.08 ha.) and Banana (*Musa balbisiana*) (26,362.54 ha.) (Mundhe, 2015). Hence, the study entitled "Impact of Changing rainfall trend on yield of mango and sweet orange in Marathwada Region" was undertaken.

Materials and Methods

The present study deals with the rainfall characteristics of the Marathwada region which include the spatial distribution and variability through different season. The study is based on 30 year annual rainfall data for seven districts in Marathwada region. The Hingoli district established recently and hence weather data was not received. The data was collected from the different agromet observatories present at different centers which comes under Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani and Forecasting Agricultural Output Using Space Agrometeorology and Land Based Observation (FASAL) unit of Parbhani unit of Parbhani. The data collected for each district of Marathwada region were subjected to statistical analysis such as mean (A), standard deviation (S.D.), coefficient of variation (C.V.) Extreme lowest and highest and rainy days and trend was worked out by excel software.

Results and Discussion

The study revealed that increasing trend (0.59 mm yr^{-1}) of annual rainfall in the Marathwada region was observed and similar trend was seen within the some districts of Marathwada region (Fig. 1). The decreasing trend within the district was observed in Aurangabad (-1.3 mm yr^{-1}), Parbhani (-0.2 yr^{-1}), Latur (-1.6 mm yr^{-1}), Beed (-1.2 mm yr^{-1}) and increasing trend was observed in Nanded (+2.4 mm yr^{-1}), Osmanabad (+2.8 mm yr^{-1}), Jalna (+3.4 mm yr^{-1}). However, rainfall trend was ranged in between -1.6 to + 3.4 and though it was found statically significant, it may be a non-significant change for agriculture. It is because of the increasing or decreasing trends and coefficient of regression showed very low. While, the trend of rainy days for Marathwada shows decreasing pattern (-0.87 R.D. yr^{-1}) and it varied district to district. Especially the rainfall (Unseasonal rainfall) during bahar treatment (i.e. the flowering is usually forced by withholding irrigation water) causes negative effect and it destructs the bahar treatment. This enhances the vegetative growth rather than the reproductive growth (i.e. flower bud or fruit bud initiation, blooming etc.).

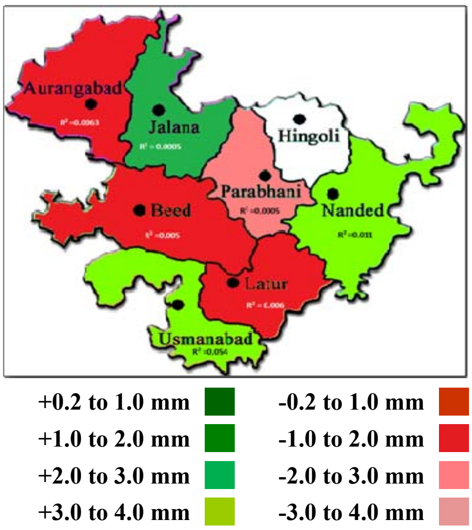

Fig. 1: District wise annual mean rainfall trend of Marathwada region.

The data revealed that more variation in production (i.e. yield) than the productivity. This may be due to increasing or decreasing area under cultivation as well as rainfall quantity and its distribution (quality). While, the year to year variation in productivity was observed because of short term weather calamities namely unseasonal rainfall during productive growth stages (i.e. bahar stage). It was observed that the more yield obtained during high rainfall years and vice versa. However some years though rainfall obtained more productivity was found less and vice versa it was because of uneven distribution of rainfall and other uncongenial weather elements. It is also understood that the productivity of the mango and sweet orange not only depends on the annual mean weather condition but also depends on seasonal and week to weather condition. As well as most important weather parameter affected on productivity of mango and sweet orange was observed rainfall in terms of quantum and distribution along with diurnal temperature.

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Impact of Agrochemicals on Environment and Farmers' Perception

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Keywords: Agrochemicals, perception, impact, environment

Introduction

Environment literally means surrounding and everything that affect an organism during its lifetime is collectively known as its environment. Our environment is often exposed to chemical contaminations; these contaminations may be due to various reasons but most of the times it is due to the use of agrochemicals. Use of agrochemicals in agriculture is obvious for the prevention of crop damaging insect pests, but these agrochemicals also cause environmental hazards. The present study deals with the perception of farmers regarding the adverse impacts of agrochemicals on environment and impact of agrochemicals on their environment.

Materials and Methods

The study was conducted in Haryana state which is geographically located at 30.73°N and 76.78°E. Two districts from Haryana state namely Karnal and Sirsa were selected purposively, as the consumption of agrochemicals is the highest in these two districts. From each districts seven villages were selected. From Karnal district district Pabana Hassanpur, Padhana, Shyamgardh, Gangar, Chapra Kheda Rasoolpur, Phoosgardh and Sohana were selected. From Sirsa district Rupana Khurd, Bakriyawali, Panihari, Kheja Kheda, Shahpur Begu, Farwain Khurd and Bajekan were selected. From each village ten farmers were selected randomly. Thus total number of fourteen villages and one hundred forty farmers were selected for the study.

Results and Discussion

Most of the farmers perceived it correct that agrochemicals can cause various problems in animals and birds like reduced reproduction and hatching, lowered life span, poisoning, fertility risks, accumulation of chemicals, lowered milk production and still birth (Table 1). Result pertaining to the positive impact of agrochemicals indicated that almost all the farmers observed positive impacts like controlled population of insect pests and insect borne diseases, reduced encroachment and deforestation, soil erosion and availability of more space for birds and animals. Regarding the negative impacts also almost all the farmers observed surface and ground water contamination, eutrophication and sedimentation, damage to aquatic life, killing of non target species, reduced population of birds and animals, and loss of biodiversity. It is apparent that there were noteworthy adverse effects of agrochemicals on environment and it is required to reduce it. It is certainly required to explore various other fields of agriculture like biodynamic agriculture, Cowpathy, homeofarming and many others which can help to perform agriculture in a more sustainable way without causing imbalance in environment. Exploring these forms will encourage farmers to reduce the use of agrochemicals and check environmental pollution.

Table 1: Farmers perceptions about agrochemicals

Positive impact on environment	**Percent farmers reporting**
Controlled population of insect and pest	100
Reduced encroachment	83
Reduced deforestation	83
Less amount of sediment runoff	81
Reduced soil erosion	81
More space available for birds and animals	81
Control over insect born diseases such as malaria	64
Negative impact on environment	
Surface water contamination	100
Eutrophication and sedimentation	100
Pesticides in aquatic body kills aquatic life	100
Ground water contamination	100
Killing of non target vegetation	100
Reduced population of birds and animals	82
Loss of biodiversity	82

Decimals rounded up to whole numbers

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Effect of Different Planting Dates on Growth, Flowering, Fruit and Seed Yield of Hybrid Tomato (*Lycopersicon esculentum* Mill.)

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Keywords: Hybrid seed yield, seed quality, tomato, planting dates

Introduction

Tomato (*Lycopersicon esculentum* Mill.), is a solanaceous, self pollinated vegetable crop. It occupies the largest area among the vegetable crops in the world after *Solanum tuberosum* L. Different growing seasons give different performance of the tomato varieties with respect to seed yield, which vary in North India plains. In developing countries like India, hybrids (F_1) are gaining popularity with the modest efforts by public as well as private sectors. Since the adoption of hybrid (F_1), yield and profit margin have increased considerably, more and more cultivators are being attracted towards tomato cultivation. The present investigation was carried out to find out the seed production potentiality of above mentioned tomato hybrids under different planting dates.

Materials and Methods

The experiment was carried out at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during in 2010-11, 2011-12 and 2012-13. Genetically pure seed of five diverse varieties namely Pusa Rohini, Azad Type-2, KS-7, KS-229 and Azad Type-3 was used as parental materials for the study. In 2010-11, seeds of five tomato varieties were sown in nursery in last week of September and 28 days old seedlings were transplanted in crossing block separately and partial diallel crosses (10) were made. The same process was repeated in 2011-12, freshly harvested seeds of five parents and its 10 crosses of both the years (2010-11 and 2011-12) were sown and transplanted (mid Oct., mid Nov. & mid Dec.) on three dates. Observations were recorded on fruit and seed yield. Five plants from each plot were randomly selected for recording the observations on plant height (cm), days to 50% flowering, number of fruits per plant, fruit yield per plant (g), seed yield per plant (g), seed yield per plot (g), fruit diameter (cm) and 1000 seed weight (g) in each planting dates.

Results and Discussion

Among parents, Pusa Rohini contributed the highest (82.20 cm) plant height on all dates of transplanting. Among the hybrids, Azad Type-2 x KS-229 combination reflected the highest plant height (66.36 cm) on all dates of transplanting. Among the parents, Pusa Rohini (36.40) exhibited highest earliness in all dates of planting by taking overall least days for 50% flowering. Among hybrids, Azad Type-2 × Azad Types-3 (35.78) took overall least days and found to be a best combination for this trait. Among parents, Azad Type-2 was found best by bearing highest no. of fruits/plant (42.11) in all three dates of planting. Azad type-2 × KS-7 combination was found to be best being bearer of highest no. of fruits (41.28) on different dates of transplanting.

Among parents, highest fruit yield per plant (1506.38 g) was recorded in Pusa Rohini. Among hybrids, Azad Type-2 x KS-7 combinations, were found best (1705.30 g) on different dates of planting also reported similar results. Among parents, Azad Type-2 produced highest seed yield (5.03 g) on all three different dates of planting. Azad type-2 × Azad Type-3 combination expressed highest seed yield per plant (9.11 g) in all dates of planting. Similar trend of performance was recorded in seed yield per plot.

Pusa Rohini exhibited the highest fruit diameter (6.09 cm) in first, second and third dates of planting. Among hybrids, Pusa Rohini × KS-7 combination was found overall best by attaining best size of fruit diameter (6.17 cm) in all three different dates of transplanting. Among the parents, Azad Type-2 was found to be best contributor by scoring (2.62 g) test on all dates of transplanting while among hybrids, Pusa Rohini x Azad Type-2 scored the highest test weight (2.58 g) in different dates of planting.

As far as over all best interaction for yield and yield contributing traits are concerned, Azad Type-2 x Azad Type-3 combination in October planted crop was found to be best.

Table 1: Pooled mean performance of parents and crossed fruits with respect to fruit yield/plant (g), seed yield/plant (g), seed yield/plot (g) and 1000 Seed weight (g) in different planting dates in tomato.

Parents & Crosses	Fruit yield/plant (g)				Seed yield/plant (g)				Seed yield/plot (g)				1000 Seed weight (g)			
	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean	D1	D2	D3	Mean
Pusa Rohini	2131.51	1558.77	828.87	1506.38	7.60	4.20	1.85	4.55	106.78	55.25	22.57	62.36	2.77	2.08	1.71	2.18
Azad Type-2	1919.25	1425.82	843.94	1396.33	8.35	4.75	2.00	5.03	108.00	63.88	25.62	65.83	2.90	2.76	2.20	2.62
KS-7	2147.90	1335.07	829.92	1437.63	6.45	3.60	1.40	3.81	85.91	43.60	16.29	48.60	3.37	2.48	1.96	2.60
KS-229	1393.3	873.44	484.35	916.94	4.55	3.35	1.45	3.11	61.62	36.71	15.74	38.02	2.87	1.83	1.47	2.06
Azad Type-3	1564.66	1111.83	658.58	1111.69	4.40	2.35	1.30	2.68	58.93	28.38	14.16	33.82	2.86	2.58	2.15	2.53
Pusa Rohini x Azad Type-2	1686.42	1246.25	749.75	1227.47	9.85	7.60	3.00	6.81	139.51	97.13	26.73	87.79	2.85	2.54	2.37	2.58
Pusa Rohini x KS-7	2276.15	1616.53	878.78	1590.4	10.40	9.65	2.90	7.65	139.23	131.54	36.89	102.55	2.43	2.42	1.97	2.27
Pusa Rohini x KS-229	1910.56	1189.55	586.47	1228.86	8.30	5.65	2.15	5.36	113.45	74.70	27.40	71.85	2.88	2.51	1.95	2.44
Pusa Rohini x Azad Type-3	2173.81	1595.22	774.28	1514.43	4.75	4.05	1.90	3.56	62.43	47.82	23.82	44.69	2.89	2.31	1.97	2.39
Azad Type-2 x KS-7	2357.84	1884.14	873.93	1705.30	11.80	8.35	2.80	7.65	153.73	115.03	32.07	100.27	2.93	2.58	2.21	2.57
Azad Type-2 x KS-229	1352.36	1061.80	388.53	834.23	9.95	7.55	3.05	6.85	140.73	99.06	36.91	92.23	2.63	2.34	1.83	2.26
Azad Type-2 x Azad Type-3	2201.26	1604.02	845.08	1550.12	13.50	10.40	3.45	9.11	182.82	138.94	41.27	121.01	2.65	2.35	1.84	2.28
KS-7 x KS-229	2372.18	1813.95	805.54	1663.89	6.25	4.70	1.95	4.30	76.67	61.77	23.54	53.99	2.72	2.44	2.26	2.47
KS-7 x Azad Type-3	2073.17	1414.77	737.12	1408.35	3.30	2.80	1.35	2.48	46.55	39.06	15.57	33.73	2.75	2.30	1.92	2.32
KS-229 x Azad Type-3	1050.15	592.51	395.45	673.37	4.70	4.25	1.90	3.61	57.40	54.24	23.91	45.18	2.87	2.31	1.94	2.37
Mean	1906.34	1354.91	712.04		7.62	5.55	2.18		102.37	72.57	25.50		2.82	2.39	1.98	
	G	D	G x D		G	D	G x D		G	D	G x D		G	D	G x D	
C.D. at 5%	48.43	21.66	83.88		0.32	0.14	0.56		19.85	0.88	34.38		0.08	0.03	0.14	

157.

Correlation and Path Analysis of Morpho-physiological Traits with Yield of Soybean (*Glycine max* L. Merrill) Genotypes under Variable Photoperiods

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Introduction

Soybean (*Glycine max.* L. Merrill) is one of the most important leguminous crops in the world. India ranks fifth in the world after the United States of America (USA), Brazil, Argentina and China in soybean production and accounts for 11.5 million metric tons (3%) of total world production in the year 2012-13 (Anonymous 2013). Variable photoperiod influences crop growth and alters yield productivity. Morpho-physiological traits are considered as indirect selection criteria associated with grain yield under variable photoperiods. Correlation and path analysis helps to find out responsible traits and their association with grain yield. These traits can be considered for selection of soybean genotypes under variable photoperiods.

Materials and Methods

A field experiment was conducted at Punjab Agricultural University, Ludhiana, in *kharif* season 2012. Conducted experiment having 15 soybean genotypes were sown in randomized block design with three replications. Data were recorded on 5 plants of each plot for morpho-physiological traits namely leaf area index, specific leaf weight, crop growth rate, relative growth rate, photosynthetic rate, transpiration rate and seed yield (g/plant) and average was calculated. The data were statistically analyzed using ANOVA. Correlation and path coefficient analysis were carried out using statistical software SPSS 16.

Results and Discussion

The correlation coefficient of yield and morpho-physiological traits of soybean genotypes under variable photoperiods (longer and shorter) was carried out and presented in Table 1. Under longer photoperiods, all parameters studied were found positively and significantly correlated with seed yield. Our results depicted that leaf area index at harvest was found to have positive significant correlation with seed yield during both the photoperiodic condition. This suggests that the maintenance of high leaf area index, particularly at the time of flowering stage is necessary for higher productivity in soybean. Likewise, under short photoperiod showed that all parameters were positively correlated with seed yield under shorter photoperiodic condition except specific leaf weight and relative growth rate.

The path coefficient analysis for various traits studied under longer photoperiodic conditions as well as shorter photoperiodic conditions. It showed leaf area index at pod initiation stage, specific leaf weight at flowering, specific leaf weight at pod, crop growth rate at 45-60 days after sowing (DAS), net photosynthetic rate at flowering and pod, transpiration rate at vegetative and pod stage had negative direct effect on seed yield. In the same way, under shorter photoperiod leaf area index at flowering and pod, specific leaf weight at pod, crop growth rate at 30-45 DAS and 45-60 DAS, net photosynthetic rate at flowering and transpiration rate at vegetative exerted negative direct effect on seed yield. Our results suggest that the leaf area index at vegetative and flowering stage, crop growth rate at 30 - 45 DAS, net photosynthetic rate at vegetative and transpiration rate at vegetative and flowering stage should be considered while selecting for high yielding soybean genotypes under variable photoperiods.

Reference

Anonymous (2013) http:/ /www.soystats.com/2013/Default-frames.htm.

Table 1: Correlation matrix of yield and Morpho-physiological traits of soybean genotypes under longer photoperiod (top of diagonal) and shorter photoperiod (bottom of diagonal).

	LAIV	LAIF	LAIP	SLWV	SLWF	SLWP	CGR1	CGR2	RGR1	RGR2	NPRV	NPRF	NPRP	TRV	TRF	TRP	SY
LAIV	1	0.787**	0.757**	0.735**	0.716**	0.657**	0.755**	0.760**	0.759**	0.764**	0.784**	0.767**	0.791**	0.724**	0.753**	0.620*	0.890**
LAIF	0.684**	1	0.740**	0.557*	0.784**	0.524*	0.596*	0.523*	0.637*	0.639*	0.611*	0.697**	0.661**	0.669**	0.590*	0.377	0.825**
LAIP	0.611*	0.528*	1	0.543*	0.721**	0.682**	0.688**	0.643**	0.858**	0.857**	0.658**	0.534*	0.671**	0.596*	0.557*	0.580*	0.713**
SLWV	0.707**	0.751*	0.613*	1	0.664**	0.645**	0.293	0.294	0.472	0.495	0.732**	0.688**	0.708**	0.523*	0.788**	0.525*	0.741**
SLWF	0.531*	0.398	0.203	0.391	1	0.677**	0.518*	0.377	0.580*	0.530*	0.524*	0.641*	0.673**	0.564*	0.635*	0.518*	0.701**
SLWP	0.407	0.247	0.142	0.27	0.182	1	0.462	0.461	0.610*	0.630*	0.584*	0.710**	0.540*	0.295	0.608*	0.675**	0.553*
CGR1	0.603*	0.298	0.144	0.486	0.384	0.326	1	0.961**	0.833**	0.821**	0.606*	0.475	0.649*	0.672**	0.51	0.630*	0.668**
CGR2	0.644**	0.503	0.229	0.552*	0.588*	0.401	0.879**	1	0.803**	0.822**	0.605*	0.515*	0.601*	0.603*	0.503	0.572*	0.607*
RGR1	0.773**	0.759**	0.505	0.852**	0.402	0.373	0.641*	0.732**	1	0.963**	0.772**	0.487	0.651**	0.723**	0.48	0.729**	0.737**
RGR2	0.718*	0.589*	0.412	0.772**	0.585*	0.353	0.776**	0.882**	0.799**	1	0.767**	0.528*	0.623*	0.619*	0.473	0.712**	0.752**
NPRV	0.604*	0.821**	0.549*	0.792**	0.156	0.204	0.504	0.601*	0.868**	0.652**	1	0.638*	0.744**	0.835**	0.693**	0.526*	0.785**
NPRF	0.665**	0.846**	0.548*	0.779**	0.452	0.524*	0.268	0.501	0.766**	0.694**	0.719**	1	0.747**	0.45	0.830**	0.436	0.636*
NPRP	0.419	0.636*	0.141	0.530*	0.051	0.473	0.271	0.336	0.574*	0.482	0.48	0.666**	1	0.738**	0.942**	0.505	0.768**
TRV	0.646**	0.615*	0.579*	0.703**	0.262	0.048	0.409	0.51	0.821**	0.524*	0.825**	0.505	0.213	1	0.611*	0.371	0.717**
TRF	0.642**	0.703**	0.455	0.649**	0.351	0.524*	0.661**	0.868**	0.775**	0.789**	0.783**	0.683**	0.49	0.602*	1	0.434	0.672**
TRP	0.611*	0.747**	0.214	0.697**	0.351	0.252	0.673**	0.691**	0.723**	0.667**	0.815**	0.599*	0.478	0.613*	0.706**	1	0.660**
SY	0.909**	0.772**	0.576*	0.805**	0.386	0.202	0.544*	0.568*	0.775	0.673**	0.705**	0.662*	0.516*	0.725**	0.629*	0.731**	1

Note: *, ** indicates the correlation significant at the 0.05 and 0.01 probability level.

LAIV= Leaf Area Index at Vegetative, LAIF=Leaf Area Index at Flowering, LAIP=Leaf Area Index at Pod, SLWV= Specific Leaf Weight at Vegetative, SLWF=Specific Leaf Weight at Flowering, SLWP= Specific Leaf Weight at Pod, CGR1= Crop Growth Rate at 30-45 days after sowing, CGR2= Crop Growth Rate at 45-60 days after sowing, RGR1= Relative Growth Rate at 30-45 days after sowing, RGR2= Relative Growth Rate at 45-60 days after sowing, NPRV= Net Photosynthetic Rate at vegetative, NPRF= Net Photosynthetic Rate at Flowering, NPRV= Net Photosynthetic Rate at Pod, TRV= Transpiration Rate at vegetative, TRF= Transpiration Rate at Flowering, TRP= Transpiration Rate at Pod, SY= Seed Yield.

158.

Microbial and Nutritional Quality of Buck Wheat Incorporated Low Gluten Bread

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Keywords: Alkaline water retention capacity, bread, buck wheat, fungal count, low gluten.

Introduction

Bread is the most important convenient food and in universally accepted by all population rich and poor, rural and urban. Factors for its quality deterioration are staling quickly due to retro gradation, growth of mould, loss of its freshness. Even if gluten is extremely important for the texture of bread but with significant increase in our gluten intake due to ubiquity and over consumption of products made with highly refine flour, we are just beginning to ignore glutens impact on our health. Gluten is responsible for triggering an immune response commonly referred as celiac disease. Buck wheat (*Fagropyrum esculentum*) is rich in fiber, calcium, iron, vitamins and essential amino acids, low in sugars and its bran contains fagropyritols and most importantly its gluten free. Therefore, it's a need to incorporate this pseudocereal to increase the nutritional quality of bread, enhance its storage life and cutting back gluten. Keeping this in view the above factors the present study was designed to incorporate buck wheat for making bread.

Materials and Methods

Wheat (Shalimar wheat-1) was procured from the division of Genetics and Plant Breeding, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir. Buck wheat was purchased from the Global Trading Ltd., Jagadhari, Haryana, India. The wheat flour used for product formulation was extra short flour (40% extraction rate), while as, buck wheat flour used was straight run flour (100% extraction rate). The milling was done in Buhler Pneumatic Mill. The process for preparation of sweetened bread using flour of wheat and buck wheat (2, 4, 6 and 8%) was standardized using straight dough process and was evaluated for crude protein, moisture, fat, fiber, alkaline water retention capacity and yeast and mould count.

Results and Discussion

Table 1 depicts the physico-chemical parameters of wheat and buck wheat flour. Highest protein (11.97%), fat (1.95%), ash (1.80%), fiber (2.36), dough development (2.50 min) were recorded in buck wheat flour. However wheat flour depicted highest % water absorption of 57.63%, peak viscosity of 3932.4 cp and moisture of 13.49%. Significant differences in nutritional properties of bread were observed with composite flour combinations. Increase in buck wheat flour concentration decreased the moisture. However flour combination (wheat: buck wheat; 100: 0) recorded highest moisture content and cohesiveness of 33.39% and 6.71. Flour combination (wheat: buck wheat; 92: 8) had highest protein, fat, ash, fiber, crumb hardness of 8.72%, 1.61%, 0.56%, 2.24% and 20.56 N. Maximum fungal count of 3.425 log cfu/g was recorded in flour combination (wheat: buck wheat; 100: 0), followed by 3.301 log cfu/g in flour combination (wheat: buck wheat; 98: 2) at 9 days of storage (Table 2).

Table 1: Physico-chemical composition of wheat and buck wheat flour

Flour	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	% Water absorption	Peak viscosity (cp)	Dough development time (min)
Wheat (40%ER)	13.49	9.45	1.60	1.02	0.68	57.63	3932.4	1.41
Buck Wheat (100% ER)	11.12	11.97	1.95	1.80	2.36	30.4	1080	2.5

ER- Extraction Rate; cp- centipoise (12 centipoise (cp)= 1 rapid visco units (RVU))

Table 2: Evaluation of low gluten bread

Parameter	Flour combinations					Mean
	F_0(100: 0)	F_1(98: 2)	F_2(96: 4)	F_3(94: 6)	F_4(92: 8)	
Moisture (%)	33.39	32.96	32.55	32.12	31.67	32.53
Protein (%)	8.64	8.68	8.72	8.76	8.80	8.72
Fat (%)	1.51	1.56	1.61	1.65	1.70	1.61
Ash (%)	0.51	0.53	0.55	0.59	0.62	0.56
Fiber (%)	2.11	2.18	2.24	2.30	2.37	2.24
Hardness (N)	11.48	12.22	17.24	20.05	20.56	16.31
Cohesiveness	6.71	0.70	0.64	0.63	0.54	1.84
Fungal count (logcfu/g) at 9 days of storage	3.425	3.301	3.000	2.828	2.523	3.015

CD($p \leq 0.05$)- Flour Combination= 0.014

159.

Effect of Spacing and Fertilizers on Seed Quality of Okra [*Abelmoschus esculentus* (L.) Moench]

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Keywords: Tetrazolium test, standard germination, accelerated ageing test, seedling establishment, dehydrogenase activity.

Introduction

Okra, *Abelmoschus esculantus* (L.) Moench, is one of the most important grown vegetable grown in area of 4.98 lakh hectares with average production and productivity of 57.48 lakh tonnes and 11.75 t/ha, respectively. In Haryana, it occupies an area of 18,200 hectares with an average production and productivity of 1.54 lakh tonnes and 8.0t/ha respectively (Anonymous, 2014). Okra thrives best under hot and humid conditions. Hence, setting of fruits, seeds and their development is better in rainy season.

Materials and Methods

The present study was carried out at CCS Haryana Agricultural University, Hisar during spring-summer season, 2013-14. The experiment with two varieties (Hisar Unnat and HBT-49-1) with three spacing and three fertilizers levels in split-split block design with three replications.

Results and Discussion

Varieties Hisar Unnat and HBT-49-1 resulted in significantly higher seed quality parameters at spacing of 30 x 15 cm with the fertilizer application of 187.5kg N + 75 kg P_2O_5 + 60 kg K_2O per hectare. Hisar Unnat gave better performance for all traits as compare to HBT-49-1 variety of okra.

Table 1: Effect of spacing, fertilizers and varieties on seed quality parameters of okra

Treatments	Seed quality				
	Accelerated ageing for 24 hrs	Accelerated ageing for 36 hrs	Accelerated ageing for 48 hrs	Accelerated ageing for 72 hrs	Dehydrogenase activity (OD)
Spacing					
S_1: 30 cm x 5	76.30	67.30	53.34	40.54	1.64
S_2: 30 cm x 10	80.63	70.10	56.82	46.26	1.99
S_3: 30 cm x 15	81.50	71.50	59.90	48.22	2.11
CD (p=0.05)	1.50	1.10	2.80	4.85	0.07
Fertilizer					
F_1: 150 kg N + 60 kg P_2O_5 (RD)	77.30	63.50	46.85	33.43	1.66
F_2: 187.5 kg N + 75 kg P_2O_5 + 60 kg K_2O	81.35	74.20	60.12	48.11	2.06
F_3: 225 kg N + 90 kg P_2O_5 + 60 kg K_2O	79.31	68.80	52.93	44.42	2.04
CD (p=0.05)	1.20	2.1	1.19	4.20	0.18
Varieties					
V_1: Hisar Unnat	83.52	71.79	55.15	42.64	1.96
V_2: HBT-49-1	75.81	65.42	58.62	39.13	1.87
CD (p=0.05)	1.28	2.32	2.77	2.84	0.08

Reference

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160.

Role of Molecular Markers in Marker Assisted Selection against Bacterial Blight in *Oryza sativa*

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Keywords: Rice, MAS, bacterial blight, microsatellite markers

Introduction

Rice (*Oryza sativa* L.) being a model crop has provided breeders with the necessary tools for marker assisted breeding. Simple Sequence Repeat (SSR) markers are easily available for any region of the genome and the likely targets of MAS include yield and agronomic traits and resistances to abiotic and biotic stresses. MAS for gene pyramiding for disease and insect resistances are being widely used. Rice productivity is affected by several biotic stresses. Bacterial blight (BB) caused by *Xanthomonas Oryzae* pv *oryzae (Xoo)* is one of the destructive diseases prevalent throughout Asia. It results in high yield losses. The development of resistant cultivars has been the most effective and economical strategy to control the disease under high irrigated ecosystem.

Materials and Methods

Oryza glaberrima has a pool of genes against BB that provides resistance to all seven races of *Xoo* pathotypes prevalent in northern India. Inheritance was studied by using backcross progenies of the cross involving *Oryza sativa* cv Pusa44 and the *O. glaberrima* acc. 102600B against the most virulent *Xoo* pathotype. Molecular analysis for mapping of gene was done using SSR markers from rice and the software used for preparing linkage map was "MAP MAKER"

Results and Discussion

Genetic analysis of the segregating progenies revealed that the BB resistance in *O. glaberrima* was conditioned by a single recessive gene (Fig. 1). Linkage mapping and molecular data of 170 SSRs revealed that the two microsatellite markers RM548 and RM593 at a distance of 1.7 and 1.1 cM respectively were associated with BB resistance. The BB resistance gene was identified and transferred from *O. glaberrima* and is tentatively designated as x*a_g*(t). The gene is novel as none of the known x*a* genes already mapped on chromosome 5S, are effective against all the *Xoo* strains. This new gene is resistant to a broad range of Xoo strains. The gene could be used in breeding programmes for developing BB resistant varieties.

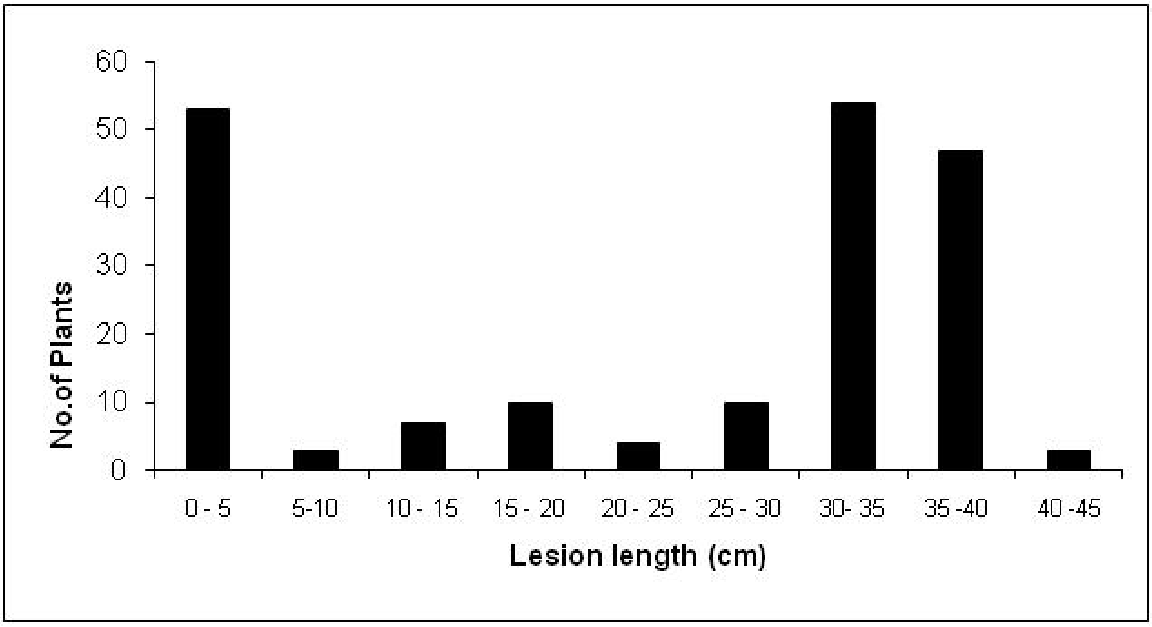

Fig. 1: Frequency distribution of disease reaction of BC_1F_2 plants to Xoo

161.

Physical, Milling and Chemical Characteristics of Some Rice (Husked & Unhusked) Cultivars Commonly Grown in the Kashmir Valley

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Keywords: Paddy, rice, milling properties, physical properties, chemical properties

Introduction

Rice (*Oryza sativa* L.) is one of the leading food crops of the word and commercially more than two thousand varieties of rice are grown throughout the world. India is the 2nd largest producer and consumer of rice in the world (DGFT 2013-14). The states of Jammu and Kashmir (J & K) lying north of the Indian Union comprise the extreme western part of the Himalayas (32.44°N and 74.5°E). Rice is grown only once a year because of extreme climatic conditions. In (J & K), rice ranks first in terms of area and production. In 2013, rice was grown on 259,000 ha, with an overall production of 557,400 tons (t) and a productivity of 2.3 t ha^{-1}. The increasing economic importance of the cereals, together with the complexity of the modern technology for their production, handling, storage, processing, preservation, quality evaluation, distribution and marketing and utilization demands comprehensive information on physical, chemical and milling properties of various cereals including rice. The present study was thus conducted with the objective to evaluate some commonly grown rice varieties in the Kashmir Valley for physical, chemical and milling characteristics.

Materials and Methods

Five rice varieties namely, Shalimar Rice-1 (V_1), Jhelum (V_2), K-332 (V_3), China-1039 (V_4) and Pusa Sugandh (V_5) procured from Seed Processing Centre, Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST) of Kashmir were milled to obtain rice in the modern rice mill in the Division of Post Harvest Technology, SKUAST-Kashmir.

The length and breadth (mm) of grain were measured by using digital vernier caliper (Mytutoys Japan) with accuracy of 0.01mm.

Length/breadth (l/b) ratio was calculated by using the following formula.

$$\frac{\text{Length (mm)}}{\text{Breadth (mm)}} \qquad \textbf{(1)}$$

In order to determine the 1000-grain weight, 1000 randomly selected grains were counted and then measured by means of a digital electronic balance having an accuracy of 0.01 g.

Hectolitre weight (kg/hl) was calculated by using following formula:

$$\text{Hectolitre weight (kg/hl)}= \frac{\text{Weight of grains}}{\text{Volume of cylinder}} \qquad \textbf{(2)}$$

The bulk density was determined using the mass/volume (g/cc) relationship by filling a cylindrical container of 500 ml volume and tare weight with the grain by pouring from a constant height, striking off the top level and weighing.

Standard American Association of Cereal Chemists (AACC, 2000) procedures were followed for determination of moisture content (%).

Based on the length and l/b ratio the grain type was classified as per Ramiah (1969).

Results and Discussion

During the course of the present study, it was observed that rice (unhusked) of test varieties namely, Jhelum, Shalimar Rice-1, K-332**,** China-1039 and Pusa Sugandh varied significantly from each other with respect to various physical characteristics. Rice (unhusked) samples of Shalimar Rice-1, Jhelum, K-332, China-1039 and Pusa Sugandh possessed 8.50, 8.38, 7.19, 8.64 and 11.75 mm grain length mm; 2.92, 2.81, 3.18, 3.16 and 2.49 mm grain breadth; 2.91, 2.97, 2.35, 2.56 and 4.54 l/b ratio; 28.27, 28.47, 23.54, 29.31 and 30.21g 1000-grain weight; 56.21, 57.18, 58.82, 58.66 and 45.58 kg/hl hectoliter weight; and 0.56, 0.57, 0.58, 0.58 and 0.45 (gm/cc) density respectively. This was in concomitance with results reported by Kashaninejad *et al.* (2007), and Mehdi *et al.* (2009). Result further showed that moisture content (%) was 13.07, 13.06, 10.75, 10.81 and 11.31 in Shalimar Rice-1, Jhelum, K-332, China-1039 and Pusa Sugandh respectively.

Table 1: Physical characteristics of different Rice (unhusked) varieties

Variety	Grain length (mm)	Grain breadth (mm)	l/b ratio	1000-kernel weight (g)	Hectolitre weight (kg/hl)	Density (g/cc)	Moisture (%)
Shalimar Rice-1	8.50	2.92	2.91	28.27	56.21	0.56	13.07
Jhelum	8.38	2.81	2.97	28.47	57.18	0.57	13.06
K-332	7.19	3.18	2.35	23.54	58.82	0.58	10.75
China-1039	8.64	3.16	2.56	29.31	58.66	0.58	10.81
Pusa Sugandh	11.75	2.49	4.54	30.21	45.58	0.45	11.31
C.D $p \leq 0.05$	0.05	0.05	0.05	0.08	0.14	NS	0.06

*Values expressed are means of 3 replicates.

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162.

Character Association and Path Analysis for Seed Yield and Component Traits in Indian Mustard (*Brassica juncea L.*)

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Keywords: Mustard, correlation, path, seed yield

Introduction

In India, Indian mustard (*Brassica juncea* 2n=4x=36) is a main species of brassicacae family and it is the second most essential oilseed crops after groundnut. Indian mustard popularly known as rai, raya or laha is one of the most important oilseed crops of the country and it occupies considerably large acreage among the *Brassica* group of oilseed crops. India stands first in acreage along with production of rapeseed and mustard in Asia. The crops are cultivated on an area of 6.70 million ha with a production of 7.96 million tones, with an average yield of 1188kg/ha (Anonymous, 2014).

Materials and Methods

This experiment was conducted at the research area of the Oilseeds Section, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar in 2010-2011. The material for present study comprised of 200 germplasm lines of Indian mustard. Each germplasm line was grown in a randomized block design with two replications having plot size of 2 rows x 3m. Data on individual plants were recorded for ten quantitative traits. Correlation coefficients were determined by using the variance and covariance components as suggested by Al-Jibouri *et al.* (1958). The path analysis was carried out as per the procedure described by Dewey and Lu (1959).

Results and Discussion

The seed yield per plant was found positive and significantly associated with number of siliquae on main shoot (0.169*), plant height (0.156*) and main shoot length (0.147*) indicating that these are the major yield attributing traits. Rest of the characters with non-significant and positive correlation like primary branch angle, number of seed per siliqua and 1000 seed weight could be improved independently without affecting others. Path analysis revealed that number of siliquae on main shoot (0.4113) had the highest direct contribution towards seed yield per plant followed by primary branch angle (0.2414) and 1000 seed weight (0.0987). Whereas Number of siliquae on main shoot had positive indirect effect was high via plant height (0.1559) and 1000 seed weight (0.1145). Indirect contribution of primary branch angle was recorded maximum via main shoot length (0.0559). In present study has clearly indicated that the need for giving due weightage for number of siliquae on main shoot and main shoot length for improving seed yield in mustard. These variables were with maximum potential of selection for seed yield improvement because these traits possessed positive and significant correlation as well as high direct effect on yield.

Table 1: Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among different characters in *Indian* mustard

Characters	Plant height (cm)	Primary branch angle	Main shoot length (cm)	Siliquae on main shoot	Seeds/ siliqua	Siliqua angle	Siliqua length (cm)	1000 seed weight (g)	Oil content (%)	Seed yield/ plant(g)
Plant height (cm)	1.000	-0.060	-0.544	0.379	-0.103	0.296	-0.197	0.133	0.200	0.222*
Primary branch angle	-0.118	1.000	0.239	0.009	0.008	-0.013	0.028	0.190	-0.051	0.025
Main shoot length(cm)	-0.167*	0.114	1.000	0.151	-0.097	-0.320	0.245	-0.097	-0.278	0.157*
Siliquae on main shoot	0.216*	-0.026	0.141*	1.000	0.082	0.034	0.055	0.278	-0.029	0.234*
No. of seeds/ siliqua	-0.052	0.043	-0.036	0.034	1.000	0.019	0.095	0.013	0.019	-0.115
Siliqua angle	0.169*	0.025	-0.155*	0.010	0.120	1.000	-0.009	-0.021	0.185	-0.064
Siliqua length (cm)	-0.130	0.023	0.139*	0.147*	0.139*	-0.015	1.000	-0.023	-0.003	-0.050
1000 seed weight	0.093	0.117	-0.050	0.186*	0.016	-0.025	-0.023	1.000	0.152	0.123
Oil content (%)	0.126	-0.038	-0.141*	-0.043	0.050	0.135*	-0.011	0.148*	1.000	0.012
Seed yield/plant	0.156*	0.031	0.147*	0.169*	0.016	-0.024	-0.006	0.105	-0.014	1.000

*Significant at P<0.05

163.

Use of EST-SSR and RGA Markers in Molecular Analysis of Segregating Populations of Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] Derived from Intervarietal Crossing

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Keywords: Molecular analysis, cluster bean, EST-SSR, RGA marker

Introduction

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] is believed to be originated in Africa but it is grown throughout the Southern Asia since ancient times as a vegetable and fodder crop. It is widely cultivated in countries like India, Pakistan, United State of America, Morocco, Italy, Germany, Greece, and Spain and is thus considered as a new crop for western agricultural practices. Clusterbean is an upright, bushy, drought hardy, deep rooted crop and assumed to be highly adapted to poor and erratic rains, less care and low input areas (Pabal and Yengokopam, 2013). Being a member of legume family, it has a property to fix atmospheric nitrogen, which improves the soil health and yield of succeeding crops. Due to its drought hardy nature, it can be easily cultivated in arid and semi arid regions.

Materials and Methods

The experiment was conducted at Chaudhary Charan Singh Haryana Agricultural University, Hisar. The analysis was performed on 40 F2 derived F3 line of clusterbean along with their parents (HG75×PNB). The protocol of cetyl trimethyl ammonium bromide (CTAB) DNA extraction method of Saghai-Maroof (1984) was used with some modifications. Quality and quantity of DNA was checked by comparing DNA samples with known amount of DNA. The DNA concentration thus estimated and rechecked qualitatively by running on 0.8% agarose gel. Part of DNA samples were diluted with appropriate quantity of TE buffer to yield a working concentration of 50ng/ml and stored at 40°C until PCR amplification. The DNA samples were analyzed using primers. The reaction was optimized at 50 ng of DNA template, 200 µM of dNTPs mix, 2.5 mM, $MgCl_2$, 0.6 µM of primers and 2 units of Taq DNA Polymerase. The amplified products were resolved on 8% PAGE. After proper run gel image were recorded in Gel DOC unit under UV light. Bands were scored as present (1) or absent (0). Missing and doubtful cases were scored as (0). Molecular weights of the bands were estimated by using 1kb DNA ladder (MBI, Fermentas, U.K.) as standards. The data was used for similarity based analysis using the programme NTSYS-Pc (Version 2.02) developed by Rohlf, (1990). Dice's similarity coefficients (F') was calculated using the programme SIMQUAL. Similarity coefficients were used to construct UPGMA (unweighted pair group method with average) to generate Dendrogram.

Results and Discussion

A total of 19 EST-SSRs and 5 RGAs primers out of 29 EST-SSRs and 5 RGAs primers showed polymorphism which was used to screen F_3 progenies of clusterbean cross (HG75×PNB) along with their parents with a view to detect polymorphism for gum content and disease resistance. A total of 19 EST-SSR and 5 RGA primers were used for DNA amplification in 40 F_3 progenies and 2 parents to detect polymorphism. Amplification was observed in all the genotypes with 100 per cent polymorphism. Allele scoring was done for the obtained EST-SSR and RGA primers in the form of 0/1 matrix which was used to calculate the similarity genetic distance using 'SIMQUAL' sub-programme of NTSYS-PC (version 2.02) software (Numerical Taxonomy and Multivariate Analysis System Programme, Rohlf, 1990). Dendrogram, representing the association among different progenies, was constructed by using distance matrix by the unweighted pair-group method with arithmetic average (UPGMA) (Fig. 1). The dendrogram indicated that 42 clusterbean genotypes (40 progenies and two parents) formed two major clusters at a similarity coefficient of 0.48. Cluster I included HG75 and 8,39,24,19,2,22 and 28 number of progenies. The second cluster was occupied by PNB and other 33 progenies. The second cluster was further divided into sub clusters at 0.51 similarity level. These sub groups are further divided into small clusters as the similarity coefficient level increases. Maximum relatedness was exhibited among the progenies 13 and 40, 16 and 23, 27 and 35, 11 and 30, 17 and 37, 18 and 26, 21 and 31.

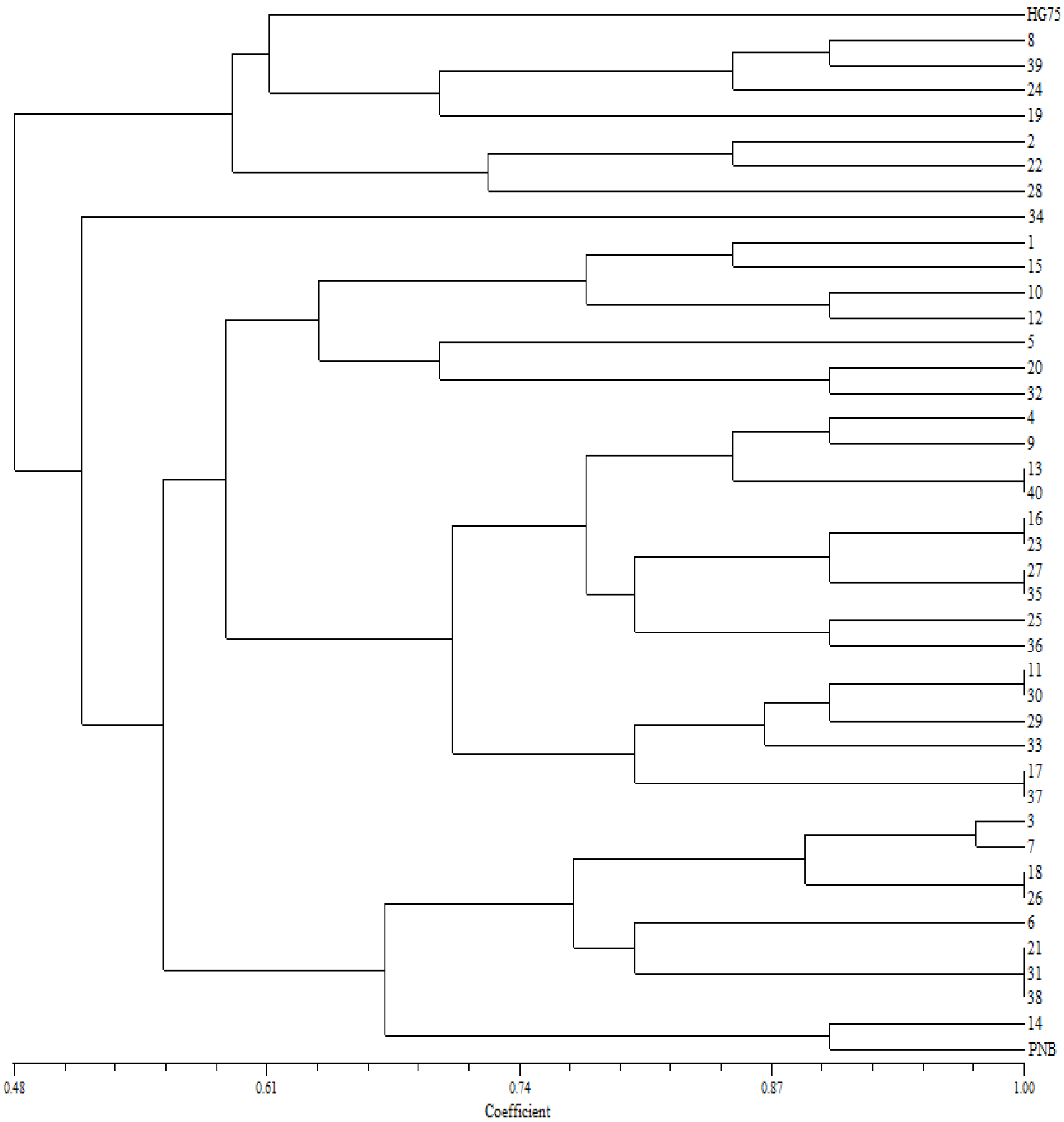

Fig. 1: Dendrogram of genetic relationships among 40 progenies and two parents based on 19 EST-SSR and 5 RGA primers

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Genetic Variability, Heritability and Genetic Advance for Seed Yield and its Component Traits in Urdbean Germplasm [*Vigna mungo* (L.) Hepper]

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Keywords: Genetic variability, heritability, genetic advance, agronomic characters and black gram

Introduction

Legumes adapt well to various cropping systems owing to their ability to fix atmospheric nitrogen in symbiosis with soil bacteria of *Rhizobium spp.* Urdbean [*Vigna mungo* (L.) Hepper,] are important legume crop widely cultivated in Asia. *V. mungo var. silvestris* is the wild proginator of urdbean. The productivity of pulse crop is very low when compared to cereals, which have been selected for high grain yield under high input conditions, while the selection pressure in case of pulses have been focused on the adaptation to both biotic and abiotic stresses. Therefore, present investigation was carried out to assess the genetic variability, different traits towards yield and selection of high yielding genotypes with better architecture.

Materials and Methods

The experiment was conducted at Narendra Deva University of Agriculture and Technology, Narendra Nagar Kumarganj, Faizabad (U.P.) during *Kharif,* season of 2011. The genetic materials consisted of 100 germplasm lines with four checks namely Uttara, Pant U-31, Shekhar and NDU-1 under normal soil and irrigated condition using augmented design. The entire experimental field was divided into 10 blocks of equal size and each block was having 14 plots. The checks were accommodated randomly in each block with test genotypes. Each plot represented by 1 row of 4 meter length, keeping row to row distance of 30 cm and plant to plant spacing of 10 cm. All the recommended cultural practices were applied to raise a good crop. The data on seed yield and its components were recorded on five randomly plants taken in each genotypes from each plot for eleven characters. However, days to 50% flowering and days to maturity were recorded on plot basis. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad sense heritability and genetic advance in per cent of mean were computed as per standard formulas.

Results and Discussion

In general, phenotypic coefficients of variability were higher than corresponding genotypic coefficients of variability for all the traits which demonstrated the effect of environment upon the traits (Table 1).A relatively higher estimate of phenotypic coefficient of variation (PCV of more than 20%) were observed for seed yield per plant (35.7) followed by biological yield (35.67), clusters per plant (26.23), plant height (26.07), harvest index (21.99) and primary branches (20.55).

The highest genotypic coefficient of variability was observed for seed yield per plant (34.71), biological yield (31.23) and plant height (25.76) which indicates the presence of exploitable genetic variability for these traits. Moderate genotypic and phenotypic coefficient of variation (10 to 20%) were observed for pods per cluster (13.01 &18.38) and seeds per pod (12.00 &18.44). which revealed that there is considerable scope for improving these trait in desirable direction through a selection programme.

Low estimates of genotypic and phenotypic coefficient of variation were observed for the days to flowering (7.28 & 8.26) and days to maturity (8.38 &8.74). Similar findings reported by Singh *et al.* (2011) and Ramya *et al.* (2010).

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Table 1: Estimates of variability, heritability and genetic advance as percentage of mean

Parameters	Range		Grand mean	Grand mean	PCV	Heritability	Genetic	Gen. adv.
	Lowest	Highest	$(\bar{X})$±SE	GCV		(b s) (%)	(GA)	As % of means (5%)
Days to 50% flowering	40.05	60.05	52.51±0.43	7.28	8.26	77.69	6.99	13.23
Days to maturity	64.12	93.12	81.90±0.68	8.38	8.74	91.86	13.59	16.56
Plant height(cm)	37.91	151.88	85.72±2.50	25.76	26.07	97.64	45.06	52.45
Primary branches/ plant	1.50	5.24	3.50±0.08	8.82	20.55	18.42	0.27	7.81
Clusters / plant	3.43	12.60	7.57±0.20	19.34	26.23	54.36	2.23	29.39
Pods / cluster	1.67	5.34	3.34±0.07	13.01	18.38	50.14	0.64	18.99
Seeds / pod	2.32	6.67	4.64±0.09	12.00	18.44	42.29	0.75	16.08
Seed yield/ plant (g)	1.58	9.25	4.29±0.17	34.71	35.74	94.31	2.99	69.45
100 seed weight (g)	2.95	5.08	3.76±0.04	5.27	10.66	24.46	0.20	5.37
Biological yield (g)	5.91	43.55	18.29±0.80	31.23	35.67	76.66	10.29	56.34
Harvest index (%)	7.80	39.83	24.48±0.69	16.76	21.99	58.07	6.47	26.31

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Effect of Sowing Dates and Plant Spacing on Growth and Development of Sweet Corn (*Zea mays saccharata* L)

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Introduction

Sweet corn (*Zea mays saccharata L)* is used as speciality maize. Sweet corn differs from other corns (field maize, pop corn and ornamental) because the kernels have a high sugar content on early dough stage. Sweet corn for processing is harvested at a relatively immature stage as compared to field corn. The urban people have great interest in consuming green cobs. Kernel quality can be determined using visual evaluation and analytical evaluation as well as physical and mechanical properties estimation. It is found that sweet corn is more delicious when it is steamed, boiled and consumed (Najeeb *et al.*, 2011).

Materials and Methods

The field experiment entitled "Effect of sowing dates and plant spacing on growth and development of sweet corn (*Zea mays saccharata* L.)" was carried at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, India Shalimar in *kharif* season 2014. Sweet corn *cv.* Misthi was chosen for the study. The experiment comprised of two factors with four sowing dates namely 24th May (D_1), 02nd June(D_2), 11th June(D_3) and 19th June(D_4) as main-plot treatments and three plant spacing *viz*. 60 cm x 20 cm(S_1), 70 cm x 20 cm (S_2)and 80 cm x 20 cm (S_3) as sub-plot treatments replicated thrice. Split plot design was used for this experiment.

Results and Discussion

Leaf area index (LAI) increased consistently up to 95 days after sowing ((DAS)). Higher value of LAI (5.77) was recorded with 24th May (D_1) sowing which was at par with 2nd June (D_2) sowing and lowest 5.56 was recorded with 19th June (D_4) sowing at 95DAS. Difference in photoperiod may have contributed to the reduced LAI with delayed sowing. Moosavi *et al.* (2012) reported similar results. Maximum LAI 5.74 was recorded with 60 x 20 cm (S_1) spacing and lowest LAI (5.63) was recorded with 80 x 20 cm (S_3) spacing at 95 DAS. Higher leaf area index of sweet corn was observed at closer spacing compared to wider spacing Table 1. More number of plants per unit area under narrow spacing may have increased total leaf area index and also high plant density of corn helps in proper utilization of solar radiation, which influences leaf area and consequently dry matter accumulation. Similar results were reported by Moosavi *et al.* and Shafi *et al.* (2012).

Table 1: Effect of sowing dates and plant spacing on leaf area index at different growth stages of sweet corn

	Growth stages								
Treatments	15DAS	25DAS	35DAS	45DAS	55DAS	65DAS	75DAS	85DAS	95DAS
Main plot									
Sowingdate									
24t May	0.32	0.37	1.73	2.73	3.46	4.42	5.15	5.44	5.77
2 June	0.30	0.37	1.73	2.72	3.44	4.39	5.15	5.43	5.76
11 June	0.26	0.36	1.63	2.52	3.25	4.18	4.93	5.25	5.57
19June	0.25	0.36	1.63	2.49	3.24	4.15	4.89	5.23	5.56
SEm±	0.01	0.004	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C.D (P≤0.05)	0.03	0.01	0.03	0.05	0.05	0.04	0.04	0.05	0.04
Sub plot									
Plant spacing									
60 x 20 cm	0.29	0.37	1.84	2.64	3.49	4.35	5.07	5.41	5.74
70 x 20 cm	0.27	0.36	1.61	2.60	3.48	4.25	5.02	5.31	5.64
80 x 20 cm	0.26	0.36	1.58	2.59	3.05	4.24	5.01	5.30	5.63
SEm±	0.02	0.001	0.008	0.01	0.01	0.02	0.01	0.008	0.006
C.D (P≤0.05)	NS	0.01	0.02	0.03	0.04	0.06	0.04	0.02	0.02

DAS=days after sowing

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166.

Determination of Lethal Dose for Gamma Rays and Ethyl Methane Sulphonate Induced Mutagenesis in Okra [*Abelmoschus esculentus* (L.) Moench.]

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Keywords: Gamma rays, ethyl methane sulphonate, okra, mutation, LD_{50}, survival, seedling growth.

Introduction

Mutation breeding has been widely used for the improvement of potential traits of various crop plants. The prime strategy in mutation breeding is to upgrade the well-adapted plant varieties by altering one or two major agronomic traits which limit their productivity or enhance their quality and potential source of creating variability. Induced mutagenesis using an array of physical and chemical mutagens, offer a possibility for the induction of desirable changes in various attributes, which can be exploited as such or through recombinant breeding. To avoid excessive loss of actual experimental materials, radio/chemical sensitivity tests must be conducted to determine LD_{50} dose before massive irradiation of similar materials are accepted. The present study is aimed at determining the optimum lethal dose (LD_{50}) for two mutagens Gamma rays as physical mutagen and EMS as chemical mutagen in okra *Abelmoschus esculentus* L. Moench.

Materials and Methods

Popular and well adapted cultivar P-8 of okra was chosen to study the effect of gamma rays and EMS on survival percentage and length of okra seedlings. The study was conducted at Vegetable Farm of CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh during June 2014. A chemical mutagen, EMS and a physical mutagen, gamma rays (60Co) were used in the present investigation to induce mutations in the selected plant material and to achieve genetic variability. Based on gamma radiation and EMS(Ethyl methane sulfonate) mutagenesis, hundred seeds were placed for each treatment in petriplates over moistened germination paper under seed germinator with control. Also treated seeds (30 each in one line) were sown in polyhouse. LD_{50} values were determined with the help of probit analysis based on survival rate of the okra plants after treatment with different doses compared with control. The germination percentage and seedling length of seeds germinated in seed germinator were measured after 12 days.

Results and Discussion

To avoid excessive loss of actual experimental materials, radio-sensitivity tests must be conducted to determine LD_{50} (the safe dose at which half of the planting material survive) doses before massive irradiation of similar materials are accepted. In the present study, from the probit curve analysis the LD_{50} value for Gamma rays and EMS were 75 kR and 1.4% respectively.

Table 1: Mean value of survival and seedling length in gamma rays as well as EMS mutated seedlings

Treatment for gamma rays (kR)	Survival		Seedling length (cm)	Treatment for EMS (%)	Survival (%)	Seedling length (cm)
	Actual	Survival (%)				
Control	100	80 (8.99**)	20.0	Control	20.0	96 (4.56**)
35	100	70 (8.41**)	18.0	0.2	15.0	93 (4.53**)
40	100	50 (7.12**)	16.5	0.4	12.5	83 (4.41**)
45	100	70 (8.41**)	14.0	0.6	11.5	71 (4.23**)
50	100	70 (8.41**)	13.5	0.7	10.0	35 (3.54**)
55	100	40 (5.09**)	12.8	0.8	9.00	33 (3.49**)
60	100	46 (6.83**)	12.0	0.9	8.00	13 (2.26)
65	100	49 (7.05**)	11.2	1.0	7.50	15 (2.70*)
70	100	50 (6.37**)	10.5	1.1	7.20	33 (3.48**)
75	100	39 (6.30**)	9.50	1.2	6.50	18 (2.86**)
80	100	0 (1.00)	8.70	1.4	6.00	10 (2.26)
85	100	10 (3.31*)	7.50	1.6	6.00	30 (3.39*)
CV		10.95	17.05	CV	34.26	10.20
CD (0.05)		1.18	3.68	CD (0.05)	5.83	0.597

Values in brackets are log transformed
(*) indicates the value which is significant at 5% level of significance
(**) indicates the value which is significant at 1% level of significance

Survival percentage of P-8 under different dose concentrations were calculated based on the survival of seedlings after treatment and compared with control. There was an abnormal reduction in the survival of seedlings with the raise of gamma dose and EMS (Table 1). Conversely, there was an increase in the survival reduction in higher doses compared to lower doses. Data analysis on number of seeds that survived showed an attendant decrease in survival significantly with applied increases in concentration of EMS. In the present study, least values of 39% and 0% survival rate were observed in the seeds irradiated with the highest dose of 75 and 85 kR gamma rays respectively (Table 1). In case of EMS, least germination percentage of 10% was observed at higher dose of 1.4%. The survival rate of control plants was certainly higher because their seeds were not exposed to any mutagenic treatment. Failure in seed germination was recorded in treated plant with a dose of 85 kR might be due to the delay or inhibition in physiological processes. Moreover the decrease in the percentage of germination at higher doses may be due to the disturbances caused at physico-chemical level of cells, chromosomal damage or due to the combined effect. The least seedling length 7.5 cm and 6.0 cm has been recorded when 85 kR of gamma dose and 1.4, 1.6% concentrations of EMS has been applied respectively as shown in Table 1.

These optimum mutagen doses determined for the okra genotype could be useful while formulating mutation breeding programme for improvement of specific traits in okra.

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Variability Studies in Sprouting Broccoli Hybrids (*Brassica oleracea* L. var. *italica* Plenck) under the Mid Hills of North-western Himalayas

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Keywords: Genetic advance, genetic diversity, genetic variability, heritability, sprouting broccoli

Introduction

Broccoli (*Brassica oleracea* L. var. *italic*a Plenck) a member of family Brassicacea is one of the nutritious cole crop. It is known for its taste, flavor, nutritive and medicinal properties. Broccoli contains the compound namely, glucoraphanin, which can be processed into an anti-cancer compound sulphoraphane. The improvement in any crop is proportional to the magnitude of the genetic variability present in the germplasm. Information on the extent of genetic variability available for yield and its component characters along with heritability and genetic advance would be of immense importance to the breeders as the success of selection of any crop improvement programme is determined by these specific genetic parameters. Genetic divergence analysis (D^2) will help the breeders in grouping of genotypes in different clusters and to identify genotypically diverse and desirable genotypes. Hence, an attempt was made with specific objectives to examine the genetic parameters of variability to identify major characters for achieving higher yield.

Materials and Methods

The present investigation was conducted at the Experimental Farm of the Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Agriculture University, Palampur, in two environments namely environment I (*rabi*, 2010-2011) and environment II (*rabi*, 2011-2012). The experimental material comprised of 16 genotypes of sprouting broccoli. There were 16 plants in each plot having 4.5 m^2 area planted at 60 cm distance between and 45 cm with in row in a randomized complete block design, with three replications. Observation were recorded on five randomly selected competitive plants per replication for fourteen characters namely days to first harvest, marketable yield per plant, terminal head weight per plant, gross weight per plant, number of spears per plant, head size index, plant frame, leaf size with leaf stalk, leaf size without leaf stalk, plant height up to longest leaf, plant height up to head, stalk length, weight of spears per plant and harvest index. The data regarding above mentioned characters were averaged and subjected to analysis of variance. The phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability (broad sense), genetic advance as per cent of mean and genetic diversity (D^2 analysis) were computed.

Results and Discussion

Significant differences among all the genotypes for all characters in environment I and environment II was observed. The phenotypic PCV, and GCV, heritability and genetic advance as percent mean were worked out for various characters (Table 1) and the estimates of various genetic parameters exhibited a wide range of variability for all the characters under study. The high estimates of PCV and GCV were observed for number of spears per plant followed by weight of spears per plant and terminal head weight per pant.

Table 1: Estimates of different parameters of variability for various characters of broccoli

Characters	Range	Mean	PCV (%)	GCV (%)	ECV (%)	h^2_{bs} (%)	GA (%)
Days to first harvest	93.46-129.00	109.32	9.62	8.01	5.32	69.40	13.76
Marketable yield/plant (g)	140.66-541.33	316.76	30.67	29.01	9.96	89.44	56.51
Terminal head weight/plant (g)	99.00-525.50	296.11	33.60	31.96	10.38	90.46	62.61
Gross weight/plant (g)	680.66-1121.16	858.05	17.23	13.49	10.73	61.26	21.75
Number of spears/plant	1.41-9.96	5.20	42.85	38.93	17.89	82.56	72.86
Head size index (cm^2)	131.17-257.38	225.56	19.22	12.85	14.28	44.76	17.72
Plant frame (cm^2)	2777.66-4837.22	3820.28	17.92	13.03	12.29	52.92	19.53
Leaf size with leaf stalk (cm^2)	476.67-798.39	624.1	18.71	15.55	10.39	69.12	26.64
Leaf size without leaf stalk (cm^2)	297.10-449.83	367.04	22.67	14.81	17.16	42.67	19.93
Plant height up to longest leaf (cm)	44.23-53.61	49.18	10.00	6.42	7.67	41.22	8.49
Plant height up to head (cm)	27.36-42.96	31.56	15.17	10.19	11.24	45.15	14.11
Stalk length (cm)	2.10-3.21	2.49	10.89	8.86	6.34	66.11	14.84
Weight of spears/plant (g)	20.83-156.66	101.96	40.46	35.31	19.75	76.17	63.50
Harvest index (%)	19.54-49.23	35.59	22.41	19.67	10.74	77.03	35.35

High heritability was noticed for terminal head weight per plant followed by marketable yield per plant, number of spears per plant, harvest index, weight of spears per plants, days to first harvest, leaf size with leaf stalk, stalk length and gross weight per plant. The genetic advance expressed as percent of mean varied from 8.49% to 72.86% for plant height up to longest leaf and number of spears per plant, respectively. High estimates of genetic advance were observed for number of spears per plant, weight of spears per plant, terminal head weight per plant, marketable yield per plant and harvest index.

Heritability along with genetic advance is more useful than the heritability alone in predicting the resultant effect of selecting best genotype as it suggests the presence of additive gene effects. High heritability associated with high genetic advance were observed for terminal head weight per plant, marketable yield per plant, number of spears per plant, harvest index and weight of spears per plant.

The multivariate analysis revealed considerable genetic diversity present in all the genotypes. Sixteen genotypes of broccoli were grouped into three clusters when studied under Tocher's method of D^2 analysis. On the basis of dendrograms, it is clear that the genotypes 'Altar' and 'Indica' were most diverse genotypes and offer promise as a breeding stock to be used in hybridization for obtaining transgressive segregants for further exploitation in broccoli improvement programme.

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Impact of Better Management Practices in Cotton on the Selected Biodiversity in Warangal, Telangana

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Keywords: Cotton, biodiversity, sustainable agriculture, Ashy Prinia

Introduction

The impact of cotton production on freshwater ecosystems through activities such as excessive water withdrawal for irrigation, runoff from fields, drainage, pesticide application, dam construction and land reclamation has already been established. There has been hardly any study to determine the impact on biodiversity because of cotton production. The impact of Better Management Practices (BMP), which can use resources effectively and reduce the negative environment foot print of cotton on the selected biodiversity is studied to validate the practices and to understand the potential impact of various cotton cultivation practices on biodiversity. World Wide Fund for Nature (WWF) -India has been working with cotton farmers to implement BMP, which can use the resources effectively and reduce the negative environment foot print of cotton. 20412 farmers in Warangal, Telangana state are adopting the BMP. The impact of BMP on the selected biodiversity is studied to validate the practices and to understand the potential impact of various cotton cultivation practices on biodiversity.

Materials and Methods

The areas with BMP and conventional cotton practices for the study were selected in the project location, Warangal. The selected areas are similar in the soil types, weather conditions, and have similar wetlands and forest land. Series of seasonal surveys were conducted to select the key species and to understand their presence, abundance and interaction with the agriculture system. The comparative analytical study on the impact of the selected biodiversity of BMP and non-BMP cotton fields of Warangal was conducted by following the standard procedure:

A. Status of biodiversity in the study area through an inventory: The detailed inventory of the biodiversity in the project location was studied.
B. Pilot survey: A pilot survey was conducted for selection and familiarization of the BMP and non-BMP sites.
C. Selection of cotton cultivation practices and identification of key species: BMP were carefully analysed for their potential positive and negative impacts on various species.
D. Seasonal sampling: The detail sampling studies were conducted during the cotton season
   Pre monsoon (pre sowing): Birds and other biodiversity observed in both non-BMP and BMP crop fields. Observations made in tanks with special reference to the tank silt
   Onset of monsoon season (sowing): Insects, arachnids and pollinators observed
   Monsoon &post-monsoon seasons (vegetative (growing)-flowering-harvesting): Observations made on pollinators/pests and insects. Observations made on feeding & nesting behaviours of birds
E. Continue the study for the next 3 years
F. Secondary data collection

Results and Discussion

A total number of 335 plant species and 332 faunal species were recorded in the study area. It indicates the potential for rich biodiversity. The study shows that some of the BMPhad direct impact on the biodiversity (Table 1, 2 &3). The frequency, abundance of the vertebrates was more in BMP area, compare to non-BMP sites. Tank silt application has supported in improving the biodiversity in the fields. A large population of Indian bull frog (*Hoplobatrachus tigerinus)* was found in the tank silt collected as manure for the BMP cotton crop fields. Indian bull frogs were recorded more in BMP compare to non BMP fields. Butterflies, odonates, arachnids and other invertebrates were studied for their frequency of visit to the BMP and non BMP cotton area. The frequency of visit was 26% more in the BMP area. Six bird species were recorded regularly in the cotton. Out of which, Ashy Prinia was selected to study its detail interaction with cotton. Ashy Priniaspent an average of 54% of time feeding, 23% scanning, 14% flying, and 4% resting activities. The time spent on scanning the whole plant, flying in search of prey also adds to the feeding behaviour of the bird. This shows that there is a chance of biological control of cotton pests namely mealy bug *(Phenacoccus solenopsis)*and others by ashy Prinia. The impact of agriculture practices on biodiversity has to be studies in detail to validate and recommend the Better Management Practices. This could help in protecting the local biodiversity, which in turn support the ecosystem to sustain the productivity from an agriculture system.

Table 1: Total number of invertebrate species recorded in the non-BMP and BMP cotton fields

Species	Non-BMP	BMP
Butterflies	11	26
Odonates	6	6
Other Insects	7	20
Arachnids	3	8

Table 2: Average individuals of Amphibian species recorded in the non-BMP and BMP cotton fields

Common Name	Species	Non-BMP	BMP
Marbled Toad	*Bufo stomaticus*	71	89
Common Indian Toad	*Duttaphrynus melanostictus*	88	181
Skittering Frog	*Euphlyctis cyanophlyctis*	38	43
Indian Pond Frog	*Euphlyctis hexadactylus*	40	54
Indian Cricket Frog	*Fejervarya limnocharis*	39	59
Indian Bull Frog	*Hoplobatrachus tigerinus*	32	70
	Total	308	496

Table 3: Average individuals of Key Insectivorous Birds recorded in the non-BMP and BMP cotton fields

Common Name	Species Name	Non-BMP	BMP
Green Bee-eater	*Merops orientalis*	12	33
Black Drongo	*Dicrurus adsimilis*	5	16
Common Myna	*Acridotheres tristis*	7	21
Plain Prinia	*Prinia inornata*	5	28
Ashy Prinia	*Prinia socialis*	18	63
Baya	*Ploceus philippinus*	8	30
	Total	55	191

BMP: Better Management Practices cotton area

169.

Performance of Improved Wheat Varieties for their Physical and Yield Parameters

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Keywords: Wheat, line sowing, broadcasting

Introduction

Wheat crop is being raised on 42% area of Jammu district through broadcasting on a large area after harvesting of rice. Broadcasting not only requires higher seed rate but also results in lower plant population. Drill/line sowing is recommended method because of its uniform seed distribution at desired depth, which usually results in higher germination and uniform stands. During the past years many varieties of wheat have been introduced and tested in Jammu district for determining their productive potential through frontline demonstration by KVK. An attempt has been made through this study to evaluate the performance of six different wheat varieties being raised in the district for their physical and yield parameters.

Materials and Methods

The study was conducted at Krishi Vigyan Kendra, R S Pura Jammu. Six wheat varieties namely RAJ-3077, HD-2967, PBW-621, JAUW-584, RSP-561 and RAJ-3765 were tested for their physical characteristics and yield parameters under irrigated conditions raised through two different sowing methods (T1: line sowing and T2: broadcasting) adopting recommended package and practices. The experiment was laid in randomized block design.

Results and Discussion

Analysis of variance depicted significant variation for all the six characters under study. Variety RSP-561 depicted maximum number of tillers per row length i.e. 85.0 and 70.33 which was statistically at par with the variety PBW-621 (84.33 and 69.67) for both the treatments respectively. Similar trend was observed for spike length wherein maximum value (9.67 cm and 9 cm) were observed for PBW-621. In case of number of grains per ear variety PBW-621 recorded maximum (43.0 and 37.33) followed by RSP-561 which recorded 42.33 and 36 grains per ear sown through line sowing and broadcasting methods, respectively. Maximum plant height (90 cm and 87 cm) was recorded for PBW-621 for both the sowing methods, whereas varieties HD-2967, JAUW-584 and RAJ 3765 recorded statistically similar values for the character under line sowing method only. Moreover, significant differences were observed among all the varieties sown by broadcasting method for the plant height. With respect to 1000 grain weight, HD 2967 recorded maximum (40.33 gm) in line sowing, whereas variety PBW-621 recorded maximum seed weight (39 gm) raised through broadcasting method. Similarly variety PBW-621 recorded maximum grain yield (46.33 q/ha and 38.0 q/ha) followed by RSP-561 depicting 45.0 q/ha and 36 q/ha grain yield respectively for both the methods under study. Varieties PBW-621 and RSP-561 outperformed all the other four varieties with respect to most of the parameter under study. Line sowing methods recorded more no of grains per year, more Plant height, high grain weight and subsequently higher grain yield for all the varieties that may be attributed to the fact that it played an important role in the placement of seed at proper depth, localized availability of fertilizer and irrigation applied, which ultimately affects crop growth and thereby yield.

Table 1: Physical and yield parameter of six different Wheat varieties raised through two different methods

Varieties	Tiller/row		Grains/ear		Plant height (cm)		Spike length (cm)		Test weight (gm)		Yield (q/ha)	
	T1	T2	T1	T2	T1	T1	T2	T2	T1	T2	T1	T2
Raj-3077	75.0	60.67	38.0	31.0	87.67	38.0	36.0	83.0	40.0	32.33	8.67	7.0
HD-2967	78.0	65.33	40.0	34.0	89.33	40.33	37.0	85.0	42.0	35.67	9.0	7.67
PBW-621	84.33	69.67	43.0	37.33	90.0	39.33	39.0	87.0	46.33	38.0	8.67	8.0
JAUW-584	79.0	68.33	41.33	30.33	88.0	39.0	38.0	77.33	43.0	34.33	9.33	8.33
RSP-561	85.0	70.33	42.33	36.0	86.0	40.0	38.33	80.0	45.0	36.0	9.67	9.0
Raj-3765	73.33	62.33	37.67	28.0	87.0	38.33	37.33	78.67	40.67	35.0	9.0	7.0
$CD_{0.05}$	0.48	0.71	1.32	1.56	1.54	1.33	0.57	1.26	1.54	1.01	1.32	1.48

T1: Line sowing T2: Broadcasting

170.

Post-harvest Keeping Quality of Gladiolus (*Gladiolus* Spp.) in Relation to Pulsing Treatment and Refrigerated Storage

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Keywords: *Gladiolus*, keeping quality, pulsing treatment, refrigerated storage

Introduction

Gladiolus is a corm propagated plant belonging to family *Iridaceae*. For the maintenance of cut flowers for longer duration, pulsing treatment along with refrigerated storage is suitable combination. Since sugars form the major food source for the flower growth, its exogenous application to the cut flowers can limit the process of senescence. The antimicrobial agents including aluminium sulphate can be added to the preservatives that prevent the blockage of spikes. GA_3 acts as senescence-delaying plant growth hormone that increases flower quality. Refrigerated storage has many advantages in keeping the flowers fresh and maintaining their continuous supply in the market.

Materials and Methods

The spikes of cultivars White Prosperity and Nova Lux were harvested at tight bud stage and given pulsing treatment with solutions containing sucrose, glucose and fructose (20%) in combination with aluminium sulphate (400 µg ml^{-1}) and GA_3 (50 µg ml^{-1}). Treatment was given by dipping the basal portions of spikes in pulsing solutions for 20 hours. After the pulsing treatment, spikes were stored in the cool chamber (4±0.5°C; 90-95% R.H.) for 6, 12 and 18 days. Keeping quality parameters were observed by placing the spikes in the distilled water in an air-conditioned laboratory (22±3°C) and 16 h light duration.

Results and Discussion

Relative water content (RWC): Table 1 shows the effect of different pulsing treatments on RWC of florets after storage for varying durations. Pulsing treatments as well as refrigerated storage did not show any significant effects on RWC of florets which may ascribe to the turgidity level of the florets that remained same. Wet refrigerated storage is known to decrease loss of water as well as provide water for continuous absorption by the spikes (Nowak and Rudnicki 1990). RWC of florets of was slightly higher in cv. Nova Lux than that in White Prosperity.

Per cent increase in fresh weight: The results presented in the Table 2 show that the spikes showed continuous increase in per cent fresh weight during the storage period of up to 18 days in both the cultivars. Pulsing treatments with sugars tended to increase per cent increase in fresh weight over the control as well as the spikes treated with solution of aluminium sulphate alone as well as in combination with GA_3.

Table 1: Effect of sugars, aluminium sulphate and GA_3 on relative water content of florets of gladiolus cultivars White Prosperity and Nova Lux after storage for varying durations

Treatment	White Prosperity					Nova Lux					Overall Mean
	0 day	6 day	12 day	18 day	Mean	0 day	6 day	12 day	18 day	Mean	
Sucrose 20% + Aluminium sulphate, 400 µg ml^{-1}	96.00	95.72	96.57	97.67	96.49	96.67	97.49	97.99	97.20	97.34	96.91
Sucrose 20% + Aluminium sulphate, 400 µg ml^{-1}+GA_3, 50 µg ml^{-1}	95.86	95.05	98.00	91.78	95.17	96.97	98.27	96.50	92.62	96.09	95.63
Glucose 20% + Aluminium sulphate, 400 µg ml^{-1}	96.31	95.87	96.72	97.96	96.71	97.75	98.66	97.73	95.33	97.37	97.04
Glucose 20% + Aluminium sulphate, 400 µg ml^{-1}+GA_3, 50 µg ml^{-1}	95.76	93.65	93.98	97.61	95.25	97.71	98.84	98.61	98.19	98.34	96.79
Fructose 20% + Aluminium sulphate, 400 µg ml^{-1}	96.65	92.13	91.26	98.07	94.53	95.65	98.89	94.43	98.27	96.81	95.67
Fructose 20% + Aluminium sulphate, 400 µg ml^{-1}+GA_3, 50 µg ml^{-1}	96.20	94.78	96.91	98.42	96.58	97.74	98.56	98.56	97.89	98.19	97.38
Aluminium sulphate, 400 µg ml^{-1}	96.48	94.58	91.42	97.79	95.07	97.63	94.68	98.65	97.91	97.22	96.14
GA_3, 50 µg ml^{-1}+Aluminium sulphate, 400 µg ml^{-1}	95.93	94.16	97.39	97.75	96.31	97.67	95.64	94.01	94.72	95.51	95.91
Control	97.03	96.32	96.66	95.34	96.34	98.26	99.03	95.67	98.32	97.82	97.08
Mean	96.25	94.69	95.43	96.93	95.83	97.34	97.78	96.90	96.72	97.19	96.51
Mean values for storage duration: 0 day=96.79; 6 day=96.23; 12 day=96.16; 18 day=96.82											
CD (p=0.05)	Cultivars (A)=NS; Storage duration (B)=NS; Treatments (C)=NS; AxB=NS; AxC=NS; BxC=NS; AxBxC=NS										

Table 2: Effect of sugars, aluminium sulphate and GA_3 on per cent increase in fresh weight in spikes of gladiolus cultivars White Prosperity and Nova Lux after storage for varying duration

Treatment	White Prosperity				Nova Lux				Overall Mean
	6 day	12 day	18 day	Mean	6 day	12 day	18 day	Mean	
Sucrose 20% + Aluminium sulphate	11.74 (20.02)	25.72 (30.44)	31.53 (34.10)	23.00 (28.19)	12.59 (20.70)	28.53 (32.27)	29.65 (32.97)	23.59 (28.65)	23.29 (28.42)
Sucrose 20% + Aluminium sulphate, 400 µg ml^{-1}	10.09 (18.51)	26.68 (31.02)	29.22 (32.67)	22.00 (27.40)	10.79 (19.16)	29.10 (32.63)	32.09 (34.48)	23.99 (28.76)	22.99 (28.08)
Sucrose 20% + Aluminium sulphate, 400 µg ml^{-1}+GA_3, 50 µg ml^{-1}	6.67 (14.95)	19.91 (26.48)	22.54 (28.32)	16.37 (23.25)	8.34 (16.72)	19.90 (26.42)	26.27 (30.76)	18.17 (24.63)	17.27 (23.94)
Glucose 20% + Aluminium sulphate, 400 µg ml^{-1}	8.74 (17.18)	21.79 (27.78)	25.20 (30.09)	18.57 (25.02)	9.57 (17.97)	26.26 (30.81)	28.01 (31.93)	21.28 (26.90)	19.93 (25.96)
Glucose 20% + Aluminium sulphate, 400 µg ml^{-1}+GA_3, 50 µg ml^{-1}	8.24 (16.67)	15.10 (22.85)	17.79 (24.84)	13.71 (21.45)	8.62 (17.06)	18.32 (25.31)	24.31 (29.50)	17.08 (23.96)	15.40 (22.71)
Fructose 20% + Aluminium sulphate, 400 µg ml^{-1}	8.52 (16.93)	17.89 (24.88)	23.17 (28.71)	16.53 (23.51)	9.15 (17.59)	16.69 (24.00)	22.94 (28.53)	16.26 (23.37)	16.39 (23.44)
Fructose 20% + Aluminium sulphate, 400 µg ml^{-1}+GA_3, 50 µg ml^{-1}	4.63 (12.36)	13.91 (21.84)	17.10 (24.39)	11.88 (19.53)	3.91 (11.39)	13.39 (21.29)	14.09 (22.02)	10.46 (18.23)	11.17 (18.88)
Aluminium sulphate, 400 µg ml^{-1}	5.22 (13.18)	12.59 (20.64)	14.85 (22.61)	10.89 (18.81)	3.64 (10.93)	14.06 (21.96)	15.82 (23.40)	11.17 (18.76)	11.03 (18.79)
GA_3, 50 µg ml^{-}1+ Aluminium sulphate, 400 µg ml^{-1}	4.51 (12.25)	16.06 (23.60)	18.72 (25.61)	13.10 (20.49)	3.01 (9.98)	10.60 (18.99)	14.62 (22.43)	9.41 (17.13)	11.25 (18.81)
Mean	7.59 (15.78)	18.85 (25.50)	22.23 (27.93)	16.22 (23.07)	7.73 (15.72)	19.65 (25.96)	23.09 (28.45)	16.82 (23.38)	16.52 (23.22)
Mean values for storage duration: 6 day=7.66 (15.75); 12 day=19.25 (25.73); 18 day=22.66 (28.19)									
CD (p=0.05)	Cultivars (A)=NS; Storage duration (B)=0.72; Treatments (C)=1.25; AxB=NS; AxC=1.76; BxC=2.16; AxBxC=NS								

Figures in parentheses are arc sine transformed values.

Reference

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171.

Influence of Seedling Age and Plant Hormones on Growth, Yield and Storability in Onion (*Allium cepa* L.)

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Keywords: Seedling age, plant hormones, growth, yield, storage, *Allium cepa* L.

Introduction

Onion (*Allium cepa* L.) 2n=2x=16, is one of the important bulbs, biennial herb belonging to family Alliaceae. Its cultivation is highly technical and depends on photoperiod and temperature (Rabinowitch and Brewster, 1990) as well as growth rate and number of days to maturity (Steer, 1980). Fluctuation in any of the environmental factors during the critical stages of bulb development leads to pre-initiation of inflorescence axis, thus deteriorating the bulb quality, yield and its storage. The experiment was intended to determine the relationship of seedling age and exogenous application of plant hormones (growth inhibitors) on crop morphology, bulb yield and storability.

Materials and Methods

The experiment was laid out in factorial randomized block design comprising of three seedling ages and six plant hormonal treatments. Seedlings were transplanted on 7th, 10th, and 11th November, 2014, when they were of 42, 56, and 70 days old. A fresh stock solutions of 500 and 1000ppm cycocel and 2000 and 2500 ppm ethephon and 1000 and 2000 ppm paclobutrazol was prepared by dissolving the required quantity in small amount of distilled water, which was then diluted with 5 ml acetone (90%) for making other concentrations. In control, only distilled water was used. Tween 20 at the rate of 1 ml per litre of plant hormone solution was added for sticking purpose. The crop was sprayed at critical stages (Brewster, 2008) of bulb development i.e., 30 days after transplanting (at thermo phase), 60 days after transplanting (at competition phase) and 90 days after transplanting (DAT) (at completion phase) or 4, 6 and 8 leaf stages. Spraying was done between 11 AM to 3.00 pm when the plants showed active stomatal opening for effective absorption of the hormones.

Results and Discussion

Six week old seedling performed poorly and showed low storability with 100% rotting and weight loss of its bulbs kept under ambient storage for eight weeks (Table 1). The plants showed statistically highest equatorial diameter, maximum sized bulbs, average bulb weight and total bulb yield. The bulbs of this category showed maximum storage with rotting (85.79%) and physiological loss in weight (81.6%). However, 10 week old seedlings outperformed other aged seedlings with respect to only vegetative characters like plant height at 70 and 100 days after transplanting, number of leaves at 70 and 100 days after transplanting and leaf length. Plant hormones, on the other hand, recorded low vegetative growth as compared to control except cycocel. Among various hormones, paclobutrazol treatments were found statistically superior in increasing the yield as compared to other treatments.

Interaction effect between 8 week old seedlings applied with paclobutrazol at 2000 ppm recorded maximum vegetative growth, yield (279.50 q/ha) and maximum shelf life. This treatment recorded minimum rotting (73.3%) and total weight loss (70%) under ambient storage. Economically too, this interaction showed maximum net returns of Rs. 3,46,869/ha with a benefit cost ratio of 4.40 compared to control with net returns of Rs. 2,27,253/ha and benefit cost ratio of 2.90 respectively.

Table 1: Influence of seedling age and plant hormones on growth, yield and storability of onion

Treatment	Plant height (cm)		No. of leaves/plant		Leaf length at harvest (cm)	Bulb size (cm^2)	Bulb weight (g)	Marketable yield (q/ha)	Total loss in %	
	70 DAT	100 DAT	70 DAT	100 DAT					Rotting	PLW
A_1C_1	21.37	41.27	3.53	6.87	1.23	16.57	38.27	40.40	100	100
A_1C_2	19.90	39.07	3.17	6.77	1.28	17.92	48.53	57.00	100	100
A_1E_1	22.98	39.33	3.37	6.37	1.02	15.85	35.00	48.10	100	100
A_1E_2	22.23	36.87	3.07	6.23	0.97	13.15	34.70	36.00	100	100
A_1P_1	21.67	38.97	3.53	6.30	1.34	17.94	47.10	51.70	100	100
A_1P_2	21.07	37.47	3.03	6.17	1.37	18.71	51.17	69.40	100	100
A_1C_0	21.50	43.90	4.27	7.47	1.03	15.98	40.10	59.30	100	100
Mean	21.53	39.55	3.42	6.60	1.18	16.59	42.12	51.70	100.00	100.00
A_2C_1	35.37	59.10	5.13	8.33	53.45	26.63	94.60	177.00	80	74.4
A_2C_2	30.60	56.57	4.83	8.60	52.57	27.37	103.47	222.90	87.5	74.2
A_2E_1	35.71	47.77	5.00	8.30	50.19	21.37	83.67	161.80	92.3	94.8
A_2E_2	34.57	44.90	4.90	8.23	50.71	19.48	74.60	157.50	100	96.0
A_2P_1	32.97	48.93	4.77	7.67	52.77	28.83	108.33	241.60	83.3	80.4
A_2P_2	31.90	48.03	4.43	7.47	55.39	32.13	110.93	279.50	73.3	70.0
A_2C_0	39.63	63.57	5.53	9.23	55.35	21.48	85.47	197.50	84.1	81.4
Mean	34.39	52.70	4.94	8.26	52.92	25.33	94.44	205.40	85.79	81.60
A_3C_1	43.57	65.93	5.63	9.93	62.55	19.83	78.17	135.70	88.2	91.5
A_3C_2	42.47	64.17	5.17	9.40	64.08	20.08	79.40	165.60	92.3	90.0
A_3E_1	42.93	65.40	5.43	9.00	61.43	19.80	69.67	133.50	88.2	94
A_3E_2	40.87	53.37	5.00	8.93	60.43	19.30	65.60	116.90	93.8	98
A_3P_1	42.70	65.50	5.53	8.83	63.56	23.88	79.37	183.40	86.7	88.4
A_3P_2	39.40	62.87	5.27	8.80	63.12	24.50	80.10	196.60	85.7	87.6
A_3C_0	46.53	67.00	6.10	10.47	60.66	19.59	72.33	164.60	87.5	88.2
Mean	42.64	63.46	5.45	9.34	62.26	21.00	74.95	156.61	88.91	91.10
S.Em±	1.79	3.30	0.30	0.36	1.68	1.31	2.98	8.60	-	-
C.D(0.05%)	NS	NS	NS	NS	NS	3.74	8.51	24.58	-	-
C.V	9.40	11.0	11.30	7.70	5.30	10.80	7.32	10.80	-	-

Note:
- Seedling age - A_1= 6 week old, A_2= 8 week old, A_3= 10 week old
- Plant hormones - C_1= Cycocel 500 ppm, C_2= Cycocel 1000 ppm, E_1= Ethephon 2000 ppm, E_2= Ethephon 2500 ppm, P_1= Paclobutrazol 1000 ppm, P_2= Paclobutrazol 2000 ppm
- Control - C_0= Distilled water spray
- DAT - Days after transplanting;
- PLW - Physiological Loss of Weight (g)

172.

Change in Protein Profile during Post-fertilization Seed Development of French Bean

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Keywords: Seed development, protein profile, French bean

Introduction

Seed development represents an important phase in life cycle of flowering plants. During this phase, development and metabolic activities are coordinated to produce seed which contains germline information and storage reserves. Normally, post-fertilization seed development till its maturity can be divided into three phases (Adams and Rinne, 1981): slow increase in dry weight of an individual seed occurs during the initial lag phase (stage-I), followed by phase-II (linear growth phase) when growth rate is at maximum and constant, after which growth rate decreases with increasing rate and reaches to zero at physiological maturity (phase-III, maximum seed dry weight). Protein accumulation proceeds with the progress in seed development along with other biochemical constituents. Considering this factual scenario, the present programme was formulated to assess the changing pattern in protein profile during seed development of five French bean genotypes.

Materials and Methods

Sufficient number of flowers of five genotypes *viz*., Sonali, Selection 9, Deepali, Abhay and Victoria were tagged on a specific date of anthesis. Developing pods were harvested at different growth stages up to 49 DAA (days after anthesis) starting from 7 DAA and 7 days interval thereafter. Soluble protein was estimated from the seeds of all stages along with N, P, K, Crude protein and carbohydrate. SDS-PAGE analysis of seed protein was done from developing seeds.

Results and Discussion

Accumulation of N, P, K content of seed continued till 49 DAA for Abhay and Victoria, while it was 42 DAA for others; similar scenario was noticed for both crude and soluble protein as well as for carbohydrate. SDS-PAGE analysis of storage protein of developing seeds indicated maximum similarity in protein banding pattern for 21 DAA with 14, 28, 35 and 42 DAA as well as for 28 DAA with 35 and 42 DAA in all the genotypes. The lowest similarity values could be recorded for 21 and 28 DAA with 49 DAA. Accumulation of different biochemical constituents in seed with progress in development grouped the genotypes into two, which indicate influence of genetic background for expression of these characters. Genotype specific pattern could also be noticed for change in protein profile with advancement in development as is evident through SDS-PAGE analysis of seed storage protein.

Table: Number of protein bands recorded at different development stages against the genotypes

Genotype	Stage of development (DAA)						Total no. of bands
	14	21	28	35	42	49	
Sonali	6	7	10	11	11	10	11
Selection 9	6	8	14	14	13	10	14
Deepali	9	11	13	13	12	13	13
Abhay	10	12	12	14	14	11	14
Victoria	11	10	12	14	14	12	14

173.

Cloning and Characterization of Bzip Type Transcription Factor in *Picrorhiza kurrooa* Royle Ex Benth.

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Keywords: bZIP transcription factor, picrorhiza

Introduction

Picrorhiza kurrooa, a medicinal plant with well known hepatoprotective activity attributed to monoterpene picrosides, has been endangered due to its extensive harvesting from natural habitat. Understanding its molecular mechanism would favour picrorhiza acclimatization and picrosides accumulation. Transcription factors (TFs) act as switches in influencing the expression of multiple pathway genes. bZIP TFs play significant roles in plants' response to biotic and abiotic stresses, therefore, this study focussed on identification and characterization of bZIP transcription factor, *pkbZIP*, from picrohiza to have an insight into regulation of picrosides biosynthesis in picrorhiza and modulating terpene metabolism in other medicinal plants of alpine zone.

Materials and Methods

pkbZIP gene of picrorhiza was cloned through degenerate primer based approach and ORF sequence was completed through RACE-PCR method. cDNA-sequences were analyzed at National Center for Biotechnology Information (http://www.ncbi.nlm.nih.gov/). Semi-quantitative RT-PCR was used to analyze tissue-specific expression and the expression changes in response to light. For gene expression studies, picrorhiza plants were placed simultaneously in continuous light and dark growth chambers maintained at 15°C and samples were harvested at 12h interval from start of the treatment (treated as 0h) and continued for 36h. Picrosides were estimated as described by Kawoosa *et al.*, 2010.

Results and Discussion

Plant bZIP TFs bind to ACGT-box in the promoters of the genes. The presence of ACGT-boxes has been reported in promoters of two regulatory genes of picroside biosynthetic pathway; *3-hydroxy-3-methylglutarylco enzyme Areductase* and *1-deoxy-D-xylulose-5-phosphatesynthase* (Kawoosa *et al.*, 2010). Since bZIP TFs play significant roles in response to abiotic stresses like light and low temperature suggesting its possible role in regulating the picroside biosynthetic pathway. Partial fragment of *pkbZIP* gene was cloned through degenerate primer based approach, and ORF sequence of 1473bp was completed through RACE-PCR method (EU785928). Bioinformatic analysis reveal highly conserved bZIP domain (N-X_7-R/K-X_9-L-X_6-L-X_6-L) in pkbZIP at amino acids 100 to 132.

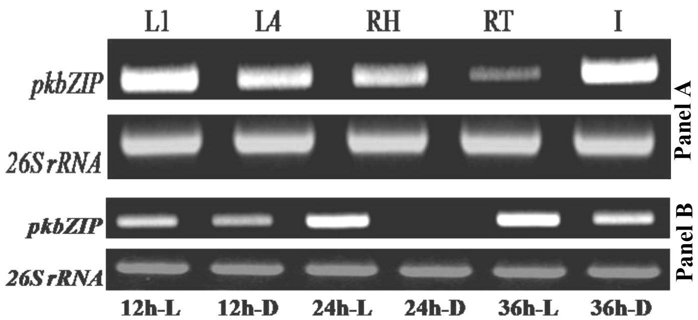

***Fig. 1: Gene expression of pkbZIP (A and B) in picrorhiza. Panel A**, expression of pkbZIP wherein L1, L4, RH, RT and I as indicated on the top of the panel represent first leaf, fourth leaf, rhizome, root and inflorescence, respectively. **Panel B**, different time of exposure (in h) to s light (L) and darkness (D). 26S rRNA was used a marker for equal loading. Name of the genes are indicated on the left side of panel A and B.*

The *pkbZIP* was strongly up-regulated in first leaf, rhizome and inflorescence however; transcript level was low in fourth leaf and root. Total picrosides content (PI+PII) was highest in the rhizomes and inflorescence, and lowest in the fourth leaf. Also, *pkbZIP* transcript constantly accumulates at higher level under continuous light conditions as compared to under dark conditions at all the time points considered. Total picrosides content (PI+PII) in light as compared to dark was higher by 70% and 65% at 12h and 36h, respectively. Gene expression and picrosides content exhibited positive correlation under light conditions (0.7788) and in different plant tissues (0.5411 and 1.0 in above and below ground plant tissues, respectively). Single TF is reported to co-ordinately regulate the expression of multiple genes in monoterpenoid biosynthetic pathway in plants therefore; *pkbZIP* might prove as potential candidate for regulating the picrosides level in picrorhiza.

Reference

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174.

Correlation and Path Analysis in Chilli (*Capsicum annuum* l.) under Temperate Environmental Conditions

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Keywords: Correlation, path analysis, *Capsicum annuum* L.

Introduction

Chilli (*Capsicum annuum* L.) is the most commonly grown spice crop in India. Yield is of utmost economic importance which a plant breeder has always to keep in view in his attempt to evolve improved cultivars of any crop. Knowledge of the association of quantitative characters specifically for yield and its attributes is of immense practical value in order to obtain an optimal selection index for yield improvement. The selection of one character will lead to indirect change(s) of other character(s) if the two are correlated. Therefore, the knowledge of phenotypic and genotypic correlation and path analysis is important for a plant breeder. Thus the present study was undertaken to study the association of various yield components in order to develop a reliable set of traits for indirect selection.

Materials and Methods

Materials comprised of sixty four genotypes of chilli being maintained at Sheri- Kashmir university of Agricultural Science and Technology-*KASHMIR,* Shalimar. The genotypes were characterized for various agro-morphological traits. The experiment was laid in square lattice design with four replications during *kharif*-2013. Each replication was divided into eight blocks with eight genotypes per block. The genotypes were planted in 3 rowed plots of 2.4 x 1.8m at a spacing of 45 x 45 cm. Observations were recorded on five randomly selected plants for each entry per replication. The formula suggested by Panse and Sukatme (1985) was used to calculate correlation co-efficient among characters. The methodology suggested by Wright (1921) and Li (1956) was adopted to carry out path coefficient analysis.

Results and Discussion

The analysis of variance revealed that all the characters exhibited significant differences among the genotype. In general the estimates of genotypic correlation coefficients were slightly higher than phenotypic correlation showing that masking effects of the environment was little indicating the presence of inherent association between various characters. Fruit yield exhibited significant and positive association with fruit diameter, fruit length, number of fruits plant^{-1}, average fruit weight, number of branches plant^{-1}, average seed weight per fruit, seed yield plant^{-1} and 100 seed weight. These results suggested that that selection for these characters are useful for improvement upon fruit yield in chilli. The path coefficient analysis (Table 1) revealed appreciable amount of direct positive effect of average fruit weight followed by seed yield plant^{-1}, number of fruits plant^{-1}, first ripe fruit harvest, fruit length and fruit diameter on fruit yield plant^{-1}. Significant positive genotypic correlation coefficients of these traits with fruit yield reveal that these traits can be used to develop an optimally reliable selection index for realizing improvements in fruit yield of chilli.

References

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Table 1: Genotypic path analysis showing direct (diagonal) and indirect (off diagonal) effects of different parameters on yield in chilli.

Parameters	Days to first flower	Days to first fruit set	Days to first green fruit harvest	Days to first ripe fruit harvest	Plant height (cm)	Plant spread (cm)	Number of branches per plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)	Number of fruits per plant	Average seed weight per fruit (g)	Seed yield per plant (g)	100 seed weight (g)
Days to first flower	**- 0.0263**	-0.025	-0.0178	-0.0179	0.0042	-0.0028	0.0039	0.0001	-0.0010	-0.0019	0.0053	-0.0011	0.0040	0.0019
Days to first fruit set	-0.0023	**-0.0024**	-0.0016	-0.0016	0.0003	-0.0003	0.0002	-0.0001	-0.0001	-0.0001	0.0005	0.0001	0.0005	0.0002
Days to first green fruit harvest	-0.0723	-0.0734	**-0.0179**	-0.1016	0.0378	0.0093	0.0053	-0.0067	0.0005	-0.0027	0.0049	0.0138	0.0112	0.0141
Days to first ripe fruit harvest	0.1108	0.1073	0.1546	**0.1629**	-0.0097	-0.0066	-0.0040	0.0095	-0.0007	0.0091	-0.0131	-0.0136	-0.0174	-0.0223
Plant height (cm)	-0.0004	-0.0004	-0.0006	-0.0004	**0.0056**	0.0003	0.0001	0.0005	0.0002	0.0007	-0.0004	-0.0002	-0.0007	0.0005
Plant spread (cm)	-0.0047	-0.0048	0.0039	0.0018	-0.0042	**-0.0444**	-0.0038	0.0026	-0.0007	0.0048	-0.0048	0.0010	0.0008	-0.0041
Number of branches per plant	0.0067	0.0057	0.0022	0.0011	-0.0002	-0.0039	**0.0456**	0.0056	0.0247	0.0024	-0.0034	0.0113	0.0076	0.0079
Fruit length (cm)	-0.0002	0.0026	0.0032	0.0030	0.0090	-0.0030	-0.0064	**0.0517**	0.0001	0.0200	-0.0063	0.0043	-0.0042	0.0144
Fruit Diameter (cm)	0.0015	0.0009	-0.0002	-0.0002	0.0001	0.0007	-0.0042	0.0001	**0.0502**	0.0081	-0.0033	0.0125	0.0058	0.0060
Average fruit weight (g)	0.0752	0.0540	0.0264	0.0577	0.2131	-0.1110	-0.0551	0.3972	0.3261	**1.0300**	-0.2609	0.6804	0.0350	0.5930
Number of fruits per plant	-0.0457	-0.0478	-0.0104	-0.0183	-0.0154	0.0247	0.1172	-0.0278	-0.0189	-0.1020	**0.3279**	-0.0621	0.1456	-0.0144
Average seed weight / fruit (g)	-0.0219	0.0237	0.0703	0.0453	0.0574	0.0123	0.1452	-0.0452	-0.0593	-0.3593	0.1481	**-0.5439**	-0.2660	-0.2452
Seed yield per plant (g)	-0.0917	-0.1322	-0.0628	-0.0640	-0.111	-0.0112	-0.0004	-0.0482	0.0960	0.0204	0.3834	0.2935	**0.6002**	0.0987
100 seed weight (g)	-0.0016	-0.0022	-0.0030	-0.0032	0.0053	0.0021	-0.0040	0.0064	0.0335	0.0133	-0.0015	0.0104	0.0038	**0.0231**
Genotypic correlation with yield plant^{-1}	**-0.073**	**-0.094**	**0.057**	**0.065**	**0.192**	**-0.134**	**0.239***	**0.346****	**0.451****	**0.643****	**0.576****	**0.406****	**0.526****	**0.473****

*Residual effect= 0.3601

175.

Association Mapping for Genetic Dissection of Seed Zinc (Zn) and Iron (Fe) Content in Common Bean (*Phaseolus vulgaris* L.)

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Keywords: Common bean, SSRs, micronutrients, association mapping, QTLs

Introduction

Common bean (*Phaseolus vulgaris* L.) is one of the most important grain legume crops grown and represents nearly 50% of the grain legumes consumed world-wide. In terms of nutritional importance legumes provide complementary nourishment in the form of proteins, lipids (oil), and minerals. Important mineral (Ca, Fe, Mg, P, K, Na, Zn, Mn) levels are higher in legumes than in cereals. Common bean is high in starch, protein and dietary fiber and is an excellent source of iron, potassium, selenium, molybdenum, thiamine, vitamin B6, and folate, Whereas, Micronutrients like Zinc and Iron are among the important minerals that are required in the diet to fulfil the nutritional needs of people. It is estimated that micronutrient malnutrition in general and deficiency of Zn and Fe in particular afflicts >3 billion people (3 out of every 6 persons) worldwide and numbers are ever increasing (Welch and Graham, 2004). Therefore, present study was conducted to identify genes/QTLs associated with seed zinc and iron content through association mapping in common bean using a core collection of 96 lines and ~80 SSR marker genotyping data.

Materials and Methods

A set of >400 common bean lines were initially collected and evaluated for a variety of morphological traits and based on the preliminary trait evaluations, a set of 96 diverse common bean lines (core set) was selected. These landraces have been collected by us from different common bean growing regions of Jammu & Kashmir and also including some exotic germplasm. A set of these 96 lines were subjected to SSR marker genotyping in the Molecular Breeding Laboratory at Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu and at Centre of Excellence in Genomics, International Crop Research Institute for the Semi Arid Tropics (ICRISAT), Hyderabad. Core set was also subjected to precise phenotyping for seed Zn and seed Fe content. The genotypic data and trait data on Zn and Fe was collectively used for working out marker-trait association (MTAs) through association mapping for seed Zn & Fe content. During this process different softwares programs were used for conducting data analysis including genetic diversity, population structure analysis and association mapping for seed Zn and seed Fe content.

Results and Discussion

For identifying marker-trait associations (MTAs) through association mapping, population structure analysis was conducted first. The analysis of population structure revealed presence of two sub-population in a collection of 96 common bean lines (Fig. 1). The information of population structure, trait phenotypic data on Zn & Fe and marker genotypic data was together and significant MTAs were identified. For Zn content, only a solitary marker explaining 33% phenotypic variation for the Zn trait was identified, while as for Fe, two markers were found significantly associated. Among these MTAs, one MTA each identified was a associated with a major gene/QTL explaining >30% phenotypic variation for seed Zn and seed Fe content. The validated associated markers with seed Zn and seed Fe content may prove useful through marker-assisted selection (MAS) programs for selecting the lines carrying allele for seed Zn and seed Fe content in common bean breeding programs.

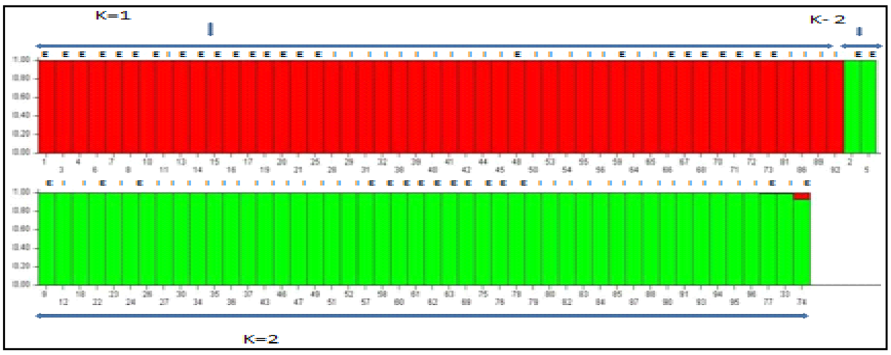

Fig. 1: Structure plot of 96 common bean lines showing two sub-populations in 96 common bean lines. The red and green coloured plots shows two different sub-populations.

Reference

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176.

Epigenomic Alterations in Rice as Drought Stress Response

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Keywords: Drought stress, rice, epigenetics, DNA methylation.

Introduction

Abiotic stress is a major constraint in crop yield. Particularly for rice, drought stress is a limiting factor which induces several changes at molecular level aimed at coping up with stress. Among various changes, epigenomic changes are also induced. Global DNA methylation changes and those surrounding MITEs (Miniature Inverted repeat Transposable Elements) were studied in three rice varieties namely Saanwal Basmati, Basmati-370 (drought susceptible) and Dular (drought tolerant) by Methyaltion Sensitive Amplification Polymorphism (MSAP). Also, Methyl Chip-on-chip revealed the methylation changes in stress responsive genes.

Materials and Methods

Plants were exposed to drought stress at vegetative phase. Plants labeled as control were watered regularly to maintain a high level of standing water, throughout the experiment. DNA was isolated from each sample and MSAP was performed by following the procedure of Akimoto *et al.* (2004). For transposon methylation display, all the steps were same as in MSAP except that one of the primers used in PCR amplification was specific for particular MITE. The Methyl Chip-on-Chip experiment involved, Immunoprecipitation of DNA, labeling of DNA with Cy3 and Cy5, hybridization on to 4X44K Agilent Chip, extraction of data and data analysis.

Results and Discussion

Cytosine methylation decreased in Basmati-370 and Saanwal whereas the drought tolerant variety i.e. Dular underwent an increase in methylation. Moreover, through MITE methylation display, methylation environment in the vicinity of MITEs was found to be dynamically altered during drought stress in all the three varieties. Methyl chip-on-chip using showed a global demethylation trend and subsequent increased expression of stress responsive genes as a result of drought. Of the several genes involved in abiotic stress response, some were hypomethylated while many others were hypermethylated in response to drought stress, owing to their respective roles in withstanding the stress. The differentially methylated gene promoters include peroxidases (ROS scavengers), hydrophilins (osmoprotectants), kinases (signaling), Universal stress proteins, Heat shock proteins (HSPs) and heat shock transcription factors (HSFs). A number of pathways such as betanidin degradation pathway, phenyl propanoid biosynthetic pathway, ascorbate glutathione metabolism pathway, jasmonic acid biosynthesis, etc. were affected by these differentially methylated genes.

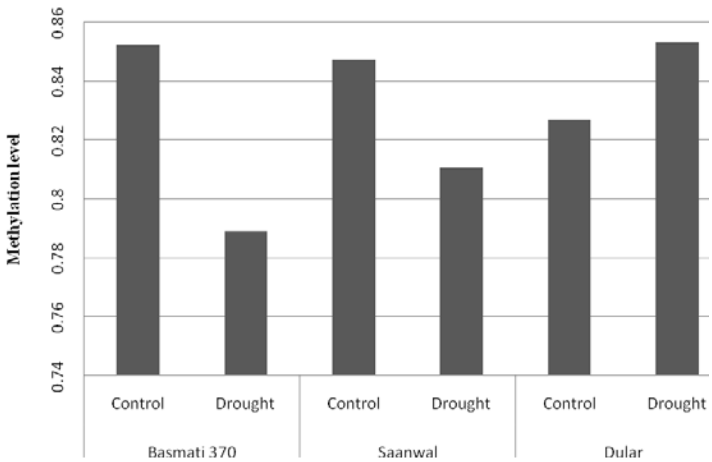

Fig. 1: Total methylation in three varieties of rice in response to drought stress treatment as detected by MSAP

Reference

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177.

Genetic Diversity Studies in Kashmiri Nakh (*Pyrus pyrifolia* Nakai.) Sing SSR Markers

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Keywords: Genetic diversity, Kashmiri Nakh, PIC, SSR markers

Introduction

Diversity in fruit species is assessed on the basis of phenotypical /morphological traits, biochemical techniques based on isozyme patterns and protein profile like SDS-PAGE, and by using DNA based molecular techniques like Restriction Fragment Polymorphic DNA (RFLP), Amplified Fragment Length Polymorphism (AFLP), Random Amplified Polymorphic DNA (RAPD), Simple Sequences Repeats (SSR) etc. The information regarding genetic diversity in *Pyrus* germplasm characterized by these methods is useful for efficient management, preservation and also for breeding purpose. Now-a-days molecular techniques are used to supplement phenotypic variability studies. Molecular differences using DNA markers are more authentic and unaffected by environmental factors. Hence characterization of genotypes at genetic level supplemented by phenotypic characters provides the first step towards more efficient conservation, maintenance and utilization of existing genetic diversity.

Materials and Methods

Leaves of eighteen Kashmiri Nakh (*Pyrus pyrifiolia* Nakai.) accessions were collected from different locations of the three districts namely Anantnag, Kulgam and Budgam of Kashmir Valley in 3rd week of March 2015. The total genomic DNA was isolated from the leaves using DNA extraction procedure as proposed by Doyle and Doyle (1990) with some minor modifications. A total of 26 microsatellite primers were used to access genetic diversity of pear genotypes. A mixture of 10 µl of various PCR reagents, based on the stock and final concentration of different components was prepared. *In vitro* amplification using polymerase chain reaction (PCR) was performed in a 96 well microtiter plate in an Eppendorf Master Cycler using 20 ng of genomic DNA of each genotype in a final volume 10 µl per reaction. The amplified product was analyzed on PAGE (12% Polyacrylamide Gel Electrophorosis) using 100bp DNA ladder.

Results and Discussion

In present study 18 accessions were used to study the genetic diversity at molecular level using 26 SSR markers. The results of present study indicated a considerable level of genetic variation among the sandy pear accessions. The PIC values provide an estimate of the discriminating power a marker. PIC value is reflection of allelic diversity and frequency among the genotypes, any value exceeding 0.5 reflects polymorphism (Wani, 2011). In present study PIC value varied from 0.39 to 0.97 (Table 1) with an average of 0.68 across eighteen sandy pear accessions. Our results are in close conformity with Bhat *et al.* (2013) who reported that PIC value ranged from 0 to 0.84 with an average of 0.53 across 11 pear genotypes.

Table 1: Polymorphic index content of twenty six SSR markers

S.No.	Marker	PIC
10	NB113a	0.94
24.	NH027a	0.39

Genetic similarity between accessions was analyzed by UPGMA. A dendrogram was generated from genetic similarity coefficients and similarity distance was observed (Table 2). The eighteen accessions showed different two way similarity coefficient values ranging from 0.12 to 0.69. The highest similarity value 0.69 was observed Accession 18 and Accession 2 and the lowest (0.12) between Accession 7 and Accession6. The dendrogram grouped eighteen accessions into two major clusters along with four sub clusters and one independent accession. The results of present study indicated a considerable level of genetic variation between the accessions falling in cluster I and cluster II. The accessions were classified into two clusters showing a high level of diversity between the clusters. Ahmed *et al.* (2010) who observed similarity coefficient range of 0.00 to 1.00 in KT53 (Btung) and between BG21 and MZ26 which are both locally called Kotharnul and grouped all accessions into 3 main clusters and two identical groups and four accessions which fell independently based on their pedigree and geographical origin.

Table 2: Similarity coefficients among pear (*Pyrus pyrifolia* Nakai.) genotypes

	Accession 7	Accession 18
Accession 6	0.12	
Accession 2	0.50	0.69

References

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178.

Studies on Mineral Composition in Chickpea Leaves at Different Stages of Maturity

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Keywords: Minerals, macronutrient and micronutrient

Introduction

Chickpea (*Cicer arietinum L.*) is the third most important food legume of the world. India is the leading producer and consumer of chickpea contributing to about 70% of the world chickpea production. Like other green leafy vegetables, chickpea leaves also contain good amount of macronutrient and micronutrient. Stage of maturity of leaves may effect on their mineral composition. So to determine the mineral composition of chickpea leaves of two *desi* and two *kabuli* varieties were studied for mineral composition at different stages of maturity

Materials and Methods

Two *desi* (HC-1, C-235) and two *kabuli* (HK-1, HK-2) chickpea were taken from department Plant Breeding of CCS Haryana Agricultural University, Hisar. The young fully expended leaves (fourth through seventh nodes from the apex, up in triplicate) at 3 stages of maturity (30, 45, 60 days) was collected. Then the leaves was washed in distilled water followed by drying at 65-70°C for minimum of 48h, so that dry weigh the same constant. The data is estimated by Atomic Absorption Spectrophotometer (AAS, Lindsey and Norwell, 1969).

Results and Discussion

Mineral content increased with the passage of time i.e. 30 to 60 days intervals for both the *desi* varieties of chickpea (Table 1). On the basis of statistical analysis, significant difference was observed among all the tested varieties. It was observed that all the mineral contents were accumulated maximum after 45 days of interval. Phosphorus (P) Content was also significantly higher in both the *desi* varieties of chickpea after 45 days of intervals. Similar trends were observed in case of Iron (Fe) & Zinc (Zn) for HC-1 and C-235. Overall C-235 was better responding for all the mineral content at all intervals as compare to HC-1. Calcium content varied from 2452.33mg to 2675.67mg/100gm and 2418.33mg to 2624.33mg/100gm in chickpea leaves HK-1 and HK-2, respectively. Phosphorus content varied from 353.67mg to 386.67mg/100gm and 349mg to 377mg/100gm in chickpea leaves HK-1 and HK-2, respectively. Iron content varied from 520.67mg to 560.00mg/100gm and 494.33mg to 515.00mg/100gm in chickpea leaves HK-1 and HK-2, respectively. Minerals (Ca, P, Fe, and Zn) were observed higher in all 3 stages (30, 45, 60 days) of maturity after sowing in HK-1 and HC-1 as compared to HK-2 and C-235 variety, respectively. Minerals (Ca, P, Fe, and Zn) were observed highest in chickpea leaves on day 45 of maturity after sowing as compared to day 30 and day 60 of maturity after sowing and significantly different (except Fe in C-235 variety).

Table 1: Mineral contents of two kabuli (HK-1, HK-2) and two desi (HC-1, C-235) chickpea varieties in leaves at different stages (30, 45, 60 days) of maturity in mg/100g sample

Minerals	HK-1 variety			HK-2 variety		
	Day 30	Day 45	Day 60	Day 30	Day 45	Day 60
Ca	2554.33^{c}±19.36 (2633.33^{c}±11.8)	2675.67^{a}±11.32 (2716.67^{b}±9.26)	2452.33^{e}±8.2 (2513.3^{d}±7.1)	2514.33^{d}±8.2 (2706.67^{b} 4.9)	2624.33^{b}±15.8 (2802.67^{a}±5.8)	2418.33^{e}±3.76 (2602.3^{c}±10.9)
P	353.67^{b}±3.84 (355.67^{de}±3.18)	386.67^{a}±2.91 (372.00^{b}±3.06)	355.33^{b}±5.21 (348.00^{e}±2.1)	349.00^{b}± (61367.3^{bc}±3.9)	377.00^{a}±3.22 (387.67^{a}±2.33)	347.00^{b}±4.58 (359.33^{cd}±4.3)
Fe	520.67^{bc}±8.82 (507.67^{bc}±2.33)	560.00^{a}±8.72 (518.33^{b}±2.03)	524.00^{b}±7.6 (505.33^{c}±2.0)	494.33^{d}±3.53 (545.33^{a}±4.1)	515.00^{bc}±3.53 (555.33^{a}±5.55)	502.33^{cd}±2.41 (546.33^{a}±4.2)
Zn	6.27^{b}±0.09 6.00^{d}±0.06	6.57^{a}±0.15 (6.40^{ab}±0.06)	6.10^{bc}±0.06 (6.10^{cd}±0.06)	5.90^{c}±0.06 (6.10^{cd}±0.06)	6.37^{ab}±0.09 (6.53^{a}±0.09)	6.10^{bc}±0.06 (6.27^{bc}±0.07)

Figures in parentheses showed the mineral content in two desi varieties (HC-1, C-235) and a, b, c and d denote genotypes

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179.

Evaluation of Some Tomato Genotypes and Their Hybrids for Yield and Component Traits Under Mid Hill Agro Climatic Zone of Himachal Pradesh

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Keywords: Hybrids, evaluation, mean performance, tomato, yield and component traits

Introduction

Tomato (*Solanum lycopersicum* L.) is rich source of vitamins and minerals. It is eaten as raw, cooked or in processed forms. Mid hills of Himachal Pradesh are leading supplier of tomatoes to the North Indian markets of country during rainy and autumn season fetching off season prices to the growers. Therefore, present study was conducted to evaluate six parental lines of tomato along with fifteen crosses and one standard check (Naveen 2000+) during 2015-16 with the aim to identify early and high yielding tomato F_1 hybrids superior to standard check.

Materials and Methods

The parents involved in the study were Solan Lalima, UHF-55, EC-2798, EC-1055, EC-1057 and EC-1058. All the 22 genotypes (6 parents, 15 F_1 hybrids and 1 standard check) were field evaluated using randomized complete block design (RCBD) with three replications. The observations were recorded on days to first harvest, plant height (cm), fruit clusters per plant, number of fruits per cluster, number of fruits per plant, fruit size (cm^2), average fruit weight (g), harvest duration (days) and fruit yield (kg/plant).

Results and Discussion

Analysis of variance showed significant differences for all the traits under study. Three parents while four crosses performed better than standard check for earliness. For plant height, two parents and six crosses surpassed the performance of standard check. Similarly, three parents and three cross combinations were found to be superior to standard check for most of the yield and component traits. Cross combinations *viz.,* Solan Lalima x EC-1055, Solan Lalima x EC-1057 and EC-1057 x EC-1058 were found to be superior to standard checks for all traits included in this study (Table 1), thus recommended for multi location testing.

Table 1: Mean performance of parents, crosses and standard check for yield and component traits in tomato

Parents	Days to first harvest	Plant Height (cm)	Fruit Cluster per plant	No. of fruits per cluster	No. of fruits per plant	Fruit size (cm^2)	Averag e fruit weight (g)	Harvest duration (days)	Fruit Yield (Kg/pla nt)
Solan Lalima	67.33	198.67	8.75	4.19	40.25	32.87	68.82	71.55	2.64
UHF-55	70.00	164.33	7.59	3.47	26.02	34.05	68.71	64.93	2.45
EC-2798	69.00	207.67	7.25	4.05	33.36	30.11	62.83	67.33	2.05
EC-1055	54.00	85.33	4.60	3.09	17.00	37.47	72.00	41.40	1.55
EC-1057	57.00	75.67	4.69	3.15	17.33	35.09	74.21	42.47	1.34
EC-1058	61.00	69.67	4.37	2.92	15.16	33.79	75.53	38.27	1.06
Solan Lalima X UHF-55	71.67	194.67	7.63	2.98	24.42	28.81	71.69	62.58	2.56
Solan Lalima X EC-2798	71.33	205.00	8.27	3.21	28.94	30.96	64.43	70.41	2.53
Solan Lalima X EC-1055	59.33	213.33	9.28	4.55	46.94	36.54	73.98	91.96	3.15
Solan Lalima X EC-1057	57.33	201.67	9.07	4.51	45.37	36.18	74.76	85.28	3.04
Solan Lalima X EC-1058	58.00	194.67	9.03	4.32	42.38	34.04	78.36	66.71	2.95
UHF-55 X EC-2798	73.67	182.67	7.48	2.95	24.94	33.57	65.99	64.70	2.44
UHF-55 X EC-1055	65.00	174.33	7.94	3.81	31.00	36.55	74.72	67.96	2.94
UHF-55 X EC-1057	66.67	182.00	7.89	3.75	30.79	36.40	74.55	67.99	2.93
UHF-55 X EC-1058	68.33	176.33	7.21	2.77	22.41	34.32	77.98	56.61	2.65
EC-2798 X EC-1055	64.00	193.67	7.64	4.31	37.41	33.86	68.53	70.50	2.04
EC-2798 X EC-1057	79.67	187.33	6.05	2.29	16.19	35.92	64.53	66.33	1.98
EC-2798 X EC-1058	83.00	153.00	5.30	2.68	16.59	28.28	68.50	60.27	1.76
EC-1055 X EC-1057	64.67	115.67	5.20	2.63	15.30	38.22	75.14	41.40	1.47
EC-1055 X EC-1058	68.33	90.67	5.48	2.78	17.63	36.18	73.16	40.97	1.34
EC-1057 X EC-1058	60.00	74.67	5.32	2.69	16.66	38.02	67.87	40.49	1.13
Naveen 2000+ (Check)	64.00	192.22	8.51	4.20	39.88	34.48	71.27	73.48	2.72
Population mean	66.06	160.60	7.02	3.42	27.54	34.35	71.25	61.53	2.22
SE(m)±	1.14	2.28	0.24	0.17	1.82	0.73	1.00	1.86	0.03
$CD_{(0.05)}$	2.28	4.56	0.48	0.34	3.65	1.46	2.00	3.72	0.05

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Morphological Characterization of Okra (*Abelmoschus esculentus* (L.) Moench.) Germplasm through D² Analysis

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Keywords: Characterization, D^2 Analysis, genetic diversity, okra

Introduction

The cultivated okra (*Abelmoschus esculentus* L. Moench) is an important vegetable crop throughout tropical and subtropical low altitude regions in Asia, Africa and America. Multivariate analysis with Mahalanobis D^2 statistics is an important breeding tool to evaluate the clustering pattern and establish the relationship between genetic and geographical divergence. Several authors have assessed genetic divergence in okra on the basis of agronomic traits.

Materials and Methods

The present investigation was carried out with thirty five diverse genotypes of okra were collected for different agro-ecological zones (Table 1) at the Experimental Farm (longitude of 77°11'30"E and a latitude of 30°52′30″N) of the Department of Vegetable Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during Kharif season (June-September) of 2012. The genotypes were planted in a randomized complete block design with three replication. The data were subjected to D2 analysis as per the standard method of Mahalanobis (1936).

Results and Discussion

The analysis of variance revealed significant differences among the accessions for all the characters studied. Accessions collected from different parts of Himachal Pradesh were distributed into four different clusters. The intra cluster distance was maximum in cluster I (3.424) and minimum in cluster II (2.587). Whereas, highest inter cluster distance (10.428) was recorded between cluster I and IV and lowest (3.943) was observed between cluster II and IV (Table 1). Earlier workers like Prakash and Pitchaimuthu (2010) also indicated the significance of genetic divergence in okra.

Table 1: Average intra and inter cluster distance (D^2)

Cluster	I	II	III	IV
I	**3.424**			
II	8.580	**2.587**		
III	6.871	4.150	**2.972**	
IV	10.428	3.943	4.167	**3.276**

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181.

Influence of Sowing Dates on Phenological Development and Yield of Wheat (*Triticum aestivum L.*) Cultivars

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Keywords: Phenology, emergence and anthesis

Introduction

Phenology is the chronology of phases of development of plant species that provides society with independent measures on how ecosystems are responding to environmental conditions. Plant phenology is strongly modulated by short and long term variability in climate and act as one of the most reliable bio-indicators of ongoing climate change (Diskin *et al.*, 2012). Crop phenology is relatively complex due to the confounding effects of climatic and agronomic factors (Estrella *et al.*, 2009). The phases of annual crop such as emergence, heading, flowering and maturity date were found to be influenced by weather and climate (Estrella *et al.*, 2009; Silbert and Ewert, 2012). Both the timing of phenological stages and relative duration of the pre and post flowering phases (vegetative and reproductive phases) are in fact critical determinant of yield (Sadras and Connor, 1991). Therefore, to study the influence of sowing dates on phenological development and yield of wheat (*Triticum astivum L.*) cultivars the present study was undertaken.

Materials and Methods

A field experiment was conducted in *rabi* season of 2011-12 at the Agrometeorological Research field of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The geographical location of which is 32°40' North latitude and 74°58' East longitudes at an elevation of 332 meters amsl. Complete randomized block design was employed with three replications and three different sowing dates. Sowing at different dates was carried out during second week of November early (D1- 08th November), normal (D2- 24th November) and late (D3- 09th December). The date of appearance of particular phenology was recorded. Emergence date was defined as the date when 50% shoot appeared above the ground surface, anthesis was when 50% flowering occurred and maturity date was when wheat was ready for harvest.

Results and Discussion

Germination took about 6 days under early (8th November), normal (24th November) and 11 days when sown late (9th December) as can be seen from the graph (Fig. 1). The reason being that early and normal sown crops experienced maximum temperature around 25°C and minimum temperature between 9 and 13°C whereas late sown crop (9th December) experienced maximum and minimum temperature about 21°C and 4°C, respectively. Under late sown conditions crop emergence was delayed by 5 days owing to low temperature (12°C) which prevailed during stand establishment. The delayed emergence resulted in poor stand establishment and reduced number of productive tillers and ultimately the final yield. This clearly indicates that high temperature expedite germination. The time duration requirement for germination increased by 53.84% in all the three varieties with delay in sowing. Among the different varieties, RSP-561 (123 and 121 days) took more time to reach the anthesis stage at first and second date of sowing as compared to PBW-343 (122 and 120 days) and DBW-17 (120 and 119 days).

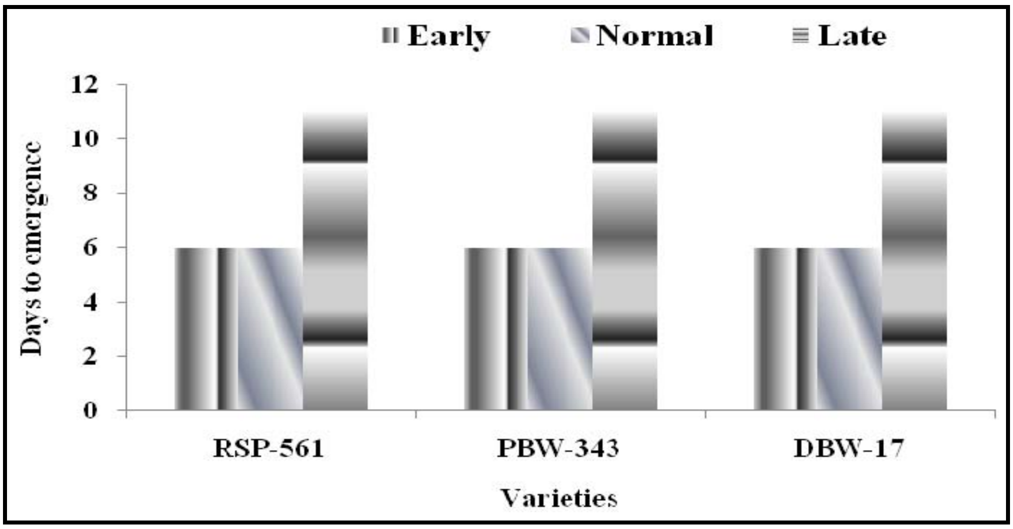

Fig. 1: Difference in days to germination of different wheat varieties under early, normal and late sown conditions.

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182.

Wheat Grain Yield, Yield Attributes, Soil Properties, Weed Count and Economics Influenced by Use of Happy Seeder Machine on Farmers Field

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Keywords: Bulk density, happy seeder, grain yield, soil fertility and yield attributes

Introduction

Paddy (rice *Oryza sativa* L) straw is the only organic material available in significant quantities with the farmers. About 40% of nitrogen, 30-35% of phosphorus, 80-85% of potassium and 40-50% sulphur taken up by rice remains in vegetative plant parts at crop maturity. Mostly farmers burns the paddy straw to ease the sowing of wheat crop. Burning causes atmospheric pollution and also results in nutrient loss. Therefore, the *in-situ* management of paddy straw in the field with happy seeder technology has many beneficial effects for preceding crops and also effect on the overall nutrient balance and long-term soil fertility

Materials and Methods

The study was conducted to accelerate the technology of happy seeder for sowing of wheat (*Triticum aestivum* L var. HD 2967) in the combine harvested fields for management of paddy straw during 2013-14, and 2014-15 at villages Fatehgarh Viran, Rampur Fasse and Mohan Majra of district Ropar. The observations such as grain yield, other yield attributes like straw weight, height at harvesting stage, effective tiller per plant, ear length, number of grains/ear, test weight from 1m row length and soil bulk density were recorded from demonstration fields to compare the performance of wheat sown with happy seeder and conventional method.

Results and Discussion

Data on yield, straw weight, height at harvesting stage, effective tiller per plant, ear length, number of grains/ ear and test weight of wheat sown with happy seeder, zero drill and conventional method is depicted in Table 1. Yield was significantly higher in happy seeder sown wheat (47.8 q/ha) in comparison to conventional method (45.1q/ha) as well as zero drill (44.12q/ha). The higher straw weight was recorded from the crop sown with happy seeder (37.5q/ha) than conventional method of sowing of wheat which was recorded to be 25.17q/ha. In addition to yield and straw weight, other parameters like height at harvesting stage, effective tiller per plant, ear length, number of grains/ ear, test weight were recorded to be 88.15cm, 10.7,11.2, 44.7, 48.3 respectively as compared to conventional method of sowing of wheat which was recorded to be 89.2, 9.6, 11.4, 39.5, 46.5 respectively. Average soil bulk density of happy seeder sown field was recorded to be 1.17g/cm^3 as compared to 1.22 g/cm^3 in conventional method. Weed count (1sq m area) was higher in conventional method of sowing of wheat as compared to happy seeder sown wheat. The grain yield and other parameters like straw weight, number of grains per ear, test weight (g), effective tillers / plant and bulk density were significantly higher in happy seeder sown wheat as compared to zero drill and conventional method of sowing of wheat.

Table 1: Yield and yield attributes of happy seeder sown wheat in comparison with conventional method of sowing of wheat

Treatments	Number of location	Grain Yield (q/ha)	Height (cm)	Straw weight (q/ha)	No. of grains /ear	Test weight (g)	Ear length (cm)	Effective tiller/ Plant	Bulk density (g/cm^3)
Zero-tillage	5	44.12a	91.34b	45.72a	40.08a	46.76a	11.70a	9.40a	1.23a
Conventional tillage	6	45.16ab	89.18ab	25.16c	39.48a	46.25a	11.41a	9.66a	1.32b
Happy seeder	12	47.89b	88.15a	37.52b	44.70b	48.35a	11.23a	10.75b	1.17a

The values depicted by different letters differs significantly at P<0.0

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Production and Marketed Surplus of Vegetables under Protected Cultivation in Himachal Pradesh

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Keywords: Protected cultivation, production, marketed surplus, constraints

Introduction

Cultivation of crops under protected conditions involves protection of production stage of crops mainly from adverse environmental conditions such as temperature, hails, scorching sun, heavy rains, snow and frost. Protected cultivation technology holds special significance for Himachal Pradesh (H.P) where arable land is scarce due to uneven terrain and holdings are small and fragmented. This technology got a big boost in the state under the NABARD sponsored scheme entitled 'Pandit Deen Dayal Kisan Bagwan Samridhi Yojna' that had an outlay of Rs. 154.92 crores. As a result, the production of commercial crops produced under protected cultivation regime has witnessed manifold increase. Hence, the present study was conducted in Mandi district of H.P to assess production, marketable surplus and to identify the problems/bottlenecks in the success of protected cultivation technology and suggest suitable measures to overcome the problems.

Materials and Methods

Two blocks namely, Sunder Nagar and Balh, having maximum number of polyhouses, were selected purposively. Fifty polyhouse beneficiaries were selected randomly from two blocks through proportional allocation method. The selected beneficiaries were divided into two strata: small (having polyhouse area of 252 sq m and less) and large (having an area of more than 252 sq m). Thus, in all 23 small and 27 large polyhouse units were selected in both the blocks. The primary data from selected farmers were collected through personal interview method. The data were then tabulated and analyzed using different analytical tools like tabular and statistical techniques.

Results and Discussion

The average size of polyhouse units on sampled farms was 365sq m with 201sq m on small and 505 sq m on large farms. Capsicum, tomato and cucumber were the major crops grown during main season and frenchbean, spinach and coriander were taken as the filler crops. Among sampled farms, 72% were growing capsicum, 20% tomato and only 8% were growing cucumber. About 60% farmers kept their polyhouses fallow after the main crop, 34% took frechbean and 6% opted for spinach and coriander as filler crop. Per farm production was estimated to be the highest for capsicum followed by tomato and cucumber. Per farm production of all the vegetables was estimated to be about 31 quintals (q) on small farms and 49q on large farm category. The quantity retained for utilizations varied from 2 to 6% of total production while losses came out to be 1 to 8%. The marketable surplus of polyhouse produce was quite high (94-98%) and was higher on large farms as compared to smaller ones. Marketed surplus of polyhouse produce varied from 90-96% (Table 1). The factor analysis showed that marketed surplus was directly related to total production of polyhouse produce. Lack of knowledge among farmers, non-availability of recommended inputs, defective construction of polyhouses, poor soil-testing facilities, and poor/no assistance for repair of polyhouses, were the major constraints reported. The production in polyhouses can be enhanced by improving the services of implementing, construction and extension agencies. Post-harvest losses need to be checked by providing modern storage facilities to the farmers. Provision of insurance and subsidy for repair of polyhouses seems to be mandatory for promotion and success of the technology. Encouraging marketing strategies increasing producers' share in consumers' rupee are also required to be enforced.

Table 1: Production and utilization pattern of polyhouse produce (%)

Vegetables	TP(q/farm)	UT	Marketable surplus	Losses	Marketed surplus
Tomato					
Small	9.43	5.19	94.81	4.61	90.21
Large	14.48	4.42	95.58	3.84	91.74
Overall	12.16	4.69	95.30	4.11	91.19
Capsicum					
Small	13.79	5.58	94.42	2.52	91.89
Large	24.94	3.97	96.03	1.78	94.24
Overall	19.81	4.49	95.51	2.02	93.49
Cucumber					
Small	8.07	5.96	94.04	2.96	91.08
Large	8.65	3.15	96.85	3.43	93.43
Overall	8.38	4.39	95.61	3.22	92.39
Coriander					
Small	0.01	4.00	96.00	4.00	92.00
Large	0.01	2.78	97.22	5.56	91.67
Overall	0.01	3.28	96.72	4.92	91.80
French bean					
Small	0.09	5.00	95.00	2.50	92.50
Large	0.87	3.19	96.81	1.06	95.74
Overall	0.51	3.33	96.67	1.18	95.49
Spinach					
Small	0.01	4.00	96.00	8.00	88.00
Large	0.02	2.22	97.78	6.67	91.11
Overall	0.01	2.86	97.14	7.14	90.00
All vegetables					
Small	31.40	5.56	94.44	3.27	91.18
Large	48.97	3.95	96.05	2.67	93.38
Overall	40.88	4.51	95.49	2.88	92.61

TP: Total production, UT: Utilization (Home consumption, gifts and kind payments)

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Protected Cultivation: An Adaptation to Changing Climate

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Keywords: Climate change, greenhouses, national initiative on climate resilient agriculture (NICRA), vegetables

Introduction

Climate change is being experienced in the state which cautions for taking appropriate safeguards in the production of vegetables. Climate change being erratic and unpredictable with available technologies in the state makes it necessary to switch on to a cultivation system which provides protection to the crops against biotic and abiotic stresses envisaged with such changes. Protected cultivation is one such technology which enables production of high quality and healthy seedlings of vegetables for transplanting in open field supporting early crop, strong and resistant crop stands. Keeping the changes in mind, National Initiative on Climate Resilient Agriculture constructed greenhouses in the adopted village Wakherwan to help farmers cater to the local demands after the area got hit by the floods.

Materials and Methods

Much of the vegetables were lost during the September floods, to overcome the loss of production of vegetables and chilling effects during winter season, the farmers were suggested to undertake Protected Cultivation. Polyhouses were constructed on community basis at different locations. The farmers were provided with high yielding variety seedlings of Kale (*Khanyarisaag*), Knol Khol vr. (*Early White Vienna*), cabbage vr. (*Pusa Drum Head*), cauliflower vr.(*Snow Ball-16*), Brinjal vr.(*Shalimar Brinjal hybrid-I*), tomato vr. (*Shalimar-I*) and capsicum vr.(*Shalimar hybrid-I*). Proper fertilizer doze as per package of practices of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir were provided at regular intervals.

Results and Discussion

At the end of the season the farmers were able to produce 6 quintals of leaves of Khanyari Saag, 60,000 seedlings of knol khol, 30000 seedlings of cabbage, 20000 cauliflower seedlings. This intervention increased the production of vegetables in the area and also benefitted the farmers economically. They were able to produce vegetables even in the off season, thereby fetching them higher returns which otherwise was not possible earlier.

Table 1: Economic Benefits from the introduction of protected cultivation

Interventions	Technology demonstrated	Critical input (Variety, Fertilizer/ Chemicals doses)	No. of farmers	Area (ha)	Measurable indicators of output	Economics of demonstration (Rs./ha)				Remarks
						Gross Cost	Gross Return	Net Return	BCR	
Protected Cultivation of vegetables	Growing of Kale (khanyar saag)	Seed FYM NPK Labour	10	3 raised beds of (3'x 4')	6 qlts of leaves of khanyariSaag	17650	30000	12350	1: 1.70	Seeds were sown on 3x4 feet raised beds
-do-	Raising of Knol Khol seedlings vr. (Early White Vienna)	-do-	10	3 raised beds of (3'x 4')	60, 000 seedlings of knol khol	15950	30000	14050	1: 1.88	0.50 / Seedling
-do-	Raising of cabbage seedlings vr. (Pusa Drum Head)	-do-	5	2 raised beds of (3'x 4')	30000 seedlings of cabbage	9650	45000	35350	1: 4.66	Rs. 1.5/ seedling

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Frost Mitigation Techniques in Indian Mustard (*Brassica juncea* L.)

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Keywords: Indian mustard, frost mitigation, productivity, profitability.

Introduction

Climate change impacts on agriculture are being witnessed all over the world and occurrence of drought, flood and frost etc. is unprecedented as well as unpredictable during the crop seasons. Indian mustard (*Brassica juncea* L.) is most important *rabi* oilseed crop of India as well as Haryana. It is mostly grown on light textured soils with low water retention capacity. It is more sensitive to frost in winter as compared to wheat (*Triticum aestivum*), barley (*Hordeum vulgare)* and oat (*Avena sativa*) (Gusta and O'Connor, 1987). There are some agro-chemicals like thiourea and dimethyl sulfoxide (DMSO) which exhibit anti freezing properties. Therefore, the present investigation was undertaken to evaluate the effectiveness of different agro-chemicals and other practices to reduce frost injury and their effect on productivity and economic viability of Indian mustard under the changing climate scenario.

Materials and Methods

The field experiment was conducted under irrigated conditions during *rabi* season of 2010-11 at Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station, Bawal on Typic Ustocrept (loamy sand). Soils were deficient in N and S; and medium in P and K. The experiment was laid out in randomized block design with three replications. There were ten treatments as given in Table 1. Sowing of Indian mustard (*Brassica juncea* L.) variety RH 30 was done on October 10, 2010. Recommended package of practices were followed to raise the crop. A total rainfall of 74.8 mm was received during the crop season. The crop was harvested on March 11, 2011.

Results and Discussion

Perusal of data (Table 1) exhibited that the yield attributes of Indian mustard (seeds/siliqua and 1,000-seed weight) were significantly enhanced by foliar spray of 0.1% dimethyl sulfoxide (DMSO) at 4°C minimum temperature superimposed at recommended package of practices (RP) i.e. T_{10} to check the frost injury over RP alone (T_1) and other frost mitigation treatments (T_2, $T_3$and T_4) but T_5, T_6, T_7, T_8, T_9 and T_{10} did not differ significantly with each other. However, number of siliquae/ plant were not significantly affected by different treatments i.e. T_1 to T_{10}.

Treatment T_{10} recorded maximum seed yield (2438 kg/ha) which was significantly higher (6.9 per cent) than treatment T_1 (2281 kg/ha) only. Though, treatment T_{10} also produced better seed yield over other frost mitigation treatments (T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9), however, the differences among these treatments were found to be non-significant. The marginal increase in seed yield under treatment T_{10} over T_1 might be due to the occurrence of mild frost injury as minimum temperature dipped to as low as 0°C for two consecutive days only on January 6 and 7, 2011 during crop season. Treatment T_{10} [RP + DMSO (0.1%) spray at 4°C minimum temperature] was found most economical and fetched highest net returns (Rs.28154/ha) and benefit (B): cost (C) ratio (2.22) over all other treatments (T_1 to T_9); and gained additional income of Rs. 2403/ha over RP alone i.e control (T_1).

To achieve sustainable yield of Indian mustard, it should be sprayed with 0.1 per cent dimethyl sulfoxide (DMSO) at 4°C minimum natural temperature superimposed at RP to avoid risk of frost injury under changing climate scenario.

Reference

Gusta L V and O' Connor B J 1987. Frost tolerance of wheat, barley, oats, canola and mustard and the role of ice-nucleating bacteria. *Canadian Journal of Plant Science* **67:** 1155-1165.

Table 1: Seed yield, its attributes and economic viability of Indian mustard as influenced by various frost management techniques.

Treatment	Seed yield (ha)	Siliquae/ plant	Seeds/ siliqua	1,000-seed weight (g)	Net returns (Rs./ha)	B: C	returns over control (Rs./ha)
T_1- Recommended package of practices (RP) i.e. control	2281	238	11.46	4.98	25751	2.16	--
T_2- RP + irrigation at 8°C minimum temperature	2313	242	11.38	4.94	24923	2.05	-828
T_3- RP + irrigation at 6°C minimum temperature	2309	241	11.41	4.95	24839	2.05	-912
T_4- RP + irrigation at 4°C minimum temperature	2338	243	11.39	4.94	25448	2.08	-303
T_5- RP + thiourea (0.05%) spray at 8°C minimum temperature	2349	239	11.54	5.02	26619	2.17	868
T_6- RP + thiourea (0.05%) spray at 6°C minimum temperature	2358	237	11.56	5.06	26808	2.18	1057
T_7- RP + thiourea (0.05%) spray at 4°C minimum temperature	2364	238	11.58	5.08	26934	2.19	1183
T_8- RP + Dimethyl sulfoxide (DMSO) (0.1%) spray at 8°C minimum temperature	2381	236	11.69	5.12	26956	2.17	1205
T_9- RP + Dimethyl sulfoxide (DMSO) (0.1%) spray at 6°C minimum temperature	2410	238	11.84	5.17	27566	2.20	1815
T_{10}- RP + Dimethyl sulfoxide (DMSO) (0.1%) spray at 4°C minimum temperature	2438	237	12.01	5.21	28154	2.22	2403
CD (P=0.05)	138	NS	0.53	0.19	-	-	

Note: Market price of produce (seed): Rs.2100/q during 2010-11.

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Changes in ISSR Patterns and Correlations among Yield and Yield Contributing Traits in Chickpea Grown under Rainfed and Irrigated Conditions

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Keywords: ISSR in chickpea, drought tolerance, rainfed

Introduction

Despite significant gains in irrigation potential during the last three decades, chickpea (*Cicer arietinum)* continued to be a rainfed crop in major parts of the country. Future estimates also indicate that not more than 25% of total chickpea area is expected to be under irrigation. Thus drought is the single most important abiotic constraint limiting the chickpea production. Soil moisture stress reduces the productivity by delay or prevention of crop establishment, destruction of established crop, predisposition of crop to pests and diseases, alteration of physiological and biochemical metabolism in plant. The improvement in the genotypes is the only alternative for yield stability under water stress environment. Therefore, the improved chickpea genotypes with better water use efficiency and high yield will be suitable for cultivation in drought prone areas and can prove a boon to improve the economic status of poor farmers. Currently available drought tolerant chickpea genotypes are very few. Considering that a large number of traits are collectively needed to confer yield under drought, there is a need to identify more genotypes to introduce diversity in drought tolerance breeding programs. Root traits, such as depth and root biomass, have been identified as the most promising plant traits in chickpea for terminal drought tolerance. Therefore, the present study was undertaken with the objective to find out indirect selection criterion for drought tolerant genotypes in chickpea.

Materials and Methods

The experiment was carried out in Department of Dryland Agriculture, CCS Haryana Agricultural University, Hisar during *rabi* 2013-14 and 2014-15, comprising 21 chickpea genotypes(including checks) in three replications, The observations on various traits including morphological parameters namely days to 50 per cent flowering, days to maturity, plant height at 30, 60,90 days after sowing (DAS) and physiological maturity (cm), primary branches/plant, pods/plant, 100- seed weight (g), seed yield per plant (g), seed yield (kg/ha), biological yield (kg/ha), rain water use efficiency (kg/ha-mm) and physiological parameters namely relative leaf water content (%), membrane injury index of leaf, specific leaf weight (gm), leaf water potential (-bars) and osmotic potential (-bars). Moisture content at different depth (0-15, 15-30, 30-60, 60-90 and 90-120 cm) was also recorded from sowing till maturity of the crop at an intervals of 30 days. Deoxyribonucleic acid **(**DNA) isolation was done as per Saghai Maroof *et al.,* (1984). Inter Simple Sequence Repeat (ISSR) analysis was carried out using the standard protocol.

Results and Discussion

Analysis of variance for all the morphological and physiological traits indicated existence of ample variability for all the traits under study. The correlations were calculated in two seasons *i.e. rabi* 2013-14 and *rabi* 2014-15 under normal irrigated and rainfed conditions. It was very interesting to note that the correlations with seed yield per plant changed under rainfed conditions. The important correlations which were observed were between branches per plant and seed yield (0.847), between relative water content and seed yield (0.541), between leaf water potential and seed yield (0.466) and negative correlation between membrane injury index and seed yield per plant (0.694) (Table 1). These correlations clearly indicate that seed yield increases with the increase in number of branches per plant, relative water content and leaf water potential. However, negative correlation between seed yield per plant and membrane injury index clearly indicated that more the injury due to drought, more susceptible is the genotype. Therefore, these four parameters can very effectively be utilised for identification of chickpea genotypes suitable for drought conditions provided the genotypes are screened under drought. This is because these correlations hold true only under rainfed conditions.

Out of fifty six primers used, one primer namely UBC-841 produced 14 bands, two bands of low molecular weight *i.e.* 43 and 60 bp were present only in high yielding genotypes irrespective of presence or absence of remaining 12 bands. This might prove a boon to the breeders to select for drought tolerant/heat tolerant genotypes in chickpea.

Reference

Saghai Maroof, M.A., Soliman, K.M., Jorgensen, R.A. and Allard, R.W. 1984. Ribosomal DNA spacer-length polymorphism in barley: Mendelian inheritance, chromosomal location and population dynamics. *Proceedings of National Academy of Sciencesc* USA 81: 8014-8018.

Table 1: Pearson correlation matrix between different morphological and physiological parameters

	DF	DM	PH	B/P	P/P	100SW	HI	RWC	MII	SLW	LWP	SY/P
DF	1.000	0.530^{*}	0.057^{NS}	-0.209^{NS}	-0.203^{NS}	0.518^{*}	0.030^{NS}	-0.144^{NS}	0.110^{NS}	-0.274^{NS}	-0.268^{NS}	-0.221^{NS}
DM	0.530^{*}	1.000	0.268^{NS}	-0.323^{NS}	-0.449^{*}	0.241^{NS}	-0.026^{NS}	0.048^{NS}	0.069^{NS}	-0.261^{NS}	-0.204^{NS}	-0.093^{NS}
PH	0.057^{NS}	0.268^{NS}	1.000	0.308^{NS}	0.166^{NS}	0.248^{NS}	0.113^{NS}	0.438^{*}	-0.328^{NS}	-0.034^{NS}	0.111^{NS}	0.400^{NS}
B/P	-0.209^{NS}	-0.323^{NS}	0.308^{NS}	1.000	0.301^{NS}	0.034^{NS}	0.106^{NS}	0.387^{NS}	-0.600^{**}	0.141^{NS}	0.561^{**}	0.847^{**}
P/P	-0.203^{NS}	-0.449^{*}	0.166^{NS}	0.301^{NS}	1.000	0.130^{NS}	0.466^{*}	0.340^{NS}	-0.264^{NS}	-0.231^{NS}	0.184^{NS}	0.390^{NS}
100SW	0.518^{*}	0.241^{NS}	0.248^{NS}	0.034^{NS}	0.130^{NS}	1.000	0.240^{NS}	-0.102^{NS}	-0.332^{NS}	-0.059^{NS}	-0.198^{NS}	0.150^{NS}
HI	0.030^{NS}	-0.026^{NS}	0.113^{NS}	0.106^{NS}	0.466^{*}	0.240^{NS}	1.000	0.553^{**}	-0.335^{NS}	-0.321^{NS}	-0.043^{NS}	0.389^{NS}
RWC	-0.144^{NS}	0.048^{NS}	0.438^{*}	0.387^{NS}	0.340^{NS}	-0.102^{NS}	0.553^{**}	1.000	-0.408^{NS}	-0.140^{NS}	0.319^{NS}	0.541^{*}
MII	0.110^{NS}	0.069^{NS}	-0.328^{NS}	-0.600^{**}	-0.264^{NS}	-0.332^{NS}	-0.335^{NS}	-0.408^{NS}	1.000	-0.297^{NS}	-0.614^{**}	-0.694^{**}
SLW	-0.274^{NS}	-0.261^{NS}	-0.034^{NS}	0.141^{NS}	-0.231^{NS}	-0.059^{NS}	-0.321^{NS}	-0.140^{NS}	-0.297^{NS}	1.000	0.238^{NS}	0.091^{NS}
LWP	-0.268^{NS}	-0.204^{NS}	0.111^{NS}	0.561^{**}	0.184^{NS}	-0.198^{NS}	-0.043^{NS}	0.319^{NS}	-0.614^{**}	0.238^{NS}	1.000	0.466^{*}
SY/P	-0.221^{NS}	-0.093^{NS}	0.400^{NS}	0.847^{**}	0.390^{NS}	0.150^{NS}	0.389^{NS}	0.541^{*}	-0.694^{**}	0.091^{NS}	0.466^{*}	1.000

DF= days to flowering, DM= days to maturity, PH= plant height, B/P= branches per plant, P/P= pods per plant, 100SW= 10 seed weight, HI=harvest index, RWC=relative water content, MII= SLW= LWP=leaf water potential, and SY/P=seed yield per plant

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Mitigation of Cold Stress in Lentil (*Lens culinaris L.*) by Psychrotolerant Plant Growth Promoting Bacteria from N.W. Himalayas

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Keywords: Psychrotolerant *Pseudomonas* strains, cold alleviation, nutrient uptake, yield, and soil enzyme activity, Lentil (*Lens culinaris L.*)

Introduction

The North Western Himalayas regions are generally cold region and cold weather affects the crop germination. At Uttarakhand generally Kumaun region temperature is 4°C to 20°C at winter season and at chilling conditions plant growth and overall productivity decline. Cold-tolerant bacteria have utility to grow at low temperature and these bacteria help improve crop quality and yield at winter season. Plant Growth Promoting Rhizobacteria (PGPR) is commonly used as a bioinoculants for improving the growth and yield of agricultural crops.

Materials and Methods

The effect of inoculation with *Pseudomonas* strains on cold alleviation and growth of lentil seedling at temperature (8°C) was investigated under organic field conditions during the year 2013-14 and 2014-15. The field experiment was conducted in randomized block design (RBD) at the experimental farm of the ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Hawalbagh, Almora, India. The site is located at 29°36′ N latitude and 79°40′E longitude at an elevation of 1,250 m above mean sea level. Cold alleviating physiological, biochemical parameters and rhizospheric soil enzymes were analyzed using standard protocols. The other important nutrients such as N, P, K, Na, Fe and Zn uptake of shoot were also analyzed by standard methodologies.

Results and Discussion

Eight psychrotolerant plant growth promoting *Pseudomonas* strains isolated from high altitude location of the N.W. Himalayas region of Uttarakhand were evaluated on lentil (*Lens culinaris* L.) to mitigate cold stress under field conditions. Statistical analysis of these parameters revealed that uninoculated control was under cold stress while eight bacterial strains were positively alleviating cold stress in lentil plants. Inoculation with PGP bacteria significantly enhances root/shoot biomass and nutrient uptake as compared to non-bacterized control at 60 days of plant growth. Bacterization significantly improve the level of cellular metabolites like chlorophyll, anthocyanin, free proline, total phenolics, starch contents physiologically available iron, proteins & amino acids that sign of the alleviation of cold stress in lentil plants. Increased the relative water content, reduced membrane injury (electrolyte leakage) was also recorded in bacterized lentil plants (Table 1). Enzymes activity such as dehydrogenase and phosphomonoesterase were also analyzed in bacterized and non-bacterized lentil plants.

Psychrophilic pseudomonas strain PGRs4 significantly enhanced lentil yield (average of two years) by 17.0% followed by NARs9 (16.1%) and PPERs23 (9.4%) over uninoculated control (12.7 q/ha). Thus the psychrotolerant *Pseudomonas* strain could effectively provide a promising solution to over-come cold stress, which is the major factor hindering lentil productivity under cold climate conditions. Cold tolerant bacterial strains used as a bioinoculants in hilly areas to increase the yield of crop production under cold stress conditions.

Table 1: Effect of cold tolerant PGP Pseudomonad on physiological parameters of lentil under field conditions

Treatment	Physiological parameters									
	45DAS						90DAS			
	Chlorophyll/ g in tissue			Physio. av. Iron	Proline (µM/ml)	RWC (%)	Chlorophyll/ g in tissue			Physio. av. Iron
	Chl a	Chl b	Total				Chl a	Chl b	Total	
Control	0.83d	0.16b	0.99c	46.9b	6.1abc	74.5a	1.03c	0.31a	1.34b	9.9e
PGERs17	1.03cd	0.54a	1.57a	48.9b	6.8ab	84.7a	2.45a	0.52a	2.97a	18.7b
PPERs23	1.03c	0.25b	1.28b	52.0ab	7.2a	82.6a	1.34bc	0.32a	1.66b	14.5cd
PBRs5	1.29ab	0.17b	1.46ab	50.3ab	5.7abcd	87.3a	1.18bc	0.35a	1.53b	18.6b
PGR4	1.20abc	0.20b	1.41ab	50.6ab	4.4bcde	78.9a	1.93ab	0.24a	2.17ab	12.3de
NPRp15	1.11bc	0.23b	1.34ab	49.3b	3.7cde	80.2a	1.49bc	0.50a	1.99b	22.6a
NPRs3	1.11bc	0.18b	1.29b	51.7ab	3.2de	85.5a	1.70abc	0.46a	2.15ab	12.3de
NARs9	1.36a	0.20b	1.56a	48.0b	3.0e	78.5a	1.54bc	0.29a	1.83b	17.5bc
PPRs4	1.22abc	0.22b	1.43b	55.7a	3.4de	84.5a	1.55bc	0.44a	1.98b	15.6bcd

Chl - Chlorophyll; RWC - Relative water content; Physio. av. Iron - Physiologically available iron (Fe); DAS - Days After SowingDifferent alphabet in the same column showed significant differences among the treatments

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Characterization of Grain Amaranth (*Amaranthus hypocondriacus* L.) Germplasm in Alfisol of Jharkhand for Tolerance to Drought Condition

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Keywords: Grain amaranth, *Amaranthus hypocondriacus* L., characterization, drought condition, alfisol

Introduction

In the Indian sub-continent grain amaranth (*Amaranthus hypocondriacus* L.) is a potential crop. The diversity of this crop is found maximum in India. The productivity of this crop requires genetic improvement through exploitation of germplasm available. A thrust for germplasm collection, augmentation and evaluation is of utmost significance to have a dynamic breeding program. Production through improvement of pulse crops is necessary. The superior donor parents are urgently required for incorporating desirable characters in the pulse crops. The present paper deals with characterization, preliminary evaluation and identification of promising accessions with desirable traits.

Materials and Methods

The preliminary characterization and evaluation of 99 accessions was carried out in *rabi* 2012-13 and 2013-14 at the farm area of Birsa Agricultural University, Kanke, Ranchi, which is situated at 23°17' north latitude and 85°19' east longitude with an altitude of about 625 meter above mean sea level. The soil is mostly red lateritic with pH value ranging from 4.5 to 6.3, poor in fertility and low in water retentive capacity. The normal annual precipitation is around 1088 mm, mostly confined to four monsoon months (June to September). The germplasm accessions were raised in an augmented incomplete block design with 3 checks in each block. The accessions were grown in 4m row with a row spacing of 45 cm and plant to plant spacing of 15cm. The trial was unprotected for diseases. The data on 11 quantitative and 9 qualitative characters were recorded using minimal descriptors developed by Mahajan *et al.*, (2000), NBPGR.

Results and Discussion

The early plant vigour showed poor in 40 accessions, good in 30 accessions and 29 very good in accessions. Plant growth habit was expressed as erect in 67 accessions, spreading in 27 accessions and drooping in 5 accessions. The leaf colour expressed its yellow in 10 accessions, yellowish orange in 9 accessions, yellowish green in 23 accessions, yellowish orange in 9 accessions, green in 21 accessions, pinkish green in 25 accessions, pink in 2 accessions, redish green in 5 accessions, and red in 1 accession. The characters of leaf length, leaf width, petiole length, days to 50% flowering, number of branches/plant, plant height, inflorescence length, days to 80% maturity, seed yield/plant, g/10ml seed weight and seed yield (kg/ha) were highly variable based on the variance. Grain amranthus (*Amaranthus hypochondriacus* L.) is a winter potential crop in the invariability and evaluation of 99 accessions was carried in augmented incomplete block design with three checks (GA 2, Suvarna, L830 and BGA 2) during *rabi* 2012-2013. The data on 11 quantitative and 9 qualitative characters were recorded. A wide range of variability was observed for all the morphological characters. High variability was observed for trait such as seed yield (kg/ha), g/10ml seed weight, days to 80% maturity, inflorescence length (cm), plant height (cm), number of branches Table 1. The productivity of this crop can be improved through exploitation of vigour plant, days to 50% flowering, petiole length (cm), leaf width (cm), leaf length (cm) and seed yield/plant. The accession with superior desirable traits can be utilized in different breeding program for improvement of particular character or for the development of a new variety.

Table 1: Grain amaranth accessions showing high seed yield (>28 g) in comparison to that of checks.

Accession number	Leaf Length (cm)	Leaf Width (cm)	Petiole Length (cm)	Days to 50% flowering	Number of branches/ plant	Plant height (cm)	Inflores cence length(cm)	Days to 80% maturity	Seed yield/ Plant	g/10ml seed weight	Seed yield (kg/ha)
IC21803-A	7.5	3.5	5.5	78	2.5	61.7	21.0	159	28.6	10.5	4237
IC21937	10.5	4.0	5.0	81	3.5	51.0	32.0	144	30.2	9.5	4474
IC35713	7.0	3.0	4.0	74	5	46.0	25.0	141	32.5	10.1	4815
IC35735	12.5	6.0	6.5	73	3	81.1	22.0	155	31.6	10.1	4681
IC94661	10.0	6.0	6.0	72	4	39.0	30.0	142	34.0	9.6	5037
IC95516	9.0	6.0	5.0	77	6	34.0	25.0	135	29.8	10.1	4415
IC120689	6.0	5.0	4.0	70	3	45.0	20.0	148	30.4	10.3	4504
SKGPA-80	3.0	7.0	12.0	68	8	77.0	28.0	155	28.5	9.1	4222
SKGPA-88	13.0	6.0	7.0	79	5	49.0	31.0	155	28.3	9.0	4193
SKGPA-101	8.0	4.0	5.0	67	4	31.0	25.0	126	30.4	9.5	4504
SKGPA-105	12.0	6.0	7.0	60	5	72.2	25.0	153	28.4	8.0	4207
SKGPA-106	10.0	6.0	9.0	62	5	28.0	19.0	132	33.4	10.0	4948
GA 2	13.0	6.0	9.0	90	7	98.3	35.0	160	23.3	9.1	3452
Suvarna	8.5	4.5	6.0	96	1	78.1	15.0	168	19.9	8.2	2948
BGA 2	11.5	5.0	8.3	93	6	77.0	25.0	161	20.6	6.1	3052

189.

Vigour Index and Relative Growth Rate in Wheat (*Triticum aestivum* L.) Seedlings under Heat Stress as Affected By Trehalose Application

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Keywords: Wheat, trehalose, heat stress, vigour index, relative growth rate.

Introduction

Wheat (*Triticum aestivum* L.) is a cereal of choice and main food for people all over the world. Heat stress affects the wide spectrum of both biochemical and physiological responses within the plant cells. High temperature regime induces activity of antioxidant enzyme compared to control temperature. Trehalose is a soluble, non-reducing disaccharide of glucose. It is present in a large variety of organisms and can serve as reserve of carbohydrate and as a protectant in response to different stress conditions. Trehalose is known to protect membranes and macromolecules. Its accumulation allows plants to tolerate stress, including heat-stress.

Materials and Methods

Six genotypes of wheat (*Triticum aestivum* L.) namely HD 2967, C306, PBW621, PBW590, PBW343 and PBW175 were selected. Seeds were surface sterilized with 0.1% mercury chloride for 2-3 minutes to avoid any fungal infection during seed germination. On seventh day after sowing (DAS) trehalose (1mM and 1.5mM) application was given followed by heat stress, incubated at 35°C and 40°C, for 4 and 8 hrs. Controlled Petri-dishes were placed in an incubator in which temperature was maintained at 25°C.

Vigour index of seeds were calculated as suggested by Abdul Baki and Anderson (1973). Relative Growth Rate (RGR) were calculated as suggested by Gardener *et al* (1985).

Results and Discussion

Germination rate and seedling growth have been reported to decrease at high temperature levels. There was reduction in germination percentage when temperature stress was increased. Table 1- depicts the vigour index of selected wheat genotypes under control (25°C), moderate (35°C) and severe (40°C) heat stress for 4 and 8hrs. The percentage germination reduces with increase in temperature stress. The genotype PBW621 and HD2967 performed better than other genotypes under moderate (35°C) heat stress. Under severe (40°C) heat stress PBW343 and HD2967 performed better than other genotypes. At severe heat stress PBW175 genotype showed minimum vigour index. Higher percentage of seed germination was recorded in PBW621. Vigour index effectively increased with the application of trehalose. More increase was recorded with the application of 1.5mM as compared to 1mM of trehalose.RGR of various wheat genotypes was found to differ (Table 2). Significantly more values of RGR was recorded in HD2967 and PBW621 genotypes under control as well as varying levels of heat stress. RGR decreased with increased level of heat stress. Moderate and severe heat stress significantly decreased RGR of all genotypes, but more adverse effects were recorded in PBW175 and PBW590. More declines in RGR were recorded in all the genotypes when they were stressed under 8 hours as compared to 4 hours. It was recorded that all the genotypes showed increase in RGR after the application of trehalose at high concentration (1.5Mm) as compared to low concentration (1mM).

References

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Gardener F P, Pearce R B, Mitchell R L 1985. *Physiology of Crop Plants. Lowa* Pp 187-208. State University Press.

Table 1: Effect of trehalose on vigour index of wheat genotypes under heat stress (4hrs and 8hrs) of 35±2°C and 40±2°C.

Treatments	Genotypes 4 hours					
	HD2967	PBW175	C306	PBW343	PBW621	PBW590
T1-Control at 25°C	190.00	158.33	195.56	170.00	200.00	168.89
T2-T1+(tre-1mM)	196.00	164.00	199.52	174.80	205.00	175.08
T3-T1+(tre-1.5mM)	198.00	168.00	202.96	177.13	208.10	177.80
T4- at 35°C	170.00	142.22	150.00	141.67	170.00	142.22
T5-T4+(tre-1mM)	174.16	147.02	156.00	146.26	175.80	147.00
T6-T4+(tre-1.5mM)	178.84	150.68	159.00	149.96	179.00	150.66
T7- at 40°C	73.22	50.00	55.55	73.33	66.66	67.33
T8-T7+(tre-1mM)	77.00	54.96	59.86	78.43	69.56	70.08
T9-T7+(tre-1.5mM)	80.06	57.84	62.66	80.86	72.89	73.96
CD 5%	V=1.0876, T=1.2936, V×T=1.834					
	8 hours					
T1-Control at 25°C	193.00	159.00	197.00	170.66	202.00	168.00
T2-T1+(tre-1mM)	198.00	163.00	201.00	176.00	207.00	172.00
T3-T1+(tre-1.5mM)	202.84	166.66	204.66	179	210.46	175.86
T4- at 35°C	170.86	143.00	151.00	142.00	171.00	143.00
T5-T4+(tre-1mM)	175.87	148.00	156.00	148.00	174.80	148.00
T6-T4+(tre-1.5mM)	179.06	154.00	160.00	155.00	178.86	153.00
T7- at 40°C	74.00	53.00	58.00	75.00	67.00	68.76
T8-T7+(tre-1mM)	79.00	58.00	63.00	79.00	71.00	73.66
T9-T7+(tre-1.5mM)	84.81	62.86	67.08	82.46	75.87	77.86
CD 5%	V=1.654, T=1.323, V×T=1.966					

Table 2: Effect of trehalose on Relative Growth Rate (RGR) of wheat genotypes under heat stress (4hrs and 8hrs) of 35±2°C and 40±2°C

Treatments	Genotypes 4 hours					
	HD2967	PBW175	C306	PBW343	PBW621	PBW590
T1-Control at 25°C	0.152	0.137	0.143	0.145	0.156	0.141
T2-T1+(tre-1mM)	0.153	0.137	0.145	0.148	0.156	0.142
T3-T1+(tre-1.5mM)	0.154	0.138	0.149	0.149	0.158	0.143
T4- at 35°C	0.146	0.132	0.138	0.138	0.150	0.133
T5-T4+(tre-1mM)	0.148	0.132	0.138	0.139	0.151	0.134
T6-T4+(tre-1.5mM)	0.149	0.133	0.139	0.141	0.152	0.136
T7- at 40°C	0.131	0.120	0.126	0.126	0.138	0.123
T8-T7+(tre-1mM)	0.132	0.122	0.127	0.126	0.138	0.124
T9-T7+(tre-1.5mM)	0.134	0.124	0.129	0.127	0.139	0.125
CD 5%	V=0.0396, T=0.0424, V×T=0.0996					
	8 hours					
T1-Control at 25°C	0.156	0.133	0.146	0.146	0.156	0.148
T2-T1+(tre-1mM)	0.157	0.134	0.148	0.147	0.158	0.148
T3-T1+(tre-1.5mM)	0.158	0.135	0.149	0.149	0.159	0.149
T4- at 35°C	0.143	0.130	0.137	0.142	0.146	0.135
T5-T4+(tre-1mM)	0.144	0.131	0.138	0.143	0.147	0.136
T6-T4+(tre-1.5mM)	0.145	0.133	0.140	0.145	0.148	0.138
T7- at 40°C	0.126	0.110	0.118	0.116	0.123	0.112
T8-T7+(tre-1mM)	0.126	0.111	0.119	0.118	0.126	0.114
T9-T7+(tre-1.5mM)	0.127	0.119	0.129	0.120	0.127	0.116
CD 5%	V=0.0735, T=0.0654, V×T=1.0369					

190.

Status of Hydrogen Peroxide (H_2O_2) Metabolising Enzymes in *Cajanus cajan* L. under Salt Stress

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Keywords: Pigeonpea, salinity stress, antioxidative defense system

Introduction

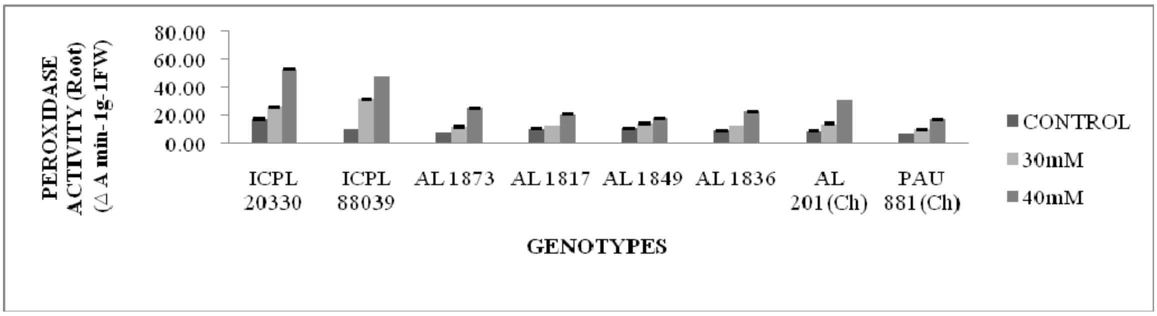
The frequently changing climatic conditions have paved the way for increasing agronomic losses particularly in the water limiting conditions. Water limiting conditions leads to increase in the salinity levels at the upper surface of soil. Salinity is a major hurdle limiting yield and productivity of pigeonpea. Salinity stress imposes oxidative stress which induces the reactive oxygen species (ROS) production in different cell compartments. ROS detoxifying systems of superoxide dismutase (SOD), peroxidase (POX) and catalase (CAT) play central role in defense system. The study is done to compare antioxidative defense system in roots and shoots of tolerant and sensitive genotypes of *Cajanus cajan*, prescreened on the basis of physiological parameters under saline conditions.

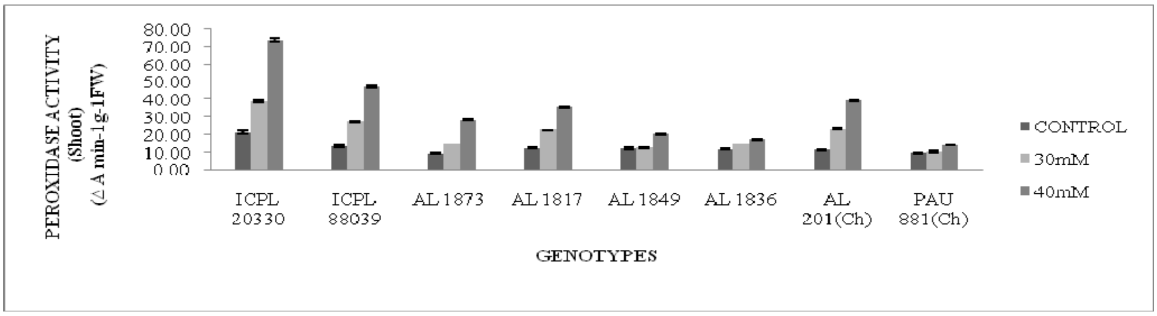
Materials and Methods

For the study, eight pigeonpea genotypes [Tolerant -ICPL 20330, ICPL 88039, AL 1873; Sensitive- AL 1817, AL 1836, AL 1849 AL 201(Check) and PAU 881(Check)] were grown in the plant growth chamber at constant conditions, temperature 25±1°C, relative humidity 60-70% in dark for eight days at 30mM and 40mM NaCl. Petridishes were watered till eight days with their respective saline solutions. The activity of SOD, POD and CAT were estimated in the roots and shoots of 8 days old seedlings at 30mM and 40mM NaCl (Kaur *et al.*, 2009).

Results and Discussion

A significant increase in POD activity was observed in roots and shoots of all the genotypes at 30 and 40mM NaCl concentration from their respective control. Elevation in POD activity on account of salt stress might (Fig. 1) be due to increase in concentration of toxic substrate i.e. H_2O_2 which, in absence of POD would caused cytoxicity in plant tissue through hydroxyl radicals produced in Haber-Weiss reaction (Meloni *et al.*, 2003) as it might have happened in case of sensitive genotypes. A higher SOD activity on treatment with NaCl concentrations (30mM and 40mM) indicated the upregulation of resistance mechanism that may be due to the overproduction of superoxide radicals as observed in the shoots of tolerant genotype ICPL 20330. There was a significant decrease in CAT activity in roots and shoots of seedlings with increasing salt stress, irrespective of the tolerance capacity and sensitivity of genotypes. The less CAT activity of tolerant genotypes as compared to sensitive genotypes was a good implication of tolerant genotypes to cope up with increasing salt induced ROS. The decline in CAT activity may be partly due to its inhibition by O_2^- because these radicals serve as an alternative substrate for CAT and causes its inactivation by binding to its catalytic site.





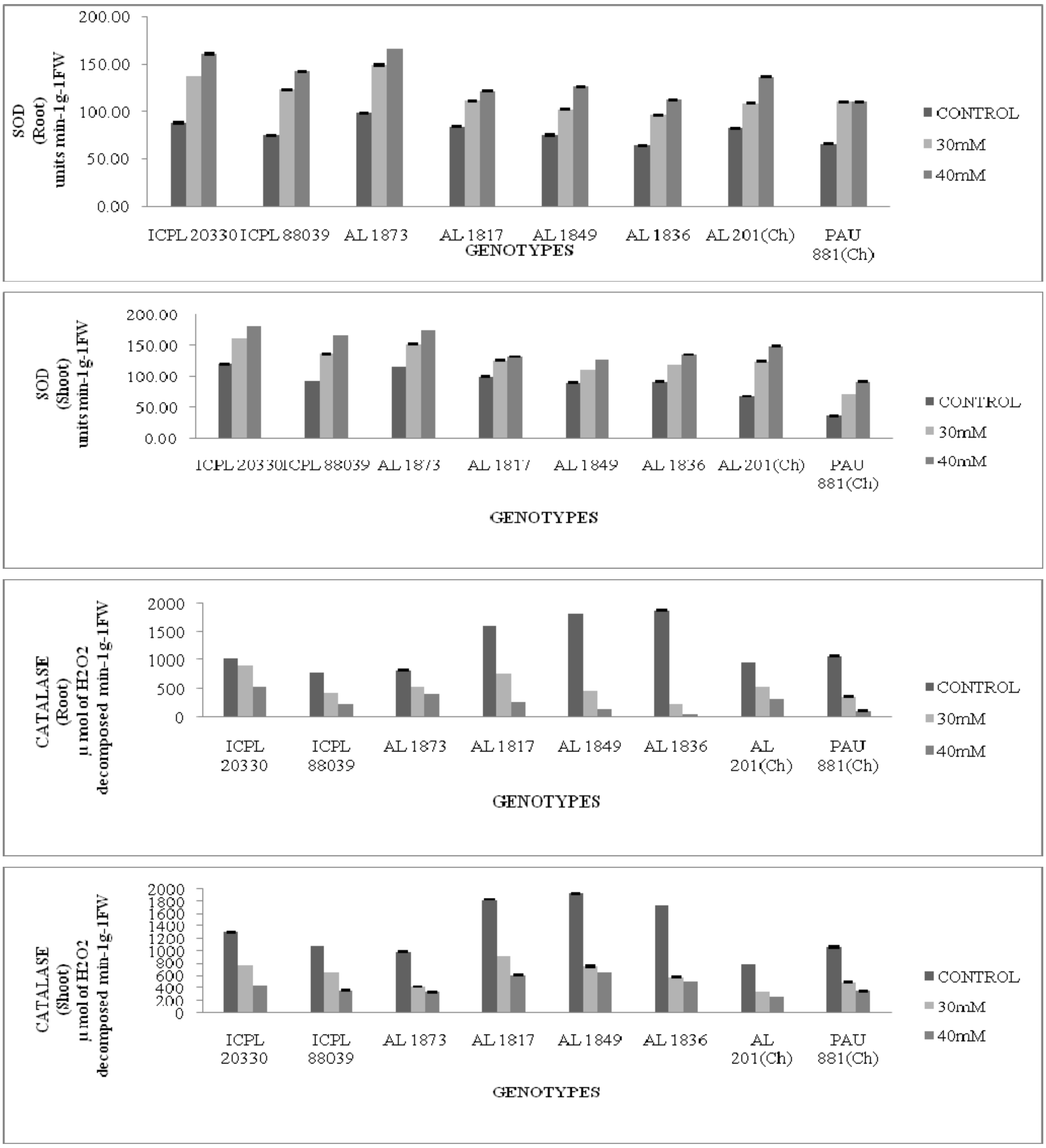


Fig. 1: Enzymatic activities (POD, SOD and CAT) in root and shoot of pigeonpea genotypes under salt stress conditions. Error bars denote±SD (Standard Deviation)

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191.

Antioxidative Capacity of Roots Determine Water Deficit Stress Tolerance Capacity in Chickpea Cultivars

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Keywords: Chickpea, water deficit stress, free radical scavenging capacity

Introduction

Chickpea (*Cicer arietinum* L.) is a major grain legume crop, and terminal drought severely constrains its productivity. Drought caused depletion in crop production can be the result of many morphological, physiological, and metabolic changes that occur in plants. Oxidative stress induced by excessive Reactive oxygen species (ROS) generation is an inevitable consequence of water deficit stress. In the present study the influence of mild and severe water deficit stress on total phenolic content and antioxidative capacity due to scavenging of 2,2-diphenyl-1-picryl hydrazyl (DPPH) and hydroxyl free radicals was investigated in roots of two chickpea cultivars differing in rooting behaviour and drought tolerance: ICC4958 (deep rooted, drought tolerant) and ILC3279 (shallow rooted, drought susceptible).

Materials and Methods

Seeds of ICC4958 and ILC3279 chickpea cultivar were sown in Randomised Block Design in Pulse Research Area of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana. At 60 days after sowing (DAS) water deficit stress was created on central two plots by withholding irrigation and using rainout shelter. The plots that received irrigation were kept as control. Total phenol content in tissues was estimated in different tissues according to Swain and Hills (1959). Antioxidant activity in tissue samples was measured by estimating the ability to scavenge 2,2-diphenyl-1-picryl hydrazyl cation and hydroxyl ion radicals (Ahuja *et al.* 2015). The data were statistically analysed by ANOVA using the factorial experiments in Completely Randomized Design.

Results and Discussion

Roots of ICC4958 responded to stress by increase (43%) in total phenols at 85 DAS (Table 1) and increased OH radical scavenging activity both at 85 and 100 DAS while in roots of ILC3279 only mild stress caused an increase in $OH^{\cdot}$ scavenging activity. DPPH scavenging capacity in roots of ICC4958 under water deficit stress was increased and the increase was more prominent under mild stress (38%) as compared to severe stress (16%) while DPPH scavenging activity in roots of ILC3279 was increased by 27% under mild stress and decreased by 23% under severe stress (Table 1). Thus roots of ICC4958 responded to stress immediately by increasing the antioxidative defence which helped them to survive prolonged stress exposure, maintaining their function. On the other hand, primary response of roots of ILC3279 to stress was to enhance free radical ($OH^{\cdot}$ and DPPH) scavenging activity but continuous stress exposure caused a marked reduction in total phenols and DPPH scavenging capacity (Table 1). Thus the overall effect of water deficiency on ILC3279 roots was weakened antioxidative defence system while roots of ICC4958 are better adapted to combat excessive ROS generated by water deficit stress.

Table 1: Effect of water deficit stress on free radical scavenging activity in roots of ICC4958 and ILC3279 chickpea cultivars

Parameter	Cultivar	Control		Water deficit stress	
		85DAS	100DAS	85DAS	100DAS
DPPH scavenging activity (%)	ICC4958	28.90±4.43	35.03±2.95	46.41±6.61	41.89±7.35
	ILC3279	35.92±5.86	38.64±6.42	49.09±1.09	29.87±1.54
OH· scavenging activity (%)	ICC4958	54.19±1.71	53.79±1.69	61.78±2.56	57.37±0.90
	ILC3279	59.42±1.32	48.95±3.85	64.45±1.37	46.84±2.73
Total phenol (µg/g FW)	ICC4958	0.38±0.029	0.31±0.055	0.66±0.076	0.33±0.067
	ILC3279	0.62±0.071	0.76±0.092	0.61±0.037	0.29±0.045

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192.

Biochemical Characterization of Wheat Genotypes Showing Differential Antioxidant Response under Drought

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Keywords: Antioxidant response, drought, wheat

Introduction

Drought stress is acting as one of the major hurdles faced by wheat (*Triticum aestivum* L.) crop worldwide which threatens its productivity. Lobell *et al.* (2013) suggested that increase in temperature and incidences of drought associated with global warming are severe limitations for the yields of crops. The antioxidant status of plant plays a key role in conferring tolerance against water deficit induced oxidative damage. Thus, antioxidant system was exploited to categorize 21 wheat genotypes according to their drought tolerant and susceptible characters.

Materials and Methods

Present study was designed with 21 wheat genotypes including 11 indigenous genotypes *viz.* C306, PBW644 and PBW527 (6n drought tolerant), PBW550, DBW17 and HD2967 (6n sensitive) WHD943, PPW274, PDW291, PDW314 and PDW215 (4n) and ten Australian cultivars included Gladius, Annuello, Wyalkatchem, Datatine, Janz, Castleode, Babbler, Drysdale, Yitpi and Baxter. Growth data and biochemical analyses *viz.* contents of proline, glycine betaine, malondialdehyde and hydrogen peroxide and activities of ascorbate peroxidase and glutathione reductase were carried out at 8th day after germination. Further stress tolerance index was calculated and clustering analysis was also done to reveal complete linkages between different genotypes (Fig. 1).

Results and Discussion

Shoot lengths of different wheat genotypes showed a decrease whereas root lengths mainly increased or remained unaffected. Under drought stress, hydrogen peroxide content was found to be elevated with maximum increase in sensitive cultivars. Also, there is an increase in malondialdehyde content upon imposition of water deficit conditions with highest increase in roots of PBW621 and shoots of DBW17 genotypes. Genotypes showing increased osmolyte (Proline and Glycine betaine) contents also showed an upregulation in their enzymatic response, thus imparting greater tolerance to these genotypes. It could be concluded that different wheat genotypes showed variable antioxidant response *via* upregulating antioxidative enzyme machinery, increasing contents of osmolytes and by eliminating reactive oxygen species and its byproducts. Thus on the basis of stress tolerance levels calculated from stress tolerance index (STI) values of various parameters, it can be proposed that these genotypes could be categorized as: highly drought tolerant *viz.* Baxter and Janz, moderately drought tolerant *viz.* PBW644, PBW 274, Gladius, Babbler, Drysdale, Yitpi, C306, PBW527, WHD 943, Wyalktchem, moderately susceptible *viz.* PDW314, PDW215, Annuello, Castleode and highly susceptible *viz.* PBW621, DBW17 and HD2967. Thus, it could also be inferred that the varying antioxidant capacity of these genotypes under water deficit conditions can be exploited to classify them as tolerant and susceptible cultivars. Based upon the stress tolerance levels showed by these genotypes, further proteomic analysis could be conducted to identify differentially expressed proteins under water deficit conditions.

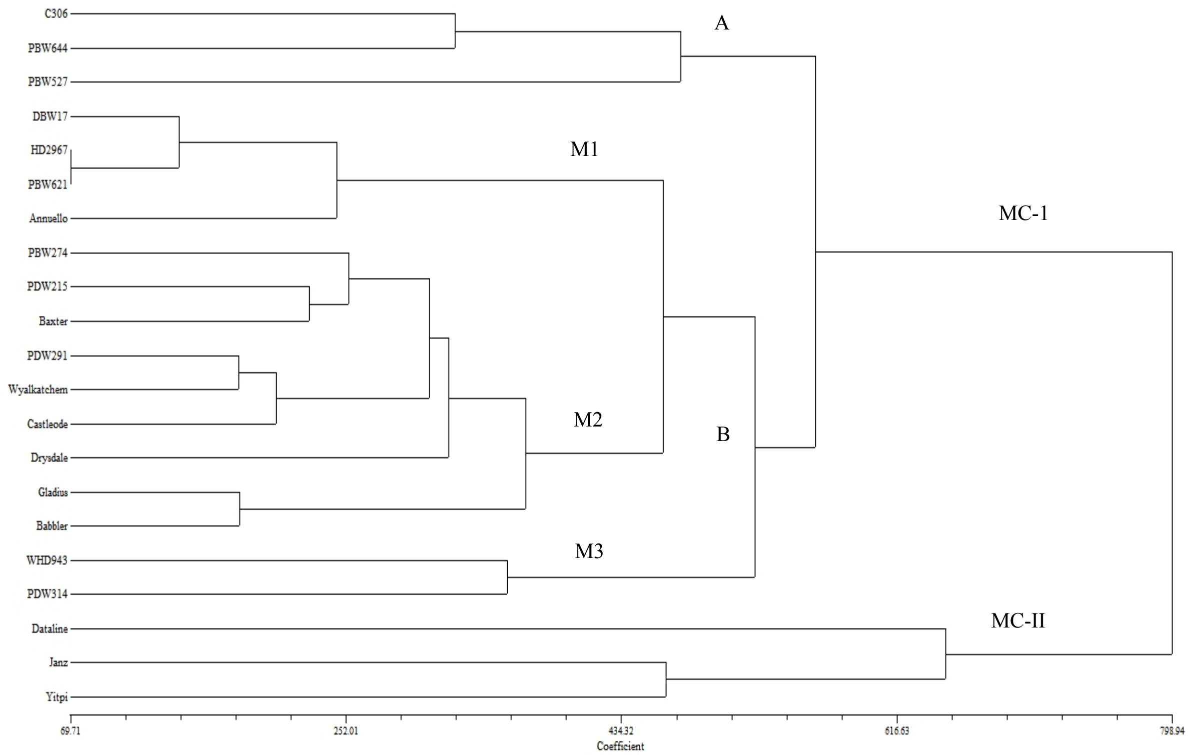

Fig. 1: Dendrogram of 21 wheat genotypes obtained with complete linkage clustering based on furthest neighbor approach (MC-I, Major cluster; MC-II, Major cluster II; A and B Subcluster of MC-I; M1, M2 and M3-Subcluster of B.)

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193.

Studies on Growth Parameters in Pigeonpea [*Cajanus cajan* (L.) Millsp.] Genotypes under Normal and Waterlogged Soil Conditions

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Keywords: Growth parameters, dry matter, waterlogging, pigeonpea and correlation.

Introduction

Cajanus cajan is highly sensitive to waterlogging (Perera *et al.* 2001) and cannot withstand low oxygen conditions, caused by waterlogging, resulting in substantial yield losses. Among the abiotic stresses waterlogging is one of the important constraints in production of pigeonpea caused due to erratic and intense rainfall for a prolonged period and occurs when the soil pores in the root zone get saturated and thus restricts normal air circulation (Kumutha *et al.*, 2008). The investigations pertaining to growth parameters under waterlogging would be highly meaningful through screening of suitable genotypes which could be grown successfully under such conditions.

Materials and Methods

An experiment was undertaken to assess the effects of an eight days artificial waterlogging in natural field conditions on growth parameters of twelve pigeonpea genotypes during rainy season of 2011-12 and 2012-13 in a randomized block design replicated five times in two sets; the first set was kept as normal conditions while second set was grown under waterlogged conditions for eight days continuously 40 days after sowing followed by drain out of water from plots after eight days of termination of waterlogging stress period.

Results and Discussion

To account for yield variation in terms of growth and development is very complex, since it involves the effect of external factors on all the physiological processes of plants. The interrelation between different processes and their dependence on internal factors is determined by the genetic constitution of the plant. Various empirical relationships such as leaf area index, specific leaf area, crop growth rate and relative growth rate described the connection between the end point of a long chain of interdependent processes in the environment and plant. The genotype KPBR 80-2-1, ICPB 2039 and ICPH 2431 accumulated the highest dry matter under normal and waterlogged conditions. A pattern of linear increase in LAI exhibited under all conditions. Genotype KPBR 80-2-1 attained the higher LAI under both the conditions during most of the crop life span. ICPH 2740 and ICPL 20241 showed the highest SLA at varying intervals under both the conditions. The RGR indicated the higher magnitudes at very early stage of growth i.e. 30-60 DAS followed by a reduction in remaining phase of growth. KPBR 80-2-1 and ICPH 2431 had comparatively higher CGR during most of the growth period under stressed and non stressed conditions respectively. Significant correlations were shown among the characters investigated under both the conditions (Table 1). Due to waterlogging the highest reduction was observed in CGR (17.36%) followed by LAI (13.03%), RGR (8.19%), TDM (6.85%) and SLA (4.72%). It is concluded that the genotypes viz., KPBR 80-2-1, ICPB 2039 and ICPH 2431 are tolerance to waterlogging among the genotypes.

Table 1: Correlation coefficients among characters for waterlogged conditions (above diagonal) and normal conditions (below diagonal)

Variables	TDM	LAI	SLA	RGR	CGR
TDM	1.000	0.804**	0.171	0.070	0.942**
LAI	0.789**	1.000	0.699*	0.104	0.695*
SLA	0.156	0.704*	1.000	0.070	0.022
RGR	-0.136	-0.029	0.078	1.000	0.233
CGR	0.912**	0.634*	-0.034	0.114	1.000

Correlation significant at the 0.01 level (**) and 0.05 level (*)

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194.

Effect on Population of Onion, *Allium cepa* L. Insect Pests in Relation to Biotic Factors under Field Condition

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Keywords: Biotic factor, onion, pest population, major insect pests

Introduction

Onion (*Allium cepa* L.) is well known as the most important crop in the world. The onion plant is attacked by several insect pests like thrips (*Thrips tabaci*), maggots (*Delia antiqua*), cut worms (*Agrotis ipsilon)*, jassid (*Amrasca biguttula biguttula*) etc. Among these pest thrips (*T. tabaci*) can cause yield loss >50% but can be even more problematic when it transmits some viral diseases (Diaz- Montano *et al.,* 2011). The predator complex found in onion production systems against *T. tabaci* such as lacewing larvae *(Crysoperla carnea)*, ladybird beetles (*Menochilus sexmaculata*) and predatory thrips (Aeolothripidae) (Kirk, 1997b; Sabelis and Van Rijn 1997). The present investigations were, therefore, undertaken effect of biotic factors in relation to onion pests under field condition.

Materials and Methods

Experiment on effect of the biotic factors on major insect pests in onion under field condition was conducted during *rabi* 2014- 15. In onion variety Agrifound light red was transplanted on 26th November 2014 (48th standard meterological week). The experiment was conducted in a randomized block design with three replications. The populations of major insect pests and their natural enemies were observed at weekly interval on randomly selected five plants. The population of insects was recorded by visual appearance of cricket *(Gryllus pennsylvanicus)*, lady bird beetle (*M. sexmaculata*), green lacewing *(C. carnea*), spider (*Lynx spp.*) and the thrips, jassids were counted by shaking in white card sheet. For the ease of analysis and finding, meteorological data were also pooled out at weekly interval. The data of various pest populations were correlated with population of their natural enemies.

Results and Discussion

The population of insect pests and associated natural enemies were observed on variety Agrifound light red, during *rabi* 2014-15. The population of green lacewing, lady bird beetle and spider was correlated with onion thrips, jassid and crickets pest population. The green lacewing population was found highly significant positive correlation with jassid (r= 0.83) and cricket (r= 0.87) while negative but not significantly correlated with thrips (r= -0.13) (Table 1). The lady bird beetle population was found highly significant and positive correlation with jassid (r= 0.81) and cricket (r= 0.95) while it did not significantly correlate with thrips (r= 0.02). The spider population was found highly significant and had positive correlation with jassid (r=0.94) and cricket (r=0.70) but non-significant with thrips (r=0.42).

Table 1: Correlation coefficients between Population of natural enemies and insect pests of onion during *Rabi* season 2014-15

Population of natural enemies of onion pest	Population of onion insect pest		
	Thrips	Jassid	Cricket
Green lacewing	-0.13	0.83**	0.87**
Lady bird beetles	0.02	0.81**	0.95**
Spider	0.42	0.94**	0.70**

**: Highly significant (1%)

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195.

Applications of Factor Analysis to Horticultural crop- A Statistical Approach

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Keywords: Apple, morphological characteristics, factor analysis

Introduction

Apple (*Malus domestica* Borkh) yield is a complex trait which is influenced by several factors and identifying a single variable representative of the complex trait (yield) may not be reliable, thus researcher is faced with the possibility of separately examining many related variables. A series of univariate statistical analyses for each of the variables does not hold promise as it ignores the correlation among the variables. On the contrary, multivariate analysis takes into account the relative importance of the various influencing characters. An attempt has been made to bring out the basic components of morphological characters contributing significantly towards apple yield by using Factor Analysis.

Materials and Methods

Field experiment was conducted in 2014-15 at farmer's apple orchard in Jubbal block of Shimla district. Four branches from each of the tree in four directions as per the practice in vogue were selected and the following observations were recorded i.e. yield (Y), tree height (X_1), canopy spread (X_2), trunk girth (X_3), FD: flower density (X_4), FDI: flower density index (X_5), FI: flowering intensity (X_6), FS: fruit set (X_7), CD: crop density (X_8), LD: length diameter ratio (X_9), and fruit weight (X_{10}). Factor Analysis was carried out to bring out the basic components associated morphological characters of apple.

Results and Discussion

Apple yield was found to be significantly and positively correlated with fruit weight (0.89), trunk girth (0.56), tree height (0.55), canopy spread (0.47), flower density index (0.38) and fruit set (0.22). Factor analysis is a multivariate statistical technique widely used by researchers for studying the correlation among many observed variables in terms of smaller number of unobserved variables called factors. Four of the ten Factors have eigen values greater than unity (Gutman's lower bound) which played the main role in the analysis. The variables loading for first factor is highest for three characters 'height', 'canopy' and 'Trunk Girth'. This component was interpreted as "Vegetative Characteristics". The second factor comprised of 'Flower Density' and Flower Density index', 'Flowering Intensity', 'Crop Density' and 'fruit weight' which were collectively termed as "Flowering and Fruiting Characteristics". The third factor was comprised of 'Fruit Set' and fourth factor was comprised of 'LD ratio'. These components explain 31.70%, 24.24%, 13.15% and 10.25% respectively of the total variation. Together they account for 79.34% of total variation of the original variables. Thus Factor Analysis has brought out some of the basic factors associated with morphological characters of apple tree and can be considered as important tool for optimizing apple yield. These factors were

$F_1 = 0.841\ X_1 + 0.813\ X_2 + 0.840\ X_3$

$F_2 = 0.622\ X_4 + 0.690\ X_5 + 0.527\ X_6 + 0.656\ X_8 + 0.696\ X_{10}$

$F_3 = -0.901\ X_7$

$F_1 = 0.931\ X_9$

Table 1: eigen vectors and factor pattern of Factor Analysis

Characteristics	eigen vectors				factor pattern			
	F1	F2	F3	F4	F1	F2	F3	F4
Height (m)	0.472	0.234	0.106	0.018	**0.841**	0.365	0.122	0.018
Canopy (m)	0.456	0.155	0.144	0.050	**0.813**	0.241	0.165	0.051
Tree girth (cm)	0.472	0.240	-0.072	-0.087	**0.840**	0.373	-0.082	-0.088
FD (Flower density)	-0.321	0.400	0.223	0.075	-0.571	**0.622**	0.255	0.076
FDI (Flower density index)	-0.205	0.443	0.096	-0.112	-0.365	**0.690**	0.110	-0.113
FI (Flowering intensity)	-0.052	0.339	0.357	-0.155	-0.093	**0.527**	0.410	-0.157
Fruit set	-0.080	0.090	-0.786	-0.284	-0.143	0.141	**-0.901**	-0.287
CD (Crop density)	-0.357	0.421	-0.098	-0.072	-0.635	**0.656**	-0.112	-0.073
LD Ratio	-0.084	0.086	-0.164	0.919	-0.149	0.134	-0.188	**0.931**
Fruit weight (kg)	0.240	0.447	-0.350	0.130	0.427	**0.696**	-0.402	0.132

196.

Role of Better Management Practices in Reducing Cotton Carbon Emissions in Warangal Cotton Fields of Telengana State

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Keywords: Better management practices, greenhouse gas emission, cool farm tool

Introduction

Cotton is an important cash crop for India, with 11 million ha of land in production. Cotton cultivation is generally characterized by unsustainable use of resources, such as overuse of pesticides, fertilizers and water for irrigation (in case the cotton field is irrigated). World Wide Fund for Nature (WWF)-India is working with farmers in Warangal district to promote better management practices (BMPs) in cotton so as to reduce the environmental impact associated with the overuse of inputs and resources. WWF-India has initiated a study to estimate the greenhouse gas (GHG) emissions of cotton production systems, comparing traditionally grown cotton with BMP cotton. The major objectives of the study were to:

- Assess the GHG emissions in selected cotton fields (including both BMP and conventional cotton plots). Emissions from the conventional field fetched the baseline information for the area.
- Assess the performance of BMPs by comparing emissions between BMP and conventional plots.
- Understand the GHG emission reduction potential of BMPs.

Materials and Methods

WWF-India used the Cool Farm Tool version 373 (CFT 373) to calculate GHG emissions from selected farm plots under traditional cultivation (TC) and BMP cotton production systems in Warangal district, a major cotton-growing district located in the northern part of Telengana. The Cool Farm Tool is a green house gas calculator developed by Sustainable Food Lab, US and University of Aberdeen and integrates several globally determined empirical models in a GHG calculator (Hillier *et al.*, 2011). WWF-India analyzed 48 farm sample plots, comprising 27 using BMPs and 21 using traditional practices, for GHG estimation. Farm data for each of the plots in 2010 was collected individually from the growers. Data such as crop yield, fertilizer application, organic matter application, pesticide application, cultural practices, and volume of irrigation water provided, farm energy and transportation was collected and fed into CFT 373 for an output emission table. For each analysis the Cool Farm Tool provides total emission information per production area, unit area and tone of finished product. The GHG emission value is represented in kilograms of CO_2 equivalent (kg/CO2e) per hectare and kg/CO_2e per kilogram of seed cotton.

Results and Discussion

The study area has a tropical climate with an average annual temperature of 32°C. The soil is fine textured with poor drainage, organic matter less than 1.72%, and pH between 7.3 and 8.5. The results from TC indicated that average fresh farm product (seed cotton) was 2.25tonnes/ha. The average fertilizer application, including nitrogenous, phosphate and potash, in TC was 1067kg/ha. The average GHG emissions from TC were 3,236kg/ CO_2e/ha and 1.5kg/CO_2e/kg of seed cotton produced. The average seed cotton production with BMPs was 2.41 t/ha, which is slightly higher than TC. Farmers mostly used recommended doses of fertilizer, at an average rate of 531kg/ha. They sprayed pesticides 12 times per hectare on average. The estimated average GHG emissions from the BMP plots were 1,032kg/CO_2e/ha and 0.43kg/CO_2e/kg of seed cotton produced. TC uses almost twice as much fertilizer as BMPs, and more than the recommended dosage. This results in almost double the emissions, but does not increase the yield.

Table 1: GHG emissions in BMP and TC plots

Plots	Number	kg CO_2e/kg			kg CO_2e/ha		
		Mean	SD	SE mean	Mean	SD	SE mean
BMP	27	0.43	0.119	0.023	1032	281.7	54.2
TC	21	1.5	0.589	0.128	3236	963.8	210.3
t_{value}	-8.2	Significance	$4.99x10^{-8}$	t_{value}	-10	Significance	$6.76X10^{-10}$

Fertilizer management is the most crucial management practice in terms of GHG emissions reduction and contributes significantly to the overall emissions. The regression analysis indicates that in traditional cotton cultivation, the overall emissions are strongly and significantly correlated to the emissions from fertilizer application.

Reference

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197.

Growth and Yield of Wheat in Jatropha (*Jatropha curcas* Linn.) Based Agrisilviculture System

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Keywords: Prunning, *Jatropha curcas,* fertility levels, agrisilviculture system, wheat yield

Introduction

The structural and functional of tree species in agroforestry systems greatly affect the overall productivity of the system. Ratanjyot *(Jatropha curcas* Linn.) is a small oil seed tree/shrub of family Euphorbiaceae having its versatile utility. Being an oil bearing plant, Jatropha may utilize large quantity of nutrients from soil to yield satisfactory and may, therefore, severely compete with crops in agroforestry and deplete soil fertility under poor nutrient management situations. Therefore, the objectives of this study were to determine growth and yield of wheat in *Jatropha (Jatropha curcas Linn.)* based agrisilviculture system in *Tarai* region of the central Himalayan foot hills.

Materials and Methods

A study was carried out at Agroforestry Research Centre, Haldi, Pantnagar, Uttarakhand. The experiment was composed of a tree/shrub species Jatropha *(Jatropha curcas* linn), with twelve treatment combinations comprising four pruning height, no pruning**,** 50 cm height**,** 100 cm height**,** 150 cm height in Jatropha and three fertility levels, 50% of recommended dose of NPK (RDF)**,** 100% (120 kgN+60kg P_2O_5+40 kgK_2O/ha) RDF**,** 150% RDF for wheat with four replications. The observations on growth and developmental such as emergence count, number of shoots/m^2, height (cm/plant), per m^2 dry matter were taken and the data were analyzed using factorial randomized block design.

Results and Discussion

Germinant/m row, vegetative period up to 50% heading and total crop period upto 80% physiological maturity was not significantly influenced either by pruning heights or fertility levels. The number of shoots/m^2 and plant height (cm/shoot) were significantly influenced by fertility levels, except 30 days after sowing (DAS), but remained unaffected by pruning heights at all stages of crop growth except at 70 DAS for number of shoots/m^2 (Table 1). Grain, straw and biological yield reduced by 16.56%, 12.56% and 13.85% respectively under Jatropha in comparison to sole crop. Yadav *et al.* (2015) have shown reduction in grain, straw and/or biological yield under Jatropha.

Table 1: Shoot height (cm) and Total plant dry matter (g/m^2) as influenced by pruning heights and fertility levels at various stages of crop growth

Treatment	Shoot height (cm)						Total plant dry matter (g/m^2)					
	30 DAS	50 DAS	70 DAS	90 DAS	110 DAS	Harvesting	30 DAS	50 DAS	70 DAS	90 DAS	110 DAS	Harvesting
Sole crop	17.5	34.5	53.1	75.4	90.6	93.2	15.7	103.2	375.0	885.0	1613	1850
A. Pruning height												
No pruning	17.1	33.0	50.1	72.3	88.6	89.4	10.4	85.8	334.9	764.8	1346	1522
50 cm ht.	17.1	34.1	50.7	73.0	89.6	89.9	11.2	90.3	368.4	835.5	1448	1663
100 cm ht.	17.3	33.3	50.6	74.0	89.6	89.8	13.1	86.7	353.9	789.8	1564	1687
150 cm ht.	17.3	33.4	51.6	73.0	89.2	89.5	12.2	92.8	341.0	850.2	1481	1731
CD at 5%	NS	NS	NS	NS	NS	NS	1.47	NS	NS	NS	103	75.7
B. Fertility levels												
50% RDF	17.2	32.0	49.3	72.3	87.6	87.6	10.1	73.1	304.1	731.7	1219	1365
100% RDF	17.2	33.2	51.3	73.8	89.8	90.4	10.9	90.7	371.6	816.0	1610	1848
150% RDF	17.1	34.5	52.3	75.2	90.4	91.0	14.0	102.2	372.3	882.6	1553	1739
CD at 5%	NS	0.68	1.55	1.47	1.02	0.83	1.26	6.75	36.6	67.3	89.7	65.5

NS- Non significant RDF- Recommended dose of fertilizer for wheat

Our study showed that pruning in Jatropha are promising for agrisilviculture since the yield losses of wheat were lowest under pruned Jatropha in comparison to no pruning (Yadav *et al.* 2014). Therefore, it is suggested to adopt tree management (pruning) practices to minimize the yield losses of wheat. However, financial implications must be carefully considered for adopting such managerial interventions under agrisilviculture system. For getting better production of wheat under Jatropha based agrisilviculture system in *Tarai* region of Uttarakhand, pruning is essential for improving wheat yield.

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198.

Re-established Desiccation Tolerance of Post Germinated Wheat Embryo

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Keywords: Re-established desiccation tolerance, wheat

Introduction

Re-established desiccation tolerance (Re-DT) is post-germination growth arrest of embryo if it is exposed to stress during germination. This tolerance is largely unknown and could in many ways be similar to secondary dormancy. This tolerance remained for few days (2-3 days) after germination in *A. thaliana* but after this time window, this tolerance does not come. Transcriptomic studies have indicated that this tolerance could be used by desiccation tolerant plant throughout its life cycle. As this tolerance withstands up to 90-95% of water loss, it should be studied for associated factors responsible for such extreme tolerance. In this study, this tolerance has been studied in two wheat cultivars contrasting in drought tolerance.

Materials and Methods

Seeds were taken during after-ripening at the period of 15 days till 90 days after harvest. ROS (reactive oxygen species) and NO (nitric oxides) were measured in dry embryo/seed. Seed germination in water and ABA (abscisic acid) was taken as measure of dormancy and ABA-sensitivity respectively. For DT (desiccation tolerance), 1 day germinated seed was exposed to water (for DT) and polyethylene glycol- PEG (for Re-DT) for next 24h, then desiccated (to 0.1g water per gram dry weight) in desiccation chamber for 3.5 days, regrown in water for 3 days, and % survival was measured. For finding time window after germination till this tolerance remains, 1, 2, 3, 4, and 5 day germinated seeds were exposed to water (for DT) and to PEG (for Re-DT) for next 24h, desiccated and regrown as above.

Results and Discussion

Among wheat (*Triticum aestivum*) cultivars, PBW644 was drought tolerant and ABA-higher sensitive and PBW343 was drought susceptible and ABA-lesser sensitive. Level of DT remained almost same in both cultivars but level of Re-DT was higher in PBW644 at all stages of after-ripening. During post germination, level of Re-DT remained till 5th day thereafter got decreased in PBW644, while in PBW343, it decreased after 2 day post-germination. During after-ripening, dormancy and ABA-sensitivity was decreased while ROS (H_2O_2, hydroxyl radicals, superoxides)/NO increased in embryo as well as in seed of both cultivars. PBW644 showed higher dormancy/ABA sensitivity and lesser levels of ROS/NO than PBW343 at all stages of after-ripening (Table 1). There was positive relation of dormancy and ABA sensitivity and there was a negative relation of the level of ROS/NO with dormancy/ABA sensitivity. Seeds of PBW644 were more dormant, ABA higher sensitive, contained less ROS/NO in its embryo/seed than PBW343. DT/Re-DT was not related to dormancy status of seed. PBW644 showed higher level of DT/Re-DT than PBW343 and also showed longer time window to establish this tolerance.

Table 1: Changes of following parameters in two wheat cultivars during after-ripening (0-90 days after harvest)

Parameter	Cultivars		Comparison between cultivars
	PBW343	PBW644	
Seed dormancy	Decreased	Decreased	Decrease was less in PBW644 than PBW343
ABA sensitivity	Decreased	Decreased	Decrease was less in PBW644 than PBW343
ROS in dry embryo and seed	Increased	Increased	Increase was less in PBW644 than PBW343
Nitric oxide in dry embryo and seed	Increased	Increased	Increase was less in PBW644 than PBW343
Desiccation tolerance (DT) of germinating embryos at 2 days after germination	Not effected	Not effected	No difference between the cultivars
Re-established DT of germinating embryos at 2 days after germination	Not effected	Not effected	But higher in PBW644 than PBW343

199.

Endophytes of Finger Millet (*Eleusine coracana*)

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Keywords: Finger millet, endophytes, ribotyping

Introduction

Finger millet (*Eleusine coracana*) is often referred to as a famine crop as it can survive in harsh conditions such as degraded soils and poor moisture availability. It grows well on acidic soils and those deficient in several micronutrients. Nutritionally it has earned the sobriquet of a supercereal as it is rich in the sulphur containing amino acid methionine and also a good source of calcium and iron. We have tried to explore the endophytes present in some genotypes of finger millet to understand how they may be involved in imparting different traits to this nutritionally important crop.

Materials and Methods

The leaves of 3-4 day old seedlings of VL 149 and JWM 1 genotypes were surface sterilized and ground aseptically in distilled water. The last wash water was retained for use as control inoculum. The plant extract and the last wash water was spread on different media for bacterial and fungal growth and incubated in two sets at 28°C and 37°C, respectively. The colony characteristics of the bacteria and fungus were noted. The pure cultures were used for isolation of total DNA which was then subjected to 16S/18S ribotyping. The sequences thus obtained were subjected to BLAST for identification of putative endophytes.

Results and Discussion

Several endophytes of finger millet were obtained on all the different media used viz. LB agar, Nutrient agar, Soyabean Caesin digest, McConkey agar, Nitrate HiVeg agar and potato dextrose at 28°C as well as 37°C. The colony characteristics varied in shape from convex to flat. The edges were smooth, serrated, radiating or irregular. The colour was transparent, pale, yellow, brown white, orange etc. The fungal colonies were either white or dark coloured. The size of the colonies was pin pointed to more than 1cm diameter. The DNA obtained from almost 40 of these microbes was amplified with universal primers for either 16S or 18S, cloned and sequenced. The sequences thus obtained were subjected to BLAST with the nucleotide sequences available in the NCBI. Some results are given in the table below.

Details of BLAST analysis

Microbe	V3 partial region included	V 6 region included	Best match	Organism to which matched
NRV	YES	YES	882/895 (99%)	*Bacillus kribbensis*
V 1	YES	YES	925/929 (99%)	*Escherichia fergusonii*
V4	YES	YES	975/981 (99%)	*Bacillus firmus*
V9	YES	YES	864/867 (99%)	*Bacillus stratosphericus*
V 11	YES	YES	773/777 (99%)	*Bacillus thuringiensis*
V 13	YES	YES	748/749(99%)	*Paenibacillus polymyxa*
V 14	YES	YES (partial)	587/594(99%)	*Bacillus licheniformis*
V 15	YES	YES	734/736 (99%)	*Bacillus stratosphericus*
V 16	YES	YES	670/672 (99%)	*Bacillus stratosphericus*
V 22	YES	YES	728/730 (99%)	*Achromobacter spanius*
J 1	YES	YES	648/657 (99%)	*Escherichia fergusonii*
J 3	YES	YES	872/873 (99%)	*Bacillus stratosphericus*
J 4	YES	YES	594/596 (99%)	*Bacillus anthracis*
J 5	YES	YES	790/793 (99%)	*Bacillus stratosphericus*
J 7	YES	YES	940/953 (99%)	*Enterobacter cowanii*
J 10	YES	YES	1003/1015(99%)	*Paenibacillus barcinonensis*
J 12	NO	YES (partial)	309/316 (98%)	*Salmonella bongori*
V 2 (Fungus)	----	-------	808/808 (100%)	*Cladophialophora bantiana*

Majority of the microbes belonged to the phylum firmicutes, some to proteobacteria and some were fungal species. Similarity to sequences of *Paenibacillus polymyxa* which is involved in drought tolerance and *Bacillus stratosphreicus* which is salinity tolerant were found. Also, nitrogen fixing bacteria like *Bacillus firmus* were detected. These microbes along with others may be individually or together contributing to the better growth and survival of finger millet in adverse conditions. Further studies are being carried out. Once their role is identified they can be employed for expression of important traits in other crops. This has the potential to revolutionize the process of introduction of new traits in plants which at present is being done by genetic engineering. This will obviate the need for transgenic plants which are not generally favoured by society. Also, to the best of our knowledge this is the first report on endophytes of finger millet worldwide.

200.

Effect of Planting Time on Physiological Parameters of German Chamomile (M*atricaria chamomilla* Linn.)

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Keywords: Growth, German chamomile, salinity, planting time

Introduction

German chamomile (M*atricaria chamomilla* Linn.) is one of the important medicinal herb native to southern and eastern Europe. Agricultural production adversely affected by soil salinity is one of the worldwide problems. Amelioration and utilization of these saline soils have been the focus of research for the last few decades. Chamomile is valuable crop suited for a variety of soils. Its potential requires to be examined in India as an export crop in view of its high price. It is necessary to promote this valuable crop as a commercial crop mainly for the export of chamomile form India. Therefore the present study was carried out the observe the effect of chloride and sulphate dominated salinity on growth parameters at various planting time to find the best sowing time.

Materials and Methods

The present experiment was carried out in the screen house of the Department of Botany & Plant Physiology at CCS Haryana Agricultural University Campus, Hisar. The plants were raised in polythene bags each containing 6 kg of dune sand. The sand filled polythene bags were saturated with the solution of salinity treatment along with the nutrient before sowing. Two types of salinity namely chloride and sulphate dominated salinity with three replication was given at 5 different salinity level such as 0 (control), 4, 8, 12 and 16 dSm^{-1} (decisimen per meter) at three different planting time i.e. early (sowing time 15 September), timely (18 October) and late (5 November).

Results and Discussion

The seeds germinate and emerge as seedling in 4 to 5 days after sowing. Experimental results demonstrate a hundred percent seedling establishment after 15 days of emergence in control indicating zero per cent seedling mortality. The range of decline in seedling establishment was from 100 to 94.4% for timely sown, 100 to 93.2% for early sown and 100 to 95.6% for late sown seeds (Fig. 1). Salinity affects imbibition, germination and root elongation of *Matricaria comomilla* and result into decrease of germination percentage (Joneidi, 2013).

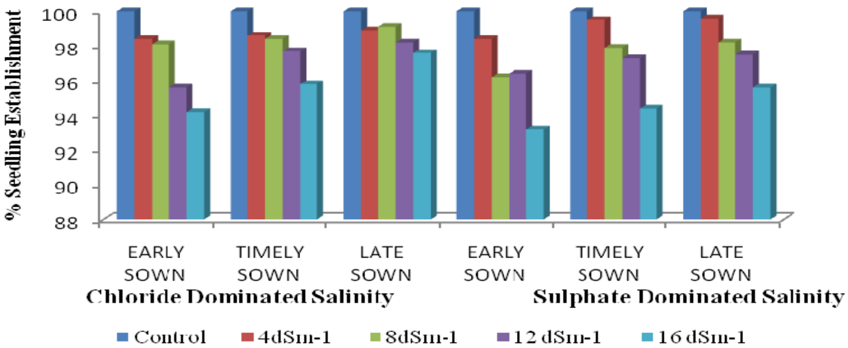

Fig. 1: Effect of planting time on per cent seedling establishment under chloride and sulphate dominated salinity

A substantial delay in flower initiation but also an early maturity of German chamomile under salinity stress has been observed at different planting times. The parameters such as leaf dry weight/plant stem & branches dry weight/ plant, root dry weight/plant, flower heads dry weight, all suffered a decline with the increasing salinity levels of the growing medium. Leaf dry weight was more affected in late sown seed and least in early sown at both salinity types. The reason for the decrease in plant growth may be explained by the in osmotic pressure due to increasing salt level, which lessens the available water to plant (Huang *et al.*, 2006). Plants survived and complete its life cycle even at highest salinity level (16 dSm^{-1}) at all planting time. The early sown seeds produce flower which results into high oil yield. This herb can therefore be grown earlier in the areas affected by salts.

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201.

Correlation Studies of Various Morpho-physiological Traits in Recombinant Inbred Population of Wheat under Rainfed and Irrigated Environments

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Introduction

Wheat is one of the most important cereal and a staple food for more than one third of the world population. While climatic fluctuation in present scenario influences the wheat productivity, in which drought is one the most common environmental stress affecting about 32% of 99 million hectares under wheat cultivation in developing countries and at least 60 million hectares under wheat cultivation in developed countries (Shamsi *et al* 2011). Morphological and physiological traits of wheat have a special role in determining the importance of each trait in increasing yield and introducing commercial varieties that can withstand seasonal drought stress condition (Mollasadeghi *et al* 2011). The aim of the research reported in this paper was to estimate the association of various morphological and physio-biochemical traits under rainfed conditions along with the type and extent of their contribution to yield.

Materials and Methods

The experiment was conducted during *Rabi* seasons of 2012-13 and 2013-14 at Punjab Agricultural University, Ludhiana. The experimental material consisted of 175 recombinant inbred lines **(**RILs) and parental lines (PBW 343, C 518) along with 19 checks (PBW 621, PBW 644, PBW 527, C306, C273, C591, C286, C281, C285, PBW 706, PBW 175, PBW 691, BWL 1856, HD 2967, Kirchauff, Babax, Excalibur, Gladius, Drysdale). The experimental design was 14x14 square lattice having 1m^2 plot with three replications. The drought environment was created by withholding of irrigation. Data of physiological and yield related parameters were recorded under both irrigated and rainfed environments. The analysis of variance was done using a simple lattice designs by SAS (version 9.2). Pearson's correlation coefficient among all characters studied was analyzed by statistical software JMP (version 12.0).

Results and Discussion

Correlations coefficient among various physio-biochemical and yield component traits was carried out with respect to irrigated and rainfed conditions and results obtained are presented in the Table 1. Under irrigated environments, grain filling period (GFP) was found positively correlated with peduncle length (PL), stomatal density (SD), water soluble carbohydrates (WSC),1000 grain weight (TGW) and grain yield (GY). Chlorophyll content (CC) was observed to be associated with relative water content (RWC) and grains number per spike (GN). Thousand grain weight had significant positive correlation with GFP, PL, WSC, GN, GY and harvest index. Grain yield had a significant positive correlation with GFP, WSC, GN, TGW and harvest index.

In case of rainfed environment, GFP had significant positive correlation with CC, PL, TGW and GY. Canopy temperature (CT) had significant negative correlation with SD, GN and TGW. Relative water content showed significant positive correlation with CC and GN. Stomatal density had significant positive correlation with CC and GN, and had negative correlation with canopy temperature. Thousand grain weight was found significant positively correlated with GFP, PL, WSC, GN, GY and harvest index, and had negative correlation with canopy temperature. It is concluded that the traits related with 1000 grain weight and grain yield can be important for the evaluation and improvement of wheat cultivars under drought stress. In context of this, GFP, PL, WSC, GN and TGW showed strong positive correlation and canopy temperature showed negative correlation with grain yield under rainfed environment. These traits may be considered as effective selection criteria for drought tolerance in wheat cultivars.

Abbreviations: GFP-grain filling period, CTA- canopy temperature at anthesis, PL- peduncle length, RWC-relative water content, STD- stomatal density, MWSC- mobilized water soluble carbohydrates, GN-grains per spike, TGW-1000 grain weight, GY- grain yield, HI- harvest index

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Table 1: Correlation among various physio-biochemical and yield components traits in RILs under irrigated and rainfed enviornments

	GFP	CTA	CCI	PL	RWC	STD	MWSC	GN	TGW	GY	HI
Irrigated											
GFP	1										
CTA	0.002	1									
CCI	0.060	-0.037	1								
PL	0.228**	0.053	0.063	1							
RWC	0.131	-0.024	0.181*	0.082	1						
STD	0.155*	-0.140	0.006	0.022	0.102	1					
MWSC	0.212**	0.005	-0.033	0.136	0.025	-0.082	1				
GN	-0.004	-0.154*	0.282**	0.195**	0.150*	0.095	0.117	1			
TGW	0.238**	0.004	0.045	0.315**	0.071	0.076	0.381**	0.286**	1		
GY	0.193*	-0.092	-0.029	0.088	0.059	0.071	0.203**	0.273**	0.498**	1	
HI	0.120	-0.066	0.109	0.053	0.147	0.120	0.102	0.284**	0.293**	0.451**	1
Rainfed											
GFP	1										
CTA	-0.058	1									
CCI	0.149*	-0.094	1								
PL	0.296**	-0.052	0.074	1							
RWC	-0.026	-0.089	0.228**	0.036	1						
STD	0.088	-0.196**	0.180*	0.048	0.110	1					
MWSC	0.135	0.040	0.065	0.179*	0.013	-0.024	1				
GN	-0.042	-0.232**	0.204**	0.202**	0.190*	0.231**	0.121	1			
TGW	0.294**	-0.186*	0.122	0.353**	0.116	0.025	0.331**	0.258**	1		
GY	0.219**	-0.132	0.012	0.267**	0.028	-0.045	0.186*	0.205**	0.457**	1	
HI	0.112	-0.080	0.023	0.022	-0.100	-0.132	0.024	0.216**	0.270**	0.608**	1

** and * indicates significant at 1% and 5% probability level

202.

Weather Based Cane Productivity Model for Central Uttar Pradesh, India

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Keywords: Weather parameters, sugarcane, simulation model, productivity

Introduction

Sugarcane (*Saccharum officinarum* L) is a long duration crop, being cultivated in tropics and subtropics in India. Being, a plant of tropical habitat, sugarcane requires warm and moist climate for its best growth. Due to its long duration, its response to weather parameters varies with phenological stages of the crop. In the initial stages of germination and establishment, soil temperature around 21°C is quite conducive. Relatively high temperature (30-35°C), longer duration of bright sunshine and low humidity conditions are conducive for the buildup of shoot population. Fairly hot (24-30°C) and moist (relative humidity 70% or more) weather with high incidence of solar radiation accelerate the elongation of the crop. For maturity and ripening of cane, temperature between 10-15°C, low relative humidity (50-60%) with bright sunshine are ideal. However, frost during maturity span is undesirable. As a duration crop, it reflects strong interaction with weather parameters. The crop interactions in formative and elongation phases (April-October) primarily dictate the crop productivity. Weather based statistical and simulation models for estimating crop productivity in sugarcane have been widely suggested (Agrawal and Mehta, 2007, Srivastava *et al.*, 2007). In the present study, a weather based interactive model was developed for Shahajahanpur district of Central Uttar Pradesh using long-term (1981-2005) yield and monthly weather data on maximum, minimum and range of temperature, rainfall and number of rainy days for district.

Materials and Methods

The long-term (1981-2005) cane productivity data along with monthly average weather data on maximum, minimum and range of temperature and total monthly rainfall and number of rainy days was were collected from Shahajahanpur district of Central Uttar Pradesh. The productivity data was individually correlated with these weather data from April to October (the actual growth and development span of sugarcane) and composite variables were generated based on weightage of correlations obtained. The model description is given below

Model description: p

$Y= a_0 + \sum a_i z_i + e$

j=1

$= a_0 + a_1 z_1 + a_2 z_2 + \ldots\ldots e$

n_2

Where, $z_i = \sum r_{im}\, x_{jm}$

$m=n_1$

Y-variable to forecast, x_{im} - i-th parameter in m-th month, r_{im} -correlation coefficient between y and i- th weather parameter in m-th month, n_1 - initial month for which weather has been considered, n_2- final month for which weather considered and e- error term

The productivity data from 1981-2000 was regressed with composite variables and weather based model was generated. The model was successfully validated for 2001 to 2005 with Root Mean Square Error **(**RMSE) 8.3%.

Results and Discussion

The weather based model in terms of composite variables for maximum (Z_1), minimum (Z_2), rainfall (Z_3), number of rainy days (Z_4) and range of temperature (Z_5) using crop yield and weather data from 1981-2000 was developed as under:

$Y= 84.36+2.553Z_1+0.281Z_2+0.027Z_3 -0.138Z_4+0.101Z_5$ (R^2= 0.47)

The sugarcane yield reflected highest negative correlation with Maximum temperature (Tmax) for August. Minimum temperature (Tmin) for the month of June reflected highest positive correlation with yield. The total rainfall in the month of September showed highest negative correlation with yield. The highest positive correlation of yield was found with total number of rainy days in the month of August. The range of temperature in the month of August reflected highest negative correlation with sugarcane yield. The pattern of observed and estimated yields are presented in Fig. 1.

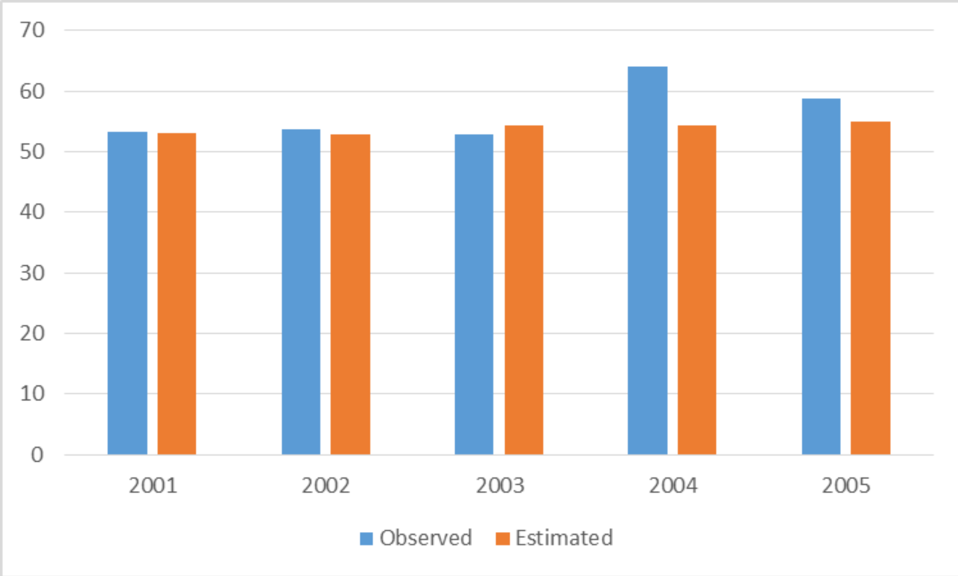

Fig. 1: Observed and estimated yield of sugarcane in Shahajanpur district of U.P.

The estimated data compare well with observed data except for the 2004. The % RMSE between observed and estimated productivity was 8.32%. The relatively higher yield disparity between observed and estimated yield for 2004 (nearly 10 t /ha) could be attributed to relatively lower average maximum temperature and also lower range of temperature in time span from April-October in 2004 (Table 1)

Table 1: Average weather parameters for the April to October

Year	Maximum Temperature (°C)	Range of temperature (°C)
2001	34.1	10.6
2002	34.9	11.0
2003	33.9	10.2
2004	**33.6**	**9.8**
2005	34.4	10.5

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203.

Host and Location Mediated Variation in Life Cycle and Biological Attributes of Summer R*angeeni* Lac Crop

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Keywords: Lac insect, *Ziziphus mauritiana*, *Butea monosperma*, biological attributes, *rangeeni strain*

Introduction

India is the largest producer of lac in the world. Three commercially potential products obtained from lac insect are - resin, dye and wax which find application in diverse areas such as food, pharmaceuticals, cosmetics, paints, varnishes etc. Lac derived products are biodegradable, non-toxic, and environment friendly. In addition to this, the lac insect-host association contributes to the conservation of biodiversity, *viz*., soil flora, fauna, and soil microorganisms. Lac insect life cycle and biological attributes varies from host to host and location to location. The present study was therefore undertaken to study the life cycle and biological parameters of lac insect in Ranchi, Jharkhand and Jhalda, West Bengal on two commercial lac host trees.

Materials and Methods

The *rangeeni* strain broodlac was cultured on *ber* (*Ziziphus mauritiana*) and *palas* (*Butea monosperma*) during two consecutive years, to raise summer season (*baisakhi*) crops during 2011-12 and 2012-13 at Institute Research Farm, Ranchi (Jharkhand) and Jhalda, West Bengal. Duration of pre sexual, male emergence and life period of female lac insect were recorded on both host. To determine the productivity linked attributes 1 cm^2 area was randomly selected and numbers of lac larvae settled were counted for initial density of settlement after 21-days of inoculation. Simultaneously, counting of dead larvae was also recorded for initial mortality. Ten such sites selected from the same host plant and average taken as mean density of settlement and mean mortality. The process (as in initial density of settlement) was repeated 14-16 weeks of inoculation for recording male and female numbers for determination of sex ratio (% of male insects). The resin output by an individual female was also recorded by weighing individual matured female lac insect after removing the dead insect body from the cell after larval emergence. Fecundity were assessed by storing individual matured female into glass vials plugged with cotton for about a month and the emerged larvae were counted. The data were subjected to analysis of variance (ANOVA) for the significance of (P= 0.05) by using statistical package AGRES.

Results and Discussion

Lac insect life cycle during summer *rangeeni* (*baisakhi*) crop

Variation in pre sexual maturity, duration of male emergence and total life cycle period differ significantly between hosts and locations. However, the interaction between location and host was significant only for pre sexual maturity period during summer rangeeni (2011-12) crop. Difference in pre sexual maturity period in Jharkhand and West Bengal were 15 and 18 days on *palas* and *ber*, respectively similarly, the difference in total life cycle period was 9 and 8 days on palas and ber, respectively. During summer *rangeeni* (2012-13) crop variation in pre sexual maturity was observed significantly different between the locations only whereas duration of male emergence and total life cycle period differ significantly between host and location. It was observed that the lac insect takes more time to complete its life cycle on *ber* in comparison to *palas* at both locations during two consecutive crop years.

Biological attributes of summer *rangeeni* (*baisakhi*) crop

The biological attributes of *rangeeni* lac insect shows significant differences in pre harvest (initial density settlement, initial mortality and sex ratio) and post-harvest (survival at maturity, fecundity and resin weight) parameters at both locations and hosts. Initial mortality and sex ratio differs significantly between hosts, locations and interaction between location and host whereas initial density of settlement showed significant difference only between locations. Survival at maturity differs significantly between hosts, locations and interaction between location and host whereas fecundity and resin weight were significantly different only between locations. Broodlac yield ratio differs significantly only between the hosts during summer lac crop 2011-12. Similarly during 2012-13, initial mortality differs significantly between hosts, locations and interaction between location and host whereas sex ratio showed significant difference only between hosts. Similar trend was observed in broodlac yield ratio during summer lac crop 2012-13 as compared to 2011-12.

204.

Pest Management through ICT Based Extension in Cotton

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Keywords: Pest monitoring, refugia, cotton pests, IPM, ICT

Introduction

Central Institute for Cotton Research has executed an extension mechanism called *E- kapas network* for effective knowledge transfer to cotton growers. The voice SMS alerts were disseminated in local language to farmers registered with E- kapas network. This system has been executed because India has been struggling with challenges with regard to increasing productivity for decades and the lack of information about yield enhancing cotton technologies among farmers contributes to this in a major way. The extension personnel failed in spreading technologies to all the cotton farmers of the region as it was done manually. So with a view to spread latest knowledge to all cotton farmers, this system has been executed.

Materials and Methods

Punjab Agricultural University, Regional station, Faridkot, Punjab as a cooperating centre for e-kapas has been actively participating in this project. The farmers from various cotton growing districts of Punjab were registered with their address and mobile number during University extension activities like kisan mela, kisan divas, training camps, field visits and field days. The centre documented the frequently asked questions (FAQs) in cotton and collected from nearby Kisan Call Centres and conducted Focus Group Discussions among cotton growers at regional level. Using software named Unicel, voice SMSs related to cotton cultivation, protection technologies, weather, production and Integrated Pest Management (IPM) have been timely sent to the registered farmers.

Results and Discussion

Till date, 7020 cotton growers belonging to Punjab state have been registered with Regional Station, Faridkot (Punjab). So far, 43 voice SMSs have been sent to cotton growers which were recorded in Punjabi Language and lasts for 30 seconds. Until December 2015, a total of 1,36,983 voice SMS alerts on cotton production have been sent. The target is to register 5000 farmers in the year 2016-17. Information has been sent about the pest monitoring, countering pest epidemic situation, diseases and disorders with the timely use of recommended chemicals for protecting the crop more than once. The information regarding *Refugia* has been given to farmers which is indispensable to transgenic cotton technology. Farmers have been informed about the spray technology to deal with serious insect vector e.g. whitefly. Importance of IPM to reduce pesticide load and input costs has been emphasized through this network. The overall success rate of voice SMSs was 77.6%. The data pertaining to this is presented in Table 1. Success rate was limited to less than 80% because problems were faced in implementation w.r.t. sending of voice SMS like invalid numbers and wrong numbers were given by farmers unknowingly. At many occasions, 'ring time out and congestion' were the major constraints experienced in sending e-kapas alerts to registered cotton farmers (Usha Rani and Wasnik*,* 2011). The acceptance of a few technologies by some farmers seemed to be difficult as evident by the feedback collected from them. The farmers having doubts on aspects of cotton cultivation called back to the number provided in voice SMS.

Table 1: Overall success rate of voice SMS

Information	**2014-2016**
No. of FAQs collected	97
No. of farmers enrolled	7020
Number of voice message uploaded	26
Number of voice message sent successfully	43
Overall Success percent	77.6

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205.

Estimation of Genetic Components Affecting Inheritance of Yield Contributing Traits in Linseed (*Linum usitatissimum* L.)

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Keywords: Linseed, heritability and genetic inheritance.

Introduction

Linseed (*Linum usitatissimum* L.) is annual self-pollinated diploid (2x=2n=30) oilseed crop belonging to *Linaceae* family. Qualitative characters controlled by one or a few major genes are more readily manipulated in a breeding programme as compared to quantitative traits controlled by many genes. Nevertheless, the breeder is concerned mainly with quantitative characteristics which could be of use in both formulating and performing the breeding programme. Hence, the present investigation has been carried out to study the nature of gene action for yield and its contributing traits in this crop.

Materials and Methods

The experimental material for present investigation comprised of 28 F'$_1$s (developed by crossing eight parental lines viz., NDL 2004-05, R-552, TL-11, TL-27, EC-1392, A.95.B, GS-234 and Shekhar) in half diallel fashion design during *rabi* 2011-12. The test genotype Shekhar was used as check. A total of 36 treatments (28 F1's + 8 parents) were evaluated in randomized block design with three replication at N.D. University of Agriculture and Technology, Faizabad, India.

Results and Discussion

Genetic components of variation namely D, H_1, H_2, F, h^2 and E for eleven characters in F_1s generation are presented in Table 3. Analysis of variance reveals that additive and dominance genetic variances were significant for most of the characters. Additive component (D) was highly significant and positive for most of the characters studied, indicated that additive gene actions condition the above characters. The estimates of dominance component H_1 and H_2 showed highly significant values for all the characters. This indicated that dominant gene actions condition the above characters. Significant value of D and H revealed the importance of additive and dominant genetic effects. The value of dominant components was higher than additive components for all the characters studied except plant height, indicating that genes showing dominant genetic effects for such traits were more important than additive genetic effects. The significant of positive value of h^2 indicated presence of dominance. The proportion of positive and negative alleles in the parent ($H_2/4H_1$) was less than unity for all the characters, which indicated that the positive and negative alleles were distributed asymmetrically. The proportion of the dominant and recessive genes in the F_1s (KD/KR) was recorded more than unity for all the characters, indicated that the dominant genes were frequently distributed as compared to their recessive genes. High heritability coupled with moderate genetic advance in per cent of mean was recorded for harvest index, seed yield per plant and number of capsules per plant.

Table 1: Estimates of genetic components of variance in respect to eleven characters in diallel cross in Linseed

Characters	D	H_1	H_2	h^2	F	E	$H_1/D^{0.5}$	$H_2/4H_1$	KD/KR	'r'	h^2/H_2
Days to 50 per cent blooming	20.90**	45.16**	33.60**	50.40**	6.77	1.86	1.47	0.86	1.25	0.82*	1.50
Days to maturity	9.84**	24.70**	17.37**	12.68**	5.74	2.09*	1.58	0.17	1.45	0.75*	0.73
Plant height (cm)	86.42**	84.02**	51.30**	14.58	103.21**	1.07	9.9	0.15	4.07	0.93**	0.28
No. of primary branches per plant	0.207*	1.59**	1.23**	0.61**	0.41	0.05	2.78	0.19	2.11	-0.02	0.50
No. of secondary branches per plant	34.85**	124.76**	104.79**	72.28**	51.52*	2.12	1.89	0.21	2.28	0.72*	0.70
Number of capsule per plant	686.37**	2493.30**	1968.03**	1346.27**	987.94**	18.56	1.91	0.20	2.21	0.62	0.68
Number of seeds per capsule	0.16	0.90**	0.68**	-0.01	0.32	0.08*	2.34	0.19	2.48	-0.01	-0.01
1000 Seed weight (g)	1.01**	1.31**	1.12**	0.27	0.21	0.01	1.14	0.21	1.20	0.77*	0.24
Biological yield / plant(g)	6.62*	34.53**	31.61**	40.57**	6.84	0.34	2.28	0.23	1.59	-0.09	1.28
Seed yield per plant (g)	0.60*	4.60**	4.39**	4.54**	0.35	0.05	2.76	0.24	1.23	0.22	1.03
Harvest index (%)	21.23	105.25**	94.45**	3.74	25.67	2.38	2.23	0.22	1.75	-0.22	0.04

* Significant at 5 per cent level; ** Significant at 1 per cent level.

4

Horticulture Crops

206.

Studies on Variability, Heritability and Genetic Advance in Garlic (*Allium sativum* L.) for Yield Related Traits

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Keywords: Garlic, variability, PCV, GCV, heritability, genetic advance

Introduction

Garlic (*Allium sativum* L.), a member Alliaceae family, is the second most important widely cultivated bulbous crops after onion. The lack of genotypes with high yield with better storage potential is the main constraint limiting the productivity in India, which is why, the average productivity of garlic in India is low compared to other countries. Therefore, the present investigations were undertaken to select genotypes having high bulb yield.

Materials and Methods

The investigation was carried out at research farm and laboratory of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar in 2014-15. Twenty five genotypes were planted on 28th October 2014 in randomized block design (RBD) with three replications. The cloves of each genotype were planted manually in flat beds of 3x2 m size at a spacing of 15x10 cm. The standard agronomic practices as recommended for vegetable crops were followed to ensure a uniform and healthy crop stand. The bulbs were harvested on 22nd April. Ten plants were selected randomly from each genotype per replication and were used for recording observations. All the statistical analysis was carried out by using OPSTAT statistical analysis tool.

Results and Discussion

Genetic variability studies showed high GCV and PCV values for average weight of cloves, average bulb weight and pseudostem length, indicating that a greater amount of genetic variability was present for these characters. Moderate PCV and GCV values for marketable yield, total yield, number of cloves per bulb, leaf width, number of leaves per plant, total soluble solids, polar and equatorial diameter of bulb indicated that a moderate amount of genetic variability was present in these characters, which provided average scope for selection. PCV and GCV were recorded low for leaf length, plant height and days to harvesting, indicating limited scope of improvement for these traits. High heritability coupled with high genetic advance as percent of mean was observed for average weight of cloves, average bulb weight, marketable yield and total yield, indicating that these traits were under the strong influence of additive gene action, and hence, simple selection based on phenotypic performance of these traits would be more effective. Moderate heritability and low genetic advance values were observed for the characters plant height, number of leaves, leaf length, leaf width, pseudostem length, polar diameter, equatorial diameter and number of cloves per bulb.

Table 1: Average Mean, range, phenotypic and genotypic coefficients of variation, heritability, genetic advance and genetic advance as % of mean for different characters in garlic

Characters	General mean	Range of mean		Coefficient of variation		h^2 (BS) (%)	Genetic advance	Genetic advance as % of mean
		Minimum	Maximum	Phenotypic (%)	Genotypic (%)			
Plant height (cm)	78.168	63.23	95.5	10.512	9.680	84.788	14.352	18.361
Number of leaves per plant	10.779	7	14.3	17.449	13.001	55.516	2.151	19.955
Leaf length(cm)	35.671	29.53	42.16	12.082	9.819	66.049	5.864	16.438
Leaf width (cm)	2.240	1.36	3.55	18.823	17.997	91.417	0.794	35.446
Pseudo-stem length (cm)	28.605	16.7	38.06	21.366	18.670	76.358	9.614	33.608
Polar diameter of bulb (cm)	40.567	28.56	53.8	14.562	13.227	82.508	10.040	24.750
Equatorial diameter of bulb (cm)	40.937	30.2	49.6	13.889	13.340	92.254	10.805	26.394
Average bulb weight (g)	32.964	18.5	51.60	32.815	31.836	94.122	20.973	63.625
Number of cloves per bulb	33.741	21.9	44.4	19.588	17.987	84.313	11.480	34.022
Average weight of cloves (g)	52.584	30.0	108.86	37.163	36.794	98.024	39.460	75.043
Total yield(q/ha)	106.013	55.13	140.27	19.875	19.308	94.377	40.964	38.641
Marketable yield	103.911	53.44	138.5	20.152	19.622	94.810	40.898	39.359
Days to harvesting	171.493	167.67	182.66	2.297	1.272	30.676	2.489	1.451
TSS (%)	36.469	27.00	43.43	15.816	8.461	28.616	3.400	9.323

h^2- Heritability and TSS-Total soluble solid

207.

Heterosis for Fruit Quality Parameters in Tomato (*Solanum lycopersicum* L.)

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Keywords: Tomato, quality, line × tester, heterosis, F_1 hybrid

Introduction

Tomato being most used culinary vegetable round the globe can meet the nutraceutical requirements through its lycopene, carotenoids and ascorbic acid. Even though the primary objective of any breeding program is a high yielding cultivar/hybrid, the need for good quality fruit in tomato is of great importance owing to the reason that high yielding hybrid with poor fruit quality and appearance will not be preferred. Hence present investigation was carried out at Indian Institute of Horticulture Research, Bengaluru during 2013-14 and 2014-15 to assess the heterosis levels expressed by hybrids.

Materials and Methods

Six lines and three testers were crossed in Line × Tester fashion at IIHR, Hesaraghatta, Bengaluru during *Rabi* and the evaluation of hybrids along with their parents and checks for various fruit quality traits during summer 2014 in Randomized Block Design in three replications. Each entry in a replication was represented by 40 plants. About 5 fruits from each replication of each entry were considered to record observation for quality traits and the average value obtained from 3 replications was employed for data analysis to estimate the level of heterosis recorded by the hybrid progenies.

Results and Discussion

The range of *per se* performance, range of heterosis over better parent (BP), standard checks Arka Rakshak (SC 1) and Abhinav (SC 2) and two best heterotic hybrids over BP and SC are presented in Table 1. Obtained results revealed that the hybrids IIHR 2892 x IIHR 2852 and IIHR 2848 x IIHR 2852 exhibited standard heterosis of 30.67% and 21.24%, respectively over standard check Abhinav for fruit firmness. Standard heterosis of 86.50% has been recorded for total carotenoid in the hybrid combination IIHR2892 x IIHR2852 over the check Arka Rakshak. IIHR2892 x IIHR2852 have recorded standard heterosis for yield along with important fruit quality traits like acid, total carotenoids, lycopene, fruit firmness and fruit breadth. Heterosis for all quality characters along with that of the yield was found in none of the hybrids evaluated. However, the combination IIHR2892 x IIHR2852 has showed significant standard heterosis in desirable direction for five quality characters like ascorbic acid, total carotenoids, lycopene, fruit firmness and fruit breadth along with that of yield per hectare. Hence, this hybrid can be further evaluated for its stability in quality under various environmental conditions and recommended for further use.

Table 1: Range of heterosis and best heterotic hybrids for various fruit quality characters

Character	Mean range	Heterosis (%) range over			Best heterotic hybrids over		
		BP	SC 1	SC 2	BP	SC 1	SC 2
Fruit length (cm)	4.84 - 6.64	-22.94 - 12.56	-26.08 - 14.57	-24.03 - 17.75	IIHR2848xIIHR2853 (12.56)	IIHR2848xIIHR2853 (14.57)	IIHR2848xIIHR2853 (17.75)
Fruit breadth (cm)	5.31 - 7.55	-27.52 - 23.99	1.08 - 43.78	4.39 - 48.49	IIHR2892xIIHR2852 (23.99)	IIHR2850xIIHR2853 (43.78) IIHR1816xIIHR2853 (30.71)	IIHR2850xIIHR2853 (48.49) IIHR1816xIIHR2853 (34.99)
Firmness (kg/cm^2)	5.02 - 8.78	-31.84 - 18.34	-40.79 - 3.58	-25.31 - 30.67	IIHR2892xIIHR2852 (18.34)	-	IIHR2892xIIHR2852 (30.67) IIHR2848xIIHR2852 (21.24)
Locules	3 - 6.28	-40.39 - 37.22	-3.42 - 94.93	12.5 - 135.37	IIHR977xIIHR2853 (-40.39) IIHR2891xIIHR2853 (-36.86)	-	-
TSS (°B)	3.9 - 4.84	-17.53 - 6.37	-11.17 - 10.41	-22.53 - -3.71	-	-	-
Pericarp thickness (cm)	5.11 - 9.22	-31.83 - 5.09	-34.74 - 17.75	-16.32 - 50.98	-	IIHR2848xIIHR2852 (17.75)	IIHR2848xIIHR2852 (50.98) IIHR2848xIIHR2890 (38.26)
Ascorbic acid (mg/100g)	8.06 - 18.21	-50.40 - 93.76	-32.83 - 51.78	3.16 - 133.11	IIHR977xIIHR2853 (93.76) IIHR977xIIHR2852 (46.49)	IIHR977xIIHR2853 (51.78) IIHR1816xIIHR2890 (45.94)	IIHR977xIIHR2853 (133.11) IIHR1816xIIHR2890 (124.15)
Total carotenoids (mg/100g)	6.34 - 24.17	-62.22 - 102.43	-51.08 - 86.50	-68.97 - 18.31	IIHR2892xIIHR2852 (102.43) IIHR2891xIIHR2853 (61.81)	IIHR2892xIIHR2852 (86.50) IIHR2891xIIHR2853 (63.48)	IIHR2892xIIHR2852 (18.31)
Lycopene (mg/100g)	3.75 - 15.11	-60.98 108.13	-53.24 - 88.40	-70.93 - 17.13	IIHR2892xIIHR2852 (108.13) IIHR2891xIIHR2853 (79.67)	IIHR2892xIIHR2852 (88.40) IIHR2891xIIHR2853 (68.25)	IIHR2892xIIHR2852 (17.13)
Yield (t/ha)	48.38-88.56	39.65 - 166.61	-39.27 - 11.18	-7.7 - 68.96	IIHR1816xIIHR2852 (166.61) IIHR2850xIIHR2852 (157.45)	-	IIHR1816xIIHR2853 (68.96) IIHR2891xIIHR2853 (67.13)

*Values in the parenthesis indicates values of heterosis

BP= Better Parent, SC-1= Standard Check 1 (Arka Rakshak), SC-2= Standard Check 2 (Abhinav)

208.

Efficiency of RAPD Markers in Genetic Divergence Analysis of Pea Genotypes

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Keywords: *Pisum sativum*, genetic diversity, RAPD

Introduction

Pea (*Pisum sativum* L.) is a major cool-season crop and an essential component of sustainable cropping systems. The relatively narrow gene pool and use of a small number of varieties as parents by competing breeding programmes have led to low genetic diversity among pea cultivars (Baranger *et al.,* 2004). We used random amplified polymorphic DNA (RAPDs) to characterize field and garden pea germplasm for the identification of potent diverse genetic resources for its further improvement through various breeding approaches.

Materials and Methods

Fifty four genotypes of *Pisum,* collected from diverse sources were used for molecular characterization. The seed material was multiplied for a season to check for the genetic purity of the accessions through phenotypic characters. Genomic DNA was isolated and quantified. The stock DNA was diluted to 20-25 ng/µl for further polymerase chain reaction (PCR) analysis. A set of 22 RAPD primers was used for molecular characterization. Amplified PCR products were resolved by electrophoresis on 1.5% agarose gel and scoring was done. The data matrix of markers was converted into genetic similarity matrix using Jaccard coefficient and NTSYS-PC 2.0.

Results and Discussion

Out of 30 RAPD primers tested, 22 primers produced clear and reproducible amplicons. A total of 168 amplicons ranging from 200 to 5000 base pair were produced out of which 154 (89.32%) were polymorphic. The discriminatory power of RAPDs was determined by calculating various parameters namely polymorphic percentage of bands, polymorphic information content, resolving powder and marker index. Based on these parameters five primers namely OPX-01, OPE-02, OPA-11, OPE-10 and OPC-18 were remarkably informative. Genetic similarity estimates based on the binomial data using Jaccard's coefficient ranged from 0.34 (Kaza-2/IC-218991) to 0.89 (IC-209118/IC-209123) with an average similarity index of 0.54 exhibiting considerable diversity among the pea genotypes studied. All the wild collections have shown less degree of similarity with the cultivated varieties and other collections displaying substantial diversity. Whereas, high similarity estimates were revealed within the cultivated varieties depicting their narrow gene-pool. The similarity estimates were then used to execute cluster analysis using un-weighted pair group method with arithmetic mean (UPGMA). The dendrogram showed clear pattern of clustering according to the source of the germplasm (Fig. 1). The germplasm under study displayed considerable diversity and therefore can potentially be used in pea breeding programmes to broaden the narrow genetic base of existing varieties as putative assurance against unpredicted biotic and abiotic stresses.

Reference

Baranger A, Aubert G, Arnau G, Laine A. L, Deniot G, and Potier J 2004. Genetic diversity within *Pisum sativum* using protein and PCR-based markers. *Theoretical and Applied Genetics*, **108**, 1309-1321.

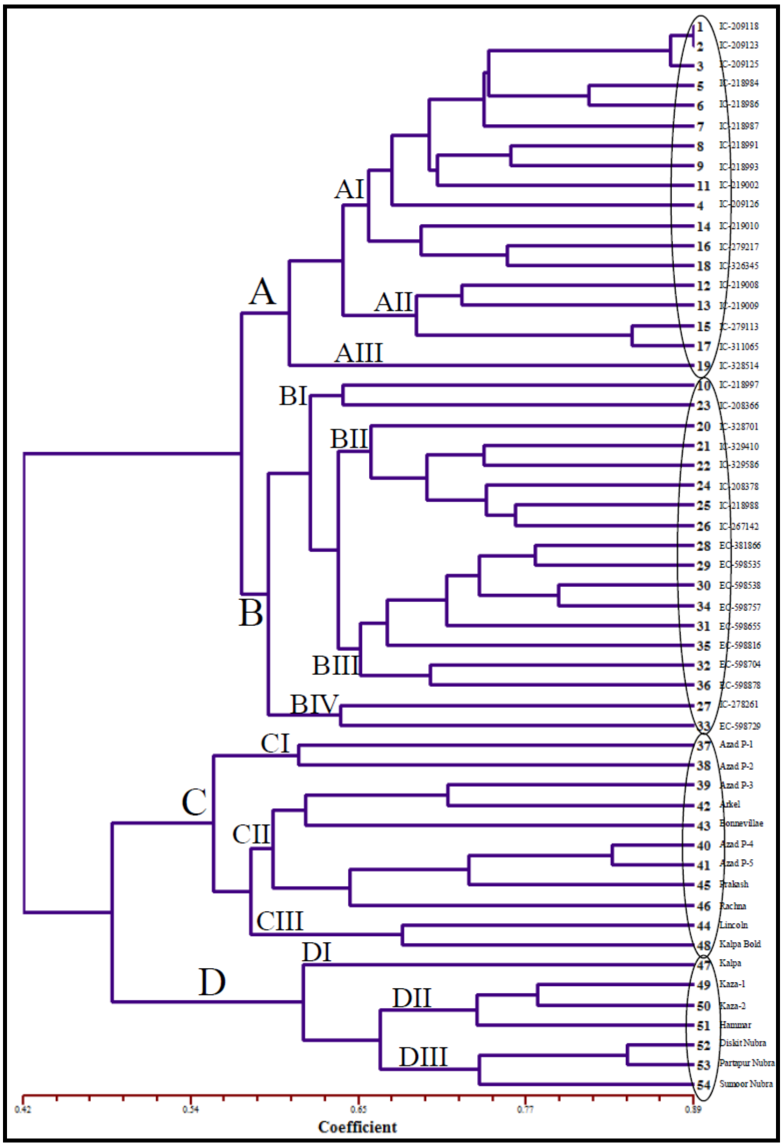

Fig. 1: Dendrogram depicting the genetic relationship among 54 genotypes of Pisum based on Jaccard's similarity coefficient

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Site Suitability of Coriander in India- A GIS Study

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Keywords: Coriander, GIS, site suitability, variability

Introduction

Coriander (*Coriandrum sativum* L.), an important annual herb belonging to family Apiaceae is valued for two primary products which are used for flavoring purposes. There is no information available exclusively on area and production of leafy type coriander in India. General information available on this seed spice is that it occupies the largest area (3. 40 lakh ha), accounting for 44% of the total area under seed spices (2005-06). It is cultivated largely in Rajasthan, Madhya Pradesh, Andhra Pradesh and Tamil Nadu and lesser extent in other states. Geographic Information Systems (GIS) technology is a computer-based data collection, storage, and analysis tool that combine previously unrelated information into easily understood maps. The database prepared from existing field survey can be compiled by digital map plotting for easy monitoring of change in cropping pattern. The spatial analysis thus helps in choosing the best location for the crop depending on the environmental parameters. Coriander being a tropical crop, it requires a cool and comparatively dry and frost-free climate. It can be cultivated successfully in plains during winter season at frost-free climate and in temperate zones during summer.

Materials and Methods

The suitability map was drawn with the help of eco-crop model of DIVA GIS. In eco-crop, the growing period is defined between Gmin and Gmax (expressed in days). 12 possible growing seasons are considered, starting at the first of each month. The length of the growing season is defined as the average of 'Gmin'- 30 days, and 'Gmax, 140 days and GUsed - 80 days.Different temperature and rain fall parameters were also considered during preparation of the map like optimum, Maximum, minimum and killing conditions. The suitability map is given below (Fig. 1). The analysis of the map indicates the suitability of the crop in other parts of India.

Results and Discussion

The map showed that except some portion of Western Ghats and North Western dry and desert area almost whole India is suitable for coriander cultivation. The suitable area was compared with the area under coriander in the different states of India. DASA data of 2010 was used for the analysis.

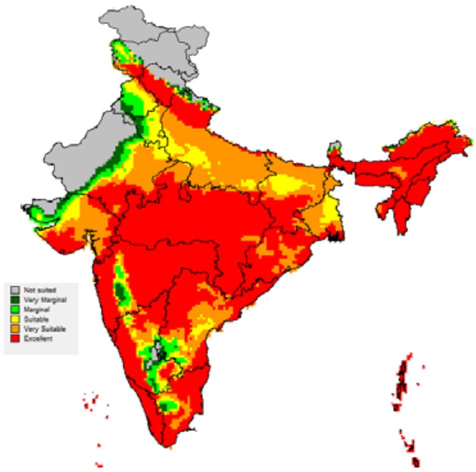

Fig. 1: Eco-crop model of the coriander of India drawn with the help of DIVA GIS.

The map indicates that Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Kerala Orissa and North Eastern states are highly suitable for the crop while Rajasthan, Uttar Pradesh West Bengal and Bihar are very suitable. Andhra Pradesh. Madhya Pradesh and Rajasthan are having highest area under cultivation of the crop (Table 1).

Table 1: Area under coriander in India

State	Area ('000 ha)
Andhra Pradesh	25.00
Bihar	2.30
Chattisgarh	3.70
Haryana	2.20
Karnataka	6.00
Madhya Pradesh	108.40
Meghalaya	0.10
Orissa	19.10
Rajasthan	131.10
Tamil Nadu	17.40
Uttar Pradesh	5.50
Total	320.80

Source: DASD (2010)

This study will help in growing coriander in non-traditional areas also and gain increased income from this short duration crop.

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Assessment of Variability in Fruit Quality Parameters of Kashmiri Nakh (*Pyrus pyrifolia* Nakai.)

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Keywords: Genetic variability, morphology, Kashmiri Nakh, yield efficiency

Introduction

The Chinese sand pears are widely grown in North Western Himalayan region including Jammu and Kashmir, Himachal Pradesh and Uttarakhand. The maximum area under cultivation of Chinese sand pear is existed in Kashmir valley. Therefore, it is locally known as "Kashmiri Nakh". The Jammu & Kashmir is well suited for the production of temperate fruits due to geographical diversity, unevenness, naturalized population and inter-specific cross pollination, the region represents high degree of genetic diversity in fruit plants. The wide diversity of the pear genotypes has great variability in their fruit quality. Therefore, characterization for all existing variation within genotypes is of vital importance.

Materials and Methods

In present study existing Kashmiri Nakh areas were explored in three districts namely, Anantnag, Kulgam and Budgam of Kashmir Valley. Thirty accessions of Kashmiri Nakh were selected at fruit maturity stage from different sites of these districts for evaluation of their fruit quality. Ten well ripe fruits per tree were picked randomly during two consecutive years (2013 and 2014) from all the sites. The fruits were evaluated for quality parameters (texture, firmness, colour, juiciness, Total soluble solids, acidity and sugars). The data presented is pooled data of two years (2013 and 2014) was subjected to the following statistical and biometrical analysis *viz.,* analysis of variance and coefficient of variation, estimation of correlation coefficient and D^2 analysis

Results and Discussion

The quality characteristics of each accession studied are given in Table 1. In present study it has been observed that only 2 (6.66%) accessions had fine texture of flesh, while 18 (60%) had medium and rest 10 (33.33%) had coarse texture of flesh. Texture of flesh was assessed by a panel of judges. Regarding the firmness the accessions ranged between soft, medium and firm. Similarly, juiciness of flesh also showed a wide variability among the thirty sandy pear accessions under study. The maximum TSS (17°B) was recorded in accession 12 whereas, minimum TSS (9.20°B) was recorded in accession 5. When fruit was harvested fully ripe on the tree, it had maximum sugar content with high soluble solids. The variation in fruit acidity may be due to different rates of conversion of organic acids into soluble sugars by different genotypes. The data obtained in the present study revealed a high variability among the accessions regarding total sugars, reducing and non-reducing sugars. The mean values of both years are presented in table which revealed that highest mean values for total sugars (11.15%) was recorded in the fruits of accession 28 and the lowest amount of total sugars 4.50% was recorded in the fruits of in accession 19.

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Table 1: Mean score of fruit quality characteristics (descriptive) of pear (*Pyrus pyrifolia* Nakai.)

Accession No.	Texture of flesh	Fruit firmness	Juice content (%)	TSS (%)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non Reducing (%)
Accession 12	Fine	Medium	Medium	17.00	0.22	5.20	4.50	0.70
Accession 13	Fine	Medium	Juicy	13.90	0.23	6.95	5.95	1.00
Accession 18	Medium	Firm	Juicy	15.00	0.46	7.30	4.60	2.70
Accession 24	Medium	Medium	Medium	11.51	0.11	11.00	5.25	5.75
Accession 28	Medium	Firm	Medium	10.85	0.22	11.15	7.15	4.00

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Genetic Evaluation of Cucumber Hybrids under Mid Hill Conditions of Himachal Pradesh (*Cucumis sativus* L.)

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Keywords: Cucumber, mean performance

Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important summer vegetables grown in India for its tender fruits. Despite being native of India and having sufficient genetic variability, much work has not been done for its improvement. At national level, F_1 hybrid Pusa Sanyog has been released by Indian Agricultural Research Institute, Katrain which out yielded the other recommended varieties. However, its performance is confined to cooler and sub-tropical conditions. To tide over the situation, present investigation was carried out to evaluate hybrids having desirable horticultural and quality traits under mid hill conditions and to make available their seeds to the farmers at a reasonable price

Materials and Methods

In the present investigation thirty three cucumber hybrids developed by public sector including standard check Malini developed by private sector were evaluated in Randomized Block Design with three replications at Experiment Farm, Department of Vegetable Science and Floriculture during spring-summer, 2014. The data were recorded for yield and related horticultural traits in each replication

Results and Discussion

The trait nodal position of first female flower helps to identify the early hybrids of cucumber, it ranged from 3.00 to 5.45 nodal position with overall average of 4.10 nodal position. Out of 32 hybrids tested (excluding check Malini), 25 were significantly superior over the check Malini. Earliness is a desired trait in cucumber as the market prices are generally high, early in the season and hence, days taken to first fruit harvest are indicator of early maturity. The range for this character varied from 31.44 (EC-5082 × K-pap) to 42.67 days (Cucumber Hybrid 11) with overall population average of 38.34 days. Nineteen hybrids showed significantly better performance over the check Malini while 13 were statistically at par to the check. It is of utmost importance to develop a hybrid which has a potential to surpass the commercially adopted cultivars/hybrids otherwise hybrid will be of no significance. The top hybrid which gave the maximum marketable yield per plant (kg) was PLPGy-07 × 173934 (3.232 kg), which was significantly superior to all other hybrids. On the basis of marketable yield per plant and other component traits, the top three cucumber hybrids were PLPGy-07 × 173934 (3.232 kg), EC-5082 × DPC-1 (2.929 kg) and PLPGy-F × JLG (2.926 kg).

Table 1: Mean performance of cucumber hybrids with respect to different traits

Genotypes/ traits	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Number of fruits per plant	Duration of availability of marketable fruits (days)	Marketable yield per plant (kg)
Cucumber Hybrid 1	16.11	4.27	239.89	11.11	46.33	2.664
Cucumber Hybrid 2	15.43	4.18	236.67	9.67	48.89	2.285
Cucumber Hybrid 3	17.33	4.23	280.22	8.22	54.00	2.303
Cucumber Hybrid 4	16.98	4.42	253.08	7.78	45.44	1.967
Cucumber Hybrid 5	17.11	4.25	239.11	8.89	58.22	2.123
Cucumber Hybrid 6	16.22	4.38	247.67	9.22	42.11	2.283
Cucumber Hybrid 7	16.61	4.26	243.81	10.56	43.00	2.573
Cucumber Hybrid 8	17.85	4.39	256.89	7.33	51.44	1.882
Malani (c)	16.06	3.74	184.78	11.33	41.89	2.093
Cucumber Hybrid 9	13.78	3.69	169.78	8.33	45.89	1.414
Cucumber hybrid 10	16.17	4.29	241.00	9.33	52.00	2.248
Cucumber Hybrid 11	15.61	4.19	236.11	11.56	41.89	2.728
Cucumber Hybrid 12	16.30	4.26	245.00	10.44	42.44	2.558
Cucumber Hybrid 13	16.36	4.20	240.78	9.44	41.78	2.272
Cucumber Hybrid 14	17.28	4.25	246.45	10.78	43.89	2.656
PCUCH -3	17.48	4.37	249.22	7.55	48.56	1.880
Cucumber Hybrid 15	17.07	4.19	223.55	8.11	52.67	1.812
PLPGy-1 X K-90	17.68	3.87	230.00	10.67	42.33	2.451
PLPGy-1 X PLP.Local-1	17.36	3.88	244.89	9.55	48.33	2.339
PLPGy-1-0 X K-pap	16.83	4.41	259.55	9.56	42.67	2.479
PLPGy-1- 0 X PLP Local 2	16.66	4.31	235.11	9.67	42.56	2.271
PLPGy-07 X 173934	16.26	5.07	285.19	11.33	54.89	3.232
PLPGy-1-08 X SG	17.70	4.27	257.78	6.56	45.11	1.689
PLPGy-08 X JLG	20.22	5.24	374.44	7.11	42.11	2.663
PLPGY-1-08-.A-13 X DPC 1	18.41	4.26	251.11	8.22	47.11	2.062
PLPGy-D X JLG	16.39	3.70	215.67	8.33	47.11	1.795
PLPGy -E X JLG	20.78	4.51	273.11	9.22	45.22	2.518
PLPGy-F X JLG	18.33	3.80	260.89	11.22	42.00	2.926
EC-5082 X K-pap	17.32	4.20	236.67	12.00	52.67	2.840
G-1X SG	16.44	4.39	216.55	13.11	48.44	2.839
G-3 X K-pap	15.00	4.34	211.11	12.89	57.11	2.720
G-3 X JLG	16.22	4.33	220.78	10.22	45.89	2.256
EC-5082 X DPC-1	16.22	4.45	244.22	12.00	52.45	2.929
Mean	16.90	4.26	243.97	9.74	47.16	2.356
SE (m)±	0.24	0.10	3.20	0.16	0.29	27.66
C.D. @ 5%	1.20	0.58	12.73	1.14	2.24	23.57
C.V. (%)	9.46	3.76	12.27	8.90	11.05	22.03

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Varietal Characterization of Muskmelon for DUS Testing

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Introduction

Muskmelon (*Cucumis melo* L.) is one of the most important crops of cucurbitaceae family and consumed as 'Dessert fruit'. It is an excellent cash crop in several Asian and South American countries and an unavoidable item of Western dietary. India being the centre of diversity provides a wide range of variation for genetic improvement of muskmelon and several varieties has been released. The persistence of great genetic variability in muskmelon and the true character expression in the example varieties assume a greater significance under PPV&FR Act, 2001 for their protection on a set of relevant characteristics.

Materials and Methods

Twelve extant varieties of muskmelon were characterized for 34 morphological traits at three locations (ICAR-CIAH, Bikaner, ICAR-IIVR, Varanasi and ICAR-IIHR, Bengaluru) for three consecutive years from 2011 to 2013 during summer season in RBD replicated thrice to validate Distinctiveness, Uniformity and Stability (DUS) test guidelines for the states of expression of various characteristics. Among 34 morphological characters studied, 19 were visually assessed and 15 were measured. The observations for the assessment of distinctiveness and stability were made on 10 plants or parts of plants from each replication selected randomly.

Results and Discussion

Among the 12 muskmelon varieties, considerable variation was observed for all the important characters. Under results, no intra-varietal variation was observed for any of the visual characteristics examined. Further the expression of characters in different varieties remained same for the three consecutive years confirming the uniformity and stability of the variety for visual characteristics. The fruit shape in longitudinal section was expressed as ovate (MHY-5), elongated globe (Arka Rajhans), oblate (GMM-3, Kashi Madhu) and obovate (Durgapura Madhu). The rind colour of fruit have been grouped as yellow (Kashi Madhu), yellow green (Durgapura Madhu) and orange (Arka Jeet). The sutures on fruit surface were found to be absent in Arka Jeet, MHY-3 and present in Hara Madhu, Kashi Madhu varieties. With respect to netting on fruit surface the varieties have been grouped as absent of netting (Arka Jeet, MHY-5) and moderate netting (RM-50, Punjab Sunehri). The flesh colour was expressed as creamish white (Arka Jeet), grey orange (GMM-3), yellowish green (Durgapura Madhu), green (Hara Madhu) and orange (Kashi Madhu). The varieties were grouped into different categories for each character based on 34 descriptors which may be used as reference varieties. Identified 6 traits (Table 1) as grouping traits *viz*., sex expression (at full flowering), fruit shape in longitudinal section, rind colour of fruit, sutures on rind, surface netting of fruit and fruit flesh colour. The morphological characterization of extant varieties was completed to establish distinctness of the candidate variety from all other varieties to utilize these varieties as reference material for protection of other varieties under PPV&FR Act.

Table 1 Grouping characteristics of muskmelon for DUS testing

Characteristics	State of expression	Example varieties	Type of Assessment
Sex expression (at full flowering)	Monoecious	-	VG
	Andromonoecious	Kashi Madhu, Pusa Madhuras, Hara Madhu, Durgapura Madhu	
	Others	-	
Fruit: shape in longitudinal section	Ovate	MHY-5	VG
	Oval	-	
	Elongated globe	Arka Rajhans	
	Round	-	
	Oblate (Flat globe)	GMM-3, Kashi Madhu	
	Obovate	Durgapura Madhu	
	Cylindrical	-	
Fruit: rind colour	Creamy white	-	VG
	Yellow	Kashi Madhu	
	Yellow Green	Durgapura Madhu	
	Orange	Arka Jeet	
	Others	-	
Fruit: sutures	Absent	Arka Jeet, MHY-3	VG
	Present	Hara Madhu, Kashi Madhu	
Fruit: surface netting	Absent	Arka Jeet, MHY-5	VG
	Moderate	RM-50, Punjab Sunehri	
	Dense	-	
Fruit: flesh colour	Creamish white	Arka Jeet	VG
	Grey orange	GMM-3	
	Yellowish green	Durgapura Madhu	
	Green	Hara Madhu	
	Orange	Kashi Madhu	

VG=Visual assessment by a single observation of a group of plants or parts of plants.

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Sprouting Behaviour of Different Sizes and Cultivars of Potato under Room Temperature Storage

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Keywords: Potato cultivars, potato tuber sizes, sprouting behavior

Introduction

The present research was carried out in laboratory of the department of vegetable science, CCS Haryana Agricultural University, Hisar during spring-summer season. The study was investigated to storability and sprouting behavior of different grades (small, medium and large tubers) of Indian potato cultivars under room temperature conditions. The present experiment was planned to evaluate the effect of tuber size on keeping quality of potato varieties and to assess the sprouting behavior of different grades potato cultivars.

Materials and Methods

The present investigation was carried out in Laboratory of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during spring-summer season. Hisar is situated at a latitude of 29°10" N, longitude of 75°46" E and height of 112 meters above mean sea level and enjoys semi-arid and subtropical climate with hot and dry summer and severe cold in winter months. The three grades of potato tubers, *i.e.* small, medium and large, of variety Kufri Badshah, Kufri Bahar, Kufri Pukhraj and Kufri Pushkar were packed in gunny bags in all the possible combinations under room temperature conditions. The data related to sprouting behavior were statistically analyzed by using Complete Randomized Design (factorial). The tubers showing sprouting were weighed at an interval of 10 days and percentage of sprouting of tubers was calculated on number and on weight basis separately.

Results and Discussion

The sprouting loss was significantly influenced due to the effect of variety, size and their combination on 90th day of storage. Sprouting started on 60th day of storage in all the treatment combinations. It is evident from the Table 1 (a) and 1(b) that the percent sprouting loss increased considerably as the storage period increased. The rate of sprouting loss was highest between 60th and 70th day, moderate between 70th and 80th day and lowest between 80th and 90th day as shown in the Table 1 (a) and Table 1 (b). The highest loss was recorded on 90th day followed by 80th day of storage. Large sized tubers had the maximum sprouting rate as well as increasing number of sprouts with increasing size of potato tubers as shown in Table 1 (a) and 1 (b). The sprouting percentage increased with the progress in storage period and it was 100% in Kufri Bahar. The minimum sprouting was observed in Kufri Pushkar. The sprouting was noticed more in larger tubers than medium or smaller tubers. The sprout weight differed significantly, which was significantly lower in smaller tubers than medium and larger tubers. The minimum sprout weight was observed in small sized tubers (6.92g) followed by medium sized tuber (9.81g) and the highest sprout weight was noticed in large sized tubers (12.88g) on 90th day of storage.

Table 1(a): Effect of varieties and tuber size on sprouting (%) on weight basis of potato during storage under at room temperature conditions

Treatments	Storage period (days)			
	60	70	80	90
Kufri Badshah (V_1)				
Small (S_1)	20.1 (26.80)	32.0 (36.25)	40.7 (39.62)	44.2 (42.09)
Medium (S_2)	30.0 (33.20)	42.0 (40.38)	50.0 (45.73)	57.4 (49.25)
Large (S_3)	39.0 (39.10)	58.9 (48.43)	65.0 (54.01)	71.7 (57.84)
Mean	**29.7 (30.02)**	**44.3 (41.69)**	**51.9 (46.45)**	**57.8 (49.73)**
Kufri Bahar (V_2)				
Small (S_1)	55.3 (48.37)	75.0 (61.19)	100.0 (89.39)	100.0 (89.39)
Medium (S_2)	67.1 (55.42)	78.4 (63.61)	100.0 (89.39)	100.0 (89.39)
Large (S_3)	87.7 (70.23)	100.0 (89.39)	100.0 (89.39)	100.0 (89.39)
Mean	**70.0 (58.01)**	**84.5 (71.40)**	**100.0 (89.39)**	**100.0 (89.39)**
Kufri Pukhraj (V_3)				
Small (S_1)	47.3 (44.21)	62.0 (50.40)	69.0 (54.99)	76.0 (59.65)
Medium (S_2)	60.0 (49.52)	68.0 (54.50)	76.0 (59.87)	80.6 (63.81)
Large (S_3)	67.6 (56.02)	77.0 (60.11)	82.0 (65.12)	88.6 (70.22)
Mean	**58.3 (49.92)**	**69.0 (55.00)**	**75.7 (59.99)**	**81.7 (64.56)**
Kufri Pushkar (V_4)				
Small (S_1)	8.0 (15.54)	12.6 (20.75)	20.3 (26.76)	25.3 (30.18)
Medium (S_2)	21.0 (26.24)	31.5 (34.89)	44.0 (41.88)	52.3 (46.30)
Large (S_3)	38.5 (37.27)	43.0 (42.34)	56.5 (48.72)	65.0 (53.71)
Mean	**22.5 (26.35)**	**29.0 (32.66)**	**40.3 (39.12)**	**47.5 (43.40)**
Mean of Size				
Small (S_1)	***43.5 (33.73)***	***45.4 (42.15)***	***57.5 (59.22)***	***61.4 (55.33)***
Medium (S_2)	***59.4 (41.09)***	***55.0 (48.34)***	***67.5 (54.75)***	***72.6 (62.19)***
Large (S_3)	***77.6 (50.65)***	***69.7 (60.10)***	***75.9 (64.31)***	***81.3 (67.79)***
C.D. at 1% level of significance				
Variety	**0.75**	**1.17**	**0.78**	**0.75**
Size	**0.65**	**1.01**	**0.67**	**0.64**
Variety x Size	**1.30**	**2.03**	**1.35**	**1.29**

Values in parentheses are transformed values

Table 1b: Effect of varieties and tuber size on sprouting (%) on number basis of potato during storage under room temperature conditions

Treatments	Storage period (days)			
	60	70	80	90
Kufri Badshah (V_1)				
Small (S_1)	6.9 (14.90)	12.2 (20.46)	19.3 (26.04)	40.5 (40.37)
Medium (S_2)	21.2 (27.40)	32.3 (34.60)	48.7 (44.21)	55.7 (48.23)
Large (S_3)	56.6 (48.04)	77.9 (62.20)	97.2 (80.34)	100.0 (89.40)
Mean	**28.2 (30.11)**	**40.8 (39.08)**	**55.1 (50.20)**	**65.3 (59.33)**
Kufri Bahar (V_2)				
Small (S_1)	65.5 (53.99)	83.9 (66.32)	100.0 (89.39)	100.0 (89.39)
Medium (S_2)	74.1 (59.41)	86.3 (68.25)	100.0 (89.39)	100.0 (89.39)
Large (S_3)	90.0 (71.59)	100.0 (89.40)	100.0 (89.39)	100.0 (89.39)
Mean	**76.7 (61.67)**	**90.1 (74.65)**	**100.0 (89.39)**	**100.0 (89.39)**
Kufri Pukhraj (V_3)				
Small (S_1)	48.3 (44.01)	61.8 (51.80)	67.8 (55.15)	85.5 (67.60)
Medium (S_2)	57.3 (49.17)	70.4 (57.04)	81.5 (64.50)	90.9 (72.37)
Large (S_3)	73.5 (59.90)	84.9 (66.76)	90.6 (72.08)	94.7 (77.84)
Mean	**59.7 (51.02)**	**72.4 (58.53)**	**80.0 (63.91)**	**90.4 (72.60)**
Kufri Pushkar (V_4)				
Small (S_1)	19.3 (26.05)	31.9 (34.62)	40.3 (39.35)	44.8 (42.24)
Medium (S_2)	24.0 (29.31)	39.0 (38.64)	53.4 (46.93)	58.4 (49.81)
Large (S_3)	37.4 (37.70)	55.1 (47.91)	74.7 (59.76)	79.9 (62.48)
Mean	**26.9 (31.02)**	**42.0 (40.40)**	**56.1 (48.68)**	**61.0 (51.51)**
Mean of Size				
Small (S_1)	***35.0 (34.74)***	***47.4 (43.30)***	***56.8 (52.48)***	***67.7 (59.90)***
Medium (S_2)	***44.2 (41.32)***	***57.0 (49.63)***	***70.9 (61.26)***	***76.2 (64.95)***
Large (S_3)	***64.4 (54.30)***	***79.5 (66.53)***	***90.6 (75.39)***	***93.7 (79.78)***
C.D. at 1% level of significance				
Variety	0.83	0.34	0.36	0.63
Size	0.72	0.29	0.31	0.55
Variety x Size	1.44	0.58	0.62	1.09

Values in parentheses are transformed values

214.

Selection Parameters in Bitter Gourd (*Momordica charantia* L.) for Yield and Yield Contributing Traits

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Keywords: Bitter gourd, GCV, PCV, heritability.

Introduction

Bitter gourd (*Momordica charantia* L.) is one of the important commercial cucurbitaceous vegetable cultivated in India. It has occupied third position next to onion and okra in the export trade. It is also known as bitter melon, bitter cucumber and balsam pear etc. (Morton, 1967). The crop is highly cross pollinated due to monoecy, in which a large amount of variation has been observed for most of the economically important traits. A speedy crop and product improvement can be brought about bitter gourd by assessing the genotypic and phenotypic variability, heritability and genetic advance of yield and yield components.

Materials and Methods

Materials for the study comprised of thirty accessions of bitter gourd including two check varieties i.e. Pusa Vishesh & P.D.M. The experiment was laid out in a randomized block design with three replications. Five plants were raised separately for each accession at spacing of 2.5×2m. The observations on eleven characters were recorded from all the five the plants separately for each genotype. The mean data for the design (RBD) were statistically analyzed using method given by (Pans and Sukhatme, 1967).

Results and Discussion

Analysis of variance in the experiment indicated that the genotypes evaluated differed significantly for all the eleven traits. In general magnitude of PCV (Phenotypic coefficient of variance) for all the traits were higher than the magnitude of GCV (Genotypic coefficient of variance) (Table 1) which indicated that environment influenced considerably in expression of these traits. The estimates of genotypic as well as phenotypic coefficient of variability were observed higher for node number to anthesis of first staminate flower (32.41%) followed by fruit length (24.97%), number of fruits per plant (23.88%). The estimates of heritability in broad sense (h^2_{bs}) ranged from 40.5 (days to anthesis of first pistillate flower) to 92.8 per cent (node number to anthesis of first staminate flower). Highest estimates of genetic advance in per cent of mean was recorded for node number to anthesis of first staminate flower (61.96%), fruit length (47.38%), number of fruits per plant (44.53%) and fruit yield per plant (42.01%). These characters may also provide good response to selection owing to their high transmissibility and variability and genetic advance showing additive gene effect. These characters also keep an important role in improvement of economic yield and component traits by selection in bitter gourd.

Table 1: Estimates of range, grand mean, phenotypic, genotypic, environmental, coefficients of variation, heritability in broad sense (h^2_{bs}) and genetic advance in per cent of mean ($\overline{GA}$) for eleven characters in bitter gourd genotypes

Characters	Range		Grand mean	P.C.V. (%)	G.C.V. (%)	E.C.V. (%)	Heritability broad sense (%) (h^2_{bs})	Genetic advance (5%)	Genetic advance in per cent of mean
	Lowest	Highest							
Node no. to anthesis of first staminate flower	5.43	19.40	9.69	32.41	31.22	8.70	92.8	6.00	61.96
Node no. to anthesis of first pistillate flower	10.17	22.43	13.97	19.75	18.43	7.09	87.1	4.95	35.43
Days to anthesis of first staminate flower	37.40	50.77	44.09	8.45	6.84	4.96	65.6	5.03	11.41
Days to anthesis of first pistillate flower	41.10	52.77	48.70	7.74	4.93	5.97	40.5	3.14	6.46
Days to first fruit harvest	53.03	65.43	60.15	6.88	4.82	4.91	49.0	4.18	6.95
Fruit length (cm)	9.23	24.47	17.15	24.97	23.97	7.02	92.1	8.13	47.38
Fruit diameter (cm)	2.50	4.57	3.73	12.94	11.18	6.52	74.6	0.74	19.89
Vine length (m)	1.55	3.23	2.15	18.47	17.04	7.12	85.1	0.69	32.39
Number of fruit / plant	10.27	30.27	18.40	23.88	22.72	7.35	90.5	8.19	44.53
Average fruit weight (g)	71.90	136.63	106.52	16.01	14.34	7.10	80.3	28.20	26.47
Fruit yield / plant (kg)	0.997	2.211	1.625	22.89	21.60	7.56	89.1	0.683	42.01

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215.

Pollination Compatibility among Different Apple Cultivars under Kashmir Conditions

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Introduction

The research entitled "Pollination compatibility among different apple cultivars" was undertaken in an apple orchard in Kashmir during 2014-2015. Apple was introduced in the country by the British in the Kullu Valley of the Himalayan state of Himachal Pradesh as far back as 1865, while the coloured Delicious cultivars of apple were introduced to Shimla hills of the same state in 1917. Pollination is essential preliminary step for the sexual reproduction of flowering plants including apple. Genetically apples show gametophytic self-incompatibility (Thompson and Thompson, 1992) which necessitates the pollen transfer from another pollinizer variety to set fruit in marketable quantities.

Materials and Methods

The apple cultivars (Red Delicious, Red Fuji, Red Chief, Gala Mast and Summer Red) were evaluated for their blooming period, initial bloom, full bloom, petal fall complete, petal fall flowering duration. Hand cross pollination, emasculation, pollen collection fruit set were studied for the cultivars. The fruit set was determined after 15 and 21 days of pollination and at harvest by counting the number of fruits on the selected branches to determine the final fruit retention at harvest.

Results and Discussion

Remarkable variations were observed in the phenological aspects of different varieties from the initial bloom to complete petal fall stages. Initial bloom stage was first noticed at 11 days after reference date (DARD) in the cultivar 'Red Chief' and late (21 DARD) in 'Golden Delicious' followed by 'Fenna' (19 DARD) (Table 1). The duration of flowering (initial bloom to complete petal fall) ranged from 24 days in '*Malus floribunda'* to 13 days in 'Red Delicious'. Kumar (1996) found duration of 10-17 days in different apple cultivars and suggested long flowering duration to be more useful as pollinizers. The fruit set after 15 days was highest (84.12%) with *Malus floribunda* followed by Manchurian (80.17%) and minimum (73.57%) recorded with the pollinizer Golden Delicious irrespective of the varieties. The data pertaining to fruit set (%) after 21 days of hand pollination recorded significant differences. The highest fruit set after 21 days of hand pollination was noticed with the pollen of *Malus floribunda* (81.99%) followed by Manchurian (78.50%) and 78.04 *per cent* in Fenna. The data on fruit set of hand pollinated fruits at harvest was found highest with the pollen of *Malus floribunda* (76.63%) followed by Golden Hornet (75.80%) and a minimum (61.04%) with Golden Delicious irrespective of the varieties under study.

Table 1: Phenological stages (DARD)* and flowering duration of pollinizers and the varieties under study

Treatments	Initial bloom (10%)	Full bloom (80%)	Petal fall (10%)	Complete petal fall (80%)	Flowering duration (Cpf-Ib)
Golden Delicious	21.00	26.00	32.00	36.00	15.00
Malus floribunda	12.00	19.00	30.00	36.00	24.00
Golden Hornet	16.00	22.00	30.00	35.00	19.00
Manchurian	12.00	17.00	23.00	27.00	15.00
Fenna	19.00	25.00	32.00	36.00	17.00
Red Delicious	17.00	21.00	27.00	30.00	13.00
Red Chief	11.00	16.00	22.00	26.00	15.00
Red Fuji	12.00	17.00	24.00	30.00	18.00
Gala Mast	12.00	16.00	24.00	27.00	15.00
Summer Red	14.00	19.00	24.00	30.00	16.00
C.D.($p \leq 0.05$)	1.01	1.13	1.91	0.95	1.34

(DARD)*= Days after reference date taken as 1st April.

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216.

Evaluation of Exotic Apple Varieties on M9T337 for Growth and Quality Attributes under Kashmir Conditions

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Keywords: Apple varieties, M9T337, high density, quality, yield

Introduction

Apple (Malus x domestica Borkh.) is the most ubiquitous of temperate fruits and has been cultivated in Europe and Asia from antiquity. For the temperate zone to prosper in apple, it is imperative to shift to new varieties which have both high yield potential as well as good marketability. In order to solve the problems of low productivity, poor quality, less colour and irregular bearing habits in current apple plantations in the Kashmir Valley, two apple varieties namely Super Chief Sandidge and Fuji Zehn Aztec were evaluated for various morphological and fruit characteristics at Sher-Kashmir University of Agricultural Science and Technology Kashmir (SKUAST-K) Shalimar with the objective to study the performance of newly introduced apple varieties for growth and quality attributes under high density conditions.

Materials and Methods

Two exotic varieties of apple grafted on M-9 T337 rootstock were introduced by SKUAST-K in spring 2013 from an Italian nursery, GRIBA, Italy. The plant material was one year old with 3 plus feathers. The trees of uniform size, vigour and bearing capacity were selected for experimentation located at Shalimar campus of SKUAST-Kashmir and were evaluated for various morphological and fruit characteristics. All the trees received uniform cultural practices during the year under study as per the package of practices of SKUAST-Kashmir. The experiment was laid in randomized complete block design with five replications and two trees per treatment as plot size.

Results and Discussion

Variety Super Chief Sandidge showed a minimum tree height (1.31m) compared to Fuji Zehn Aztec (1.96m). Trunk cross sectional area was recorded more in Fuji Zehn Aztec (4.70cm^2) than Super Chief Sandidge (3.72 cm^2) (Table 1). The first flower opening and end of flowering was observed earlier in Super Chief Sandidge (45.35DARD and 57.28 DARD respectively) than Fuji Zehn Aztec (47.85DARD and 60.36DARD). Fruit set percent was recorded highest in Super Chief Sandidge (62.55%) and lowest in Fuji Zehn Aztec (57.48%) (Table 1). The maximum average yield was recorded in Super Chief Sandidge (2.45kg/tree) compared to Fuji Zehn Aztec (2.05kg/tree). Fruit weight was recorded maximum in Super Chief Sandidge (193.99g) than Fuji Zehn Aztec (157.62g). As is evident from Table 1Fuji Zehn Aztec appeared to be more flat in shape (0.77) and Super Chief Sandidge round (0.87). Super Chief Sandidge showed high TSS (14.12°Brix) and low acidity (0.20%) while variety Fuji Zehn Aztec showed TSS of 12.40°Brix and acidity (0.32%) (Table 1). The study revealed that both the varieties performed well under Kashmir conditions, however the variety Super Chief Sandidge showed better performance interms of both yield and quality attributes compared to Fuji Zehn Aztec. Besides the varieties may recommended for further research, mass multiplication and ultimate adoption by the orchardists of the valley.

Table 1: Various morphological and fruit characteristics of exotic apple varieties.

Variety	Tree Height (m)	TCSA(cm^2)	First Flower Opening (DARD)	End of flowering (DARD)	Fruit set (%)	Yield (kg/tree)	Fruit weight (g)	L/D ratio	TSS (°Brix)	Total acidity (%)
Super Chief Sandidge	1.31	3.72	45.35	57.48	62.55	2.45	193.99	0.87	14.12	0.20
Fuji Zehn Aztec	1.96	4.70	47.85	62.55	57.48	2.05	157.62	0.77	12.40	0.32
CD ($p \leq 0.05$)	0.40	0.28	0.30	1.08	1.99	0.13	33.42	0.05	0.96	0.05

DARD: Days after reference date

Reference date: 1st March 2014

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Evaluation of Promising Local Selections of Sucking Type of Mango (*Mangifera indica* L.)

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Keywords: Mango, Local sucking type, evaluation, growth, yield and quality.

Introduction

Mango (*Mangifera indica* L.) belongs to family Anacardiaceae is the most popular and the choicest fruit produced in the tropical and sub-tropical regions of the world. In Jammu & Kashmir mango is grown in sub-tropical areas of Jammu, Samba, Kathua, Udhampur, Reasi, and Rajouri districts of the Jammu division. In this region, old mango plantation predominantly from seedling origin are established naturally or propagated through selected stones from meritorious indigenous mango plants on the basis of fruit quality characteristics by local fruit lover during 19th and early 20th century. Hence, the present survey was carried out to investigate the nature and assessment of genetic variability in mango seedling progenies for the most suitable cultivar for cultivation under rain-fed conditions.

Materials and Methods

The present investigations entitled "Evaluation of promising local selections of sucking type of mango (*Mangifera indica* L.) was carried out at Rainfed Research Sub-Station for Sub-tropical fruits from 2007 to 2014. Thirteen sucking type mango grown in Jammu, Samba and Udhampur districts of J&K were evaluated. Out of them, five number local sucking type of mango namely Selection-1 (Kala-Amb), Selection-2 (Jirrali-alla Barota Amb), Selection-3 (Bada Amb), Selection-4 (Jirrali-alla Kala Amb), Selection-5 (Raya Local) were planted to study growth yield and quality characteristics of mango. In order to study the fruit characteristics, ten fruits were randomly picked stored at room temperature in a basket up to proper maturity/ripening. The length and breadth of fruit was measured using vernier caliper. The weight of the samples and then the peel, pulp and stone of these fruits were separated and were weighed separately. The total soluble solids (T.S.S) of the fruit pulp was recorded with the help of Erma hand refractometer (0-32 0B). Total number of fruits harvested from each mango tree were counted and weighed on electronic balance and expressed in yield Kg/tree.

Results and Discussion

The results showed that flowering in all the mango selections starts in the 3rd week of February. The physic-chemical characteristics given in Table 1 show that maximum fruit length (7.57cm) was recorded in selection- 2 and fruit breadth (6.23cm) in selection-5. The maximum fruit weight (176.82g), pulp weight (92.72g) and stone weight (27.58g) was observed in selection -5. The quality characters showed that maximum total soluble solids (19.12°B) and total sugars (15.18 per cent) was observed in selection-1 followed by TSS (18.91°B) total sugars (14.68%) in selection-5 while, TSS (17.59°B) and total sugars (14.79 per cent) was found minimum in selection-2. The highest fruit drop was observed in selection-4 (85.40%). Most of the genotypes date of harvesting ranges from 2nd to 4th week of June.

The highest yield (85.00 kg tree^{-1}) was recorded in selection-5 (Table 1). The selection-5 also showed minimum floral malformation (7.23 per cent). On the basis of growth, yield and quality, it was concluded that out of all sucking type of mango selections, selection-5 was found to be the best for cultivation under rain-fed conditions of Jammu.

Table 1: Physico-chemical characteristics of local sucking type of mango selections

Mango sucking type	Flowering time	Yield (kg tree^{-1})	Length (cm)	Breadth (cm)	Fruit weight (g)	Pulp weight (g)	Stone weight (g)	TSS°B	Total sugars	Floral malfor-mation (%)
Selection-1	3rd week of Feb.	35.00	5.26	4.24	65.46	36.24	12.76	19.12	15.18	15.51
Selection-2	3rd week of Feb.	65.00	7.57	5.54	144.23	88.39	26.62	17.59	14.79	7.52
Selection-3	3rd week of Feb.	54.00	7.14	5.29	117.68	69.79	22.49	17.61	14.21	8.92
Selection-4	3rd week of Feb..	60.00	5.46	4.44	65.91	32.34	18.52	18.21	14.59	11.21
Selection-5	3rd week of Feb.	85.00	7.11	6.23	176.82	92.72	27.58	18.91	14.68	7.23

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Evaluation of Pomegranate (*Punica granatum* L.) Germplasm under Jammu Sub-tropics

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Keywords: Pomegranate, evaluation, yield and fruit cracking

Introduction

Pomegranate (*Punica granatum* L.) is an important fruit of tropical and subtropical regions of the world and has originated in Persia, Afghanistan and Baluchistan (De Candolle 1967). In India, its cultivation is scattered all over the country especially in Maharashtra, Rajasthan, Gujarat, Karnataka and Andhra Pradesh. Pomegranate fruits have high nutritive and therapeutic value, excellent keeping quality and high market demand. Therefore, its cultivation is most lucrative and remunerative. The subtropical region of Jammu also offers suitable climatic conditions for its cultivation. But prior to taking up its cultivation commercially, suitable cultivars for the region were to be identified. Therefore, work was undertaken to introduce and evaluate different pomegranate cultivars in Jammu subtropics to find out most suitable cultivar for this region.

Materials and Methods

To evaluate the pomegranate germplasm under Jammu subtropics, eight pomegranate cultivars namely Kandhari, Ganesh, Dholka, Bedana, Kabuli, G-137, Jalore Seedless and local selection were introduced at the Research Farm of Division of Fruit Science, Udheywalla, Sher-e-Kashmir University of Agriculture Sciences and Technology of Jammu, in 2007. The introduced varieties were planted in the field in randomized block design with each cultivar replicated thrice. Data was recorded for percent fruit cracking, average fruit weight (g) and fruit yield (kg/plant). Percent fruit cracking was calculated by dividing the number of fruit cracked with the total number of fruits on the plant multiplied by 100. Average fruit weight was calculated by dividing the total weight of ten fruits by ten for each replication. Fruit yield was calculated by weighing all the fruits at the time of harvest and expressed as kg/plant.

Results and Discussion

Table 1 reveals that among eight pomegranate cultivars, lowest incidence of fruit cracking (2.40%) was observed in Kandhari, whereas, higher fruit cracking was observed in the cultivars Ganesh (28.50%) and G-137 (28.00). Highest average fruit weight of 296g was recorded in cultivar Ganesh closely followed by 294g in G-137, 290g in Dholka and Bedana and were statistically at par with each other. However, highest fruit yield 9.80 kg/plant was observed in Kandhari followed by 9.0 kg/plant in Kabuli. The lower incidence of fruit cracking and higher yield per plant in Kandhari has also been reported by Sharma and Bist (2005). Therefore among the germplasm screened, Kandhari was found to be the highest yielding cultivar with minimum incidence of fruit cracking under Jammu sub-tropics.

Table 1: Fruit cracking (%), average fruit weight (g) and fruit yield (kg/plant) of different pomegranate cultivars

Cultivar	Fruit Cracking (%)	Average fruit weight (g)	Fruit yield (kg/plant)
Kandhari	2.40	280	9.80
Ganesh	28.50	296	8.80
Dholka	15.57	290	8.70
Bedana	12.25	290	8.40
Kabuli	9.44	274	9.00
G-137	28.00	294	8.23
Jalore Seedless	8.10	272	8.16
Local Selection	20.69	132	4.22
$CD_{0.05}$	4.50	13.35	0.46

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219.

Functional and Structural Characterization of Apocarotenoid Biosynthesis Genes in Saffron (*Crocus sativus* L.)

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Keywords: Saffron, apocarotenoids, real time PCR, promoter motifs

Introduction

Saffron (Crocus sativus) is a triploid perennial and world's highest priced cropthat contains medicinally and economically important bioactive compounds(crocetin, crocin, picrocrocin and safranal). The apocarotenoid pathway has been worked out in saffron and many of the genes involved have been identified. However, the regulation of this pathway is still not clear. Also, the information on genomics of *C. sativus* is limited except for the information on its Expressed Sequence Tags (Agostino *et al.*, 2007). Therefore, efforts are being made to understand the regulatory and functional mechanisms that may help in engineering the pathway.

Materials and Methods

The saffron plants growing under field conditions in Pampore region of Kashmir were used. Fresh leaves, petals, stamens and stigmas were separated from the whole flowers of saffron at different developmental stages for RNA isolation. The corms were also collected at different developmental stages. Total RNA from different tissue samples was extracted using Trizol reagent.First strand cDNA was synthesized. Quantitative real time Polymerase chain reaction assay was done for expression profiling of different genes. DNA was isolated from young leaves and quantified.PCR based genome walking was done for amplification of promoters of selected genes. Different bioinformatics tools were used to determine the presence of specific motifs and functional elements present in promoter region.

Results and Discussion

For gene expression studies various materials like corms and flowers of saffron at various stages of development were used (Fig. 1). Higher gene expression was observed in stigma of unopened flower followed by corm, stamen and tepal. Vegetative tissue, such as leaf, showed least or negligible expression in comparison to other tissues during all stages of development. Besides, promoters of various genes involved in carotenoid pathway have been cloned and sequence characterized.

Expression analysis of various genes involved in apocarotenoid biosynthesis pathway and knowing the promoter sequence of genes would be helpful in understanding its regulatory control and factors that can enhance the biosynthesis and accumulation of crocetin, crocin, picrocrocin and safranal, the key components associated with saffron.

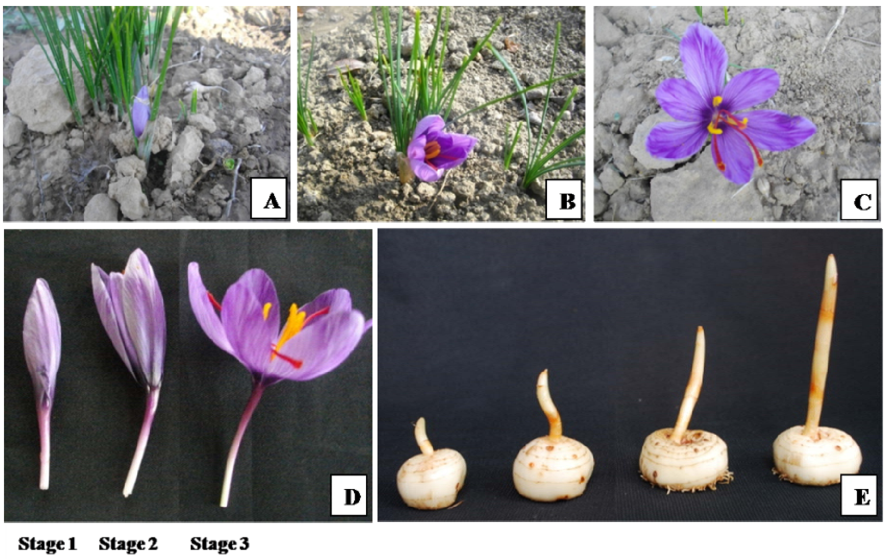

Fig. 1: Vegetative and flowering stages of saffron plant growing under field conditions. *(A) Stage1: early stage of flower (unopened, pre anthesis); (B) Stage2: mid stage of flower (partially opened, anthesis); (C) Stage3: mature stage of flower (fully opened, post anthesis); (D) Different stages of saffron flower; (E) Different developmental stages of corm*

Reference

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220.

Identification of Virulence Genes from *Venturia inaequalis* Causal Agent of Apple Scab

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Keywords: *Venturia inaequalis,* transcriptome, virulence genes

Introduction

Apple (*Malus × domestica)* is one of most important fruit crop of temperate region. Various fungal pathogens attack the crop and reduce the overall production. Of all the fungal diseases, apple scab caused by the *Venturia inaequalis* is the biggest challenge faced by apple growers all over the world. It can cause upto 70% of loss in highly infected orchards. Therefore, understanding the biology of the pathogen is very important to develop the control measures. In present study virulence associated genes from *V. inaequalis* have been identified and characterized.

Materials and Methods

Pure cultures of *V. inaequlais* were grown on the PDA slants. RNA was isolated using TRIZOL method with minor modifications. Transcriptome profiling was done using Hiseq platform.

Results and Discussion

Analysis of transcriptome was carried out (Ashburner *et al.,* 2000). Functional annotation of transcrips was analysed using Gene ontology: tool (Fig. 1). Maximum transcripts are found to have ATP binding function and oxidoreductase activity. Catalytic activities of transcripts have also been identified. Nucleus related function has also been found in top 15 functional GO annotation. About Transcripts having function related to nucleus Virulence related pathways have been identified from the transcriptome. Pathways like Transport, SNF1/AMPK pathway, Melanin biosynthesis pathway etc. have been identified. Candidate virulence genes were also found in other pathways like Amino acid biosynthesis, Calcium signaling, Calcium/calcineurin signaling pathway, cAMP/PKA pathway etc. Most of identified genes are transcription factors. This study will helpful in devising new approaches for the control of apple scab.

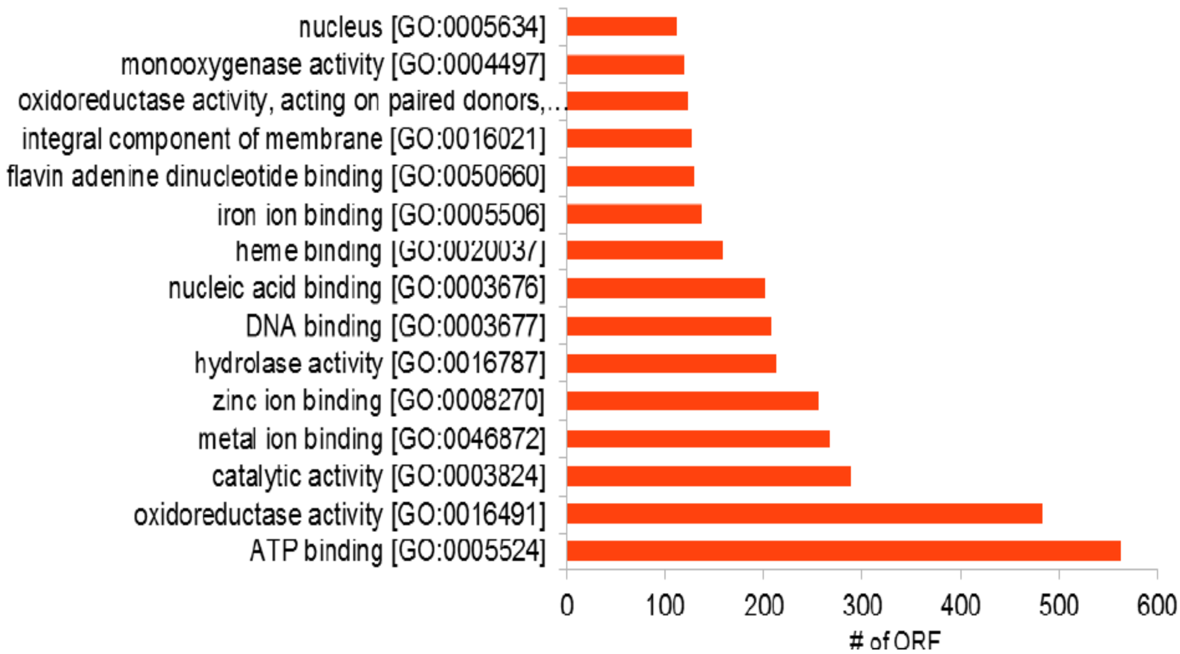

Fig. 1: Top 15 molecular function from GO annotation using transcripts

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221.

Pollination Management Research in Apple- A Case Study in Kashmir Valley

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Keywords: Inadequate pollination, apple, pollinators, pollinizers and nectar corridor

Introduction

Kashmir Valley is the apple bowl of India both in terms of area under plantations and production. It provides livelihood to lakhs of people in the valley, both on farm and off farm sector. However, from the past one decade, farmers have been recording falling yield of apple crop (up to 30-40%) due to inadequate crop pollination. Apple being the most significant cash crop among all the fruits grown in Kashmir Valley shows the gametophytic self-incompatibility giving birth to the need of pollination service in the apple-orchard system of Kashmir Valley. In apple-orchard system, three componential systems define the significance of main variety, pollinizer and pollinator. Availability of pollinizers and pollinators with the main variety's bloom, serving an important ecological service called pollination, results into the quality as well as quantity of apple (Gautier-Hion and Maisels 1994).

Materials and Methods

Field surveys were carried out in Kashmir Himalaya in 2012-2015 to display the current floristic diversity pertaining to insect pollinators diversity, abundance of pollinizers in apple orchards and conservation of insect pollinators habitat. The climate is predominantly temperate with wet and cold winters and relatively dry and hot summers. It is marked by well-defined seasonality, with four seasons a year, winter (December-February), spring (March-May), summer (June-August) and autumn (September-November). Identification of pollinators was done on the basis of recent available literature (Michener, 2007) and with the help of different insect taxonomy specialists. All the samples of identified insect pollinators and pollenizers have been placed in the laboratory of Research and Training Centre for Pollinators, Pollinizers and Pollination Management, Sher e Kashmir University of Agricultural Science and Technology of Kashmir, Srinagar, Jammu and Kashmir (India)

Results and Discussion

The collection of different types of pollinators belonging to different insect orders was carried out from 90 randomly selected orchards of three main apple growing districts namely Shopian, Pulwama and Baramulla on warm sunny days between 10: 0 am and 2: 0 pm during peak bloom. The bees visiting apple blossoms were netted. The insects collected were killed with ethyl acetate, pinned, stretched and placed in specially designed boxes. The specimens were identified with the help of the relevant literature and specialists in India and abroad. After thorough identification, the pollinators were found to belong to three insect orders with 9 families, 21 genera and 38 species (Table 1).

The studies were carried out in 30 orchards, with 10 orchards per district for identification of native pollinators. The nests of soil dwelling pollinators were identified. The nests were observed to be 9 to 12 cm deep in the ground. Two types of interventions were made for habitat management of soil dwelling pollinators in farmers' field with: Placement of circular mud mounds of 13 inch diameter and 18 inch depth and placement of wooden hollow blocks and reeds

The study revealed that there was an increase in the population of soil dwelling bees like *Lassiogglossum* and *Andrena* bee and in case of wood dwelling bees *Megachile* and *Osmia* showed an impressive population increase in the farmers' field.

A questionnaire was framed to gather information regarding pollination in three districts. The results revealed that percentage awareness in three districts regarding pollination (2-3%), ≤1% pollenizers are used in apple orchards and 98% follow monoculture of growing Red Delicious cv.

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Table 1: List of identified insect pollinators on apple in Kashmir Himalaya

Species	Genus	Family	Order
Xylocopa valga	*Xylocopa*	Apidae	Hymenoptera
Xylocopa violacea	*Xylocopa*	Apidae	Hymenoptera
Bombus simillmus	*Bombus*	Apidae	Hymenoptera
Bombus tunicatus	*Bombus*	Apidae	Hymenoptera
Bombus trifasciatus	*Bombus*	Apidae	Hymenoptera
Amegilla fallax (Smith)	*Amegilla*	Apidae	Hymenoptera
Apis cerana Fabricius	*Apis*	Apidae	Hymenoptera
Apis mellifera Linn.	*Apis*	Apidae	Hymenoptera
Lassioglossum himalayense Bingham	*Lassioglossum*	Halictidae	Hymenoptera
Lassioglossum nursei Blüthgen	*Lassioglossum*	Halictidae	Hymenoptera
Lassioglossum rugolatum Smith	*Lassioglossum*	Halictidae	Hymenoptera
Lassioglossum polyctor Bingham	*Lassioglossum*	Halictidae	Hymenoptera
Lasioglossum marginatum Brullé	*Lassioglossum*	Halictidae	Hymenoptera
Lasioglossum sublaterale Blüthgen	*Lassioglossum*	Halictidae	Hymenoptera
Lasioglossum leucozonium Schrank	*Lassioglossum*	Halictidae	Hymenoptera
Halictus constrictus Smith	*Halictus*	Halictidae	Hymenoptera
Halictus (*Seladonia*) *propinquus* Smith	*Halictus*	Halictidae	Hymenoptera
Sphecodes tantalus Nurse	*Sphecodes*	Halictidae	Hymenoptera
Sphecodes lasimensis Blüthgen	*Sphecodes*	Halictidae	Hymenoptera
Andrena patella Nurse	*Andrena*	Andrenidae	Hymenoptera
Andrena cineraria Linn.	*Andrena*	Andrenidae	Hymenoptera
Andrena floridula Smith	*Andrena*	Andrenidae	Hymenoptera
Andrena flavipes Panzer	*Andrena*	Andrenidae	Hymenoptera
Ceratina hieroglyphica	*Ceratina*	Ceratidae	Hymenoptera
Ceratina propinqua	*Ceratina*	Ceratidae	Hymenoptera
Anthidium conciliatum	*Anthidium*	Megachalidae	Hymenoptera
Megachile conjuncta	*Megachile*	Megachalidae	Hymenoptera
Megachile rotundata	*Megachile*	Megachalidae	Hymenoptera
Heriades spp.	*Heriades*	Megachalidae	Hymenoptera
Athalia proxima	*Athalia*	Tenthredinidae	Hymenoptera
Metasyrphus bucculatus	*Metasyrphus*	Syrphidae	Diptera
Sphaerophoria bengalensis	*Sphaerophoria*	Syrphidae	Diptera
Episyrphus balteatus	*Episyrphus*	Syrphidae	Diptera
Eristalodes paria	*Eristalodes*	Syrphidae	Diptera
Eristalis tenax	*Eristalis*	Syrphidae	Diptera
Eoseristalis cerealis	*Eoseristalis*	Syrphidae	Diptera
Pieris brassicae	*Pieris*	Pieridae	Lepidoptera
Vanessa cashmirensis	*Vanessa*	Nymphalidae	Lepidoptera

222.

Screening Methods to Detect Apomixis in *Allium tuberosum* and Use of This Reproductive Mode in Crop Improvement

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Keywords: Apomixis, *Allium tuberosum*

Introduction

Apomixis allows clonal reproduction through seed and results in the offsprings that are genetically identical to the mother plants. If the apomixis is harnessed, it would allow fixation of desired genotypes including F1 hybrids, resulting in great economical benefits. Identifying sources of apomixis require reliable methods to screen the mode of reproduction. The methods used for screening apomixis in *Allium tuberosum* are discussed in the paper.

Materials and Methods

The present work was initiated on few plants growing in Botanical Garden of University of Jammu. Chromosome count was determined from the somatic cells. For studying reduction division in embryosac mother cells, young inflorescences were fixed in carnoy's fluid for 24 hours followed by preserving in 70% ethanol. Meiosis in embryosac mother cells was studied by hydrolysing ovaries in 1N HCL at 60 degree followed by staining in feulgen for 15-20 minutes. Ovules were dissected and squashed in 1% acetocarmine.

Results and Discussion

Cytomorphological studies carried out on the basic stock of *Allium tuberosum* pointed that this species is nearly autotetraploid and sets on an average 54 seeds per inflorescence (seed germination=72%), though the variations exist with regard to number of seeds per fruit (Table 1)

Table 1: Number of seeds per fruit in 130 fruits scanned randomly

Number of seeds per fruit	Number of seeds per fruit	% age
1	24	18.46
2	51	39.23
3	33	25.38
4	14	10.76
5	08	6.15

High seed fertility in an autotertraploid was first indicator pointing towards apomixis. For determining the type of apomixis, embryosac mother cells of parent plants were studied for reduction division. Occurrence of majority of embryosac mother cells (91%) with 64 chromosomes that form 32 bivalents at metaphase I or exhibit 32: 32 segregation at anaphase I indicated that the diplospory is operative in this species. For studying the extent of formation of zygoid number of chromosomes in embryosac mother cells, progeny of 68 plants was raised from the seed harvested from the basic stock and studied for morphological descriptors, chromosome count and meiosis in female track. While the latter studies indicated that the species is strongly apomictic, isolation of aneuploids amongst the seed progeny indicated that the species is also able to reproduce sexually. Such type of facultative apomicts are benefitted with short term fitness of suitable genotype and long term future as these can switch between asexual and sexual modes of reproduction and can remain evolutionary active.

223.

Evaluation of Different Substrates for Spawn Production of 'Pink Pleurotus' [*Pleurotus Djamor* (Rumph. ex. Fr.) Boedijn] Mushroom

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Keywords: Evaluation of Substrates, Pink Pleurotus (*Pleurotus djamor*), Spawn preparation.

Introduction

Mushrooms often called as 'Queen of vegetables', are in fact a group of higher fungi, belonging to the class Basidiomycetes or Ascomycetes. More than 2000 edible mushrooms have been reported throughout the world while in India 283 have been recorded and eight are being cultivated commonly. 'Pink Pleurotus'is edible mushroom containing high protein and low fats, essential amino acids, vitamins and mineral elements needed by human body. Mushrooms are commonly grown on pasteurized wheat or rice straw. However, they can be cultivated on a wide variety of lignocellulosic substrates, playing an important role in managing organic wastes whose disposal could otherwise be problematic.

Materials and Methods

All the substrates was washed 2-3 times with tap water and boiled in water for 15 minutes and excess water was drained out by spreading upon wire mesh under shade. The substrates were then mixed with 2% mixture of calcium carbonate and calcium sulphate (1: 4 ratio) after cooling of grains. The grain mixture was filled in narrow mouthed glass bottles upto $3/4^{th}$ of their capacity and plugged with non-absorbent cotton. All the substrates were autoclaved and then after cooling down at room temperature they were inoculated with pure culture of 'Pink Pleurotus' under aseptic conditions of laminar air flow cabinet. The inoculated bottles were incubated at 25±2°C.

Results and Discussion

Barley grains resulted in highest spawn weight (30.30g) followed by maize grains (28.00g). The spawn weight in maize de-shelled cob and dried pea grains was 22.40 and 20.30 g, respectively (Table 1). The spawn colour and textures on different substrate showed slight variation and while the spawn colour ranged from 'Delicate Pink' to 'Grace full Pink', spawn texture ranged from 'Creepy' to 'Fluffy' (Table 1). Spawn colour on all other substrates *viz*., wheat grains, barley grains and maize grains, was 'Grace Full Pink' with 'Fluffy' texture. The spawn smell on all the substrates was pleasant. All the substrates supported the growth of *Pleurotus djamor* and were found suitable for spawn production of *Pleurotus djamor* However barley grains followed by maize grains showed highest in weight of spawn and less numbers of days taken for complete spawn run when compared with check wheat grains of *Pleurotus djamor.*

Table 1 Effect of different substrates on spawn run, weight, colour, texture, smell and pH of spawn of 'Pink Pleurotus'

Substrates	Complete spawn run (days)	Weight of spawn (g)	Colour	Texture	Smell	Mean pH
Barley grains	6.90	30.30	Grace full pink	Fluffy	Pleasant	7.35
Dried peas grains	10.10	20.30	Merrie pink	Cottony	Pleasant	7.57
Maize de-shelled-cob	11.80	22.40	Delicate pink	Creepy	Pleasant	8.11
Maize grains	7.20	28.00	Grace full pink	Fluffy	Pleasant	7.18
Wheat grains (check)	8.00	27.40	Grace full pink	Fluffy	Pleasant	7.34
S.E (d)	0.275	0.21				0.047
C.D (p≤0.05)	0.555	0.42				0.096

224.

Increase the Efficiency of Potato Seed Production by Increasing the Number of Harvested Tubers

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Keywords: *In-vitro* plantlets, multiple harvest, grading

Introduction

Potato is conventionally vegetatively propagated and is subjected to seed borne diseases and built up of viruses, which consequently decline its multiplication rate. Production of micro-tubers through micro-propagation has been useful as a complementary method for the clonal multiplication of pathogen-free plants. By using *in-vitro* method large scale production of plantlets is possible that can directly be used in field as a substitute to tuber seed. If more than one harvest are possible *in-vitro* developed from such plants, more production of seed tuber can be obtained, unlike to the conventional potato production method in which tubers are used as seed and only single harvest is practiced.

Materials and Methods

Investigation was carried out in potato cultivar Kufri Himalini to increase the efficiency of seed production by increasing the number of tubers by two harvests from *in-vitro* grown plants. The study was carried out at Seed Science Research Block and Tissue Culture Section, College of Forestry and Hill Campus, Ranichauri, during 2010-2011. *In-vitro* plantlets hardened for 10 & 30 days (10-P&30-P) were planted in summer 2010 and harvested twice (H1 at 3 months and H2 for 4 months) viz. a- viz. control (C at 4 months). Interpretation of the results was based on "Z-test" at 0.05 level of significance

Results and Discussion

In-vitro plantlets of uniform length (16.25cm) were hardened in polyhouse for different time periods i.e.10 days and 30 days. The increase in height of plantlets recorded at every 10 day interval. Final height attained in 10 days hardened (10-P) and 30 days hardened (30-P) plantlets was 8.25cm and 14 cm, respectively. The in-vitro plantlets hardened in polyhouse were transplanted in field. Tubers were harvested after 90 and 120 days of transplanting in case of P-H1 and P-H2, respectively, *viz. a-viz.* control (P-C) after 120 days. After each harvest tubers were graded into 6 grades (G1 through G6) on the basis of individual tuber weight. The tubers in H1+H2 of 10-P (750) and 30-P (1266) were 217% &184% higher, respectively, than their respective controls. Weight of H1+H2 of 10-P (16.244kg) and 30-P (29.887kg) were also 105% & 140% higher than their respective controls. The performance of 30-P was proven to be better than 10-P because weight (24.155kg) and number (1266) of tubers was higher in 30-P-H1 +H2 as compared to 9.327kg and 750 number in 10-P-H1+H2. Harvested tubers were graded in 6 groups based on weight and tubers in G2, G3 and G4 (5 to 35g) contributed 69% in 10-P &58% in 30-P. By two harvests (H1+H2) from *in-vitro* plantlets more number of suitable seed grade could be obtained. Diameter in all grades of H2 was smaller than respective values of control indicating that the size of tuber in H2 harvest was smaller than control because additional H1 harvest had already been obtained from those plants. In fact big size of tubers obtained in control was not desirable. The data revealed that grade wise number of eyes increased gradually. Average number of eyes ranged between 1.6 to 4.9 in H1, 1.8 to 4.7 in H2 and 2 to 4.7 in control in both 10-P and 30-P harvests. However the values for average number of eyes recorded in H1-G1 in both 30-P and 10-P was a bit higher than rest of the groups. It was likely that the higher number of eyes during very early growth phase could have been due to the fact that in-vitro grown plantlets were used.

Table 1: Number of tubers of different harvests collected from 10 and 30 day hardened plantlets

Treatments	Number of tubers (60 plants)	
	10 day hardened plantlets(10-P)	30 day hardened plantlets(30-P)
P-H1	297	551
P-H2	453	715
P-H1+P-H2	750	1266
P-C	346	689

Table 2: Weight of tubers of different harvests collected from 10 and 30 day hardened plantlets

Treatments	Total weight of tubers(kg) (60 plants)	
	10 day harden plantlets (10-P)	30 day harden plantlets (30-P)
P-H1	6.917	5.732
P-H2	9.327	24.155
P-H1+P-H2	16.244	29.887
P-C	15.447	21.419

By using *in-vitro* method large scale production of plantlets is possible that can directly be used in field as a substitute to tuber seed. If more than one harvest are possible *in-vitro* developed from such plants, more production of seed tuber can be obtained, unlike to the conventional potato production method in which tubers are used as seed and only single harvest is practiced.

225.

Effect of Girdling and Growth Regulators Application on Fruit Quality and Yield of Pear cv. Punjab Nectar

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Keywords: Pear, girdling, growth regulator, fruit quality

Introduction

Pear is one of the important temperate fruit crop next only to apple, it is placed in the family Rosaceae, sub-family Pomoideae, along with apple and quince. The Asian pear (*Pyrus pyrifolia* (Burm) Nakai) was originated in China, where its cultivation dates back to 2500-3000 years. A temperature range of 27°C to 33°C in summer and winter temperature of 7°C or below for 2-3 months is very congenial for most of the English and Chinese varieties of pear (Nauriyal and Prakash, 1990).

Semi soft cultivar of pear like Baggugosha and Le Conte which are popularly grown in lower hilly areas are shy and irregular bearer. New strains of semi soft pear like Punjab Beauty, Punjab Gold, Punjab Nectar and Punjab Soft collected from indigenous and exotic sources approved by Punjab Agriculture University, Ludhiana are gaining popularity amongst the orchardists of Punjab in the low chilling pear growing areas. The fruit of semi soft pear has good flavour and on ripening it becomes more acceptable and thus sells at a premium than Patharnakh. Girdling of pear fruit tree trunks is a practice used in order to control the excessive vegetative growth in fruit trees and consequently enhance yield by increasing fruit set, fruit size or both (Smit *et al.,* 2005). The growth regulators which modify the canopy structure and other yield attributes. To get maximum benefits from the crop, it is indeed a requirement to study the effect of different mechanical and chemical treatments on productivity and quality of semi soft pear cultivars.

Keeping above facts in mind, the experiment was planned to judge the effect of girdling and different growth regulators on the fruit quality and yield of newly recommended semi soft pear cv. Punjab Nectar.

Materials and Methods

The present experiment was conducted in the Punjab Government Progeny Orchard and Nursery, Attari, Amritsar on 15 years old soft pear (Punjab Nectar) trees during the fruiting year 2012. The experimental pear trees were applied with uniform cultural practices as per recommendations of PAU Ludhiana.

The experimentation consisted of trunk girdling, branch girdling, Naphthalene Acetic Acid 20 ppm and GA_3 (10, 20 and 30 ppm). The girdling was performed during the dormant period; NAA was applied at full bloom whereas GA_3 was superimposed after one week of the application of NAA. The treatment comprised T1 (Trunk Girdling + 20 ppm NAA + 10 ppm GA_3), T_2 (Trunk Girdling + 20 ppm NAA + 20 ppm GA_3), T_3 (Trunk Girdling + 20 ppm NAA + 30 ppm GA_3), T4 (Trunk Girdling + Water Spray), T_5 (Main Branch Girdling + 20 ppm NAA + 10 ppm GA_3), T_6 (Main Branch Girdling + 20 ppm NAA + 20 ppm GA_3), T_7 (Main Branch Girdling + 20 ppm NAA + 30 ppm GA_3), T_8 (Main Branch Girdling + Water Spray), T_9 (Ungirdling + 20 ppm NAA + 10 ppm GA_3), T_{10} (Ungirdling + 20 ppm NAA + 20 ppm GA_3), T_{11} (Ungirdling + 20 ppm NAA + 30 ppm GA_3) and T_{12} (Control (Ungirdling + Water Spray). Growth, yield and physio-chemical parameter were estimated. The data was statistically analyzed by method of analysis of variance using RBD as described by Panse and Sukhatme (1989).

Results and Discussion

Effect of girdling and growth regulators application on fruit set, fruit yield, length, fruit breadth and fruit weight in fruits of pear cv. Punjab Nectar

Treatments Code	Fruit set (%)	Fruit yield (kg)	Fruit length (cm)	Fruit breadth (cm)	Fruit weight(g)
T_1	13.80	69.00	7.80	6.30	180.00
T_2	14.60	73.00	8.00	6.70	185.30
T_3	15.40	77.00	8.40	7.00	191.00
T_4	13.00	65.00	8.00	6.40	182.00
T_5	16.60	83.00	8.00	6.73	188.00
T_6	17.60	88.00	8.50	7.10	195.00
T_7	18.40	92.00	9.00	7.50	200.00
T_8	15.60	78.00	8.20	6.65	185.30
T_9	13.00	67.00	7.60	6.00	170.00
T_{10}	13.60	68.00	7.80	6.40	175.30
T_{11}	14.60	73.00	8.10	6.50	178.00
T_{12}	12.00	60.00	6.50	5.90	158.00
Mean	14.85	74.25	7.99	6.59	182.33
CD (at 5% level)	1.24	6.20	0.82	0.72	16.45

Treatment T_7 caused a significant improvement on fruit set data and the crop yield per tree. Maximum fruit set (18.40%) with fruit yield of 92 kg per plant were recorded. Fruit size in terms of length and breadth experienced an increase in growth regulators treatment along with girdling and minimum in control. There was a significant increase in fruit weight with treatment T_7. Minimum specific gravity was recorded in fruit of plants treated with 20 ppm NAA + 10 ppm GA_3. The best fruit colour i.e. bright yellowish green was observed in fruits obtained from branch girdled trees (i.e treatment T_8). Growth regulators alongwith branch girdling found to decrease in the fruit firmness. Highest juice percent (75.16%) was recorded under treatment T_7, which was found to be significant to all the other treatments. The application of growth regulators (GA_3 and NAA) at 30 ppm alongwith branch girdling proved to be highly effective in improving the qualitative characters like TSS, TSS: acid ratio, reducing sugars and total sugars and in minimizing the acidity level of fruit.

The finding of the present study reached to the conclusion that soft pear cv. Punjab Nectar trees highly respond to the application of 30 ppm GA_3 and branch girdling for improving the crop yield of superior quality fruits under Amritsar conditions of Punjab. There was no negative effect on the tree health in girdling treatments. The study leaves the scope to continue this for at least three consecutive years so as to formulate the recommendations to be used by the fruit growers of Punjab.

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226.

Effect of Different Herbicides on Growth, Yield and Quality Parameters of Kinnow

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Keywords: Growth, herbicides, kinnow, quality, yield

Introduction

There are many factors which condense the production of citrus plants and weeds are one of them which lessen the production of kinnow, a mandarin hydrid (*Citrus nobilis* Lour. *X Citrus deliciosa* Tan.). Weeds in the orchards fight with trees for nutrients, water and light resulting in stressed plant and poor fruit quality and yield. Weeds reduce the crop production and contribute in future problems through constant increase in weed seed banks. Chemical control of weeds in citrus was reported to affect various physical and chemical properties and quality of fruits. The weed density can affect the vegetative growth, fruit yield and critical periods.

Materials and Methods

The experiment was laid out in randomized block design with 9 herbicidal treatments namely atrazine 2 kg, glyphosate 1%, paraquat 0.6%, atrazine 1 kg + glyphosate 1%, atrazine 1 kg + paraquat 0.6%, atrazine 2 kg + glyphosate 1%, atrazine 2 kg + paraquat 0.6%, manual weeding at monthly interval and control (unweeded check). Plant girth, fruit length and breadth were measured with the help of digital Vernier Calipers. Plant spread was determined by measuring distance between point to which most of the branches of the tree had grown in the east-west and north-south direction. The height of the tree was measured with the help of measuring pole up to the maximum point of height. The leaf water potential was determined by pressure chamber apparatus. The Total Soluble Solids (TSS) of the representative fruit juice was determined by using hand refractometer. The titratable acidity and ascorbic acid was determined as per the method given by AOAC (1990).

Results and Discussion

Data given in Table 1 clearly indicates that the TSS, acidity, ascorbic acid and juice content were significantly influenced by various weed control treatments. The maximum TSS and minimum acidity was recorded with manual weeding at monthly interval followed by atrazine 1 kg + glyphosate 1% and minimum TSS and maximum acidity was recorded in control. The highest ascorbic acid and juice content was observed in manual weeding at monthly interval treatment followed by atrazine 2 kg + paraquat 0.6% and lowest was recorded in control.

The improvement in fruit quality with various herbicidal treatments may be due to reduced weed growth as compared to control. The nutrients and the moisture availability in sufficient quantity also help in improving the quality of fruits as compared to untreated plot.

Table 1: Effect of various herbicidal treatments on quality parameters of kinnow

Treatments	TSS (°B)	Acidity (%)	Ascorbic acid (mg/100g)	Juice content (%)
Atrazine 2 kg	7.90	0.89	35.74	43.26
Glyphosate 1%	8.00	0.87	38.29	46.77
Paraquat 0.6%	7.90	0.88	37.00	44.40
Atrazine 1 kg + glyphosate 1%	8.30	0.84	39.57	49.52
Atrazine 1 kg + paraquat 0.6%	8.07	0.86	38.82	47.86
Atrazine 2 kg + glyphosate 1%	8.37	0.79	41.23	51.78
Atrazine 2 kg + paraquat 0.6%	8.33	0.81	40.76	50.77
Manual weeding at monthly interval	8.50	0.78	42.37	52.27
Control (Unweeded check)	7.80	0.91	33.87	42.13
SE(m)±	0.06	0.01	0.38	0.47
C.D. at 5%	0.19	0.03	1.16	1.41

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In Vitro Mass Multiplication and Genetic Fidelity Assessment of *Asparagus adscendens* Roxb

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Keywords: *Asparagus adscendens* Roxb., *Direct regeneration, Rhizome explants*

Introduction

Asparagus adscendens have medicinal usage in treating spermatorrhoea, chronic leucorrhoea, diarrhoea, dysentery, senile pruritus, asthma and fatigue insulin-enhancing activity. The plant is not commercially grown, so availability of planting material is scanty. Because of its significant properties, it has been over exploited, which in turn has led to its inclusion in the list of threatened plant species. Unlike other extensively studied *Asparagus* species, there is single report of *in vitro* micro-propagation of *A. adscendens* using nodal explant (Mehta and Subramanian, 2005) but still there is no report on micro-propagation using rhizome explants. Hence, the study was taken to develop a protocol for *in vitro* propagation of *A. adscendens* using rhizome explants.

Materials and Methods

Plants of *Asparagus adscendens* Roxb. were collected from wild as well as from the fields of medicinal plants. Rhizome explants were excised and surface sterlized. Explants were established, shoot multiplied and in-vitro rooting was achieved on Murashige and Skoog medium with varying concentrations of auxins and cytokinins. The experiments were conducted in a completely randomized design (CRD). The data recorded on different parameters were subjected to analysis of variance (ANOVA) using CRD. A total of 10 RAPD and 10 ISSRs marker were used to check the genetic similarity of in vitro grown plant with mother plant.

Results and Discussion

Rhizome explants were surface sterilized by the treatment of 3% NaOCl for 2 minutes followed by a combination of fungicides (2% bavistin+2% mancozeb) for 20 minutes along with 0.1% $HgCl_2$ for 2 min and this treatment resulted in 88.33% uncontaminated cultures. The optimum concentration for establishment and proliferation of rhizome explant cultures was 0.2 mg/l 6-Benzylaminopurine (BAP) with 0.2 mg/l Kn which showed highest number of explants inducing shoots (9.00), number of shoots per explants (4.67) with multiplication rate of 3.50 per cent. High frequency of rooting 63.80% was obtained in regenerated shoots of length 3-4 cm on half strength MS medium supplemented with 1.0 mg/l Indole-3- butyric acid (IBA) (Table 1 and Fig. 1) and out of 10 Random amplified polymorphic DNA markers and out of 10 Inter simple sequence repeats (ISSR) 7 gave amplification. All the primers gave clear and distinct monomorphic bands and negligible polymorphism was detected during the marker analysis of micro propagated and *in vitro* conserved clones. Banding pattern of micro-propagated plants was similar to those of the mother plant.

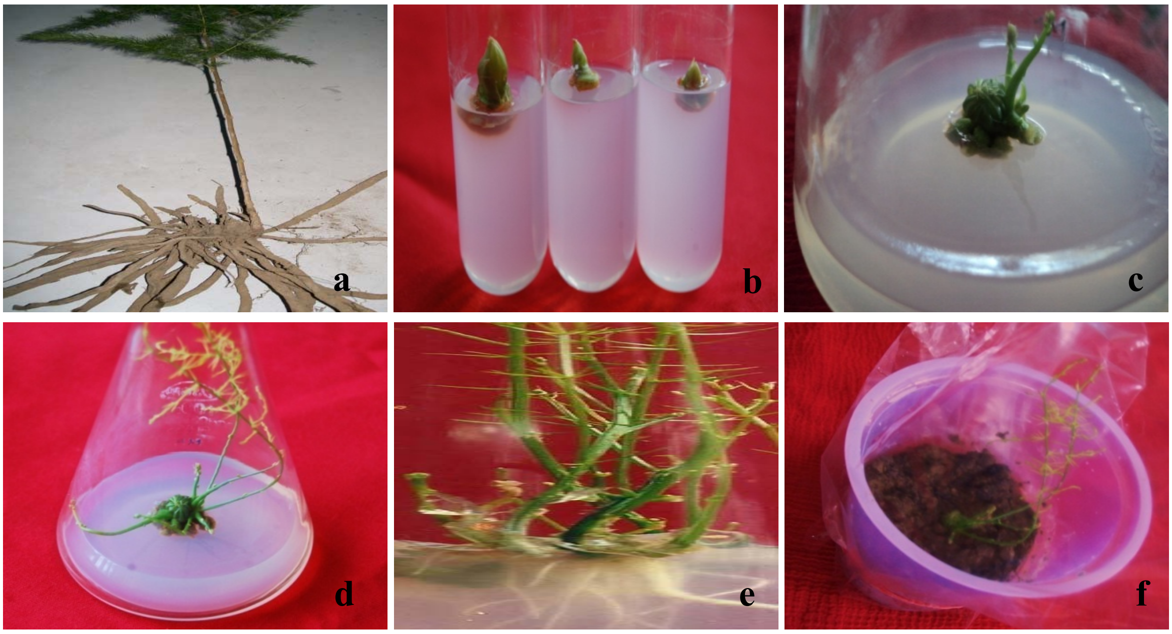

Fig. 1: In vitro plantlet regeneration from rhizome explants of Asparagus adscendens Roxb a.) Source of rhizome explant b.) Rhizome explant cultured on regeneration medium c.) In vitro establishment of cultures d.) In vitro shoot multiplication e.) Rooting in in vitro established cultures f.) Hardening of in vitro raised plantlets.

Table 1: ***In vitro*** **root regeneration on half strength MS medium supplemented with IBA and ancymidol**

Medium Composition	Percent rooting	No. of roots	Root length
1/2MS	0.00 (0.00)	0.00 (1.00)	0.00 (1.00)
1/2MS+0.1mg/l IBA	0.00 (0.00)	0.00 (1.00)	0.00 (1.00)
1/2MS+0.2mg/l IBA	0.00 (0.00)	0.00 (1.00)	0.00 (1.00)
1/2MS+0.3mg/l IBA	0.00 (0.00)	0.00 (1.00)	0.00 (1.00)
1/2MS+0.4mg/l IBA	0.00 (0.00)	0.00 (1.00)	0.00 (1.00)
1/2MS+0.5mg/l IBA	13.70 (21.70)	2.80 (1.94)	3.33 (2.08)
1/2MS+0.6mg/l IBA	16.16 (23.68)	3.16 (2.04)	3.20 (2.04)
1/2MS+0.7mg/l IBA	21.70 (27.75)	3.13 (2.03)	3.16 (2.04)
1/2MS+0.8mg/l IBA	26.20 (30.77)	3.13 (2.03)	3.43 (2.10)
1/2MS+0.9mg/l IBA	35.60 (36.61)	3.20 (2.04)	3.66 (2.16)
1/2MS+1.0mg/l IBA	51.96 (46.10)	3.50 (2.12)	3.76 (2.18)
1/2MS+1.5mg/l IBA	47.26 (43.41)	3.43 (2.10)	3.66 (2.16)
1/2MS+2.0mg/l IBA	44.60 (41.88)	3.40 (2.09)	3.66 (2.16)
1/2MS+1.0mg/l IBA+0.1mg/l Ancymidol	59.60 (50.51)	3.73 (2.17)	3.86 (2.20)
1/2MS+1.0mg/l IBA+0.2mg/l Ancymidol	63.03 (52.54)	3.63 (2.15)	4.00 (2.23)
1/2MS+1.0mg/l IBA+0.3mg/l Ancymidol	63.80 (53.01)	3.63 (2.15)	4.33 (2.30)
1/2MS+1.0mg/l IBA+0.4mg/l Ancymidol	61.80 (51.80)	3.60 (2.14)	4.06 (2.25)
1/2MS+1.0mg/l IBA+0.5mg/l Ancymidol	60.60 (51.10)	3.60 (2.14)	4.10 (2.25)
CD	2.69 (1.63)	0.25 (0.06)	0.18 (0.04)
SE	0.93 (0.56)	0.09 (0.02)	0.06 (0.01)

Reference

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Maturity Indices of Aonla Cultivars under Rainfed Conditions of Shivalik Foothills of Himalayas

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Keywords: Aonla, maturity indices, rainfed condition

Introduction

In India, aonla (*Emblica officinalis* Gaertn) is cultivated on a commercial scale in Uttar Pradesh, Maharashtra and Gujarat. It is highly nutritious and claimed to be the 2nd richest source of vitamin-C. Aonla is a minor sub-tropical fruit; the importance of this economically viable fruit is understandable because of low cost of cultivation and better economics returns. It is harvested by farmers on the basis of visual characters. In order to determine the appropriate stage of maturity it is pertinent to study the maturity indices of different cultivars in Jammu conditions. Maturity standards of aonla fruits working under Jammu conditions have been determined.

Materials and Methods

The present investigation was carried out at Rainfed Research Sub-Station for Sub-tropical fruits, Raya, Jammu and Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu during 2012 and 2013. The experimental field is situated at an elevation of 332 m above mean sea level and lies between 32°39" North latitude and 74°53" East longitude. The mean annual rainfall is about 1000-1200 mm. Soil of the experimental field was sandy clay in texture, having pH: 6.50, organic carbon: 0.50%, available N: 174.50 kg/ha, available P: 15.80 kg/ha and available K: 140.00 kg/ha. The study was conducted with six commercially important aonla cultivars, viz. Banarasi, Chakaiya, Neelam, Francis, Kanchan and Desi. The experiment was conducted on the layout of randomized block design, wherein one tree each of the six cultivars form one replication and there were three replications per cultivar. The observations on each of 2 sample trees within each cultivar and replication were recorded. Length and diameter of fruits were taken with the help of vernier callipers. The fruit weight on electronic balance. Chemical analysis such as total soluble solids (TSS) of aonla fruits were determined with the help of hand refractometer. The acidity of the aonla fruits was determined by the procedure given by (Ranganna, 2003). Total acid content was estimated by titrating sample against 0.1 N NaOH using phenolphthalein as an indicator. The ascorbic acid content was determined by AOAC (2004).

Results and Discussion

The perusal of data in Table 1 on average fruit weight of different aonla cultivars indicates that Cultivar Neelam had maximum fruit weight of 41.46 g followed by Banarasi (36.42 g) while Desi aonla had a minimum weight of 13.6 g (Table 1). Increase in fruit weight in Neelam may be due to more activeness of monocarp cells which enlarge during fruit development. A wide variation in the length and diameter were found under different varieties, where it ranged from 2.64 to 3.73 cm and 2.84 to 4.42 cm, respectively in Desi to Neelam varieties. These observations are in line with. TSS of 12.20°B followed by Neelam (10.73°B) and lowest TSS of 9.90°B was noted in Chakaiya variety. Significantly higher acid content was observed in cultivar Desi (2.08%), whereas it was lowest in Neelam (1.64%). The maximum TSS: acid ratio was obtained in cultivar Neelam (6.54) and minimum in Chakaiya (5.00). The vitamin-C content of aonla cultivar varied from 480.20 to 596.03 mg/100g pulp. The maximum vitamin-C content was recorded in Neelam (596.03 mg/100g) and it was significantly higher than all other cultivars. It was followed by Banarasi and Kanchan which recorded vitamin-C content of 584.00 mg/100g and 580.13 mg/100g, respectively. Minimum vitamin-C content of 480.20 mg/100g was recorded in Desi.

Table 1: Fruit weight, fruit length, fruit diameter, and specific gravity of different aonla cultivars (Pooled data of 2 years)

Cultivar	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	TSS	Acidity (%)	TSS: acid ratio	Vitamin-C mg/100g fruit
Banarasi	36.42	3.62	4.34	10.69	1.78	6.01	584.00
Chakaiya	31.00	3.48	4.22	9.90	1.98	5.00	563.45
Neelam	41.46	3.73	4.42	10.73	1.64	6.54	596.03
Francis	33.12	3.54	4.27	10.19	1.95	5.22	571.15
Kanchan	35.14	3.58	4.31	10.42	1.90	5.48	580.13
Desi	13.61	2.64	2.84	12.20	2.08	5.86	480.20
CD $_{(-0.05)}$	3.85	0.27	0.12	0.32	0.16	1.21	2.16

Reference

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Poly-tunnel Technology: An Affordable Method for Early Season Production of Bottle Gourd

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Keywords: Growing condition, harvest index, poly-tunnel, split plot design, transplanting

Introduction

Cucurbits are generally raised in open as spring, summer and rainy season crop. The fruits remain available from April to November, which leads to market glut and price crash problem in the main season. In north India, cold winter and danger of frost are the main hindrances to get sowing of an early crop. Poly tunnel creates a favourable microclimate around the crops by increase in temperature and entrapment of carbon dioxide (Principle of green house effect), thereby enhancing the germination and photosynthetic activity of the plants and hence the yield. These structures also protect the plants from frost, pest, high winds and rains.

Materials and Methods

Experiment was laid out in split plot design replicated thrice with five different dates of sowing *i.e.* 15th December, 30th December, 15th January, 30th January, 15th February and three different growing conditions [direct seed sowing under straw mulch, direct seed sowing under poly-tunnel, transplanting of seedlings under poly-tunnel]. Thus, making a total of fifteen treatment combination. Parameters recorded were lowest node at which first female flower appeared, number of fruits per vine, early fruit yield, total fruit yield and harvest index. Mean values of different recorded characters were used for statistical analysis. The significance of treatment differences was tested at 5% levels of probability.

Results and Discussion

Data presented in Table 1 indicates that earliest/lowest node at which first female flower appeared, number of fruits per vine, early fruit yield (q/ha) and total fruit yield (q/ha) were significantly influenced by both dates of sowing and growing conditions. However, harvest index (%) was significantly influenced by growing conditions but was found to be non-significant with dates of sowing. A significant interaction effect was observed between sowing dates and growing conditions for early fruit yield (q/ha) and total fruit yield (q/ha). However, a non-significant interaction effect was observed between sowing dates and growing conditions for earliest/lowest node at which first female flower appeared, number of fruits per vine and harvest index (%). It is revealed from the data recorded for various observations that earliest node at which first female flower appeared (as female flower appearance at earliest node to the base of plant is preferred to get higher early and total fruit yield), number of fruits per vine, early fruit yield (q/ha.) and total fruit yield (q/ha.) were best with 15th December date of sowing (D_1) and direct seed sowing under poly-tunnel (M_2) growing condition *i.e.* D_1M_2. While, harvest index (%) was maximum with 15th February date of sowing (D_5) and transplanting of seedlings under poly-tunnel (M_3) growing condition *i.e.* D_5M_3.

So, it is concluded that for getting optimum growth and maximum early and total fruit yield of bottle gourd, the 15th December date of sowing (D_1) and direct seed sowing under poly-tunnel (M_2) planting method was more suitable.

Table 1: Effect of sowing time and growing conditions on yield and yield attributing parameters of bottle gourd

Treatment		Node at which first female flower appeared (Mean)	Number of fruits per vine (Mean)	Harvest index (%) (Mean)	Early Yield (q/ha) (Mean)	Total Yield (q/ha) (Mean)
Sowing dates						
D_1	15th December	13.25	12.00	64.77	383.47	476.13
D_2	30th December	13.70	11.67	64.06	299.88	442.08
D_3	15th January	13.92	10.47	65.04	167.31	413.71
D_4	30th January	14.30	10.25	65.19	39.25	393.46
D_5	15th February	14.61	9.25	65.89	0.00	356.99
C.D. (P=0.05)		0.42	1.80	N.S.	28.86	24.48
Growing conditions						
M_1	Direct seed sowing under straw mulch	14.57	7.71	61.16	No early yield	332.90
M_2	Direct seed sowing under poly-tunnel	13.38	12.83	66.62	191.57	490.59
M_3	Transplanting of seedlings under poly-tunnel	13.92	11.63	67.19	164.39	425.93
C.D. (P=0.05)		0.36	1.09	3.76	9.89	16.42

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Standardization of Maturity Indices of Aonla cv. NA-7 under Rainfed Conditions of Shivalik Foothills of Himalayas

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Keywords: Aonla, Maturity indices, rainfed condition

Introduction

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn) is one of the most important traditional and underutilized fruits of Indian origin, having immense potential for cultivation on marginal or wastelands. It is the richest source of ascorbic acid among the fruits except Barbados cherry. In recent years, the processing and value addition of aonla has increased many folds due to increase in its area and production. Aonla has acquired wide popularity all over the world for its medicinal properties. The fruit, due to its sour and astringent taste, has very limited table value. Because of its highly acidic and astringent nature, the consumers do not relish this fruit in fresh form. Being an underutilized fruit crop little attention has been given to establishing reliable maturity indices of aonla. However commercial used parameters like TSS: acid ratio, colour of fruit surface, can be used for determining the maturity index of particular cultivars of aonla.

Materials and Methods

A field experiment was carried out in the Research orchard of Division of Fruit Science, SKUAST-Jammu during 2011-12 to 2012-13. Twenty four trees of NA-7 were selected for the purpose. Four branches were selected randomly from each side of the trees were tagged before swelling of fruits in August. Sampling was done on the basis of calendar dates. First sampling was taken on 11th October, 2011 in cultivar NA-7. Further samples were taken at seven days interval during different stages of fruit growth and development. Physical parameters such as fruit length, breadth was determined by Vernier calliper and fruit weight by digital balance. Fruit volume was calculated by water displacement method. Chemical parameters viz., TSS: acid ratio, sugars and ascorbic acid was determined by AOAC (2004). All the data were subjected to a one-way analysis of variance (ANOVA) using OPSTAT at 5% level of significance.

Results and Discussion

The results of present investigation on maturity indices of NA7 aonla indicates that fruit length, breadth, weight and volume increases a faster rate from early stage of fruit development to middle growth period i.e. from 11th October to 27th December 2011-12. After that the development process slows down i.e. from 03rd January to 10th January 2011-12. Growth of fruits in term of length, breadth, weight and volume increased from first sampling date till maturity in January. The increase in fruit length, breadth and weight during growth and development could be initially due to cell division and cell enlargement and accumulation of food substances in the fruit pulp. Fruit volume increased up to 75 days after fruit set. The average fruit weight, stone weight, pulp weight, pulp to stone ratio, TSS content and ascorbic acid content increased up to 3rd January, then decreased thereafter. However, the increases in these parameters were more pronounced up to 5th November. The titratable acidity increased gradually up to 5th November, then decreased thereafter. In NA-7 aonla cultivar showed that with the progress in growth and development period all chemical parameters increases expect acidity. The TSS, TSS/Acid ratio and sugars increases at a faster rate from early stage of fruit development to middle growth period i.e. from 11th October to 27th December 2011-12. Further, development process slow down again i.e. from 03rd January to 10th January 2011-12. Sugars increased continuously throughout the growth and development of NA-7. This increase in sugar content might be due to accumulated translocation of photosynthates from leaves to fruits as carbohydrates are manufactured in these leaves. This decrease in acidity might be due to rapid utilization of organic acids and conversion of organic acids into their salts and sugars either by enzymes invertase during the period of ripening or by reaction involving the reversal of glycolytic pathway (Agrawal and Chopra, 2004). Ascorbic acid content increased rapidly from the beginning of sampling i.e. 11th October to 10th January during both the years. The increase in ascorbic acid content during growth and development of the fruit might be associated with increase in total sugars which served as precursors for its synthesis in fruits. From above investigation, it is concluded that aonla cultivars NA-7 gets ready for harvesting in the 1st week of January and various quality parameters were very useful in fixing the maturity standards in NA7 aonla.

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Table 1: Periodic changes in fruit characters of NA-7

Dates	Length	Breadth	Weight	Volume	Pulp/Stone ratio	TSS/Acid ratio	Sugars	Ascorbic acid
11-10-11	0.92	0.90	0.98	0.98	4.07	1.47	1.84	64.00
18-10-11	1.80	1.73	4.65	2.98	5.81	1.63	1.98	133.43
25-10-11	2.15	2.33	10.11	3.49	10.25	2.56	2.66	190.10
01-11-11	2.75	2.63	15.20	10.79	14.22	2.62	2.90	190.10
08-11-11	2.70	3.12	19.15	15.49	16.43	2.82	3.60	220.10
15-11-11	2.85	3.58	20.10	20.20	13.97	2.98	4.20	260.10
22-11-11	2.85	3.73	25.00	23.12	10.17	2.86	5.10	270.15
29-11-11	2.94	3.78	36.20	25.14	11.40	3.00	5.80	300.10
06-12-11	3.00	3.93	38.13	29.20	16.24	3.17	6.42	380.15
13-12-11	3.35	4.08	40.20	35.64	14.47	3.70	6.98	400.15
20-12-11	3.70	4.46	42.50	40.11	12.82	3.77	7.20	490.21
27-12-11	3.78	4.49	49.10	45.29	15.42	3.84	7.10	502.15
03-01-12	3.75	4.38	42.10	44.11	14.10	3.83	7.10	500.15
10-01-12	3.75	4.38	42.10	43.44	14.12	3.83	7.08	500.12
C. D.	0.03	0.05	0.05	0.03	0.44	0.04	0.01	2.60

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Integrated Weed Management in Turmeric (*Curcuma longa* L.)

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Keywords: Fresh yield, phyto-toxicity, weed dynamics.

Introduction

Turmeric (*Curcuma longa* L.) is largely grown as a rain-fed crop, takes long time span of about 8 - 9 months. Delayed emergence, slow initial growth, poor canopy development of turmeric provides ideal environment for weeds to grow and cover the ground quickly and compete with the crop causing considerable yield reduction of about 30-75%.

Materials and Methods

A field experiment was conducted in *kharif* 2014 to study the efficacy of weed control methods on weed dynamics and productivity of turmeric. The 15 treatments comprised of T_1, T_2, T_3, T_4, T_5, T_6 and T_7 as integration of chemical and hand weeding i.e., metribuzin 0.7kg a.i./ha or pendimethalin 1.0 kg a.i./ha or atrazine 0.75kg a.i./ha or oxyfluorfen 0.3kg a.i./ha or oxadiargyl 0.25kg a.i./ha pre-emergence or glyphosate 1.25l a.i./ha or glyphosate 1.85l a.i./ha post-emergence each followed by 2 hand weeding at 45 and 75 days after planting (DAP) respectively; T_8, T_9 and T_{10} integrated with metribuzin 0.7kg a.i./ha or pendimethalin 1.0 kg a.i./ha or atrazine 0.75kg a.i./ha pre-emergence each followed by fenoxaprop-p-ethyl 67g a.i./ha + metsulfuron 4g a.i./ha at 45 DAP respectively; T_{11}, T_{12} and T_{13} integrated with metribuzin 0.7kg a.i./ha or pendimethalin 1.0kg a.i./ha or atrazine 0.75kg a.i./ha pre-emergence each followed by straw mulch at 10 DAP followed by hand weeding at 75 DAP respectively; T_{14} and T_{15} as H.W. at 25, 45 and 75 DAP and un-weeded check respectively.

Results and Discussion

Application of metribuzin 0.7 kg a.i./ha pre-emergence followed by fenoxaprop-p-ethyl 67g a.i./ha + metsulfuron 4 g a.i./ha at 45 DAP recorded 66.96%, at 90 DAP and 54.67%, at 150 DAP reduced total weed density compared to hand weeding respectively. Application of metribuzin 0.7 kg a.i./ha pre-emergence followed by fenoxaprop-p-ethyl 67g a.i./ha + metsulfuron 4 g a.i./ha at 45 DAP also recorded reduced density of broad leaved, grassy and sedge weeds. Among all the treatments integrated with metribuzin 0.7kg a.i./ha followed by fenoxaprop-p-ethyl 67g a.i./ha + metsulfuron 4 g a.i./ha at 45 DAP recorded maximum phyto-toxicity while treatment integrated with metribuzin 0.7 kg a.i./ha followed by straw mulch at 10 DAP followed by handweeding at 75 DAP recorded reduced phyto-toxicity.

Application of atrazine 0.75 kg a.i./ha pre-emergence followed by straw mulch at 10 DAP followed by hand weeding at 75 DAP recorded higher rhizome yield.

Thus, it can be concluded that application of atrazine 0.75 kg a.i/ha pre-emergence followed by straw mulch and handweeding at 75 DAP may be practiced for better crop growth, higher productivity and profitability of turmeric owing to better weed control.

Table 1: Weed density (no. m^{-2}) and total weeds dry matter accumulation (g m^{-2}) in turmeric as influenced by weed control methods

Treatment	Broad leaved weeds (no./m^2)			Grassy weeds (no./m^2)			Sedge weeds (no./m^2)			Total weed density (no./m^2)			Total dry matter accumulation by weeds (g/m^2)			Phyto-toxicity (0-10 scale)	Fresh yield (t/ha)
	30 DAP	90 DAP	150 DAP	30 DAP	90 DAP	150 DAP	30 DAP	90 DAP	150 DAP	30 DAP	90 DAP	150 DAP	30 DAP	90 DAP	150 DAP	60 DAP	
T1-Metr. f.b. 2H.W.	13.16 (180)	25.80 (667)	19.76 (159)	18.12 (328)	19.03 (363)	15.61 (244)	10.08 (101)	6.48 (43)	5.63 (33)	24.63 (609)	32.72 (1072)	25.83 (667)	8.73 (75.81)	22.65 (512.62)	20.87 (435.06)	3.33	20.95
T2-Pend. f.b. 2H.W.	15.68 (247)	27.98 (789)	23.41 (199)	23.10 (533)	21.43 (459)	20.88 (438)	14.25 (203)	8.03 (64)	9.33 (87)	31.34 (983)	36.16 (1312)	32.71 (1075)	11.75 (137.57)	29.77 (887.76)	22.21 (493.12)	3.00	18.90
T3-Atr. f.b. 2H.W.	11.91 (142)	25.48 (651)	16.40 (192)	15.47 (243)	18.77 (352)	15.24 (238)	8.19 (67)	6.15 (37)	5.00 (25)	21.22 (451)	32.25 (1040)	22.95 (534)	7.87 (61.51)	21.29 (452.77)	19.65 (385.77)	2.33	20.58
T4- Oxy. f.b. 2H.W.	7.33 (53)	21.92 (485)	15.15 (375)	15.00 (233)	16.01 (256)	12.94 (167)	7.33 (53)	6.15 (37)	4.18 (17)	18.30 (340)	27.85 (779)	20.46 (422)	6.90 (47.25)	18.56 (344.15)	19.28 (371.41)	3.33	16.07
T5-Oxa. f.b. 2H.W.	7.10 (52)	21.53 (464)	14.08 (248)	14.91 (228)	14.95 (223)	15.24 (238)	6.12 (39)	6.12 (37)	4.12 (17)	17.71 (319)	26.92 (725)	21.29 (454)	6.70 (44.35)	18.20 (330.73)	18.35 (336.44)	3.67	15.26
T6-Gly.1.25 l a.i./ha f.b. 2H.W.	5.17 (27)	19.36 (379)	13.83 (550)	13.26 (183)	13.42 (180)	12.63 (159)	3.70 (13)	5.58 (32)	0.71 (0)	14.71 (223)	24.22 (591)	18.72 (350)	6.84 (46.37)	17.35 (300.54)	17.80 (316.41)	5.00	18.51
T7-Gly.1.85 l a.i./ha f.b. 2H.W.	4.91 (24)	18.05 (325)	13.79 (487)	13.19 (181)	11.79 (139)	12.52 (158)	3.52 (12)	5.70 (32)	0.71 (0)	14.57 (217)	22.28 (496)	18.62 (348)	6.53 (42.23)	17.02 (289.25)	17.59 (309.25)	5.00	18.16
T8-Metr. f.b. feno. + mets.	12.08 (148)	12.88 (165)	6.95 (49)	16.20 (264)	6.96 (48)	10.54 (111)	8.51 (72)	3.34 (11)	0.71 (0)	21.95 (484)	14.98 (224)	12.66 (160)	7.98 (63.71)	13.48 (181.29)	12.22 (148.88)	7.67	7.44
T9-Pend. f.b. feno. + mets.	13.49 (187)	13.77 (191)	11.55 (238)	18.12 (328)	8.95 (80)	10.66 (113)	13.31 (177)	4.64 (21)	0.71 (0)	26.28 (692)	17.07 (292)	15.72 (248)	10.77 (115.53)	15.94 (254.04)	15.05 (225.97)	8.00	5.55
T10-Atr. f.b. feno. + mets.	7.57 (57)	17.21 (299)	12.64 (390)	15.10 (240)	11.08 (123)	12.25 (151)	7.76 (60)	4.64 (21)	0.71 (0)	18.74 (357)	21.02 (443)	17.61 (311)	7.36 (53.75)	16.59 (274.99)	17.09 (291.71)	8.33	3.25
T11-Metr. f.b. Str M. f.b.H.W.	13.20 (175)	25.37 (661)	19.28 (135)	16.37 (273)	18.77 (352)	15.48 (240)	9.61 (92)	6.53 (43)	5.07 (25)	23.23 (540)	32.34 (1056)	25.24 (640)	8.22 (67.59)	21.55 (464.17)	19.27 (370.74)	1.33	28.06
T12-Pend. f.b. Str. M. f.b.H.W.	15.43 (240)	25.80 (667)	22.08 (191)	22.23 (496)	21.16 (448)	17.70 (321)	13.34 (181)	8.03 (64)	7.42 (55)	30.18 (917)	34.34 (1179)	29.33 (862)	11.19 (124.88)	26.85 (721.18)	21.01 (441.00)	1.67	26.05
T13-Atr. f.b. Str. M. f.b.H.W.	8.82 (77)	24.49 (603)	15.75 (190)	15.32 (240)	18.31 (336)	13.25 (175)	8.16 (67)	6.13 (37)	5.07 (25)	19.48 (384)	31.23 (976)	21.18 (448)	7.57 (57.69)	20.57 (422.94)	18.43 (339.43)	0.67	29.04
T14-3 Handweeding	5.87 (36)	20.59 (427)	13.88 (271)	14.14 (200)	14.71 (219)	12.64 (161)	4.20 (17)	5.58 (32)	0.71 (0)	15.89 (253)	25.97 (678)	18.77 (353)	6.62 (43.39)	18.04 (325.15)	17.68 (311.96)	0.00	19.29
T15- Un- weeded check	17.04 (291)	35.59 (1267)	25.37 (643)	23.85 (569)	24.19 (585)	21.15 (447)	15.03 (226)	15.64 (244)	9.61 (92)	32.94 (1086)	45.79 (2096)	34.39 (1182)	12.11 (146.11)	33.00 (1089.0)	25.09 (629.97)	0.00	2.81
SEm±	0.90	1.33	0.77	1.44	0.55	1.03	0.49	0.46	0.28	1.35	1.09	0.90	0.28	0.39	0.28	0.51	1.10
LSD (0.05)	2.61	3.86	2.22	4.17	1.59	2.98	1.43	1.33	0.82	3.92	3.16	2.60	0.82	1.12	0.81	1.48	3.19
CV %	14.74	10.30	8.15	14.70	5.95	12.22	9.65	12.11	12.33	10.62	6.66	6.96	5.76	3.25	2.59	22.99	11.44

Data in parentheses are original values.

f.b.- followed by, H.W.- handweeding

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Effect of Growth Regulators on Growth and Yield of Turmeric var. Suroma

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Keywords: Growth regulators, turmeric rhizome sizes, growth and yield attributes.

Introduction

Turmeric (*Curcuma longa* L.) is an important, sacred and ancient spice of India. It is a major rhizomatous spice produced and exported from India. Turmeric is a herbaceous perennial plant, native to tropical South-East Asia, belonging to the family zingiberaceae, under the order scitaminae. India is the world's largest producer and exporter of turmeric and it produces nearly 50 per cent of global turmeric production. It is grown in an area of 1.92 lakh hectares with an average production of 8.93 lakh MT. The cost of planting material amounts to 50% of crop production in turmeric. Studies on the use of different growth regulators are scanty. Hence there is a need to study the effect of different growth regulators to know the best suited growth regulator for getting higher yields under field condition.

Materials and Methods

The study was carried out in the field of Plantation, Spices, Medicinal and Aromatic Crops of Kittur Rani Chennamma College of Horticulture Arabhavi during May of 2012-2013. There were three treatments G_1 (Cycocel 1000ppm), G_2 (6- BA 5 ppm), G_3 (NAA 20 ppm) and G_4 (Control) were used for the experiment. The field trial was laid out in RBD and was replicated three times at spacing of 45 cm between rows and 22.5 cm between the plants (ridge and furrow method) was followed, accommodating 98,765 plants per hectare. Observations on growth parameters were recorded on five randomly selected clumps in each treatment at monthly intervals starting from 30 days after planting (DAP) till harvest i.e upto 180 days after planting (DAP).

Results and Discussion

Experimental results indicated that the treatment G_3 (NAA 20 ppm) recorded maximum (80.84 cm) plant height, number of leaves per tiller (26.32), leaf area (288.38cm^2), number of tillers per clump (5.63), harvest index (88.01%), number of rhizomes per clump (31.03), diameter of rhizome clump (29.02 mm), clump size (42.37 cm^2), yield per clump (295.41g), yield per plot (8.08 kg) and yield per hectare (18.08 t/ha) at 180 DAP. Growth attributes such as plant height, pseudostem girth, number of leaves per tiller, leaf area, number of tillers per clump, harvest index, number of rhizomes per clump, diameter of rhizome clump, clump size, yield parameters were highest in treatment G_3 (NAA 20 ppm) which may be attributed to the formative effect of cell elongation and cell division.

Growth regulator, NAA 20 ppm which influenced fresh rhizome yield and yield attributes significantly, may be attributed to its formative effect on cell elongation, cell division and better vegetative growth interms of plant height, number of leaves and leaf area, which might have influenced the production of more number of rhizomes, diameter and size of clump, finally leading to increase in fresh rhizome yield in turmeric. Synthesis of more photosynthates due to better growth and translocation into sink might have resulted in better yield of rhizomes. NAA 20 pmm is best among the different growth regulators used in this experiment.

Table 1: Effect of growth regulators on the plant height, pseudostem girth, number of leaves per tiller, leaf area, number of tillers per clump and harvest index in turmeric var. Suroma

Treatment	Plant height (cm)	Pseudo stem girth (mm)	No. of leaves per plant	Leaf area (cm^2)	No. of tillers/ clump	Harvest index (%)
G_1: Cycocel 1000 ppm	65.60	6.67	19.04	190.01	4.40	75.16
G_2: 6- BA 5 ppm	73.59	7.12	21.04	212.82	4.06	76.92
G_3: NAA 20 ppm	80.84	7.09	26.32	288.38	5.63	88.01
G_4: Control	67.73	6.72	21.04	202.72	4.65	73.52
S.Em±	1.36	0.11	0.33	4.19	0.13	1.48
CD @ 5%	4.61	NS	1.126	14.203	0.44	5.03

Table 2: Effect of types of rhizome sizes on the number of rhizomes per clump, diameter of rhizome per clump, clump size, yield per clump, yield per plot and yield per hectare in turmeric var. Suroma

Treatment	No. of rhizomes per clump	Diameter of rhizome clump (mm)	Clump size (cm^2)	Yield (g/clump)	Yield (kg/plot)	Yield (tons/ ha)
G_1: Cycocel 1000 ppm	23.61	22.67	28.79	214.26	4.24	10.77
G_2: 6- BA 5 ppm	27.25	25.73	36.16	222.13	5.99	14.13
G_3: NAA 20 ppm	31.03	29.02	42.37	295.41	8.08	18.08
G_4: Control	23.68	23.33	37.23	219.77	5.36	13.44
S.Em±	0.46	0.45	0.66	9.00	0.27	0.35
CD @ 5%	1.55	1.53	2.23	30.49	0.92	1.17

233.

Changes in Activity of Cell Wall Degrading Enzymes and Pectin during Different Stages of Guava Fruit Ripening

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Keywords: Guava, polygalacturonase, pectin methyl esterase, pectin

Introduction

Guava (*Psidium guajava* L.) a climacteric fruit is one of the well known edible tree fruits grown widely in more than sixty countries of the world. It is a perishable fruit highly prone to bruising and mechanical injuries. To reduce the percent losses in guava and to avoid glut, it is desirable to evolve technologies for prolonging its keeping quality through delaying softening process during ripening or development of practical solution to the post harvest problems requires detailed understanding of biochemistry of fruit ripening. In order to improve the quality, storage, and processing characteristics of guava fruits, it is necessary to study the activity of cell degrading enzyme.

Materials and Methods

Plant material for the present study comprised of twelve year old, uniformly growing and bearing fruit trees of three different guava cultivars namely L-49 (Sardar), Hisar Surkha and Hisar Safeda grown in sandy loam soil under irrigated conditions in the Research Orchard of the Division of Fruit Science, Udheywalla, SKUAST-J which is situated at an elevation of 300 m above mean sea level and lies at 32.43° North latitude and 74.54° East longitude. The experiment was laid out according to randomized block design, planted in square system at a distance of 5 m x 5 m. Observations were recorded for the winter season crop at the time of harvesting, twenty fruits were taken from each cultivars, harvested with secateurs keeping small intact pedicel with each fruit, on the basis of visual observation and firmness at three maturity stages namely green mature stages, GMS (100% green fruit); half ripe stages, HRS (50% yellow and 50% green) and full ripe stages, FRS (80% yellow and 20% green fruit). Pectin was analyzed by adopting the standard procedure suggested by AOAC (1977) whereas activity of pectin methyl esterase and polygalacturonase were assayed by the method of Hagerman and Austin (1986).

Results and Discussion

The perusal of data (Table 1) revealed that among all the cultivars, activity of PG was found maximum in cv. L-49 that increased progressively with advancement of ripening and reached its maximum from 85 unit/ g.f.wt. at GMS to 127.50 unit/g.f.wt. at FRS followed by Hisar Surkha and Hisar Safeda with value of 77.30 unit/g.f.wt. and 70 unit/g.f.wt. at GMS to 113.25 unit/g.f.wt. and 105 unit/g.f.wt. at FRS, respectively. Similarly activity of PME was also found highest in cv. L-49 that increased significantly from 42.25 unit/g.f.wt. to 56.25 unit/g.f.wt. at HRS and then decline significantly to 52.25 at HRS followed by Hisar Surkha. The maximum pectin content of 1.14% was observed at GMS which decreased progressively during ripening and attained a minimum value 0.77% at FRS in cv. L-49, while minimum pectin content was observed in Hisar Safeda with 0.92% at GMS which with the advancement of fruit ripening decreased to 0.61 per cent at FRS).

Table 1: Changes in the activity of cell wall degrading enzymes and pectin of different guava cultivars during different stages of ripening

Stage	PG (unit/g.f.wt)			PME (unit/g.f.wt)			Pectin (%)		
	L-49	Hisar Surkha	Hisar Safeda	L-49	Hisar Surkha	Hisar Safeda	L-49	Hisar Surkha	Hisar Safeda
GMS	85	77.30	70	42.25	35.50	31.50	1.14	0.94	0.92
HRS	112.50	93.25	87.50	56.25	45.50	41.50	0.96	0.76	0.74
FRS	127.50	113.25	105	52.25	40.50	36.50	0.77	0.65	0.61
C.D $_{(p=0.05)}$	2.90	0.37	3.43	3.43	2.76	2.49	0.13	0.04	0.10

It is thus concluded that on the basis of these results, it could be suggested that since transition of guava fruits from green mature stages GMS (100% green fruit) to half ripe stages HRS (50% yellow and 50% green) is accompanied by major metabolic changes, it will be appropriate to harvest the fruits at HRS stage that will facilitate safer handling, transportation and will avoid postharvest losses.

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234.

Influences of Different Mulching Materials on Conservation of Soil Moisture in Aonla (*Emblica officinalis* Gaertn.) cv. NA-7 Under Subtropical Rainfed Conditions of Jammu

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Keywords- Aonla, mulching, soil moisture, conservation, rainfed

Introduction

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.) is indigenous to Indian sub-continent, belongs to the family Euphorbiaceae. Owing to its hardy nature, suitability to various wastelands, high productivity, nutritive and therapeutic values, aonla has become an important fruit. The practice of mulching in fruit trees impart manifold beneficial effect, like stabilization of soil temperature, reduced water loss through evaporation resulting in more stored soil moisture, maintenance of soil fertility, suppression of weed growth, improvement in growth and yield, etc. Keeping the beneficial aspects of mulching in background, this investigation was undertaken to assess the affect of different mulching materials on soil moisture conservation at different depths of aonla orchard under rainfed conditions of Jammu.

Materials and Methods

The present investigation was carried at Rainfed Research Sub-Station for Sub-tropical fruits Raya, Jammu and Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in 2013-14. The experimental field is situated at an elevation of 332 m above mean sea level and lies between 32°39" North latitude and 74°53" East longitude. Experiment was laid out in a randomized block design with seven treatments: T1 (black polythene), T2 (white polythene), T3 (paddy straw), T4 (saw dust), T5 (sarkanda), T6 (dry grass), T7 no mulch (control). All the treatments were replicated four times. Application of treatments was done during the spring season namely 19th February, 2013. Soil moisture content was recorded in two depths i.e., 0-15 cm and 15-30 cm, respectively.

Results and Discussion

Increase in soil moisture content from 50 to 255 days after mulching treatment was significant at both the depth of soil (0-15 cm and 15-30 cm). The higher soil moisture content with different dates after mulching ranged between 21.42 and 15.71% at 0-15 cm depth and 23.62 and 16.53% at 0-30 cm depth were recorded under black polythene mulch. Among the organic mulches higher soil moisture content with different dates after mulching was recorded in paddy straw mulch which ranged between 20.25 and 15.31% at 0-15 cm depth and 22.62 and 15.38% at 15-30 cm depth. The least soil moisture content was recorded in control at 0-15 cm and 16-30 cm depth at different dates after mulching. Increased soil moisture content below the mulches in various organic and inorganic mulching treatments might be due to reduction in soil surface evaporation, increased infiltration percolation capacity of soil, suppression in extreme fluctuation of soil temperature thus retaining the soil moisture in the soil for longer duration. These results are in confirmation with the results of (Rao and Pathak 1996), (Pande *et al.*, 2005) and (Singh *et al.*, 2010) in aonla.

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Table 1: Soil moisture content at 0-15 cm and 15-30 cm depths in aonla orchard under different mulching treatments

Treatments	Soil moisture content at 0-15 cm depth (%) on days after mulching (DAM)							
	50 DAM	80 DAM	110 DAM	140 DAM	170 DAM	200 DAM	230 DAM	260 DAM
Black polythene	21.42	20.11	19.91	19.31	18.73	17.81	16.79	15.71
White polythene	21.15	19.16	18.78	18.13	17.42	16.53	15.44	14.38
Paddy straw	20.25	20.01	19.75	19.09	18.31	17.42	16.38	15.31
Saw dust	19.35	19.17	18.82	18.31	17.42	16.51	15.45	14.39
Sarkanda	18.15	18.01	17.81	17.22	16.51	15.64	14.57	13.48
Dry grass	20.05	19.87	19.31	19.01	18.29	17.33	16.27	15.22
Control (unmulched)	17.68	17.17	16.81	16.23	15.55	14.59	13.51	12.43
C D $_{(p=0.05)}$	2.20	1.85	1.51	1.06	1.15	1.21	0.95	12.43
	Soil moisture content at 15-30 cm depth (%) on days after mulching (DAM)							
Black polythene	23.62	22.73	21.71	20.76	19.72	18.69	17.61	16.53
White polythene	22.91	20.94	19.88	18.91	17.89	16.81	15.73	14.60
Paddy straw	22.62	21.68	20.61	19.69	18.65	17.58	16.44	15.38
Saw dust	21.98	20.99	19.92	18.95	17.93	16.81	15.74	14.63
Sarkanda	21.77	20.81	19.74	18.82	17.79	16.66	15.59	14.44
Dry grass	22.12	21.15	20.08	19.12	18.09	17.04	16.03	15.01
Control (unmulched)	17.78	17.02	16.51	16.01	15.59	14.64	13.61	12.44
C D $_{(p=0.05)}$	2.12	1.84	1.16	1.62	1.11	1.02	1.30	1.10

235.

Influence of Planting Time and Spacing on Growth Parameters of Tuberose (*Polianthes tuberosa* L.)

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Keywords: Planting time, spacing, tuberose

Introduction

Polianthes tuberosa is a member of family Asparagaceae. It can be cultivated both in tropical and sub tropical condition. All flower lovers like tuberose due to its luxuriant vegetative growth, pretty and fragrant spikes, which have long vase life and transportability. Due to varied agro climatic conditions prevailing in India tuberose is planted at different dates in different parts of the country. It is planted in February and March in the plains and in April and May in the hills. Spacing between plants is particularly important for the cultivation of tuberose to maximize flower quality and quantity characteristics.

Materials and Methods

The current investigation entitled "Influence of planting time and spacing on growth parameters of tuberose (*Polianthes tuberosa* L.)" was carried out at experimental orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar during 2013-14. Beds were prepared by maintaining plot bed size 1.20 × 1.20 m for planting of bulbs. Total number of beds prepared was thirty six. Prajwal variety of tuberose was selected for the study. The planting was done at fortnight intervals starting in last week of March, second week of April, last week of April and second week of May in 2013. Bulbs were planted at three different spacing (20 × 10 cm, 20 × 20 cm, 20 × 30 cm). For collection of data from the field, ten plants were selected randomly and tagged in each treatment (plot) sparing the border plants.

Results and Discussion

The data of Table 1 indicates that planting time and spacing were found significant in decreasing the number of days taken for initiation of sprouting of bulbs in tuberose. Maximum number of days (16.86) taken for initiation of sprouting of bulbs was recorded in last week of March planting (T_1 treatment) with closer spacing (20 × 10 cm) while minimum number of days (8.66) was taken in 2nd week of May plantation (T_4 treatment) along with wider spacing (20 × 30 cm).

Table 1: Effect of planting time and spacing on days taken for initiation of sprouting of bulbs in tuberose cv. Prajwal

Treatments	Spacing (cm)			Mean
Time of planting	S_1 (20 x 10 cm)	S_2 (20 x 20 cm)	S_3 (20 x 30 cm)	
T_1 (Last week of March)	16.86	16.13	15.90	16.30
T_2 (Second week of April)	14.30	13.76	12.90	13.65
T_3 (Last week of April)	11.16	10.20	9.70	10.35
T_4 (Second week of May)	9.76	9.20	8.66	9.21
Mean	13.02	12.32	11.79	
CD at 5%	T= 0.16	S= 0.13	T x S= 0.27	

236.

Effect of Nitrogen and Phosphorus Application on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.) under Semi-arid Conditions of Haryana

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Keywords: Nutrient management of marigold, nitrogen and phosphorus use

Introduction

African marigold (*Tagetes erecta* L.) belongs to the family Asteraceae and is a native of Mexico. It is extensively cultivated in Haryana due to its hardiness, vigorous nature, free flowering habit, easy cultivation and high productivity. An adequate supply of nitrogen is associated with vigorous vegetative growth, while phosphorus is associated with the development of roots and early maturity of crops. The present investigation was conducted at experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar (Haryana), India with an objective to standardize the optimum dose of nitrogen and phosphorus in African marigold.

Materials and Methods

Twenty treatment combinations comprising five levels of nitrogen (0, 15, 20, 25 and 30g/m^2) and four levels of phosphorus (0, 15, 20 and 25g/m^2) were tried in factorial randomized block design with three replications. Half dose of nitrogen and full dose of phosphorus and potassium were applied as basal dose. Remaining half dose of nitrogen was applied at 30 days after transplanting (DAT). Observations were recorded for various growth, flowering and yield parameters in African marigold cv. Local Selection. Experimental data were subjected to statistical analysis by using factorial randomized block design for analysis of variance (ANOVA) as suggested by Panse and Sukhatme (1995).

Results and Discussion

All growth and flowering parameters were significantly influenced with every increase in nitrogen and phosphorus dose. The various growth parameters namely plant height (77.10cm), plant spread (65.67cm), fresh and dry weight of plant (479.67g and 47.97g, respectively) increased significantly with the increase in nitrogen levels up to 30g/m^2 and also with increase in phosphorus levels up to 25g/m^2 whereas maximum number of primary branches per plant (8.37) were obtained with the application of 30g N/m^2 with 20g P_2O_5/m^2 (Table 1). The various floral parameters like number of buds per plant (69.30), duration of flowering (62.26 days), days to 50% flowering (79.54), number of flowers per plant (59.55), flower diameter (8.32cm) and stalk length (7.58cm) were obtained maximum with application of 30g/m^2 nitrogen and 25g/m^2 phosphorus (Table 2). The maximum fresh (9.37g) and dry weight (0.93g) of flower, flower yield per plant (558.09g) and flower yield per hectare (34.88t) were observed in plants fertilized at 30g N/m^2 and 25g P_2O_5/m^2. On the basis of these results, it may be concluded that 30g N/m^2 along with 25g P_2O_5/m^2 seemed to be optimum for better growth, flowering and flower yield of African marigold cv. Local Selection.

Table 1: Effect of nitrogen and phosphorus on growth and yield of African marigold

Treatment	Plant height (cm)	Plant Spread (cm)	Primary branches/plant	Fresh weight of plant (g)	Dry weight of plant (g)	Flower yield per plant (g)	Flower yield per hectare (t)
				N (g/m^2)			
0	64.09	52.47	5.34	295.96	29.60	356.02	22.25
15	66.80	54.78	6.33	345.17	34.51	397.48	24.84
20	69.31	58.49	6.91	387.17	38.71	426.15	26.63
25	72.91	61.28	7.32	420.77	42.07	469.97	29.37
30	74.23	62.03	7.78	434.65	43.96	504.80	31.55
CD (5%)	2.26	1.80	0.25	4.32	1.83	1.82	0.99
				P (g/m^2)			
0	66.39	52.51	5.97	343.28	34.32	372.92	23.31
15	68.44	56.46	6.69	364.31	36.43	412.88	25.81
20	70.90	60.27	7.10	385.74	38.58	449.38	28.09
25	72.14	61.64	7.18	413.55	41.36	488.36	30.52
CD (5%)	2.02	1.61	0.23	4.18	1.74	1.63	0.88
				N× P			
N_0P_0	62.67	46.42	4.60	267.71	26.77	282.99	17.69
N_0P_1	64.10	51.43	5.20	283.14	28.31	316.99	19.81
N_0P_2	64.60	53.14	5.67	312.12	31.21	393.63	24.60
N_0P_3	65.00	56.90	5.90	321.00	32.10	430.48	26.90
N_1P_0	63.00	49.13	4.87	322.57	32.25	349.78	21.86
N_1P_1	66.14	54.78	6.75	331.60	33.16	375.96	23.50
N_1P_2	69.71	57.16	6.80	350.00	35.00	416.94	26.06
N_1P_3	68.33	58.13	6.90	376.50	37.65	447.25	27.95
N_2P_0	65.43	53.50	6.14	360.28	36.02	372.46	23.28
N_2P_1	67.28	56.75	7.11	371.00	37.10	414.89	25.93
N_2P_2	70.10	61.60	7.12	390.00	39.00	434.05	27.13
N_2P_3	74.43	62.13	7.30	427.40	42.74	483.23	30.20
N_3P_0	69.43	56.40	6.86	380.50	38.05	429.99	26.87
N_3P_1	71.50	59.13	7.12	408.40	40.84	452.10	28.26
N_3P_2	74.86	64.30	7.57	430.50	43.05	475.04	29.69
N_3P_3	75.86	65.36	7.72	463.67	46.36	522.76	32.67
N_4P_0	71.44	57.10	7.37	385.33	39.38	429.37	26.83
N_4P_1	73.16	60.21	7.28	427.42	42.87	504.48	31.53
N_4P_2	75.24	65.15	8.37	446.20	45.62	527.26	32.95
N_4P_3	77.10	65.67	8.11	479.67	47.97	558.09	34.88
N×P	4.15	3.30	0.51	8.44	2.65	3.64	1.92

Table 2: Effect of nitrogen and phosphorus on flowering parameters of African marigold

Treatment	No. of buds per plant	No. of flowers per plant	Duration of flowering (days)	Flower diameter (cm)	Stalk length (cm)	Fresh weight of flower (g)	Dry weight of flower (g)
				N (g/m^2)			
0	52.17	45.36	45.72	5.52	4.19	7.81	0.78
15	56.90	48.29	52.83	6.30	5.07	8.21	0.82
20	59.26	50.28	55.56	6.79	6.20	8.46	0.84
25	62.15	52.72	57.27	7.09	6.48	8.74	0.87
30	65.34	56.33	58.92	7.54	6.84	8.94	0.89
CD (5%)	0.81	1.00	1.03	0.19	0.17	0.20	0.02
				P (g/m^2)			
0	54.52	47.29	50.08	5.95	4.60	7.71	0.77
15	57.39	48.97	52.88	6.40	5.78	8.39	0.83
20	60.39	51.34	55.48	6.96	6.14	8.74	0.87
25	64.35	54.78	57.81	7.27	6.49	8.90	0.89
CD (5%)	0.73	0.89	0.92	0.17	0.15	0.18	0.02
				N× P			
N_0P_0	47.14	40.81	43.51	4.90	3.62	6.94	0.69
N_0P_1	49.67	42.62	44.90	5.41	3.90	7.50	0.75
N_0P_2	54.75	47.75	46.44	5.73	4.30	8.25	0.82
N_0P_3	57.14	50.26	48.02	6.04	4.93	8.57	0.85
N_1P_0	53.75	45.64	48.44	5.51	4.08	7.67	0.76
N_1P_1	55.28	46.71	51.24	6.36	5.09	8.05	0.80
N_1P_2	56.57	48.81	54.43	6.64	5.31	8.55	0.85
N_1P_3	62.00	52.00	57.23	6.66	5.82	8.60	0.86
N_2P_0	53.86	47.31	50.80	6.10	4.84	7.87	0.78
N_2P_1	57.50	48.42	54.12	6.50	6.29	8.57	0.85
N_2P_2	60.55	50.53	56.72	7.13	6.73	8.60	0.86
N_2P_3	65.15	54.86	60.62	7.41	6.96	8.81	0.88
N_3P_0	57.87	49.72	52.93	6.44	5.12	7.98	0.79
N_3P_1	59.00	51.62	56.12	6.81	6.64	8.76	0.87
N_3P_2	63.55	52.33	59.13	7.21	6.98	9.08	0.90
N_3P_3	68.20	57.25	60.90	7.91	7.17	9.13	0.91
N_4P_0	60.00	53.00	54.71	6.79	5.37	8.10	0.81
N_4P_1	65.50	55.50	58.02	6.91	7.01	9.09	0.90
N_4P_2	66.55	57.30	60.70	8.16	7.41	9.20	0.92
N_4P_3	69.30	59.55	62.26	8.32	7.58	9.37	0.93
N×P	1.63	NS	1.8	0.38	0.33	0.36	0.04

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Effect of Planting Time and Paclobutrazol on Growth and Seed Yield of Onion (*Allium cepa* L.)

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Introduction

A field experiment was carried out at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar (Haryana) during Rabi season of 2013-14 and 2014-15 to investigate the effect of planting time and paclobutrazol levels on growth and seed yield of onion. The results of the experiment showed that growth and seed yield of onion significantly influenced by different planting time and paclobutrazol concentrations used.

Materials and Methods

The experiment was laid out in randomized block design (factorial) with three replications of each treatment. The bulbs of Hisar-2 variety of onion were planted in a plot, having size 3.6x3.6 m at a plant spacing of 45x45 cm. There were 12 treatment combinations comprising of three planting time (D_1: First week of October, D_2: Third week of October and D_3: First week of November) and four levels of paclobutrazol (G_1: Control, G_2: Paclobutrazol 500 ppm, G_3: Paclobutrazol 750 ppm and G_4: Paclobutrazol 1000 ppm). The paclobutrazol was applied as foliar spray 45 days after planting (DAS).

Results and Discussion

All the planting time treatments differed significantly with respect to all the characters. The crop planted in first week of October found best for days taken to sprouting initiation (4.58 and 4.33), sprouting completion (6.67 and 6.25), number of shoots per plant (5.52 and 5.95), length of leaves (55.73 and 58.49 cm), length of flower stalk (103.04 and 107.47 cm), umbel diameter (6.17 and 6.59 cm), number of umbels per plant (12.08 and 12.48), number of seeds per umbel (541.63 and 579.70) and seed yield per hectare (844.84 and 926.08 kg). In case of paclobutrazol levels, all the levels of paclobutrazol were statistically non-significant with respect to days to sprouting initiation, sprouting completion, number of shoots per plant and umbel diameter. The maximum values for length of leaves (55.76 and 57.64 cm), length of flower stalk (103.70 and 107.48 cm), number of umbels per plant (11.92 and 12.41), number of seeds per umbel (526.79 and 562.76) and seed yield per hectare (834.56 and 930.58 kg) was obtained from the crop, which was sprayed with paclobutrazol at the rate of 500 ppm. Among the interaction, the maximum values for number of umbels per plant (12.70 and 13.17), number of seeds per umbel (571.17 and 610.23) and seed yield per hectare (954.72 and 1065.01 kg) were registered when the crop was planted in first week of October and sprayed with paclobutrazol at 500-ppm concentration during both the years.

From the present investigation, it is concluded that planting time first week of October in combination with paclobutrazol 500 ppm can be recommended for getting higher seed yield from onion crop.

Table 1: Effect of planting time and paclobutrazol on growth and seed characters of onion

Treatments	Days to sprouting initiation		Days to sprouting completion		Number of shoots per plant		Length of leaves (cm)		Length of flower stalk (cm)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Planting time										
D_1: First week of October	4.58	4.33	6.67	6.25	5.52	5.95	55.73	58.49	103.04	107.47
D_2: Third week of October	4.75	4.50	6.83	6.33	5.40	5.73	53.68	55.88	100.28	104.68
D_3: First week of November	5.50	5.08	8.25	7.17	5.24	5.48	51.94	53.07	95.96	101.24
C.D. at 5%	0.60	0.51	0.45	0.56	0.13	0.21	0.75	0.89	1.27	1.60
Paclobutrazol										
G_1: Control	4.78	4.56	7.22	6.44	5.52	5.74	55.76	57.64	103.70	107.48
G_2: Paclobutrazol 500 ppm	4.67	4.33	7.00	6.22	5.66	5.96	55.14	56.81	101.57	105.32
G_3: Paclobutrazol 750 ppm	5.11	4.78	7.22	6.67	5.30	5.69	53.52	55.62	98.79	102.58
G_4: Paclobutrazol 1000 ppm	5.22	4.89	7.56	7.00	5.09	5.49	50.70	53.18	94.66	99.81
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.87	1.03	1.47	1.85
Interaction										
D_1G_1	4.33	4.00	6.33	5.67	5.67	5.93	58.00	60.47	106.10	112.03
D_1G_2	4.00	3.67	6.00	5.67	5.80	6.20	57.40	59.33	104.57	109.67
D_1G_3	4.67	4.67	7.33	6.67	5.47	5.90	55.20	57.80	102.30	106.13
D_1G_4	5.33	5.00	7.00	7.00	5.20	5.73	52.30	56.37	99.20	102.03
D_2G_1	4.67	4.67	7.00	6.33	5.53	5.77	55.63	57.57	103.67	107.43
D_2G_2	4.67	4.33	6.67	6.00	5.60	5.97	55.10	57.07	101.90	105.07
D_2G_3	5.00	4.67	6.67	6.33	5.33	5.70	53.53	56.47	99.27	103.13
D_2G_4	4.67	4.33	7.00	6.67	5.13	5.50	50.43	52.43	96.30	101.10
D_3G_1	5.33	5.00	8.33	7.33	5.37	5.53	53.63	54.90	101.33	103.91
D_3G_2	5.33	5.00	8.33	7.00	5.57	5.70	52.93	54.03	98.23	101.23
D_3G_3	5.67	5.00	7.67	7.00	5.10	5.43	51.83	52.60	91.80	100.07
D_3G_4	5.67	5.33	8.67	7.33	4.93	5.23	49.37	50.73	88.47	98.30
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	1.51	1.79	2.54	3.20

Table 2: Effect of planting time and paclobutrazol on growth and seed characters of onion

Treatments	Umbel diameter (cm)		Number of umbels per plant		Number of seeds per umbel		Seed yield per hectare (kg)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Planting time								
D_1: First week of October	6.17	6.59	12.08	12.48	541.63	579.70	844.84	926.08
D_2: Third week of October	5.72	6.18	11.54	11.95	507.08	538.27	759.66	835.38
D_3: First week of November	4.94	5.44	10.64	11.02	425.51	461.43	578.18	671.64
C.D. at 5%	0.17	0.28	0.21	0.37	12.15	16.37	56.52	73.57
Paclobutrazol								
G_1: Control	5.71	6.20	11.39	11.69	513.10	544.74	770.91	846.63
G_2: Paclobutrazol 500 ppm	5.76	6.20	11.92	12.41	526.79	562.76	834.56	930.58
G_3: Paclobutrazol 750 ppm	5.51	5.96	11.57	11.91	472.07	509.01	685.31	776.61
G_4: Paclobutrazol 1000 ppm	5.46	5.92	10.80	11.26	453.67	489.34	619.47	690.31
C.D. at 5%	N.S.	N.S.	0.24	0.42	14.03	18.91	65.26	84.95
Interaction								
D_1G_1	6.37	6.67	12.03	12.33	556.93	595.87	893.81	961.30
D_1G_2	6.31	6.62	12.70	13.17	571.17	610.23	954.72	1065.01
D_1G_3	6.07	6.59	12.17	12.53	525.00	560.47	808.22	879.66
D_1G_4	5.95	6.47	11.40	11.90	513.40	552.23	722.62	798.34
D_2G_1	5.76	6.32	11.53	11.80	516.17	546.60	801.63	872.42
D_2G_2	5.83	6.27	11.93	12.36	526.73	554.00	879.00	941.55
D_2G_3	5.64	6.03	11.67	12.03	498.37	533.90	699.58	801.63
D_2G_4	5.63	6.10	11.03	11.60	487.07	518.57	658.43	725.92
D_3G_1	5.00	5.60	10.60	10.93	466.20	491.77	617.28	706.16
D_3G_2	5.13	5.70	11.14	11.70	482.47	524.03	669.95	785.17
D_3G_3	4.83	5.27	10.87	11.17	392.83	432.67	548.14	648.55
D_3G_4	4.80	5.20	9.97	10.27	360.53	397.23	477.36	546.66
C.D. at 5%	N.S.	N.S.	0.41	0.73	24.29	32.75	113.04	147.14

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Effect of Irrigation Intervals and Calcium Sprays on Fruit Cracking and Fruit Drop and Yield of Litchi (*Litchi chinensis* Sonn.) cv. Dehradun

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Keywords: Litchi, irrigation, calcium chloride, fruit cracking and fruit drop.

Introduction

Litchi (*Litchi chinensis* Sonn.), belonging to sapindaceae family, originated from the subtropical areas of southern China. It is highly specific to climatic requirements and probably due to this reason its cultivation is restricted to few countries in the world. It comes to market in late May and early June when no other fruits are available. Consequently, it fetches high price in market. Nutrient management is essential for maximum yield, good quality and profitability (Ganeshamurthy *et al.,* 2011). Besides nutrient management, water management is also an important aspect of litchi cultivation. Litchi requires optimum soil moisture for its optimum growth, development and fruit production. Efficient water and nutrient management can overcome several physiological disorders of litchi such as poor fruit set, heavy fruit drop and fruit cracking. Among nutrients calcium has been reported to improve fruit quality in litchi substantially. Keeping in mind all these facts present investigation was undertaken with the objective of determining effect of irrigation intervals and calcium sprays on fruit cracking and fruit drop of litchi.

Materials and Methods

An experiment was carried out at the Research Farm, Division of Fruit Science, Udheywalla, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in 2013. The experiment was laid out in randomised block design with ten treatments each replicated thrice. Calcium chloride salts were given at three concentrations (1, 1.5 and 2%) at fruit set stage and at 21 days intervals thereafter till harvest. Each tree was subjected to different irrigation regime and different concentration of $CaCl_2$ namely T_1 (Irrigation at 3 days interval [control]), T_2 (Irrigation at 6 days interval +1% $CaCl_2$), T_3 (Irrigation at 6 days interval +1.5% $CaCl_2$), T_4 (Irrigation at 6days interval +2% $CaCl_2$), T_5 (Irrigation at 9 days interval +1% $CaCl_2$), T_6 (Irrigation at 9 days interval +1.5% $CaCl_2$, T_7 (Irrigation at 9 days interval +2% $CaCl_2$), T_8 (Irrigation at 12 days interval +1% $CaCl_2$), T_9 (Irrigation at 12 days interval +1.5% $CaCl_2$), T_{10} (Irrigation at 12 days interval +2% $CaCl_2$). The percentage of fruit drop and fruit cracking was recorded on the basis of fruit set on tagged branches of the tree. For fruit yield, total number of fruits in each tree per replication was counted. The counting was made two to three times for minimizing the counting error.

Results and Discussion

It was revealed from the data that T_4 i.e. irrigation at 6 days intervals and Calcium sprays at the rate of 2% was most effective in reducing the incidence of fruit cracking (8.27%) and fruit drop (61.33%) and resulted into highest yield (53.09 kg/ tree) (Table 1). T_8 i.e. irrigation at 12 days intervals and calcium chloride sprays at the rate of 1% showed maximum incidence of fruit cracking (22.71%) and fruit drop (79.37%) and minimum yield (37.45 kg/ tree) which was significantly lower than control i.e. 14.51%, 75.71% and 42.70 kg/ tree of fruit cracking, fruit drop and fruit yield respectively. It is now an established fact that calcium plays an important role in fruit cracking as it imparts turgidity to cells thus plays an important role in maintaining of membrane integrity and permeability (Rab and Haq, 2012). But the present results further establish the role of calcium at low water levels. Increase in irrigation interval from 3 to 6 days resulted into increased fruit yield because of induced mild water stress due to increased irrigation interval which triggers more flowering and consequent higher yield. Irrigation is an important agro- technical element, which distinctly increases the competitiveness and efficiency of production. Further increase in irrigation interval to 9 and 12 days resulted into excessive water stress and also nullified the effect of calcium sprays. In the present study calcium helped to control fruit cracking and fruit drop even at longer irrigation intervals when compared to control. Thus it can be suggested that if litchi is sprayed with 2% $CaCl_2$ better fruit yield and quality can be obtained even with less irrigation thereby, optimising the use of precious input i.e. water which is getting scarce day by day.

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Table 1: Effect of irrigation intervals and calcium sprays on fruit cracking (%), fruit drop (%) and fruit yield (kg/tree) of Litchi (*Litchi chinensis* Sonn.) cv. Dehradun.

Treatments	Fruit cracking	Fruit drop	Fruit yield
T_1 (Irrigation at 3 days interval [control])	14.51	75.71	42.70
T_2 (Irrigation at 6 days interval +1% $CaCl_2$)	10.48	67.64	49.27
T_3 (Irrigation at 6 days interval +1.5% $CaCl_2$)	9.90	66.91	50.36
T_4 (Irrigation at 6days interval +2% $CaCl_2$)	8.27	61.33	53.09
T_5 (Irrigation at 9 days interval +1% $CaCl_2$)	13.69	69.72	42.83
T_6 (Irrigation at 9 days interval +1.5% $CaCl_2$)	12.59	68.52	43.31
T_7 (Irrigation at 9 days interval +2% $CaCl_2$)	12.25	67.73	44.54
T_8 (Irrigation at 12 days interval +1% $CaCl_2$)	22.71	79.37	37.45
T_9 (Irrigation at 12 days interval +1.5%$CaCl_2$)	21.50	78.47	38.33
T_{10} (Irrigation at 12 days interval +2% $CaCl_2$)	19.72	77.65	39.26
C.D. at 5%	1.38	1.45	1.47

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Effect of Shoot Pruning on Flowering, Yield and Quality of Mango cv Mallika Grown in Laterite Soil

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Keywords: Flowering, laterite soil, mango, quality, shoot pruning and yield.

Introduction

Mallika cultivars of mango (*Mangifera indica* L.) often show sharp decline in yield and quality after 10 to 12 years of fruiting owing to various reasons. It was reported that annual shoot tip pruning in mango provides reliable synchronized flowering in selected shoots year after year in trees thus remaining in the same size for many years. No investigation has been made earlier to know the effect of shoot pruning on mango cv. Mallika grown in laterite soil of West Bengal. An investigation was undertaken to recommend correct time of shoot pruning for getting higher fruit yield and quality fruits.

Materials and Methods

Investigation was undertaken in 2012 in a private farm, Jhargam, West Midnapur district of West Bengal on ten years old mango trees cv. Mallika planted at a spacing of 5.0 × 5.0 x 5.0 in triangular system. The experiment consisted of five treatments replicated four times with complete randomized block design. Treatment included: shoot tip pruned on 15th June, 15th July, 15th August, 15th September and without any shoot pruned of trees. The observation recorded were as follows: percentage of dead shoots, average shoot length, average number of laterals/ pruned shoots, date of flowering initiation, peak period of flowering, percentage of fruited panicles, fruit yield per plant, fruit weight, total soluble solids, acidity and ascorbic acid content of fruit.

Results and Discussion

The results revealed the shoots pruned on 15th June recorded maximum shoot length (45.5 cm), fruited panicles per plant (66.3%) and fruit yield per plant (89.2 kg). The yield which is the most important aspect for fruit growers was found to have significantly improved due to cultural practices like shoot pruning. Shoot pruning operation lead to increase in fruit yield which might be due to effective diverting of nutrients and water taken up by the tree to productive branches in mango (Yeshitela *et al.* 2003 and Mukunda *et al.* 2006). Fruit weight was maximum (361 g) recorded from the plants pruned on 15th September. Minimum acidity content was recorded on shoots pruned on 15th August. While no-pruning (control) had lowest fruit weight (281 g) and lower in yield (58.4 kg/ per plant) with lowest total soluble solids (22.9°Brix). Total soluble solids (TSS) and vitamin C (26.1°Brix) (36.6 mg per 100 g) were highest in the 15th June shoot pruned trees while lowest TSS (22.9°Brix) and ascorbic acid content (24.7 mg per 100 g) were recorded from unpruned trees. Conclusively, the 15th June shoot pruning for 'Mallika' could be recommended for restoring the maximum production and good quality fruits in triangular planting system of mango.

Table 1: Effect of shoot pruning on yield and quality of mango cv Mallika

Shoot pruning treatments	Shoot mortality (%)	Yield (kg/plant)	Fruit weight (g)	TSS (°Brix)	Vitamin C (mg per 100 g)
$T_{1:}$ 15th June	15.20	89.20	334.00	26.10	36.60
$T_{2:}$ 15th July	19.40	64.70	290.00	24.30	29.60
T_3: 15th August	21.90	63.70	259.00	24.90	28.10
T_4: 15th September	8.40	37.50	361.00	25.00	24.70
T_5: Control	4.40	58.40	281.00	22.90	25.30
C.D. at 5%	0.95	2.85	16.09	1.26	1.34
SE(m)	0.30	0.91	5.167	0.40	0.43
SE(d)	0.43	1.29	7.307	0.57	0.61
C.V.	4.40	2.92	3.388	3.28	2.99

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240.

Effect of Plant Growth Regulators on Fruit Retention and Physico-chemical Properties of Mango cv. Amrapali Gown in Laterite Soil at Close Spacing

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Keywords: Mango, fruit retention, growth regulators, West Bengal

Introduction

Despite profuse flowering and very high fruit set, the ultimate retention and marketable produce of mango (*Mangifera indica*) is phenomenally low primarily due to heavy fruit drop. Many investigators found that spraying mango trees with plant growth regulator like *naphthalene acetic acid* (NAA) at different concentrations increased fruit set percentage and fruit retention. It has already been proved that efficacy and concentration of plant growth regulators to a plant species for flowering, fruit set and its retention are varied in different agro-climatic condition. Meager information is available about effect of plant growth regulators on Amrapalli variety of mango grown in laterite soil at close spacing. An investigation was carried out towards the above problem for solution.

Materials and Methods

An experiment was conducted at the farmer's field at Jhargram, Paschim Medinipur West Bengal in two successive years of 2011-12 and 2012-13 on a 12 years old mango plants cv. Amrapali planted at 5 x 5 x 5 m triangular system. The experiment was laid out in randomized block design with five treatments and four replications. The treatments were: two times spray of NAA at the rate of 15 ppm (T_1), 25 ppm (T_2) and 50 ppm (T_3) at 21st day interval during pea stage; two times spray of NAA at the rate of 25 ppm at pea stage followed by NAA at 50 ppm at marbel stage (T_4) and control (water spray) (T_5). Observation was made on fruit retention (%), fruit yield, fruit weight, *total soluble sugars* (TSS) and acidity. The data obtained were analysed statistically by the analysis of variance method.

Results and Discussion

Results from two years of investigation (Table 1) revealed that fruit retention (14.25%), fruit yield (48.6 kg/tree) and fruit weight (224.58 g) were highest in the plants sprayed with NAA at 50 ppm followed by NAA at 25 ppm and lowest from control plants which had 10.08% fruit retention, 24.0 kg/tree fruit yield and 159.0g fruit weight. These findings are in close conformity with the findings of Vejendla *et al.* (2008) and Nkansah *et al.* (2012). Among the five treatments highest TSS/acid ratio was calculated from the fruits of the plants received NAA at 50 ppm and lowest from the control plants. It can be concluded that two times application of NAA at 50 ppm during pea stage at 21 days interval was beneficial for improving the fruit retention, total number of fruits, fruit weight and quality of mango cv. Amrapali under red and laterite zone of West Bengal.

Table 1: Effect of different concentration of NAA on fruit retention, yield, fruit weight and quality of mango cv. Amrapali (* Two years mean)

Treatments	Fruit retention (%)*	Yield /plant (kg)*	Fruit weight (g)*	TSS: Acid ratio*
T_1	13.05	31.3	183.03	128.15
T_2	13.90	39.2	198.75	140.12
T_3	14.25	48.6	224.58	149.05
T_4	12.00	33.5	177.00	109.82
T_5	10.08	24.0	159.00	97.33
S. Em (±)	0.21	0.47	3.03	2.4
C.D. 5%	0.65	1.52	9.45	7.48

T_1- NAA at 15 ppm -two sprays during pea stage at 21st day interval.
T_2- NAA at 25 ppm -two sprays during pea stage at 21st day interval.
T_3- NAA at 50 ppm -two sprays during pea stage at 21st day interval.
T_4- NAA was sprayed at 25 ppm at pea stage followed by NAA at 50 ppm at marbel stage
T_5 -control (water spray)

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241.

Effect of Plant Bioregulators on Yield and Shelf Life of Kinnow Mandarin (*Citrus reticulata* Blanco.)

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Keywords: Kinnow, yield, shelf life, 2,4-D, GA_3, NAA

Introduction

Citrus is the third largest fruit industry of the India where it is grown on 1042 thousand hectare with annual production of about 10090 thousand metric tonnes. Kinnow (*Citrus reticulata* Blanco.), a mandarin, is commercially cultivated for its higher yield, high processing quality, fresh consumption, aromatic flavor and better adaptation to different agro-environmental conditions. The use of plant bioregulators has become an important component of modern production technology for most of the cultivated plants and especially for fruit plants. Combined application of gibberelic acid and 2,4-dichlorophenoxy acetic acid growth regulators reduces the of fruit drop through the action of auxin and retards the softening and senescence of the peel, by allowing the longer harvest time, and more economical storing in areas where stocking capacity is limited and storage cost is high. However, it is evident that application of plant bioregulators at pre-harvest stage would surely affect the shelf life of the fruits. So the efficacy of plant bioregulators was studied to improve the yield and shelf life of kinnow mandarin under local conditions.

Materials and Methods

Studies to assess the effect of plant bioregulators on yield and shelf life of Kinnow mandarin (*Citrus reticulata* Blanco.*)* were conducted at the Rainfed Research Sub Station for Subtropical Fruit Crops, Raya, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, in 2013-2014. Seven year old plants of kinnow mandarin were selected for this experiment. Eleven treatments i.e. T_1: 10ppm 2,4-D, T_2: 20ppm 2,4-D, T_3: 30ppm 2,4-D, T_4: 25ppm GA_3, T_5: 50ppm GA_3, T_6: 75ppm GA_3, T_7: 100ppm GA_3, T_8: 10ppm NAA, T_9: 15ppm NAA, T_{10}: 20ppm NAA and T_{11}: untreated control, replicated thrice were applied during the third week of November, 2013 to check the effect on yield and shelf life of the kinnow fruit. Fruits from the treated plants were analysed at weekly interval up to 28 days of storage. The per cent loss in weight for each date of observation was calculated by using the formula suggested by Srivastava and Tondon (1968) and was calculated by dividing the difference of initial and final weight of the fruit with initial weight multiplied with 100. For assessing the quality attributes of taste, texture, flavour and colour of kinnow mandarin fruits, evaluation was carried by panel of judges. The score card of such an organoleptic valuation carried total of 40 points with 10 points for each characteristic.

Results and Discussion

On overall mean basis, maximum yield (kg/plant) was recorded in T_2 (20 ppm 2,4-D) i.e 31.10 kg/plant followed by T_6 (75 ppm GA_3), T_1 (10 ppm 2,4-D) and T_9 (15 ppm NAA). Minimum yield of 15.44 kg/plant was obtained under control (T_{11}). Percent physiological loss in weight during storage of kinnow mandarin revealed that with the advancement of storage life, the per cent weight loss was highly significant. The maximum physiological loss in weight was registered in T_6 (75 ppm GA_3) during 7^{th}, 14^{th}, 21^{st} and 28^{th} day of storage i.e 8.70%, 14.45%, 18.40% and 12.40% respectively and minimum was registered in T_{11} (control) i.e. 5.10% on 7^{th} day of storage, 13.30% on 14^{th} day of storage, 17.00% on 21^{st} day of storage and 11.10% on 28^{th} day of storage. In general physiological loss in weight increased with the advancement of storage period. The possible reason for reduced weight loss by growth regulators may be that growth regulators cause some chemical changes within the fruits resulting in retention of more water against the force of evaporation. Further, it may be possibly due to alternation of some proteinous constituents of the cell and thus increase the affinity of water (Mitchell, 1949) and (Singh *et al.* 1995). Fruits treated with 15ppm napthalene acetic acid resulted in maximum organoleptic rating of 7.2 whereas control exhibited minimum organoletpic rating of 5.4. It can be concluded that plant bioregulators might have inhibited the degradation process and delayed senescence upto 7^{th} day of storage and maintained them in good conditions.

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Table 1: Effect of plant bioregulators on yield, physiological loss in weight and organoleptic rating of kinnow mandarin

Treatments	Fruit yield (kg/plant)	Physiological loss of weight (%)				Organoleptic rating
		7	14	21	28	
T_1 (10 ppm 2,4-D)	26.58	7.40	14.10	17.50	11.45	5.6
T_2 (20 ppm 2,4-D)	31.10	8.50	14.40	18.35	12.20	6.3
T_3 (30 ppm 2,4-D)	17.56	6.00	13.50	17.05	11.15	5.6
T_4 (25 ppm GA_3)	20.31	7.00	14.10	17.35	11.40	5.7
T_5 (50 ppm GA_3)	22.97	7.70	14.25	17.60	11.60	5.8
T_6 (75 ppm GA_3)	26.89	8.70	14.45	18.40	12.40	6.6
T_7 (100 ppm GA_3)	22.61	8.00	14.30	17.80	11.75	5.7
T_8 (10 ppm NAA)	21.37	6.40	13.70	17.10	11.20	6.5
T_9 (15 ppm NAA)	26.41	5.30	13.50	18.10	11.80	7.2
T_{10} (20 ppm NAA)	22.61	6.50	13.80	17.20	11.25	6.2
T_{11} (Control)	15.44	5.10	13.30	17.00	11.10	5.4
C.D. (p=0.05)	3.31	3.05	2.38	2.75	2.42	0.50

242.

Response of Aonla (*Emblica officinalis* Gaertn.) cv. NA-7 to Orchard Floor Management under Subtropical Rainfed Conditions of Jammu

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Keywords- Aonla, orchard floor management, vegetative growth, anthesis, rainfed

Introduction

Aonla (*Emblica officinalis* Gaertn.) also known as Indian gooseberry, belongs to the family Euphorbiaceae. It is quite hardy crop, prolific bearer and highly remunerative even without much care. It is one of the most important minor fruit crops of Indian origin, which is predicted to be 'fruit of 21st century' even though it existed from time immemorial. The fruit is highly nutritive for human consumption. It is the richest source of vitamin C among fruits next to Barbados cherry and also useful for general improvement of health and medicinal purpose. Orchard floor management systems is one of the most important operations on successful orcharding and affects the growth and overall development of fruit trees. Sufficient information regarding orchard floor management in aonla is lacking. Therefore, the study was conducted to determine the vegetative growth, flowering and fruiting under different orchard floor managements.

Materials and Methods

The present investigation was carried out at Rainfed Research Sub-Station for Sub-tropical fruits Raya, Jammu and Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in 2013-14. Soil of the experimental field was sandy clay in texture, having pH: 6.50, organic carbon: 0.50%, available N: 174.50 kg/ha, available P: 15.80 kg/ha and available K: 140.00 kg/ha. Experiment was laid out in a randomized block design with seven treatments: T_1 (black polythene), T_2 (white polythene), T_3 (paddy straw), T_4 (saw dust), T_5 (sarkanda), T_6 (dry grass), T_7 no mulch (control). All the treatments were replicated four times. During the course of study, all the trees were given uniform cultural operations as per the package of practices for fruit crops of SKUAST-Jammu.

Results and Discussion

All the orchard floor management treatments increased stem girth, girth of primary branches and scion/stock ratio significantly (Table 1). However, maximum stem girth of 32.22 cm, girth of primary branches (18.64 cm) and scion stock ratio of 0.95 was found under black polythene mulch followed by paddy straw mulch and least observations were recorded under unmulched control. The results are in conformity with those reported by (Mukherjee *et al.*, 2004; Singh *et al.*, 2010). Anthesis in aonla mostly takes place in evening which varies from 5.50 to 7.48 p.m. with response to different treatments. In T1, T2 and T5 anthesis time is nearly same i.e. 6.40-7.48 P.M. with the peak of 7.15, 7.00 and 7.10 p.m. respectively. Trees under T3 and T6 open their flowers in early evening which ranges from 5.50 to 7.10 p.m. with the peak of 6.45 and 6.05 p.m. Also the concentration of the flowers were towards distal end. The results are in line with work done by (Bajpai 1965) and (Singh *et al.*, 2010) in aonla.

Table 1: Effect of orchard floor management practice on vegetative growth and anthesis of aonla under sub-tropical rainfed conditions

Treatments	Stem girth (cm)	Girth of primary branches (cm)	Scion/stock ratio	Time of anthesis (P.M)	Peak time of flower anthesis (P.M)	Concentration of flowers
T_1: Black polythene	32.22	18.64	0.95	6.45-7.48	7.15	Distal end
T_2: White polythene	31.29	18.46	0.79	6.42-7.45	7.00	Distal end
T_3: Paddy straw	31.72	18.58	0.82	6.15-7.10	6.45	Distal end
T_4: Saw dust	31.52	18.54	0.79	6.10-6.55	6.30	Distal end
T_5: Sarkanda	31.39	18.51	0.81	6.40-735	7.10	Distal end
T_6: Dry grass	31.38	18.53	0.77	5.50-6.45	6.05	Distal end
T_7: Control	31.15	18.41	0.72	6.48-7.44	7.08	Distal end
C D $_{(p=0.05)}$	0.22	0.12	0.08	NA	NA	NA

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243.

Effect of Mulching and Irrigation Intervals on Fruit Cracking, Fruit set and Yield of Litchi (*Litchi chinensis* Sonn.) cv. Dehradun

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Keywords: Litchi, irrigation, mulching, fruit cracking and fruit set.

Introduction

The litchi (*Litchi chinensis* Sonn.) an important sub-tropical evergreen fruit tree belonging to the family Sapindaceae originated from the subtropical areas of southern China. Litchi is known for its taste and flavour and rules the domestic market as "Queen of fruits" during the season. The litchi fruit is rich source of vitamins C and phenolic compounds that have antioxidant activities. Water management is an important aspect of litchi cultivation. Litchi requires optimum soil moisture for its optimum growth, development and fruit production. The litchi plants generally require regular irrigation at an interval of 2-3 days. Efficient water management can overcome several physiological disorders such as poor sex ratio, poor fruit set, heavy fruit drop and fruit cracking (Mitra and Pathak, 2010). Mulching is a beneficial practice to obtain higher income from orchards (Prakash *et al.,* 2007) and results in higher yield. The practice of mulching in fruit trees impart manifold beneficial effect, like stabilization of soil temperature, reduced water loss through evaporation, resulting more stored soil moisture, maintenance of soil fertility suppression of weed growth, improvement in growth and yield (Pande *et al*., 2005), reduces erosion by wind or water, checks surface run-off and suppress the weed growth. Keeping in mind all these facts present investigation was undertaken with the objective of determining effect of mulching and irrigation intervals on fruit cracking, fruit set and yield of litchi.

Materials and Methods

Present investigation was carried out at the Research Farm, Division of Fruit Science, Udheywalla, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, in 2014. Twenty year old plants of litchi cultivar Dehradun were subjected to mulching with black polythene and paddy straw along with regulated irrigations at the rate of 200 litres/ tree at 3, 6, and 9 days intervals. The experiment was laid out in randomised block design with nine treatments each replicated thrice.

Each tree was subjected to different mulching and irrigation regime namely T_1 (irrigation at 3 days interval [control]), T_2 (irrigation at 6 days interval), T_3 (irrigation at 9 days interval), T_4 (Paddy straw + irrigation at 3 days interval), T_5 (paddy straw + irrigation at 6 days interval), T_6 (paddy straw + irrigation at 9 days interval), T_7 (black polythene + irrigation at 3 days interval), T_8 (black polythene irrigation at 6 days interval), T_9 (black polythene+ irrigation at 9 days interval). Fruit skin cracking percentage was recorded visually by observing and counting the number of total and cracked fruits on the tagged branches. During fruit development the numbers of flowers the tagged branches were counted to determine per cent fruit set. For fruit yield, total number of fruits in each tree per replication was counted. The counting was made two to three times for minimizing the counting error.

Results and Discussion

It was revealed from the data that T_8 i.e. trees irrigated at 6 days intervals and mulched with black polythene was most effective in reducing the incidence of fruit cracking (10.15%) and resulted into highest fruit set (32.43%) and yield (59.33 kg/ tree). $T_{9;}$ tree irrigated at 9 days intervals and mulched with black polythene showed maximum incidence of fruit cracking (22.53%) and minimum fruit set (15.70%) and yield (42.60 kg/ tree) which was significantly lower than control i.e. 15.05%, 25.44% and 52.34 kg/ tree of fruit cracking, fruit set and fruit yield respectively(Table 1). A reduction in fruit cracking was recorded with the application of black polythene mulch as it served as a barrier to restrict the moisture loss through evaporation. The higher yield and fruit set under the mulch treatment is because of higher values of yield attributing characters, higher nutrient status and less fruit cracking. As far as results regarding effect of irrigation intervals on fruit cracking of litchi are concerned, minimum fruit cracking was observed when trees were irrigated at 6 days interval. Fruit cracking in litchi with a longer irrigation interval could be due to pericarp dessication, or the lowered skin strength could result from lowered solute transport for the cell wall synthesis in skin tissue.

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Table 1: Effect of mulching and irrigation intervals on fruit set (%), fruit cracking (%) and fruit yield (kg/tree) of litchi (*Litchi chinensis* Sonn.) cv. Dehradun

Treatment	Fruit set (%)	Fruit cracking (%)	Fruit yield (kg/tree)
T_1 (Irrigation at 3 days interval [control])	25.44	15.05	52.34
T_2 (Irrigation at 6 days interval)	24.01	18.29	50.91
T_3 (Irrigation at 9 days interval)	17.74	21.30	44.64
T_4 (Paddy Straw + irrigation at 3 days interval)	26.92	14.38	53.82
T_5 (Paddy Straw + irrigation at 6 days interval)	27.44	13.29	54.34
T_6 (Paddy Straw + irrigation at 9 days interval	22.77	19.05	49.67
T_7 (Black Polythene + irrigation at 3 days interval))	31.61	10.36	58.51
T_8 (Black Polythene + irrigation at 6 days interval)	32.43	10.15	59.33
T_9 (Black Polythene + irrigation at 9 days interval)	15.70	22.53	42.60
C.D at 5%	0.79	1.98	1.56

244.

Effect of Plant Growth Regulators on Growth and Flower Yield of Petunia (*Petunia hybrid L.*)

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Keywords: Plant growth regulators, GA3, CCC, NAA, petunia

Introduction

Petunia (*Petunia hybrid* L.) is a popular, easy to grow and versatile annual with showy flowers and has the longest season of bloom of all garden annuals. A wide range of colours and forms has been developed over the years, which are classified on the basis of the characteristics of flowers. Petunia plants are perennials but are generally grown as half-hardy annuals in open gardens. Petunia belongs to the family Solanaceae and genus Petunia, has its origin in South America. Petunia has 25 species. The petunia flower is funnel shaped, but hybridizers have created many variation including singles and doubles with petals that have wavy or fringed margins.

Materials and Methods

The experiment was conducted with 10 treatments: gibberellic acid (GA3) 100ppm, GA3- 200ppm, GA3- 300ppm, cycocel (CCC)- 250ppm, CCC- 500ppm, CCC-750ppm, Naphthalene acetic acid(NAA)- 30ppm, NAA- 45ppm and NAA- 60ppm. Petunia var. Picourty was sown randomized block design with 3 replications during winter season in 2011 at Floriculture Research Farm of the Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences. Row to row and plant to plant spacing were maintained at 50 cm and 55 cm, respectively. All the recommended agronomic package of practices was followed to grow a healthy crop. Observations were recorded on 10 characters.

Results and Discussion

All the genotypes showed significant differences for all the 12 parameters of growth and yield of petunia (Table 1). The maximum height of plant (27.97 cm) was recorded in treatments T2 (GA3 - 200ppm). The maximum spread of plant (69.15 cm) was recorded in treatments T2 (GA3 - 200ppm). The maximum number of leaves per plant (1559.93) was in treatments T2 (GA3 - 200ppm). The maximum number of branches per plant (18.07 cm) was recorded in treatments T2 (GA3-200ppm). The number of days required for first flower bud emergence from transplanting (49.87 days) was recorded in treatment T8 (NAA-45ppm). The fresh and dry weight of flower (1.02 g and 0.87 g) significantly increased in treatment T5 (CCC-500ppm). The flower diameter (8.75 cm) significantly increased in treatment T5 (CCC-500ppm). Significant increase in number of flowers per plant (54.47) was recorded in treatment T2 (GA3-200ppm). The maximum yield of flower per plant (105.73g) was recorded in treatment T2 (GA3-200ppm). Significantly increase in yield of flowers per plot (951.60g) and per hectare (3524.09t) were recorded in treatment T2 (GA3-200ppm). On the basis of present investigation it is concluded that the application of T2 (GA3@200ppm) was best in term of growth and yield of flower. The above findings are based on one year trial more scientific research is needed to confirm the above result.

Table 1: Performance of different treatment for various character of Petunia

Treatment	Treatment & Combination	Plant height (cm)	Plant spread (cm)	Number of leaves/ plant	Number of branches / plant	Days of first flower bud initiation	Number of flower/ plant	Diameter of flower (cm)	Fresh weight of flower (gm)	Flower yield/ ha (h)
0	Control	25.93	55.53	434.60	10.60	62.60	26.73	5.91	0.73	1.530
1	GA_3 @ 100ppm	27.80	66.80	575.00	14.13	58.87	45.60	7.82	0.86	2.835
2	GA3 @ 200ppm	27.97	69.15	1559.93	18.07	58.07	54.47	8.06	0.89	3.524
3	GA3 @ 300ppm	27.35	63.87	529.73	13.27	60.40	43.00	7.64	0.86	2.657
4	CCC @ 250ppm	23.49	50.53	381.53	12.60	65.67	35.13	8.33	0.93	2.533
5	CCC @ 500ppm	24.81	54.13	408.87	12.80	63.87	36.27	8.75	1.02	2.579
6	CCC @ 750ppm	20.27	40.87	241.33	12.47	68.13	31.80	8.13	0.91	2.375
7	NAA @ 30ppm	26.90	61.80	494.13	12.00	52.87	41.47	7.31	0.81	2.150
8	NAA @ 45ppm	26.97	62.33	523.47	12.13	49.87	42.53	7.53	0.85	2.230
9	NAA @ 60ppm	26.54	58.00	462.40	11.40	56.60	38.27	6.92	0.80	2.015
	S.Ed (±)	0.76	0.92	25.82	0.21	1.06	1.19	0.09	0.02	71.35
	CD (P=0.05)	2.25	2.75	76.71	0.62	3.15	3.53	0.26	0.07	211.99

245.

Effect of Foliar Nutrition on Yield and Nutrient Status of Mango (*Mangifera indica* L.) cv. Dashehari

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Keywords: *Mangifera indica* L., Dashehari, yield, foliar, micronutrients.

Introduction

Mango (*Mangifera indica* L.) belongs to family Anacardiaceae grown in Jammu at an area of 13057 thousand hectares with annual production of 17704 thousand metric tonnes having productivity of 1.35 metric tonnes/ hectare. In Jammu sub-tropics, from the last few years, some physiological stresses and quality related issues in mango orchards have come to fore. It was observed that unbalanced fertilization, micronutrients deficiencies, poor tree management and inadequate cultural practices are mainly responsible for orchard related issues. These problems appear mainly due to enigmatic growth behavior. Therefore, food supplements, multivitamins and mineral supplements are necessary for the healthy crops. The application of primary nutrients alone could not prove successful to produce high quality mango fruit and the application of micronutrients is necessary. Therefore, keeping in view, low quality and productivity of mango, this experiment was conducted to study the effect of foliar nutrition on yield and nutrient status of mango cv. Dashehari under Jammu sub-tropics with the objective to find out the response of foliar nutrition on yield and nutrient status of mango cv. Dashehari.

Materials and Methods

The study was conducted at experimental orchard of Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Udheywalla Jammu. The totals of sixteen treatments replicated thrice were executed in a randomized block design. The foliar application was done at the time of pea stage. In order to carry out the research analysis ten fruits were wrapped in paper and stored at room temperature in a basket up to proper maturity/ripening. The size and weight of the samples were measured and yield was recorded from the fruits harvested from each mango tree weighed on electronic balance and expressed in yield kg/tree. Nutrient content in fruits and leaves for total N was estimated by micro-Kjeldhal's method. Total P was determined by vanadomolybdo phosphoric yellow colour method. K content was estimated by Flame photometer. The estimation of Ca and Mg was done through atomic absorption spectrophotometer.

Results and Discussion

The findings of the experiment are given in Table 1, The highest fruit yield (99.72 kg tree^{-1}) and maximum. fruit length (10.45cm), breadth (6.17cm) and weight (170.17g) of mango cv. Dashehari was recorded with the application of 2.0% Ca $(NO_3)_2$+ 2.0% KNO_3 + 1.0% $ZnSO_4$+0.02% H_3BO_3 (T_{14}). Perusal of the data in Table 2 shows that the maximum leaf N (1.25 per cent), P (0.16%) and K (0.29%) respectively, were recorded with the foliar application of 2.0% $Ca(NO_3)_2$ + 2.0% KNO_3 + 1.0% $ZnSO_4$ + 0.02% H_3BO_3 (T_{14}). Based on the experimental results obtained, it was concluded that the yield and nutrient status of mango cv. Dashehari can be increased with foliar application of 2.0 per cent calcium nitrate+2.0 per cent potassium nitrate+1.0 per cent zinc sulphate+0.02 per cent boric acid at pea stage under Jammu sub-tropics.

Table 1: Effect of foliar nutrition on fruit length, breadth, weight and yield of mango cv. Dashehari

Treatment	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Yield (kgtree^{-1})
T_1- 2.0% $Ca(NO_3)_2$	9.12	5.05	141.12	85.00
T_2- 2.0% KNO_3	9.61	5.41	146.05	87.64
T_3- 1.0% $ZnSO_4$	9.28	5.17	144.00	85.78
T_4- 0.02% H_3BO_3	9.55	5.37	145.73	86.99
T_5- 2.0% $Ca(NO_3)_2$+ 2.0% KNO_3	10.03	5.63	150.65	89.52
T_6- 2.0% $Ca(NO_3)_2$+ 1.0% $ZnSO_4$	9.94	5.55	147.80	88.00
T_{7-} 2.0% $Ca(NO_3)_2$+ 0.02% H_3BO_3	10.00	5.61	150.58	88.93
T_8-2.0% KNO_3+ 1.0% $ZnSO_4$	10.16	5.81	159.60	91.45
T_9 -2.0% KNO_3+ 0.02% H_3BO_3	10.22	5.93	161.37	93.20
T_{10} -1.0% $ZnSO_4$ + 0.02% H_3BO_3	10.10	5.75	154.00	90.79
T_{11}-2.0% $Ca(NO_3)_2$+ 2.0% KNO_3+ 1.0% $ZnSO_4$	10.26	6.01	166.20	95.43
T_{12} -2.0% $Ca(NO_3)_2$+ 2.0% KNO_3+ 0.02% H_3BO_3	10.36	6.08	166.32	97.10
T_{13} -2.0% $Ca(NO_3)_2$+ 1.0% $ZnSO_4$ + 0.02% H_3BO_3	10.25	5.93	164.35	94.13
T_{14} -2.0% $Ca(NO_3)_2$+ 2.0% KNO_3 + 1.0% $ZnSO_4$ + 0.02% H_3BO_3	10.45	6.17	170.17	99.72
T_{15} -2.0% KNO_3 + 1.0% $ZnSO_4$+ 0.02% H_3BO_3	10.40	6.10	167.44	98.29
T_{16}-Spray with water only	9.01	5.00	140.48	84.00
C.D. (0.05)	0.18	0.11	3.55	3.91

Table 2: Effect of foliar nutrition on leaf N, P, K, Ca, Mg, Zn, & B of mango cv. Dashehari

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Zn (ppm)	B (ppm)
T_1	1.12	0.09	0.23	1.73	0.14	10.00	14.34
T_2	1.14	0.10	0.25	1.71	0.15	10.00	14.00
T_3	1.11	0.08	0.23	1.71	0.14	11.00	13.84
T_4	1.12	0.09	0.22	1.72	0.15	10.33	15.06
T_5	1.16	0.10	0.24	1.74	0.16	10.67	14.43
T_6	1.15	0.09	0.23	1.73	0.15	11.67	14.85
T_7	1.14	0.10	0.23	1.74	0.15	10.67	15.66
T_8	1.17	0.09	0.24	1.71	0.16	12.00	14.34
T_9	1.13	0.10	0.25	1.72	0.16	10.33	16.02
T_{10}	1.15	0.09	0.24	1.72	0.15	12.00	15.35
T_{11}	1.18	0.12	0.28	1.74	0.15	11.67	15.14
T_{12}	1.16	0.13	0.26	1.78	0.16	11.33	16.03
T_{13}	1.17	0.12	0.24	1.76	0.18	12.33	15.59
T_{14}	1.25	0.16	0.29	1.79	0.19	14.67	19.05
T_{15}	1.15	0.12	0.26	1.74	0.17	13.33	15.33
T_{16}	1.10	0.08	0.22	1.71	0.14	9.67	13.64
C.D. (0.05)	0.07	0.03	0.03	0.03	0.02	2.08	1.09

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Influence of Different Concentrations of Nitrogen, Zinc and Their Combination on Vegetative Growth of Pecan Nut Seedlings under Intermediate Agro-climatic Conditions of Jammu & Kashmir

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Abstract: The present investigation entitled "Influence of different levels of nitrogen, zinc and their combination on vegetative growth of pecan nut seedlings" was conducted at Regional Agricultural Research Station, Rajouri, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu during 2015-16. In the present study, maximum seedling height (69.99 cm), stem diameter (8.99 mm), number of leaves per plant (22.33), leaf area (103.22 cm^2), plant spread (37.89 cm), leaf length (9.14 cm) and leaf width (3.92 cm) were recorded when seedlings were sprayed with 5% N and 0.30% zinc.

Keywords: Pecan nut (*Carya illinoensis*), nitrogen, zinc, vegetative growth.

Introduction

Pecan nut (*Carya illinoensis*) is one of the most important nut crop of the family Juglandaceae, having high nutritional value containing high content of proteins (12.5%), fats (71.42%), phosphorus (0.46%) and potassium (0.23%) and is rich in oil content wherein some varieties have shown as high as 76 per cent oil.In Jammu and Kashmir, pecan nut can be successfully grown in Kathua, Udhampur, Reasi, Doda, Kishtwar, Ramban, Rajouri and Poonch districts of Jammu division and Baramula and Kupwara districts of Kashmir division. The total area under pecan nut production is increasing due its high economic returns and adaptation to intermediate zone of Jammu and Kashmir state of India. The available data revealed that the area under pecan nut in Jammu and Kashmir is about 656.00 ha, whereas, the production per annum was to the tune of 13.00 metric tonnes. Pecan nuts seedlings respond well to nitrogen and zinc. Deficiency of N cause light green colours in leaves, leaves become smaller, and premature defoliation occurs. This study was conducted to test the effects of different concentrations of Nitrogen and Zinc on the vegetative growth of pecan nut seedlings under mid hill conditions of Jammu and Kashmir State of India.

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station Rajouri, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu during 2015-16. The treatments comprised of T_0-control, T_1-N 1.25%, T_2-N 2.5%, T_4-N 5.0%, T_5-Zn 0.15%, T_6- Zn 0.30%, T_7- Zn 0.60%, T_8-N 1.25+Zn 0.15%, T_9-N 1.25+Zn 0.30%, T_{10}- N 1.25+Zn 0.60%, T_{11}-N 2.5%+Zn 0.15%, T_{12}-N 2.5%+Zn 0.30%, T_{13}-N 2.5%+Zn 0.60%, T_{14}-N 5.0%+Zn 0.15%, T_{15}-N 5.0%+Zn 0.30% and T_{16}-N 5.0%+Zn 0.60%. The foliar sprays of nitrogen and zinc were done on 20th May and 20th, June 2015 on one year old pecan nut seedlings. Equal amount of Ca (OH)2 was also used with Zn SO4 to reduce toxic effect of zinc on leaves. The data on seedling height, plant spread, stem diameter, leaves per plant, leaf area, and leaf length and leaf width were recorded during the course of present investigation.

Results and Discussion

It is clear from the data presented in Table 1 that there was significant effect of nitrogen, zinc and their combination on vegetative growth of pecan nut seedlings under intermediate agroclimatic conditions. The maximum seedling height (69.99 cm), stem diameter (8.99 mm), number of leaves per plant (22.33), leaf area (103.22 cm^2), plant spread (37.89 cm), leaf length (9.14 cm) and leaf width (3.92 cm) were recorded when seedlings were sprayed with 5% N and 0.30% zinc. The maximum seedling height may be due to moderate supply of nitrogen which have shown positive response and let the seedlings to grow to their genetic potentials. Goh and Haynes (1986) also reported increase in girth by application of nitrogen. The maximum number of leaves with the spraying of nutrients might be due to the fact that N helps in the formation of chlorophyll resulting in more number of leaves while N deficiency resulted in poor growth and hence produced minimum leaves on the plant. The application of zinc increased the vigour of the plants and hence increased the leaves. Nitrogen is the constituent of all proteins (Goh and Haynes, 1986) that is why with the increase of N, leaf size increased due to accumulation of photosynthates. The minimum leaf area in Zn deficient plants might be due to adverse affect on chlorophyll content, stomata conductance and net photosynthesis (Hu and Sparks, 1991).

It can be concluded from the trial that gradual increase in plant growth parameters occur with increase in nitrogen and zinc concentrations. 5% N level along with 0.30% Zn concentration produced the best results with respect to growth of pecan seedlings under mid hill conditions of Jammu & Kashmir.

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Table 1: Influence of nitrogen, zinc and their combination on vegetative growth of pecan nut seedlings

Treatments	Plant Height (cm)	Plant Spread (cm)	Stem diameter (mm)	Leaves/ plant	Leaf area (cm2)	Length of leaf (cm)	Width of leaf (cm)
T_0-Control	40.24	25.44	5.13	9.11	53.15	5.45	2.76
T_1-N 1.25%	41.45	27.28	5.67	11.33	59.00	5.78	3.13
T_2-N 2.5%	51.19	28.28	6.14	13.11	96.33	6.06	3.05
T_4-N 5.0%	50.00	33.28	6.32	14.00	102.20	6.59	3.39
T_5-Zn 0.15%	48.81	25.78	5.46	10.55	55.03	5.59	3.21
T_6- Zn 0.30%	49.85	28.44	5.92	12.78	90.10	5.95	3.18
T_7- Zn 0.60%	40.66	27.44	6.05	12.56	59.66	5.78	2.95
T_8-N 1.25+Zn 0.15%	49.74	25.78	6.12	13.11	63.66	5.89	3.02
T_9-N 1.25+Zn 0.30%	52.04	27.50	6.42	12.66	63.55	6.04	3.28
T_{10}- N 1.25+Zn 0.60%	54.03	31.28	5.73	13.22	65.11	6.32	3.21
T_{11}-N 2.5%+Zn 0.15%	55.80	31.61	8.31	13.44	70.00	6.42	3.44
T_{12}-N 2.5%+Zn 0.30%	58.93	31.95	6.49	19.34	70.66	6.96	3.29
T_{13}-N 2.5%+Zn 0.60%	54.54	31.45	5.99	11.22	80.44	6.71	3.09
T_{14}-N 5.0%+Zn 0.15%	65.52	34.06	7.04	16.11	83.00	7.80	3.21
T_{15}-N 5.0%+Zn 0.30%	69.99	37.89	8.99	22.33	103.22	9.14	3.92
T_{16}-N 5.0%+Zn 0.60%	60.71	31.00	6.34	14.33	91.33	7.70	3.03
CD at 5%	1.27	0.97	0.38	8.71	9.23	0.44	0.32

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Effect of Intensity of Heading Back on Litchi (*Litchi chinensis* Sonn.) Cultivar Seedless Late

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Keywords: Heading back, litchi, seedless late

Introduction

Litchi (*Litchi chinensis* Sonn.) is the sub-tropical evergreen fruit belongs to the family Sapindaceae and sub family Nepheleae and identified as main fruit crop for foreign exchange earnings. In India, Litchi cultivation is confined to Bihar, West Bengal, Uttar Pradesh, Jharkhand, Assam, Punjab, Chhattisgarh, Uttarakhand. In India, It is occupying an area of 84.2 thousand hactares with annual production of 585.3 thousand metric tonnes (Anonymous, 2014). Litchi plant starts bearing after 5-6 years of planting and attains commercial bearing stage at least after 10 years and commercially viable life (period) lies between 11 and 40 years. It has been observed in general that orchards after attaining the age of 30-40 years even spaced at 10m x 10m, turns dense with compact top canopy covering most of the branches at the bottom and bearing fruits only on the high-top produce less fruits of inferior quality. These plants pose problems in proper management such as pest control and, harvesting etc. With rising cost of management, it may not be economical to maintain these old senile orchards of above 40 years of age. Such orchards need to be rejuvenated for further higher production of quality produce.

Materials and Methods

The present investigation was conducted at the Punjab Agricultural University, Regional Research Station, Gurdaspur (Punjab) on 35-40 years old litchi cultivar Seedless Late in 2013 and 2014. The experiment was laid out under Randomized block design (RBD) with three replication.Plants of uniform growth and good health were headed back at the height of 2 m and 3m from the crotch angle in the months of December-January by retaining about four to five outward growing branches and rest should be thinned out. Bordeaux paste was applied on the cut ends and exposed branches were white washed. The new shoots were emerged around the headed limbs. In June, retained 3-4 healthy outward growing shoots oriented at the proper distance on each stub. Trees started bearing fruits after three years of rejuvenation. Data was recorded on vegetative growth, flowering and fruiting after first, second and third years of heading back of trees.

Results and Discussion

The rejuvenated plants of litchi have started bearing in 3rd year after heading back. From Table 1, it was observed that plant height, shoot sprouting, flowering and fruiting were significantly higher in heading back at 2m from crotch angle in 3rd followed by 2nd and 1st growing season than 3m from the crotch angle in 3rd followed in 2nd and 1st growing season of the tree. Therefore, it was concluded that litchi cultivar Seedless Late should be headed back to restore the productive potential at 2m from the crotch angle.

Table 1: Effect of intensity of heading back on vegetative growth, flowering and fruiting of litchi cultivar Seedless Late

Treatments	Plant height(m)			Shoot spouting(%)			Flowering (%) ≠	Fruiting (%) ≠
	1st year	2nd year	3rd year	1st year	2nd year	3rd year	3rd year	3rd year
2m from crotch angle	5.72	8.21	12.05	50.03	82.15	94.50	75.50	50.20
3m from crotch angle	4.77	6.15	7.99	26.17	40.28	62.45	40.35	25.38
CD(5%)	0.70	1.27	0.59	4.71	8.62	8.01	9.24	10.01
SE(mean)	0.11	0.19	0.09	0.72	1.32	1.22	1.41	1.53

≠ No flowering and fruiting in 1st and 2nd year

Reference

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248.

Role of Auxins for Improving Vegetative Propagation in Standard Cultivars of Chrysanthemum

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Keywords: Chrysanthemum, terminal cuttings, NAA, IBA

Introduction

Chrysanthemum (*Chrysanthemum morifolium* R.) a member of family Asteraceae, is an important ornamental plant in the global floriculture industry both as cut and loose flower. It is the world second most economically important floricultural crop following rose with 35 per cent share in the total cut flower production (Nalini, 2012). Chrysanthemum is commercially propagated through terminal cuttings. However, the propagation rate is low in standard cultivars. The use of different auxins has been reported to improve the rooting of cuttings in chrysanthemum (Petter, 1992). Therefore, the present studies were conducted to standardize the best growth regulator treatment for rooting in standard chrysanthemum cultivars.

Materials and Methods

The present investigation was carried out at the experimental field of Division of Vegetable Science and Floriculture of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in 2012-2013. The terminal cuttings were taken from the mother plants of five standard cultivars of chrysanthemum namely Excelsior, Gulmohar, Thai Ching Queen, Holiday Purple and Star Pink in the first week of July and treated with different concentrations of IBA and NAA (250 ppm, 500 ppm and 750 ppm each). The treated cuttings were planted in sand beds under shade net house. The experiment was conducted in Complete Randomized Design with three replications and the observations were recorded after 5 weeks of planting.

Results and Discussion

Data presented in Table 1 revealed that maximum rooting percentage (89.9%), longest root (5.26 cm), highest number of leaves (5.53) and plant weight (3.02 g) was obtained in cv. Gulmohar when terminal cuttings were treated with 500 ppm IBA while the treatment 750 ppm IBA produced maximum number of roots (5.50). Minimum rooting percentage (40.00), length of root (1.85 cm) and plant weight (1.50 g) was obtained in control (no auxin treatment) followed by 250 ppm IBA. The cultivars Thai Ching Queen and Star Pink showed better results with 500 ppm IBA where as 500 ppm NAA exhibited maximum rooting percentage in cvs. Holiday Purple and Excelsior.

Table 1: Effect of different concentrations of IBA and NAA on rooting parameters of terminal stem cuttings in chrysanthemum cv. Gulmohar

Treatment	Rooting percentage	No. of roots	Length of roots (cm)	No. of leaves	Plant weight (g)
IBA (250 ppm)	60.65 (50.68)	4.50	2.76	4.43	1.65
IBA (500 ppm)	89.90 (71.56)	4.43	5.26	5.53	3.02
IBA (750 ppm)	80.00 (64.13)	5.43	4.75	4.50	2.34
NAA (250 ppm)	65.00 (52.12)	3.00	3.03	3.00	1.79
NAA (500 ppm)	85.00 (66.48)	3.43	4.47	3.43	2.85
NAA (750 ppm)	70.00 (58.47)	5.50	3.90	5.43	2.78
Control	40.00 (38.10)	5.00	1.85	4.00	1.50
CD(0.05)	40.43	0.77	0.16	0.24	0.45

*Figures in the parenthesis are arc sine transformed values

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Effect of Foliar Application of Nutrients and Growth Regulators on Fruit Cracking of Lemon (*Citrus limon* L.) Cv. Eureka

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Keywords: Lemon fruit cracking, K_2SO_4, $CaCl_2$, 2,4-D, GA_3 and NAA

Introduction

Citrus is an important genus of the family Rutaceae, which occupies unique position among popular and commercially grown fruit crops in tropical and sub-tropical regions. Among different citrus species, lemon (*Citrus limon* L.) has originated in South Eastern Asia. The ellipsoidal yellow fruit is used for culinary and non-culinary purposes throughout the world. Fruits have special importance due to their distinct flavors and therapeutic values. They are rich in vitamin C with fair amounts of vitamins A and B. Besides this, they are also good source of minerals namely calcium, phosphorus and iron. Fruit cracking in citrus is one of the most exasperating problems experienced by the citrus fruit growers. Application of nutrients and growth regulators to control fruit cracking is a new innovative technique found useful in controlling citrus fruit splitting as growth regulators and nutrients markedly affect the rind structure, cell size and the thickness of the flavedo.

Materials and Methods

The study was carried out at the Rain-fed Research Sub-Station for Subtropical Fruits, Raya, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in 2014. The experiment comprised of 13 treatments replicated thrice laid in Randomized Block Design. Treatments comprised of 6% K_2SO_4 (T_1), 8% K_2SO_4 (T_2), 10% K_2SO_4 (T_3), 0.5% $CaCl_2$ (T_4), 0.75% $CaCl_2$ (T_5), 1% $CaCl_2$ (T_6), 20ppm 2,4-D (T_7), 30ppm 2,4-D (T_8), 40ppm 2,4-D (T_9), 20ppm Naphthaleneacetic acid (NAA) (T10), 30ppm NAA (T_{11}), 40ppm NAA (T_{12}), 10ppm GA_3(Control) (T_{13}). Fruit cracking percentage was recorded visually by observing and counting the number of total and cracked fruits on the tagged branches and converting the differential into percentage. Fruits with even the slightest of cracks were counted as cracked fruits.

$$\text{Fruit cracking (\%)} = \frac{\text{No. of cracked fruits on tagged branch}}{\text{Total no of fruits on tagged branch}} \times 100$$

Results and Discussion

Among the growth regulators, the minimum fruit cracking was recorded under treatment T_{12} (40ppm NAA) i.e. 13.06% which is statistically at par with the treatment T_{11} (30ppm NAA) i.e. 14.10% (Table 1). Among the nutrients the minimum fruit cracking was recorded under the treatment T_3 (10% K_2SO_4) i.e. 17.96% followed by treatment T_2 (8% K_2SO_4) i.e. 21.99% and maximum fruit cracking was noticed under the treatment T_7 (20ppm 2,4-D) i.e. 36.21%. The minimum fruit cracking was recorded under the treatment T_{12} (40ppm NAA) i.e. 13.06%.. All the treatments had a profound effect on fruit cracking percentage and the elastic and plastic properties of the citrus rind are thought to be involved in resistance to skin splitting. Application of auxins caused enlargement of cells by increasing the elasticity or permeability of cell wall (Cline and Trought, 2007). The findings have clearly indicated that there was a positive effect of nutrients and growth regulators on fruit cracking and quality of lemon.

Table 1: Effect of foliar application of nutrients and growth regulators on fruit cracking of lemon cv. Eureka

Treatments	Fruit cracking (%)
T_1 6% K_2SO_4	26.05
T_2 8% K_2SO_4	21.99
T_3 10% K_2SO_4	17.96
T_4 0.5% $CaCl_2$	30.11
T_5 0.75% $CaCl_2$	28.08
T_6 1.00% $CaCl_2$	24.02
T_7 20 ppm 2,4-D	36.21
T_8 30 ppm 2,4-D	34.71
T_9 40 ppm 2,4-D	32.15
T_{10} 20 ppm NAA	19.88
T_{11} 30 ppm NAA	14.10
T_{12} 40 ppm NAA	13.06
T_{13} 10 ppm GA_3 (Control)	15.93
C.D. $_{(p=0.05)}$	2.01

Reference

Cline, J. A. and Trought, M. 2007. Effect of gibberellic acid on fruit cracking and quality of 'Bing' and 'Sam' sweet cherries. *Canadian Journal of Plant Science*, **87**(30): 545-550.

250.

Fruit *Ber* Varieties for Winter *Kusmi* Lac Production, Livelihood Opportunities for Lac Growers in Jharkhand

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Keywords: *Ziziphus mauritiana*, *ber*, *kusmi* lac, livelihood, lac grower

Introductions

Ber tree is commercially exploited for lac cultivation in India extensively along with other host trees *palas* (*Butea monosperma*) and *kusum* (*Schleichera oleosa*). It is a very good host for both *rangeeni* and *kusmi* biotypes of bivoltine, *Kerria lacca*, (Kerr). Lac is the scarlet resinous secretion of scale insect which yields three useful materials resin, dye and wax. Only wild varieties of *ber* were exploited for commercial lac cultivation in India till date. The interactions of genotypes with environments (GxE) make it difficult for breeders to identify the best genotypes, be it during selection or for cultivar recommendation. The G x E interaction can be partitioned in studies on the adaptability and phenotypic stability.

Materials and Methods

Twenty four cultivars of *ber* were procured from Central Arid Zone Research Institute (CAZRI), Jodhpur and planted in July 1996 at IRF. All trees were pruned in February 2010 to ensure proper shoot development at inoculation time. Adequate new branches emerged at inoculation time in July. *Kusmi* broodlac was inoculated on branches of all the cultivars of *ber* used in this study to raise winter crop. Broodlac was harvested at maturity in February next year coinciding with pruning. Data were recorded for lac attributing traits including broodlac, scrapedlac and broodlac output ratio for four consecutive years (2010-11 to 2014-15). Eberhert and Russel Model (1966) was used for genotype by environment interaction and stability analysis. CAZRI *Gola* is well established fruit variety and susceptible to lac insect and thus considered as check in this studies.

Results and Discussion

Broodlac yield ratio of output and input is the main criteria to judge a cultivar of being good lac host. Among twenty four fruit cultivar of *ber Maharawali*, Thornless and *Banarasi Pebandi* along with check CAZRI *Gola* were observed promising for winter kusmi lac production (Table 1). Cultivars responded significantly different in these four environments (years). The variance due to environment was significant confirming variable and diverse nature of environments (Table 2). Environment linear and genotype x environment interaction (G × E) revealed that significant differential response to the changing environments. Cultivars *Mahrawali*, *Kali*, *Umran*, *Jogia* and *Banarasi Karaka* were found unstable (Table 1). Among stable cultivars *Chuhara* and *Banarasi Pebandi* performed well in favourable environment (bi>1). Cultivars Thornless and *Katha* consistently performed better in average environment (bi=1). These two cultivars may be recommended for winter *kusmi* lac production in Jharkhand. Farmers will get fruit from these cultivars in case of failure of lac crop thus securing livelihood for lac growers in Jharkhand.

Table 1: Winter *kusmi* broodlac output-input ratio of cultivars of *ber* and stability parameters

Varieties	2011-12	2012-13	2013-14	2014-15	Mean	bi	S2di
Randan	2.5	4.4	5.0	2.3	3.55	-0.24	1.85
Aliganj	5.3	2.7	4.2	2.9	3.76	-0.40	0.85
F1 Seb x Katha	2.8	2.8	4.0	2.8	3.08	0.01	-0.10
Bagwadi	6.1	4.4	6.8	8.1	6.35	0.79	0.62
Illaichi	4.1	5.8	7.5	9.2	6.66	1.32	-0.09
Thornless	7.6	6.0	8.2	11.8	8.38	1.38	0.87
Maharwali	4.3	3.3	11.8	15.7	8.78	3.47+	6.72**
Kali	4.5	5.9	10.1	8.4	7.23	1.02	4.59**
Cazri Gola (ch)	6.5	4.3	7.4	11.3	7.39	1.63	1.74
Reshmi	5.4	1.7	7.5	8.4	6.14	1.13	2.25
Katha	9.6	5.8	8.4	8.3	8.03	0.03	3.04
F1 Seb x Gola	7.5	4.9	7.0	12.2	7.88	1.65	3.15
BC1 Seb x Tikadi	4.5	5.5	3.5	7.1	5.18	0.63	1.28
Chhuara	3.1	6.7	7.4	10.6	6.95	1.82+	1.08
Umran	2.7	6.3	6.7	4.7	5.11	0.20	4.24**
Tikadi	3.0	2.2	2.7	4.8	3.17	0.59	-0.16
Jogia	2.8	8.2	4.7	9.8	6.36	1.42	6.71**
Banarsi Karka	2.6	9.1	4.3	8.2	6.07	0.89	10.53**
ZG-3	7.9	5.8	3.8	5.9	5.87	-0.38	2.99
Seb	3.1	3.2	3.2	6.1	3.88	0.85	-0.21
Sanaur 5	4.7	1.8	3.2	7.3	4.25	1.06	3.53
Kaithali	3.6	8.4	7.5	10.1	7.41	1.37	3.52
Banarsi Pebandi	3.5	7.1	8.2	14.9	8.41	2.910+	0.44
Mundia	2.7	6.2	3.5	6.9	4.85	0.86	2.86

Pooled Mean= 6.03
S.E(mean)= 1.04 CD at 5%=2.14
Mean of b= 1.00 S.E. of b= 0.651

Table 2: Environment (Linear) and Variety x Environment (Linear) against deviation

Source of Variation	d.f.	Mean Squares
Variety	23	12.49*
Environment	3	61.74*
Var. X Environment	69	4.53*
Env+Var X Env	72	6.91*
Env (Linear)	1	185.21*
Env X Var (Lin)	23	6.77*
Pooled Deviation	48	3.27*
Pooled Error	184	2.02

Pooled Error MSS for testing pooled deviations MSS 0.672

Reference

Eberhart, S.A. and Russel, W.A. (1966). Stability parameters for comparing varieties. ***Crop Science*** 6: 36-40.

251.

Residue Dynamics of Fenazaquin in Apple in Kashmir

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Keywords: Fenazaquin, apple, residue analysis

Introduction

The Jammu and Kashmir state has been declared as agro-export zone for apple where 30 lakh people directly or indirectly are eking out their livelihood from this industry. Recent past, however, has witnessed an increase in the arthropod pest problems especially mite infestation due to changing climatic conditions. This has led to introduction and use of a myriad of pesticides. Fenazaquin - a non-systemic acaricide intended for controlling phytophagous mites infesting a variety of fruit crops is extensively used in Kashmir. Since no information is available about its residue behavior under temperate conditions of Kashmir, it was thought pertinent to study the residue dyanamics of fenazaquin in apple.

Materials and Methods

The experiment was carried out on a 20 year old commercial "Red Delicious" apple orchard at Tel Bal, Srinagar. Fenazaquin 10 EC (Magister) was used to study the dissipation at recommended (X dose, 0.004%) and at 2X dose (0.008%). The spray was carried out one month before harvesting the fruits. Water used as control was simultaneously sprayed on separate trees. Samples of fruits were collected at 0, 3, 7, 10, 15, 20 days and at harvest. The procedure followed for extraction and cleanup was that of Kadenczki *et al.* (1992). The residue assay was carried out on a varian 450 gas chromatograph (GC) equipped with a thermoionic specific detector (TSD). The linearity plots and recovery tests were done for residue computation and validity of the procedure.

Results and Discussion

Fenazaquin 10 EC applied at X dose (0.004%) and 2X dose (0.008%) on Red Delicious apple variety left an initial deposit of 3.180±0.020 and 6.980±0.083 µg g^{-1} on the fruits at lower and higher concentrations, respectively. The initial deposits degraded with the passage of time reaching 0.098±0.001 µg g^{-1} on 20th day after spray in case of X dose with 96.91% dissipation and no residue could be detected beyond that period (Table 1). However, at 2X dose, the pesticide dissipated slowly recording a residue level of 0.290±0.036 µg g−1 on 30th day. Considering the maximum residue limits (MRL) value of 0.1 µg g^{-1} set by the European Union, the apple fruits with present residue levels shall be considered unsafe for the human consumption. The residues dissipated with a half life value ($T_{½}$) of 3.62 and 4.12 days, respectively for higher and lower doses. The kinetic parameters with respect to waiting periods (T_{tol}) were 18.55 and 30.49 days, respectively, for the lower and higher concentrations. Since the fenazaquin persisted for longer time period under the temperate climatic conditions of Kashmir, the strict observance of waiting periods becomes imperative for the safety the consumers both within the state and outside. Also for the safety of apple consumers, adoption of good agricultural practices (GAP) has to be a cardinal principle with the apple growers.

Table 1: Quantitative analysis of fenazaquin 10 EC in/on Red Delicious variety of apple

Days after treatment (X)	Residues* (µg g−1)±SD (Y)		Dissipation (%)	
	0.004 (%)	0.008 (%)	0.004 (%)	0.008 (%)
0	3.180±0.034	6.980±0.083	-	-
3	2.092±0.035	5.120±0.252	34.21	26.65
7	1.015±0.687	4.018±0.054	68.08	42.43
10	0.787±0.058	3.126±0.325	75.25	55.21
15	0.100±0.060	1.994±0.056	96.85	71.43
20	0.098±0.003	0.982±0.016	96.91	85.93
30 (Harvest)	BDL	0.290±0.036	BDL	95.84
	$T_{1/2}$ (days)= 3.62 T_{tol} (days)= 18.55 Y= 3.540-0.080 X $R^{2=}$ 0.09277	$T_{1/2}$ (days)= 4.12 T_{tol} (days)= 30.49 Y= 3.340-0.087X $R^{2=}$ 0.9188		

*Mean of 3 replications.; MRL= 0.1 (µg g−1); BDL= Below detectable limit
$T_{1/2=}$ half-life, $T_{tol=}$ waiting period, R^2= Regression coefficient

Reference

Kadenczki, L., Arpad, Z., Gadri, I., Arpad, A. Gyorft, L., Gabriela, R. and Winfried E. 1992. Column ex traction of residues of several pesticides from fruits and vegetables; A simple multi residue analysis method. *Journal of AOAC,* **75**(1): 53-61.

252.

Effect of Different Spacing's on Growth and Yield of Guava (*Psidium guajava* L.) Cv. L-49

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Keywords: Guava, high density planting, ultra high density, yield, growth

Introduction

Guava (*Psidium guajava*), the apple of tropics, is one of the most common fruits in India. It is the fourth most important fruit in area and production after mango, banana and citrus. Generally, guava is cultivated using traditional planting system, under which it is difficult to achieve desired levels of production, because large trees provide low production per unit area and need high labour inputs. Moreover, large trees take several years before they come into bearing and overall cost of production per unit area is further increased. Hence, there is overriding need to improve the existing planting system. There is currently a worldwide trend to plant fruit trees on permanent high-density planting/meadow orchard and to manipulate tree growth using canopy management to control tree growth patterns and tree shape and maintaining high fruit production of desired size and quality (Singh, 2001). Keeping in view this aspect an experiment was in order to study the effect of various spacings on growth and yield of guava cv. L-49 with the objectives studying the impact of different spacings on growth, yield and quality of guava cv. Sardar and to standardize planting distance for high density planting of guava in Jammu sub tropics.

Materials and Methods

Experiment was laid out in Randomized Block Design and guava plants of cv. L-49 were planted at four different spacings 6mx6m; 4.5mx4.5m; 3mx3m and 1.5m x1.5m with three rows of five plants in each. Data on stem height (m), Stem girth(m) and yield/Ha (Qtls.) was recorded after three years of planting.

Results and Discussion

After three years of growth the mean maximum tree height (2.56m) was recorded in closest spacing (1.5m X 1.5m) which and it decreased with increase in plant spacing. Minimum tree height (2.21m) was recorded in widest spacing (6m X 6m). Mean maximum stem girth (0.29 m) was recorded in plants planted at a distance of 6m X 6m while minimum stem girth (0.20 m) was recorded with spacing of 1.5m X 1.5m. After three years of growth, maximum yield/ha (116q) was recorded in spacing of 3m X 3m followed by spacing of 1.5m X 1.5m (68 q). Thus it was concluded that a medium high density of 3.0mx 3.0m in guava is more beneficial as compared to ultra high density.

Table 1: Effect of different spacing's on stem height (m), stem girth (m) and yield/tree (kg)

Spacing	Stem height(m)	Stem girth(m)	Yield(q/ha)
6mx6m	2.21	0.29	42.00
4.5m x4.5 m	2.27	0.24	59.00
3.0mx 3.0m	2.48	0.25	116.00
1.5m x 1.5m	2.56	0.20	68.00
C.D	0.19	0.06	

Reference

Singh, 2000-01. High Density Planting in Guava. Annual Report, Central Institute of Subtropical Horticulture, Lucknow.

253.

Performance of Different Fruits Crops Grown on Raised Soil Containers under High Ground Water Condition

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Keywords: Plant height, plant spread, stem girth, fruits, leaves

Introduction

Since time immemorial fruit plants are subjected to different types of biotic and abiotic stresses. Among them is water logged conditions or higher water table in soils affecting many tropical and subtropical fruit tree species including citrus (*Citrus* spp.), custard apple (*Annona squamosa*), bael (*Aegle marmelos*), aonla (*Emblica officinalis*) etc. The primary effect is the reduction in root shoot growth due to depletion of soil oxygen. Photosynthesis and root hydraulic conductivity declines and the translocation of photo-assimilates reduces and soil redox potential generally declines during soil water loggings. Keeping in view the excess water logged condition particularly during rainy season, performance of different fruits crops grown on raised soil containers was evaluated.

Materials and Methods

The present investigation was carried out at experimental orchard, Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha during the years 2012-15. Six fruit plants namely grape fruit (*Citrus paradisii*), sweet orange (*Citrus sinensis*), kinnow (*Citrus reticulata*), sweet lime (*Citrus aurantifolia*), custard apple (*Anona squamosa*), bael (*Aegle marmelos*) and aonla (*Emblica officinalis*) were evaluated for morphological characteristics. All fruit plants were of uniform age and replicated four times. The climate of experimental site was sub-tropical with hot and dry summer, hot and humid rainy season and cold winter months. The maximum temperature was up to 42.5°C during summer and minimum temperature of 2.3°C during winter. The mean annual rainfall was about 1000-1200 mm.

Results and Discussion

From Table 1, it is obvious that values of plant height, stem girth, number of fruits per branch, number of leaves per branch and plant spread in different fruit crops ranged from 1.80 to 6.10 m, 0.20 to 0.31 m, 1.00 to 12.00, 20.00 to 75.00 and 1.20 to 3.70 m in east to west directions and 1.30 to 3.50 m from north to south directions, respectively. Among different fruit crops maximum plant height of 6.10 m, stem girth of 0.31 m and plant of 3.70 m in east to west directions and 3.50 m from north to south directions were found in aonla, grape fruit and sweet lime plants, respectively and minimum plant height was recorded in grape fruit, while minimum stem girth and plant spread in custard apple plants. Maximum number of fruits and leaves were found in sweet lime (70.00), and bael (75.00), while minimum in custard apple and kinnow plants.

Table 1: Morphological characteristics of different fruit crops raised on soil containers under high ground water conditions

Fruit crop	Height (m)	Stem girth (m)	Number of fruits/branch	Number of leaves/branch	Plant spread (m)	
					East-west	North-south
Grape fruit	1.80	0.31	25.00	30.00	1.80	1.70
Kinnow	2.10	0.29	68.00	20.00	1.80	2.30
Sweet lime	2.40	0.30	70.00	23.00	3.70	3.50
Sweet orange	1.90	0.25	60.00	50.00	2.00	1.40
Custard apple	2.10	0.20	1.00	30.00	1.20	1.39
Bael	3.60	0.22	2.00	75.00	2.60	2.70
Aonla	6.10	0.24	12.00	43.00	3.30	1.50

254.

Studies on Enhancement in Rooting of Kiwifruit Cuttings under Zero Energy Poly-house

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Keywords: Cuttings, Kiwifruit, rooting, IBA, paclobutrazol and urea-phosphate

Introduction

The Chinese gooseberry or kiwifruit (*Actinidia deliciosa*) is a deciduous, dioecious fruiting vine belonging to family actinidiaceae and native to China. Though, it was introduced in Shimla in 1963, yet due to lack of technical knowhow, planting material its cultivation could not gain popularity and is still in infancy stage. Fruit trees are highly heterozygous in nature, hence propagation by seed never yields a true to type offspring and therefore, the asexual methods of propagation are employed to overcome this problem. This study was an attempt to increase not only the rooting ability but quality of kiwifruit cuttings with the aim to study the effect of paclobutrazol and IBA with urea-phosphate as co-factor on rooting of hardwood cuttings of kiwifruit.

Materials and Methods

A study was carried out at the experimental farm, Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir in 2014. Type of cutting was hardwood and propagation medium was sand. The size of each cutting ranged between 15 and 20 cm with diameter of 8 and 13 mm. Indole Butyric acid (IBA) was tried at 4 levels (0 ppm, 1500 ppm, 2500 ppm & 3500 ppm) and paclobutrazol at 3 levels of 0 ppm, 500 ppm & 1000 ppm. Urea-phosphate was applied at 2000 ppm as a co factor.Total treatment combinations were 24 and experimental design was CRD factorial.

Results and Discussion

Maximum rooting percentage of 56.94 was recorded when IBA was applied alone at 3500 ppm followed by 53.61 at IBA application of 2500 ppm. Maximum recording for number of primary roots (5.91), number of secondary roots (36.77), root length (7.25 cm), length of longest root (9.35 cm), diameter of longest root (0.88 mm), root mass (8.75 g) and callused cuttings (94.16%) were also recorded by the application of 3500 ppm IBA. Among all the treatment combinations, the combined effect of IBA, paclobutrazol and urea phosphate was found to be significant in improving the overall success of rooting in kiwifruit cuttings under zero energy poly-house. IBA at 3500 ppm, paclobutrazol 500 ppm in combination with urea phosphate 2000 ppm resulted in maximum rooting percentage (68.33%) (Table), callus (96.66%), survivability (96.66%), number of primary roots (7.92), number of secondary roots (50.57), root length (11.47 cm), length of longest root (14.64 cm), diameter (1.37 mm) and root mass (13.70 g). Paclobutrazol showed better results at 500 ppm for all the observations under study than 1000 ppm. Enhanced rooting success of (63.33%) was observed when cuttings were treated with combined application of IBA (3500 ppm) and paclobutrazol (500 ppm). Thus from the present study it was observed that for maximizing the success of rooting in hardwood cuttings of kiwifruit, combined application of 3500 ppm IBA, 500 ppm paclobutrazol and 2000 ppm of urea-phosphate was found to be most effective.

Table 1: Interaction effect of IBA, paclobutrazol and urea phosphate on rooting percentage of kiwifruit cuttings

Urea phosphate (ppm)	Paclobutrazol (ppm)	IBA (ppm)			
		0	1500	2500	3500
0	0	28.33 (5.32)*	41.66 (6.45)	43.33 (6.58)	46.66 (6.83)
	500	33.33 (5.77)	55.00 (7.42)	56.66 (7.53)	58.33 (7.64)
	1000	31.66 (5.63)	48.33 (6.95)	51.66 (7.19)	53.33 (7.30)
Mean		31.11 (5.58)	48.33 (6.95)	50.55 (7.11)	52.77 (7.26)
2000	0	31.66 (5.63)	43.33 (6.58)	48.33 (6.95)	51.66 (7.19)
	500	36.66 (6.05)	58.33 (7.64)	63.33 (7.96)	68.33 (8.27)
	1000	33.33 (5.77)	56.66 (7.53)	58.33 (7.64)	63.33 (7.96)
Mean		33.88 (5.82)	52.77 (7.26)	56.66 (7.53)	61.11 (7.82)
CD ($P \leq 0.05$)					
IBA × paclobutrazol × urea phosphate= 6.78 (0.48)					
*Figures in parenthesis are square root transformed values					

Reference

Wiesman, Z. and Lavee, S. 1995. Enhancement of IBA stimulatory effect on rooting of olive cultivar stem cuttings. *Scientia Horticulturae* **62**: 189-198.

255.

Effect of Heading Back and Pinching on Growth, Yield and Quality of Guava (*Psidium guajava* L.) Under High Density Plantation

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Keywords: Heading back, pinching, guava, shoot length, yield

Introduction

Guava (*Psidium guajava* L.) bears on current season's growth and flowers appear in axils of leaves, therefore, it responds well to pruning. Currently, there is a worldwide trend to plant fruit trees at higher density orcharding to control tree size and maintain desired architecture for better light interception and ease in operations such as pruning, pest control and harvesting. There are several operations involved in improving the yield and quality of guava fruits. Among them, heading back and pinching are important factors to sustain the yield and quality of fruits in high density planted guava. There are number of horticultural economic and practical reasons for heading back and pinching in guava to obtain productive and efficient trees and orchards. Some of these are firstly to control tree size and shape and secondly, for renewal of bearing shoots, rejuvenation of older plants especially in high density planting, fruit thinning to improve fruit size, yield and quality. Pinching of current season's growth is an alternative practice used to control vigor

Materials and Methods

The present investigation was carried out at experimental orchard, Department of Horticulture, CCS Haryana Agricultural University, Hisar in 2013-14. There were two treatments i.e. heading back and pinching. Heading back at the level of 150 cm, 175 cm and 200 cm and no heading back (control) was done in the month of March. Pinching i.e. no pinching, one pinching (last week of June), two pinchings (last week of June and July) and three pinchings (last week of June, July and August) were done on the headed back plants.

Results and Discussion

There was marked increment in shoot length per branch of guava hybrid Hisar Safeda due to severe pruning (heading back at 150 cm) and least shoot length was found in control. This increase in shoot length may be attributed to the reserve food material in the main scaffolds or branches due to which new growth was put forth just after the heading back. In present study, shoot length decreased with increasing numbers of pinchings. This decrease in shoot length may be due to overcome of apical dominance and emergence of lateral shoots. Yield was affected significantly by all the heading back levels as well as by pinching numbers. Regarding level of heading back, plants headed back at 200 cm level registered the highest yield (Table 1). In case of pinching numbers, trees pinched twice (June and July) gave maximum yield. The better effect of heading back on the yield per plant may be ascribed to production of shoots conducive to flowering and fruiting. The yield in severe heading back is lower due to reduced number of fruits. In un-pinched plants yield is poor due to shading effect of close planting.

Table 1: Effect of heading back and pinching on shoot length (cm) and yield (kg/tree) of guava under high density plantation

Treatment	Shoot length (cm)	Yield (kg/tree)
A) Heading back		
Control	22.73	14.43
150 cm above ground level	44.53	15.23
175 cm above ground level	40.60	15.85
200 cm above ground level	31.85	20.01
B) Pinching		
No pinching	39.90	14.75
One pinching	34.78	16.06
Two pinching	33.60	17.63
Three pinching	31.43	17.08
CD (5%)		
Heading back	0.68	0.65
Pinching	0.68	0.65
Heading back x Pinching	1.37	NS

256.

Effect of Foliar Application of Potash and its Spray Schedule on Yield and NPK Content of Leaf in Sweet Orange cv. Jaffa

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Keywords: Potash, foliar spray, sweet orange, Jaffa, NPK content, yield

Introduction

Application of potassium plays a regulatory role in many physiological and biochemical processes of fruit plants. Such as photosynthesis, nucleic acid metabolism, protein and carbohydrates biosynthesis which in result increase leaf mineral content and fruit yield. Foliar application of K has been found to rectify the deficiencies of nutrients as the availability of nutrients through foliar application is easy and quick to the plants. The present investigation was carried out to evaluate the effect of foliar application of potassium and spray schedule on nutrient concentration of the leaf of sweet orange cv. Jaffa.

Materials and Methods

The present investigation was conducted at experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar. The experiment comprised of four treatments of K fertilizers and its rate of application namely potassium nitrate at 2% (T_1) and 4% (T_2), potassium sulphate at 1.5% (T_3) and 3.0% (T_4) which were compared with T_5 i.e. control (water spray). There were three spray schedules i.e. S_1 (two sprays in the last week of April and August), S_2 (two sprays in the last week of May and August) and S_3 (three sprays in the last week of April, May and August). NPK content of the leaf was estimated and expressed in per cent. Total yield per plant was recorded at harvest.

Results and Discussion

Nitrogen content of leaves was found maximum (1.66%) with foliar application of KNO_3 at the rate of 4% which was at par with all other potassium treatments except control (Table 1). Phosphorus content of leaves was non-significant with foliar application of K from various sources. Leaf K content increased significantly with all potassium treatments and there was an increase in leaf K content with the increase in K doses of KNO_3 and K_2SO_4. Foliar application of KNO_3 of 4% gave maximum leaf potassium content (1.40%). Spray schedule of potassium did not significantly influence leaf NPK content. Yield increased significantly with all potassium treatments over control and there was an increase in fruit yield with the increase in K doses of KNO_3 and K_2SO_4. Maximum yield (74.76 kg) was recorded with KNO_3 at the rate of 4%. Increased frequency of K sprays increased the yield. Maximum yield (70.72kg) was observed with three sprays of potassium in the last week of April, May and August followed by two sprays during April and August. The increase in yield might be attributed to increased fruit reserves in the plant due to the foliar application of K. From the present study it can inferred that foliar application of K sources may improve nutritional status of leaves and fruit yield over control in sweet orange.

Table 1: Effect of foliar application of potassium and spray schedule on yield and NPK content in leaves of sweet orange cv. Jaffa

Treatment	NPK content (%) of leaf			Yield (kg/tree)
	Nitrogen	Phosphorus	Potassium	
A) K Sources				
T_1: KNO_3 2%	1.61	0.15	1.26	70.50
T_2: KNO_3 4%	1.66	0.15	1.40	74.76
T_3: K_2SO_4 1.5%	1.60	0.15	1.22	67.60
T_4: K_2SO_4 3%	1.59	0.14	1.27	69.74
T_5: Control	1.52	0.14	1.15	65.16
B) Spray Schedule				
S_1	1.60	0.14	1.24	70.19
S_2	1.60	0.15	1.24	67.15
S_3	1.59	0.15	1.30	70.72
CD (5%)				
K Sources	0.08	NS	0.09	3.45
Spray Schedule	NS	NS	NS	2.32
Source x Schedule	NS	NS	NS	5.62

257.

Quality Evaluation of Doughnuts from Pearl Millet (*Pennisetum glaucum* L.) Incorporated Composite Flour

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Keywords: Pearl millet, doughnuts, sensory, quality

Introduction

Composite flour technology refers to the process of mixing various cereal and legume flours to produce high quality food products in an economical way. Pearl millet (*Pennisetum glaucum* L.) locally known as '*bajra*' in India is rich in several nutrients as well as non-nutrients such as phenols. It has high energy, fiber, 8-15 times greater alpha amylase activity as compared to wheat, has low glycemic index and is gluten free. The mineral content in pearl millet is higher than other cereals. Therefore, the present study was conducted to expand the utility of pearl millet through value addition and to ascertain the physic-chemical and sensory characteristics of developed product.

Materials and Methods

In the present study pearl millet grains were obtained in a single lot from the Dryland Research Sub-station, Dhiansar, Sher-e-Kashmir University of Agricultural Sciences and Technology Jammu. The grains were sorted, milled and were ground to flour and used for further product development. The refined wheat flour was procured from market and was blended with pearl millet flour along with whey protein isolates to make protein enriched products. This composite flour mixture was used for development of doughnuts. For preparation of doughnuts refined wheat flour was supplemented with 10, 20, 30 and 40% pearl millet flour with 10% of whey protein isolates in each treatment. The other ingredients namely egg, sugar, oil and baking powder was same in all the treatments. The prepared doughnuts were packed in polyethylene pouches (150 gauge) and stored for a period of 90 days at refrigerated conditions. The stored products were analyzed for physico-chemical and sensory characteristics at an interval of 30 days. The data obtained were statistically analyzed using completely randomized design (CRD) and CRD factorial for interpretation of results through analysis of variance.

Results and Discussion

Results revealed that treatment T_1 (00: 100: 00: : Peral Millet Flour(PMF): Refined Wheat Flour(RWF): Whey Protein Isolate(WPI)) recorded highest diameter (8.75 cm) and thickness (2.50 cm) whereas, T_6 (40: 50: 10: : PMF: RWF: WPI) recorded maximum (5.38) spread ratio in doughnuts. The highest mean moisture content of 15.43% crude fat content of 24.76%, crude fiber content of 2.36% and ash content of 2.81% were recorded in T_6 (40: 50: 10: : PMF: RWF: WPI). However, T_2 (00: 90: 10: : PMF: RWF: WPI) recorded highest crude protein (17.99%). Maximum magnesium and phosphorus content of 139.91 and 311.69 mg/100g, respectively were recorded in T_1 (00: 100: 00: : PMF: RWF: WPI). Antinutrients (phytic acid and polyphenols) decreased with storage period and highest phytic acid and polyphenols were recorded in treatment T_6 (40: 50: 10: : PMF: RWF: WPI) which differed significantly with rest of the treatments. On the basis of sensory evaluation (Table 1) T_1 (00: 100: 00: : PMF: RWF: WPI) recorded highest score for colour (8.96), texture (8.74), taste (8.87) and overall acceptability (8.87) whereas, T_6 (40: 50: 10: : PMF: RWF: WPI) recorded lowest score for sensory parameters. From the present studies, it is therefore concluded that for the development of nutritious doughnuts pearl millet flour could be incorporated with whey protein isolates at the level of 20 and 10 per cent, respectively.

Table 1: Effect of treatments and storage period on mean score evaluation of overall acceptability of composite flour blended doughnuts

Treatments	Storage period (days)				
	0	30	60	90	Mean
T_1 (00: 100: 00: : PMF: RWF: WPI)	8.89	8.87	8.84	8.80	8.87
T_2 (00: 90: 10: : PMF: RWF: WPI)	8.76	8.73	8.70	8.66	8.71
T_3 (10: 80: 10: : PMF: RWF: WPI)	8.60	8.57	8.51	8.43	8.52
T_4 (20: 70: 10: : PMF: RWF: WPI)	8.32	8.23	8.10	7.86	8.12
T_5 (30: 60: 10: : PMF: RWF: WPI)	6.98	6.91	6.88	6.80	6.89
T_6 (40: 50: 10: : PMF: RWF: WPI)	6.81	6.63	6.64	6.28	6.53
Mean	8.06	7.99	7.90	7.80	

Effects CD (P= 0.05%)	
Treatments	0.01
Storage	0.01
Treatments × Storage	0.03

258.

Karonda (*Carissa carandus* L.): A Source of Natural Colourant and Nutraceuticals-Supplement

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Keywords: *Karonda*, natural colourant, flavonoids, phenolics, antioxidant

Introduction

The health benefits of *karonda* (*Carissa carandus* L.) are attributed mainly to the presence of some phytochemicals, which are referred as antioxidants. Despite, its multiple usefulness, it remained an underexploited fruit, probably, due to its small berry size and sour taste. However keeping in view the rising awareness among the consumers for health foods, alternative form of utilization may be devised to encourage its increased consumption by the general public. *Karonda* genotype, CIAH Selection-1, which turns dark red upon maturity; could be a likely candidate as a source of natural food colourant and antioxidants for its potential domestic and industrial application. A natural 'food colourant and nutraceuticals-supplement' was prepared from the ripe *karonda* fruits.

Materials and Methods

For colour extraction, after washing and cleaning ripe fruits were cut into halves. Seeds were removed before subjecting fruits to dehydration. The dehydrated fruits were later grounded into powder. Powdered fruit pulp was cold extracted thrice with ethanol and supernatant were pooled together, filtered and later air dried. The dried concentrated 'colour pigments' were then dissolved in water to get ready-to-use 'food colourant and nutraceuticals-supplement'. The formulation had been christened as 'Lalima'. To make it user-friendly, the formulation was packed in 10 ml plastic dropping bottles and 01 ml of this pigment suspension formulation is sufficient to give pleasing red colour to one serving of any colourless beverage such as lemon based beverages.

Results and Discussion

The naturally extracted pigments/colours are perceived by the consumer as safe to consume than the synthetic colours. Further, an added advantage of using such colours derived from natural sources is that they are bioactive.

One serve of *karonda* derived pigment supplemented beverage may additionally contain 469.2 µg anthocyanin (cyaniding-3-glucoside equivalent), 14.1 mg phenol (Gallic acid equivalent), 12.7 mg flavonoids (rutin trihydrate equivalent), with total antioxidant activities (CUPRAC) to be 390 µM Trolox Equivalent. Lemon *sherbet* supplemented with 'Lalima' (Fig. 1) was found to be more acceptable in terms of flavour and appearance among the testers than the plain lemon *sherbet*.

Fig. 1: Lemon sherbet fortified with 'Lalima', a 'natural colourant and nutraceuticals-supplement' derived from karonda genotype CIAH Selection-1.

The development of technology for value addition of the food items through alternative uses of *karonda* would help regulate the availability of such antioxidant rich sources for nutritional security.

259.

Effect of Supplementation of Knol Khol (*Brassica oleracea*) on the Physico Chemical Characteristics of Chicken Meat Balls

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Introduction

Poultry meat occupies a unique place in human diet by virtue of its specific nutritional characteristics. As consumers have become more health conscious, the trend is towards food including meat products with decreased level of fat, cholesterol, salt and caloric content as well as enriched with dietary fiber. Many incidences of people suffering from constipation have been reported throughout the world which is leading to colon cancer. To avoid such problems, incorporation of dietary fiber into poultry meat has become important since it is the key ingredient lacking in the meat products. Addition of some compatible vegetable entity into meat not only reduces its cost but also add some essential vitamins and fiber which are lacking in meat. The Khol Khol (*Brassica oleracea*) locally called *monj,* is one of the most commonly eaten vegetables in Jammu and Kashmir and was used as a fibre source in chicken meat. It contains health-promoting phytochemicals such as isothiocyanatessulforaphane,and indole-3-carbinol that are supposed to protect against prostate and colon cancer

Materials and Methods

The leaves and bulbs of knol khol were partially dried in hot air oven at 40°C for half an hour and converted into paste form by grinding. The knol khol paste thus prepared was incorporated at 3, 6, 9, 12, 15 and 18% levels in the formulation replacing lean meat. Minced meat was blended with salt, sodium tripolyphosphate and sodium nitrite for 1.5 minute. Then spice mixture, condiments and other ingredients were added and again mixed for 1.5 to 2 minutes to get the desired emulsion. Approximately 20-22g of the emulsion was taken and molded by rolling in hands and giving ball shape. The chicken meat balls thus prepared were deep fried in refined oil**.** Finally the prepared chicken meat ball were packed in laminated pouches, sealed and stored in a freezer till analysis. Various parameters namely cooking yield, emulsion stability, color values, proximate composition, pH, TBARS values, ascorbic acid, microbial analysis and sensory evaluation of chicken meat balls was carried out using standard methods at an interval of 30 days.

Results and Discussion

The highest value of emulsion Stability (91.13%) was recorded in T_1 (100: 0: : chicken meat: knol khol and the lowest value of emulsion stability (87.01%) was recorded in T_7 (82: 18: : chicken meat: knol khol). Crude fat significantly decreased while crude fibre content increased with the addition of knol khol in chicken meat. Themaximum level of ascorbic acid content of 23.48mg/100gm was recorded in T_7 (82: 18: : chicken meat: knol khol) and the minimum of 6.30 mg/100gm was recorded in T_1 (100: 0: : chicken meat: knol khol). The maximum thiobarbituric acid content of 0.39 per cent was recorded in $T_1$and the minimum of 0.19 per cent was recorded in T_7.

Thus it can be concluded from the present study that good quality chicken meat balls can be prepared with addition of knol khol upto 9% into the chicken meat with enhanced crude fibre contents, low fat, low TBARS values, and the highest sensory scores for colour, flavour, juiciness and overall acceptability. Therefore, processing of chicken meat to fibre rich value added products contribute to sustained demand for meat and efficient marketing of meat to earn reasonable returns by the processors. Such products can be formulated for consumers who are more health conscious and follow the trend of including meat products with decreased level of fat, cholesterol, salt and caloric content as well as enriched with dietary fibre.

Table 1: Effect of frozen storage (-18±2°C) on the overall acceptability of knol khol incorporated chicken meat balls

Treatments	Storage Period (Days)				Mean
	0	30	60	90	
T_1 (100: 0 : : chicken meat: knol khol)	7.34	7.23	7.05	6.85	7.12
T_2 (97: 3 : : chicken meat: knol khol)	7.39	7.23	7.04	6.88	7.13
T_3 (94: 6 : : chicken meat: knol khol)	7.44	7.28	7.07	6.92	7.18
T_4 (91: 9 : : chicken meat: knol khol)	7.46	7.24	7.11	6.97	7.19
T_5 (88: 12 : : chicken meat: knol khol)	7.19	7.03	6.87	6.75	6.96
T_6 (85: 15 : : chicken meat: knol khol)	6.99	7.31	6.70	6.52	6.88
T_7 (82: 18 : : chicken meat: knol khol)	6.89	6.70	6.56	6.32	6.62
Mean	7.24	7.15	6.91	6.74	

Effects C.D (p=0.05)

Treatment	0.04
Storage	0.09
Treatment x Storage	0.08

260.

Effect of Simulated Transportation on Physiological Properties of Ber Cv. Umran Stored under Ambient Storage Conditions

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Keywords: Ber, nylon netted bags, simulation vibration, Umran

Introduction

Ber (*Ziziphus mauritiana*) is not being marketed to any far extent places where it is not grown. This is due to absence of proper post-harvest handling technology including transportation and storage. The vibrations due to transportation are influenced by road roughness, distance, travelling speed, packaging and some characteristics of the truck such as suspension and the number of axle. In the present study, attempts was made to know the impact of transportation on physiological properties of ber by providing simulated transportation at different frequency levels for different time durations and on that basis the frequency of vibrations were standardized.

Materials and Methods

Laboratory vibration tester powered with 3HP electric motor was used to provide simulation vibration with required time as per treatments. The ber fruits of cultivar Umran were selected after harvesting and packed in nylon netted bags. Approximately 4kg fruits were packed in each of the nylon netted bags and were subjected to simulation vibration at three levels *i.e.* 50,100 and 200 rpm for 3 and 6 hour durations. The physiological parameters were recorded at alternate days up to 8^{th} day of storage after simulation vibration and fruits were stored at ambient temperature (26±3°C).

Results and Discussion

The data in Fig. 1 reveals that the firmness of the fruits decreased significantly with increased intensity and duration of vibration. Decrease in fruit firmness was presumably due to change in cell wall polysaccharides and decrease in cell wall uronic acid. Maximum fruit firmness (8.5-kg/cm^2) was observed in the fruits without simulation vibration followed by those fruits simulated at vibration of 50 rpm (7.6 kg/cm^2). The minimum firmness (5.5 kg/cm^2) was observed in the fruits simulated at vibration of 200 rpm. Firmness of the fruits also differed significantly with increased duration of vibration. It was recorded maximum (7.2 kg/cm^2) in the fruits rendered simulation vibration for 3 hours while minimum (6.9 kg/cm^2) was observed in the fruits given simulation vibration for 6 hour. The firmness also decreased significantly with increased period of storage. This might be due to the fact that decrease in fruit firmness occurs due to loss of moisture. Maximum firmness (9.5-kg/cm^2) was observed on day zero while it was minimum (4.3 kg/cm^2) on 8^{th} day of storage. The maximum fruit firmness (9.9 kg/cm^2) was observed in the fruits without simulation vibration while minimum (1.8 kg/cm^2) was recorded on 8^{th} day in the fruits simulated at vibration of 200 rpm for 6 hours.

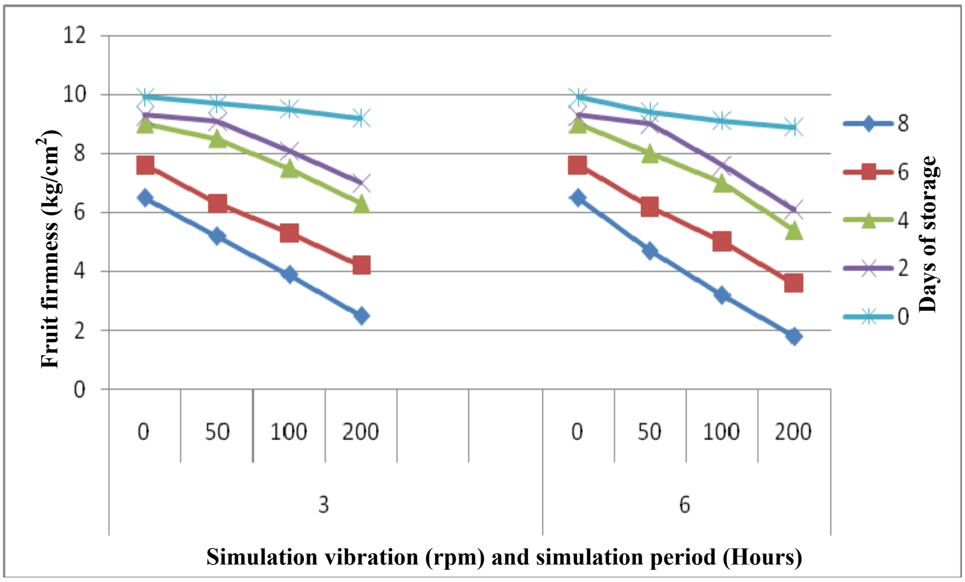

Fig. 1: Effect of simulation transportation (duration of vibration, simulation vibration and days of storage) on fruit firmness (kg/cm^2) of ber cv. Umran during storage at ambient temperature

261.

Standardization of Optimum Blends for Processing Value Added Ready-To-Serve Drink from *Aloe Vera*, Aonla and Papaya

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Keywords: *Aloe Vera*, aonla, papaya, optimum blends, RSM, low calorie

Introduction

Fruit and vegetable beverages have higher nutritional, medicinal and calorific values over synthetic beverages. Hence, more and more utilization of fruits and vegetables is necessary for processing into beverages and to avoid increasing post-harvest losses (Bhardwaj and Pandey, 2011). In the present study, *Aloe vera,* aonla (*Phyllanthus emblica* L.) and papaya (*Carica papaya*) were selected for the development of blended therapeutic ready-to-serve (RTS) drink. Acemannan, a storage polysaccharide, rich in mannose units is the main bioactive component of *Aloe vera* which is known for facilitating digestion, aiding blood and lymphatic circulation, besides improving kidney, liver and gall bladder functions (Eshun, 2004). Aonla (*Phyllanthus emblica* L.) was chosen for because it is a rich source of natural vitamin C, abundant pectin and minerals like iron, calcium and phosphorus whereas papaya (*Carica papaya*) was selected for being rich vitamin A and minerals. Keeping the above facts in view, the present study was carried out with the objectives to find out the appropriate recipe for development of RTS drink using response surface methodology (RSM), standardization of optimum blends from *aloe vera*, aonla and papaya using the best recipe given by RSM, and development of spiced and low calorie variants from the most acceptable formulation of *aloe vera*: aonla: papaya pulp/juice blend.

Materials and Methods

Papaya pulp, aonla and *aloe vera* juice was collected by cold extraction method. RSM was applied only for the preparation of papaya RTS drink and the selected recipe with optimum pulp, total soluble solids and acidity was then followed for preparation of all the beverage blends including low calorie and spiced RTS drink variants. The fresh pulp/juice and beverages were subjected to analysis for various parameters by standard methods. Formulations of different blends of *aloe vera*: aonla and *aloe vera*: papaya (25: 75, 50: 50 and 75: 25), and *aloe vera*: aonla: papaya (25: 25: 50, 20: 20: 60, 15: 15: 70 and 10: 10: 80) were standardized by subjecting to sensory evaluation. All the beverage blends were prepared by adjusting contents of pulp/juice, Total soluble solids (TSS) and acidity according to the standardized recipe generated initially by RSM.

Results and Discussion

Pulp/juice of *aloe vera*, aonla and papaya were evaluated for various physico-chemical characteristics. Results show that papaya pulp had highest yield (75.6%) followed by aonla juice (65.2%) and aloe vera juice (49.8%). TSS, acidity, pH and ascorbic acid content were recorded maximum in papaya pulp (7.1%), aonla juice (1.16%), aloe vera juice (4.8) and aonla juice (497 mg/ 100 ml), respectively. On the basis of organoleptic evaluation (9-point hedonic scale), blends of *aloe vera*: aonla (25: 75), *aloe vera*: papaya (25: 75) and *aloe vera*: aonla: papaya (10: 10: 80) were optimized and recipe having 20% juice/pulp, 15% TSS and 0.28% acidity was found most acceptable by RSM design for the preparation of RTS drink. Low calorie RTS drink developed by replacing 50% sugar with stevia and 35% sugar with sucralose were found most acceptable. Spices and ingredients namely salts, roasted cumin powder, small cardamom and black pepper (0.1% each), and chat masala (0.375%) were optimized for the preparation of spiced RTS drink.

Despite having high nutritional and medicinal qualities, the utilization of aonla and *aloe vera* have become limited in developing processed products owing to high acidity, astringency, bitterness and such other factors. It can be concluded from the present investigation that *aloe vera*, aonla and papaya pulp/juices with spices and low calorie ingredients can be conveniently and economically utilized in the development of value added nutritive and therapeutic beverages. These beverages will also improve socio-economic status of the farmers and entrepreneurs in country by enhancing the internal and export trades.

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Mature aonla fruits
↓
Washing
↓
Processing of aonla in multipurpose processing machine (Mfd. By autoflex)
↓
Seed and pomace
↓
Screw press
↓
Fresh aonla juice
↓
Sedimentation
↓ ⟶Sludge
Clarified juice
↓
Mixing sodium benzoate (1g/ L)
↓
Filling in polypropylene jars
↓
Storing in deep freezer

Freshly harvested *Aloe Vera* leaves
↓
Dipping into 500 ppm KMS solution for 1hr
↓
Washing thoroughly with tap water
↓
Keeping for flash cooling at 5°C for gel stabilization
↓
Cutting of leaves vertically into two halves and separation of gel using stainless steel knife
↓
Settling of gel for 12 hrs
↓
Washing of fillets
↓
Homogenization of fillets using MPP machine
↓
Passed through colloidal mill and filtration
↓
Mixing sodium benzoate (1g/L)
↓
Filling in polypropylene jars
↓
Storage in deep freezer

Ripe papaya fruits
↓
Washing
↓
Peeling
↓
Halving
↓
Removing seeds and inner whitish layer
↓
Cutting into pieces
↓
Blending in a mixer
↓
Homogeneous pulp
↓
Mixing of sodium benzoate (1g/kg pulp)
↓
Filling in polypropylene jars
↓
Storing in deep freezer

Blending of pulp/juice in different proportions

BLENDS	PULP/JUICE PROPORTIONS (TREATMENTS)			
A. *Aloe vera*: Aonla blend	25:75 (T_1)	50:50 (T_2)	75:25 (T_3)	
B. *Aloe vera*: Papaya blend	25:75 (T_4)	50:50 (T_5)	75:25 (T_6)	
C. *Aloe vera*: Aonla: Papaya blend	25:25:50 (T_7)	20:20:60 (T_8)	15:15:70 (T_9)	10:10:80 (T_{10})

↓
Best acceptable treatments from blend **'C'** was selected for preparation of value added RTS

i. Spiced RTS | ii. Low calorie RTS

Treat-ments	Spices	Quantity (%)
T_{11}	a.Salts, cardamom, black pepper, cumin	0.1
	b.Chat masala	0.375
T_{12}	a.Salts, cardamom, black pepper, cumin	0.2
	b.Chat masala	0.4

Stevia replaced with sugar		Sucralose replaced with sugar	
Treatments	Quantity (%)	Treatments	Quantity (%)
T_{13}	25	T_{16}	25
T_{14}	50	T_{17}	35
T_{15}	75	T_{18}	45

Selection of best treatment

After blending pulp/juice as per different treatments

Selection of best treatment

↓
Mixing syrup (water, sugar, citric acid or spice aqueous extract/sweeteners)
↓
Homogenization
↓
Straining and addition of preservative
↓
Filling into pre-sterilized glass bottles (200 ml capacity)
↓
Sealing with crown corks
↓
Processing (Boiling water for 25 minutes)
↓
Cooling, labelling and storage at room temperature

Fig. 1: Flow sheet for processing of raw materials, suitable blend proportions and preparation of RTS drink variants

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Effect of Bael (*Aegle marmelos* L.) Leaf Extracts on Shelf Life of Tomato (*Lycopersicum esculatum* L.)

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Keywords: *Bael*, coating, extract, quality, tomato.

Introduction

Tomato (*Lycopersicum esculatum* M.) is one of the most important vegetable plants in the world. India ranks second in area as well as in production of tomato. Tomato production in India is estimated at 18,227,000 metric tonnes in 2015 (FAOSTAT, 2015). Tomato is a climacteric fruit and has relatively short postharvest life. Every year approx. 25-40% tomato losses occur due to lack of suitable methods of post-harvest storage (Paul and Pandey, 2013). Hence, to extend the storage life of tomatoes, regulation of ripening by retarding the metabolic activities coupled with prevention of microbial attack is an important consideration. Coatings have the potential to reduce moisture and firmness loss, provide oxygen barrier properties, retard respiration rates, hinder solute movement, reduce metabolism, seal in flavor volatiles and improve the appearance. Keeping in view the perishability of tomato and its importance in world agricultural trade, the present study was planned to study the effect of *bael* leaf extracts on biochemical and quality parameters of tomato.

Materials and Methods

Tomatoes (BSS-488) samples were procured from the fields of Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. B*ael* (*Aegle marmelos* L.) leaf extract (2-5%) solutions were prepared with 1.5% pectin as a gelling agent. Tomatoes were dipped in the coating solution for 9 minutes, air dried and then stored at 10±1˚C and the following parameters namely physiological loss in weight, colour change, total soluble solids, acidity, crude protein, flavanoids, total phenolic content, lycopene and sugars were estimated using standard methods.

Results and Discussion

Bael coated fruits had higher content of total soluble solids as compared to control (Table 1). Acidity, ascorbic acid content, reducing and non-reducing sugars of coated and control tomatoes initially increased and then decreased with increase in the storage period (Table 1). Crude protein decreased as the period of storage increased in all the treatments. Tomatoes coated with 5% *bael* leaf extract showed highest amount of flavanoids and total phenolic content. Lycopene increased with the increase in the period of storage in control and coated tomatoes. Among all the treatments, 5% *bael* coating was most effective in retaining the texture and quality of tomato.

Table 1: Analysis of tomatoes treated with *bael* during storage at 10±1°C

Parameters	Control (0*-15** days)	2% Bael (0*-21** days)	5% Bael (0*-21** days)
Physiological loss in weight (PLW) (%)	0-19.62	0-17.67	0-15.46
Colour change	Green- Red ripe	Green- Red ripe	Green- Red ripe
Total soluble solids (˚Brix)	7.06-6.84	7.06-6.8	7.06-6.72
Titratable acidity (%)	0.586-0.346	0.586-0.376	0.586-0.421
Ascorbic acid (µg/ml)	5.05-7.29	5.05-7.59	5.05-8.41
Reducing sugars (%)	2.482- 2.40	2.482-2.52	2.482-2.61
Non Reducing sugar (%)	0.049-0.161	0.049-0.163	0.049-0.177
Crude protein (%)	13.46-8.55	13.46-8.57	13.46-9.81
Total flavonoids (mg/g dry wt)	1.51-1.30	1.51-1.35	1.51-1.50
Total phenolic content (mg/100g)	9.6-5.84	9.6-5.94	9.6-7.13
Lycopene (mg/kg f. wt)	20.15-170.98	20.15-171.18	20.15-167.94

*Shows the initial value taken at zero days after storage and **shows the final value taken at last day of storage

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263.

Waste Management of *Brassica oleraceae* Leaves to Develop High Fiber Wheat Biscuits and Noodles

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Keywords: Biscuit, cauliflower, malted wheat, noodles, waste management.

Introduction

Various studies have been carried out to develop high fibre baked and extruded products but the main emphasis has been given on incorporation of cereal and pulse husk. But the scientists have found that the fruits and vegetables contain higher level of cellulose than cereals. Besides having good amount of dietary fibre, vegetables and fruits are also considered to be chemical power houses that produce dozens of unique, complex and biologically active organic compounds which are known to affect significantly the quality and duration of life. The leaves contribute about 50% of the total production of cauliflower. The leaves of cauliflower (*Brassica oleraceae*) are available only for a short period but these can be dried or stored for use during lean season. Dehydrated leaves are also rich source of β-carotene and iron which can be used in sparce season. Hence, incorporation of fibre rich ingredients in extruded products will improve their nutraceutical properties and help to cater to the health needs of various cross-sections of the population.

Materials and Methods

Cauliflower (*Brassica oleracea*) leaves were obtained from local market, washed, blanched, dried in hot air oven at 40°C for 4-6 hours and ground to fine powder. Wheat (*Triticum aestivum*) was procured from local market, cleaned and was divided into 3 lots. One lot was milled into flour and was treated as whole wheat flour. Malted wheat flour was prepared by soaking wheat for 12 hours in water, then the water was drained off and wrapped in a moist muslin cloth and kept for germination for a period of 48 hours at room temperature (25±2°C). The germinated wheat having an average root length of 1.6 - 3.3 cm, respectively were oven dried at 70±5°C and milled. However for roasted wheat flour the lot was cleaned, roasted for 3 minutes, cooled and milled into flour. The process for preparation of sweet ʿnʾ salty biscuits using flour of wheat was standardized using creaming method and noodles by extrusion method. Standardised ratios of wheat and cauliflower powder were (100: 0; 90: 10; 80: 20; 70: 30)

Results and Discussion

The treatment combinations showed a significant effect of on nutritional composition of high fiber biscuits and noodles. The highest moisture (1.66%), protein (9.51%), ash (1.59%) and fiber (13.62%) were reported in treatment T_8(malted wheat flour: cauliflower leaf powder: : 70: 30) and the lowest protein (7.36%), ash (1.10%), fiber(6.12%), total sugar (15.03%), β- carotene (2.76mg/100gm) and iron content of 5.10 mg/100gm in treatment T_1(whole wheat flour: cauliflower leaf powder: : 100: 0). However treatment T_8 also reported highest total sugar (18.00%), β- carotene (3.13mg/100gm) and iron content of 5.59 mg/100gm). Highest fat content of 22.62% was recorded in treatment T_1 (whole wheat flour: cauliflower leaves: : 100: 00) (Table 1).

However in noodles the highest moisture (10.17%), protein (13.45%), ash (1.09%) and fiber (3.56%) were reported in treatment T_8 (malted wheat flour: cauliflower leaf powder: : 70: 30) and the lowest protein (11.38%), ash (0.82%), fiber (3.30%), total sugar (1.60%), β- carotene (7.90 mg/100gm) and iron content of 10.05 mg/100gm in treatment T_1 (whole wheat flour: cauliflower leaf powder: : 100: 0). However treatment T_8 also reported highest total sugar (3.77%), β- carotene (9.23 mg/100gm) and iron content of 11.01 mg/100gm). Highest fat content of 2.52% was recorded in treatment T_{12} (roasted wheat flour: cauliflower leaves: : 70: 30) (Table 2).

Table 1: Nutritional composition of high fiber biscuits.

Treatments	Moisture %	Protein %	Fat %	Fiber %	Ash %	Sugars %	β-carotene mg/100g	Iron mg/100g
T_1(100: 00: : Whole Wheat flour: Cauliflower leaves)	1.64	7.36	22.62	6.12	1.10	15.03	2.76	5.10
T_2(90: 10: : Whole Wheat flour: Cauliflower leaves)	1.62	7.37	22.29	6.82	1.13	15.29	2.78	5.13
T_3(80: 20: : Whole Wheat flour: Cauliflower leaves)	1.61	7.38	22.24	7.57	1.14	15.43	2.80	5.14
T_4(70: 30: : Whole Wheat flour: Cauliflower leaves)	1.60	7.38	21.97	8.39	1.20	15.89	2.86	5.20
T_5(100: 00: : Malted Wheat flour: Cauliflower leaves)	1.62	9.42	20.98	10.72	1.33	16.44	2.91	5.33
T_6(90: 10: : Malted Wheat flour: Cauliflower leaves)	1.64	9.43	20.83	11.50	1.46	16.99	2.99	5.46
T_7(80: 20: : Malted Wheat flour: Cauliflower leaves)	1.64	9.44	20.64	12.53	1.43	17.54	3.07	5.43
T_8(70: 30: : Malted Wheat flour: Cauliflower leaves)	1.66	9.51	20.12	13.62	1.59	18.00	3.13	5.59
T_9(100: 00: : Roasted Wheat flour: Cauliflower leaves)	1.58	8.40	21.56	8.65	1.18	15.50	2.81	5.18
T_{10}(90: 10: : Roasted Wheat flour: Cauliflower leaves)	1.55	8.42	21.19	9.30	1.25	15.97	2.86	5.25
T_{11}(80: 20: : Roasted Wheat flour: Cauliflower leaves)	1.54	8.44	21.11	9.96	1.35	16.31	2.91	5.35
T_{12}(70: 30: : Roasted Wheat flour: Cauliflower leaves)	1.51	8.45	21.07	10.21	1.36	16.48	2.93	5.36
Mean	1.60	8.42	21.38	9.62	1.29	16.24	2.90	5.29

C.D. ($p \leq 0.05$) Treatment: 0.02

Table 2: Nutritional composition of high fiber noodles.

Treatments	Moisture %	Protein %	Fat %	Fiber %	Ash %	Sugars %	β-carotene mg/100g	Iron mg/100g
T_1(100: 00: : Whole Wheat flour: Cauliflower leaves)	9.70	11.38	2.86	3.30	0.82	1.60	7.90	10.05
T_2(90: 10: : Whole Wheat flour: Cauliflower leaves)	9.60	11.38	2.80	3.35	0.84	1.67	7.91	10.11
T_3(80: 20: : Whole Wheat flour: Cauliflower leaves)	9.47	11.39	2.77	3.39	0.85	1.73	7.95	10.13
T_4(70: 30: : Whole Wheat flour: Cauliflower leaves)	9.20	11.40	2.75	3.41	0.87	1.81	7.98	10.24
T_5(100: 00: : Malted Wheat flour: Cauliflower leaves)	9.50	13.41	2.97	3.44	0.99	3.55	9.05	10.51
T_6(90: 10: : Malted Wheat flour: Cauliflower leaves)	9.90	13.42	2.94	3.47	1.01	3.63	9.09	10.76
T_7(80: 20: : Malted Wheat flour: Cauliflower leaves)	9.70	13.43	2.93	3.52	1.05	3.70	9.17	10.69
T_8(70: 30: : Malted Wheat flour: Cauliflower leaves)	10.17	13.45	2.91	3.56	1.09	3.77	9.23	11.01
T_9(100: 00: : Roasted Wheat flour: Cauliflower leaves)	9.77	12.38	2.61	3.38	0.94	2.58	8.03	10.24
T_{10}(90: 10: : Roasted Wheat flour: Cauliflower leaves)	9.57	12.40	2.58	3.40	0.96	2.64	8.07	10.38
T_{11}(80: 20: : Roasted Wheat flour: Cauliflower leaves)	9.43	12.40	2.55	3.43	0.98	2.69	8.96	10.58
T_{12}(70: 30: : Roasted Wheat flour: Cauliflower leaves)	9.27	12.43	2.52	3.45	1.01	2.75	8.98	10.59
Mean	9.61	12.41	2.76	3.43	0.95	2.68	8.52	10.44

C.D. ($p \leq 0.05$) Treatment: 0.01

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Effect of Pre Harvest Application of Chemicals on Shelf Life and Yield of Peach *cv.* Shan-i-Punjab

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Keywords: Calcium, peach, shelf life, Shan-i-Punjab

Introduction

Peach (*Prunus persica* (L.) Batsch) is one of the major drupaceous temperate stone fruits of family Rosaceae and sub-family Prunoidae. Peach fruit left for too long on the tree becomes too soft and cannot be shipped because of reduced shelf life (Murray *et al.,* 1998). Progress has been made in the use of controlled atmosphere storage and research has shown the potential for post-harvest disease control using biological agents. Other approaches have been tried and identification of effective natural chemical (i.e., those present in plant extracts), which may be more acceptable to consumers than those that are synthetically produced. Thus, research has been focused on extending port-harvest fruit storage life by pre or post-harvest treatments with calcium, potassium and 2 chloro, 4-pyridyl 3-phenyl urea. Keeping in view the importance of shelf life of peach, the present investigation was planned.

Materials and Methods

The trail was conducted on 10 year old uniformly vigorous Shan-i-Punjab peach trees randomly selected for the purpose of the study at Government Garden and Nursery, Attari, Amritsar. The pre-harvest application of chemicals was given at the end of 2nd stage of fruit development and at the beginning of 3rd stage of fruit development (i.e., 3 or 4 weeks before harvesting). Healthy and uniform plants of peach cv. Shan-i-Punjab were marked and sprayed with calcium chloride, potassium nitrate and CPPU L-(2 chloro-4pyridyl) 3-phenyl urea at concentration as 1, 2, 3% and spray with plain water was kept as control. A total of ten treatments were given comprising three replications in peach treatment and data were analyzed in Randomize Block Design with factorial applications. At the time of harvesting the healthy fruits were washed and air dried at room temperature. After drying, the fruits were packed in one kg Corrugated Fibre Board boxes in layers and placed in cold chamber (0 to 1°C tempt and RH 90-95%), and various observations were recorded.

Results and Discussion

Mean minimum physiological loss in weight (0.02%) was observed in peach fruits treated with CPPU 5 ppm, 2.50 ppm and $CaCl_2$ 3%. It is apparent from the data that fruits kept for storage period of 25 days showed significant losses of weight. Calcium application was effective in terms of membrane functionality and integrity maintenance, with lower loss of phospholipids and proteins and reduced ion leakage (Lester and Grusale, 1999), which could be responsible for the lower weight loss. It is revealed that fruit colour development increased with the advancement of storage period. Mean minimum values 5.53% were observed on the day of harvesting. The mean maximum values 8.05% were observed after 25 days of storage. After 5 days of cold storage, the peach fruits treated with CPPU 5 ppm showed the maximum fruit firmness (7.86). Higher fruit firmness in calcium chloride treated fruits may be due to the role of calcium in farming the cross links with carboxylic group of polygalacturonase polymers present in middle lamella of cell (Mastrangelo *et al.,* 2000). Peach fruits treated with $CaCl_2$ did not show any spoilage during the cold storage period with advancement of storage spoilage percentage increase.

Table 1: Effect of $CaCl_2$, KNO_3 and CPPU on PLW, fruit colour, fruit firmness, palability rating and spolage (%) in peach fruits

Parameters	Treatments	Storage intervals					
		05 days	10 days	15 days	20 days	25 days	Mean
Physiological weight losses (%)	T_8 - CPPU 2.50 ppm	0.021	0.03	0.03	0.04	0.05	0.02
	T_9 - CPPU 5 ppm	0.01	0.02	0.02	0.04	0.05	0.02
Fruit colour	T_3 - $CaCl_2$ 3%	0.01	0.02	0.03	0.04	0.05	0.02
Fruit firmness	T_9 - CPPU 5 ppm	7.87	7.86	7.71	6.93	6.73	6.60

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265.

Nutrient Composition of Raw and Processed Products from Jammu Potato Cultivars (*Solanum tuberosum* L.)

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Introduction

Potato (*Solanum tuberosum* L.) commonly known as the king of vegetables is the most valuable tuber crop produced in 150 countries. China is now the world's largest potato producer and India ranks fourth. The objective of the storage environment is to maintain the external and internal quality of potato tubers. Storage conditions are very specific for potatoes intended for processing where a low and uniform content of reducing sugars is required. The technique for production of flour on the small scale is very simple and cheap which require no costly machinery and utilizes solar energy for drying. Traditionally solar drying has been used as a method of preserving foodstuffs (Kolawole *et al.,* 2011). In Jammu and Kashmir (J&K) also farmers have taken up potato cultivation and they face the same problem of disposal of produce during the peak harvesting period. Processing and value addition of potato in the state is almost negligible. The short shelf life of the product necessitates finding out suitable treatments and packaging materials possessing higher storage stability, so as to increase the market potential of the product. Thus before proceeding for product development, the quality of available cultivar must be evaluated to suit the desired product characteristic.

Materials and Methods

The present investigation was carried out in the Division of Post Harvest Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Udheywalla Jammu. Medium sized matured tubers of potato cultivars, namely Kufri Badshah, Kufri Sindhuri, Kufri Chandermukhi, Kufri Chipsona-I, Kufri Chipsona-II harvested in the mid of February were procured from the State Department of Agriculture, Jammu. The potatoes were kept at room temperature (28-35°C and RH 59-83%) to assess their storage life. The cultivar having optimum quality characteristics for processing into flour were selected. The potato slices were subjected to different pre-treatments like blanching, dipping in 100ppm KMS, drying in a dehydrator at a temperature of 52±2°C and finally grinded in a mixer for preparation of flour.

Physiological weight loss of potato tubers each of cultivar was observed at ambient condition and the results were expressed as per cent on fresh weight basis (AOAC, 1995).

Results and Discussion

While studying the effect of storage on potato tubers of different cultivars at ambient temperature, it was observed that the physiological weight in loss increased during storage. The increase in physiological weight in loss might be due to sprouting, spoilage as well as loss of moisture from tubers by transpiration and respiration. This is in conformity with the results of Mehta and Kaul (1987) and Kazami *et al.*, (2001).

Table 1: Effect of storage period on physiological loss in weight (%) of different potato cultivars.

Treatments	Storage period (days)			
	0	30	60	Mean
Kufri Jyoti	-	6.80	13.40	**10.01**
Kufri Sindhuri	-	5.55	8.41	**7.98**
Kufri Baadshah	-	6.14	9.67	**8.60**
Kufri Chandermukhi	-	4.88	8.60	**6.74**
Kufri Chipsona-1	-	5.10	8.03	**6.56**
Kufri Chipsona-2	-	4.62	7.37	**7.33**
Mean	-	**5.51**	**9.24**	
CD $_{(0.05)}$				
Cultivars	0.15			
Storage period	0.08			
Cultivars x Storage	N.S			

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266.

Characterization of Five Different Apple Cultivars for Apple Cheese Preparation

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Keywords: Apple, Cheese, firmness, anthrocyanin, cultivars, non-reducing sugar

Introduction

Jammu and Kashmir (J&K) is the country's largest apple producing state, contributing 62% of total apple production of our country. Apples are highly perishable due to lack of adequate post harvest handling facilities and proper infrastructure in our country, post harvest losses due to spoilage are very high, estimated about 25-30%. Apples are eaten fresh or as compotes, jams, juices, juice concentrates, vinegars, flavorings, or extracts of various chemical compounds existing in the fruit. Apple fruit quality is very important, being determined by the content of sugars, organic acids and phenolic compounds. The aim of this paper was to study the detailed physical and chemical composition of apples from three varieties for preparation of apple.

Materials and Methods

The present investigation was conducted in the laboratory of Horticulture Department, Allahabad Agriculture University, aimed at evaluation of value addition of apple cultivars for the preparation of apple cheese. Five cultivars of apple namely Red Delicious, Ambri, American Apirouge, Golden Delicious and Maharaji (Versified) were evaluated for physical and chemical characteristics for apple cheese preparation. The experiment was laid out in randomized block design with five treatments and four replications. These cultivars used for the preparation of apple cheese were analyzed for various quality parameters at ambient temperature.

Results and Discussion

It is obvious from the Table 1, that differences in physical and chemical characteristics of all the five varieties were statistically significant. Among all the treatments T_5 (Maharaji) was found best with fruit firmness of 14.37 lb/inch^2, non-reducing sugars of 1.83%, TSS/acid ratio of 21.64 and anthrocyanin content of 12.13 mg/100g fruit followed by Treatment T_1 (Red Delicious) and least in Golden Delicious. The evaluation of physico-chemical characteristics of apple cheese from various apple cultivars revealed that the Maharaji (Versified) cultivar is best for apple cheese preparation, comparatively. The result was found in accordance with the findings of Zheng (2012) and Jihong (2007).

Table 1: Characteristics of fresh fruits of different apple varieties for cheese preparation

Varieties	Firmness (lb/inch^2)	Non-reducing sugars (%)	TSS/acid ratio	Anthrocyanin (mg/100g fruit)
Red Delicious	12.66	1.83	77.70	29.46
Ambri	11.21	1.68	72.35	22.76
American Apirouge	13.84	1.71	56.52	26.47
Golden Delicious	10.46	1.81	78.30	5.67
Maharaji	14.37	1.83	21.64	12.13
CD at 5%	1.96	0.12	5.82	5.61

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267.

Preparation of Flavoured *Ladoo* from Different Cultivars of Aonla

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Keywords: Aonla, cultivars and flavours

Introduction

Aonla (*Emblica officinalis* Gaertn) is one of the most important traditional and underutilized fruits of Indian origin, having immense potential for cultivation on marginal or wastelands. The fruit, due to its sour and astringent taste, has very limited table value. However, aonla fruits are processed into a number of products like preserve, candy, pickle, juice, shreds, ready to serve (RTS) beverages, dried powder *etc.* Its fruits are rich in vitamin C, protein, fat, crude fibre, starch, sugars, minerals and tannins. Because of its highly acidic an astringent nature, the consumers do not relish this fruit in fresh form. Hence, it is necessary to process this fruit and develop novel innovative products of high value. Therefore, keeping the above in view, flavoured ladoo from different cultivars of aonla was prepared.

Materials and Methods

The present investigation was carried out at Division of Food Science & Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu in 2014-15. The aonla fruits were washed and then steamed. Stones were removed from the aonla fruits and then segments were crushed into paste. Paste was blended with sugar/raw sugar and then blended mass was heated till final consistency of 70°Brix was obtained; after that flavours; *i.e* ginger and cardamom was added. The flavoured mass was cooled at room temperature and *ladoos* were made and packed. The product was organoleptically evaluated by departmental semi-trained panel members using 9 point hedonic rating with respect to colour, flavour, texture, taste and overall acceptability.

Results and Discussion

A perusal of data in Fig. 1 on colour and texture reveal that the maximum score of 8.50 and 8.10 was recorded in T_3 (NA-7 + cardamom + refined sugar), respectively. The highest score in flavour 8.20 was recorded in T_3 (NA-7 + cardamom + refined sugar). The maximum and minimum score in taste 8.50 and 6.36 was recorded in T_3 (NA-7 + cardamom + refined sugar) and T_{12} (desi + ginger + raw sugar), respectively (Fig. 1). The overall acceptability was maximum in T_3 (NA-7 + cardamom + refined sugar) and minimum in T_{12} (desi + ginger + raw sugar) having values of 8.28 and 6.50, respectively. Based on the sensory evaluation scores of different attributes, treatment T_3 (NA-7 + cardamom + refined sugar) ranked the best and were considered as the most suitable cultivar for developing flavoured aonla *ladoo*.

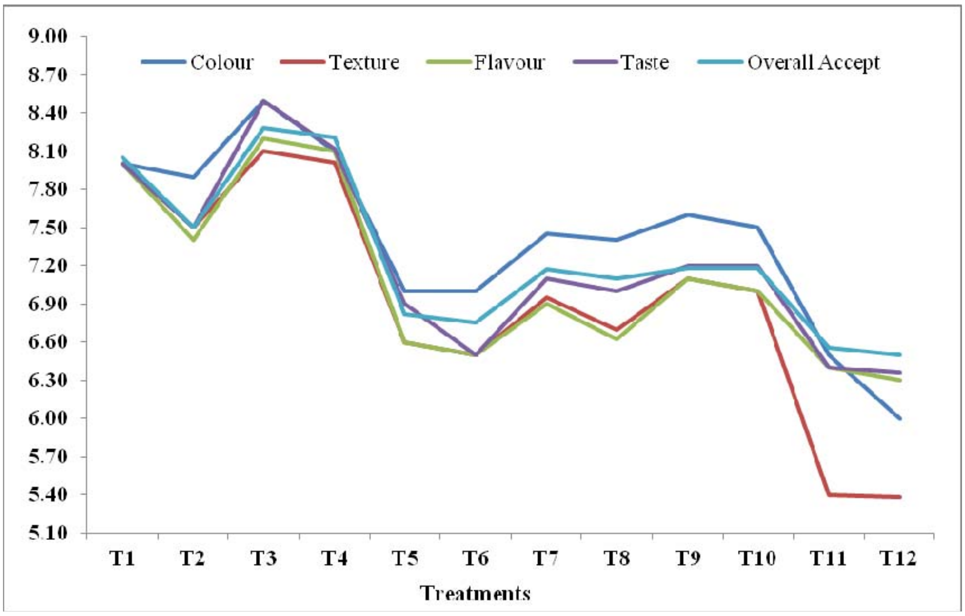

Fig. 1: Sensory evaluation of freshly prepared flavoured aonla ladoo

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Processing and Quality Evaluation of Quince Preserve

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Keywords: Preserve, quince, quality

Introduction

Quince (*Cydonia oblonga* Mill) is a native to South West and Minor Asia (West Wood, 1982). Crop occupies about 43,000 hectares of land with an annual production of 334,761 metric tonnes (Anonymous, 2002). Though quince is no longer a popular fruit tree species, it is still the most important root stock for pear cultivation. Quince is rich in essential oils. It has a pleasant flavour which is mainly due to ethyl -2 methyl-2butenoate and esters to be the base of the fruity flavour in quince. Quince is also important source of health promoting constituents, such as phenolics organic acids and amino acids. The edible portion of quince is richest source of dietary fiber Japanese quince which is rich in dietary fiber gives protection against cardiovascular diseases, diabetes, obesity, colon cancer etc. Chinese quince is often used for preparing candied fruit and liquor which were used as an effective cough and diuretic. Quince fruit is not appreciated for fresh market because of pulp hardness, bitterness and astringency but when ripe quince yields pleasant lasting and powerful flavour. It is highly demanded for processing marmalades, jam, jellies and cakes.

Materials and Methods

For titrable acidity a known weight of sample was boiled for 30 minutes.With small quantity of distilled water or grinded in pestle so as to disintegrate the tissue. Loss of water during evaporation was made up by addition of distilled water. The solution was filtered through Whatman no. 4 filter paper and volume was made upto 100ml with previously boiled distilled water. A known aliquot of the extract was titrated against standard 0.1N NaOH using Phenolphthalein as indicator and acidity was calculated using given equation

$$\text{Titrable acidity (\%)} = \frac{\text{Titrate value x normality of NaOH x Vol.made up x Eq.Wt of acid}}{\text{Wt. of sample x Vol. of aliquat taken for estimation}} \times 100$$

Results and Discussion

Data from Table 1 reveal that acidity of all the three preserved samples as per cent malic acid increases during storage, it increased from a mean value of 1.22% at 0 days to 1.31% after 90 days of storage. Amongst treatments T3 sample showed maximum mean value of 1.50 for acidity and T1 sample showed minimum mean value of 1.03 for acidity. There was a significant effect of storage, treatment, interaction on the acidity per cent during storage. The increase in acidity during storage may be due to the formation of organic acid by ascorbic acid degradation or the increase in acidity could have also occurred due the hydrolysis of pectin as reported by Cruess (1958) in jam and jellies.

Table 1: Effect of Treatment and Storage Periods on Acidity of Quince Preserves

	Storage Periods			
Treatments	**0 day**	**45 days**	**90 days**	**Mean**
T1(.25)	1.020±0.006	1.040±0.006	1.050±0.006	1.03
T2(.5)	1.21±0.006	1.260±0.006	1.330±0.006	1.26
T3(.75)	1.440±0.006	1.510±0.006	1.560±0.023	1.50
Mean	1.22	1.27	1.31	
C.D (p=0.05)	Storage: 0.20	Treatments: 0.020	Interaction: 0.020	

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269.

Ethylene perception: Target to Achieve Freshness of Fruits and Vegetables

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Keywords: Ethylene, ripening, post-harvest loss, qRT-PCR

Introduction

In plants, ethylene- a gaseous phytohormone is important for the normal development and physiological functions such as seed germination, root initiation, flower and leaf senescence, abscission, fruit ripening. Fruit ripening plays a major role in pre and post-harvesting technology, which has a significant impact, especially on the farm profitability and food availability. It is obvious that inhibiting ethylene perception may have a beneficial effect on the extension of freshness of fruits and vegetables. We studied the expression patterns of ethylene receptor genes (LeETR1, LeETR2, LeETR4, and LeETR5) involved in tomato ripening. Distinct pattern of expression of receptor genes were observed.

Materials and Methods

The ripening studies were performed by harvesting tomatoes at mature green stage from local orchards. Two different ripening stages of tomato *i.e.,* breaker and red ripe stage were taken for studying the expression patterns of ethylene receptor genes. Total ribose nucleic acid (RNA) was isolated and the samples with A260/280nm ratio 1.8-2.0, were converted to cDNA. mRNA levels in the samples were quantified using quantitative real time - polymerase chain reaction (qRT-PCR). Expression profiles of different ethylene receptor genes, and other genes such as LeCTR1, LeEIL4 which are involved in ethylene signaling pathway were studied.

Results and Discussion

Each qRT-PCR was performed in triplicates and the mean was used for analysis. Relative abundance of mRNA in the two different ripening stages of tomatoes *i.e.,* breaker and red ripe stage were evaluated using 2(-Delta Delta C(T)) method. Among all the receptor isoforms, LeETR4 was found be highly expressed in the breaker stage, than the red ripe stage. Expression patterns of other genes such as LeACS, Leaco1, LeCTR1, LeEIL1, LeEIL4, which are involved in downstream signaling events of ethylene pathway, were also studied. These observations indicate that, among the ethylene receptors, LeETR4 plays a critical role in the ethylene-mediated processes. Modulating the expression levels of LeETR4 will have significant response on the ethylene-mediated processes, especially fruit ripening to achieve desirable attributes such as delayed ripening. Tomato fruits with altered expression of LeETR4, help in mitigating the post-harvest losses, which ultimately would increase the farm profitability. Expression of genes, involved in ethylene signaling pathway between the two different stages of tomatoes are depicted in Fig. 1.

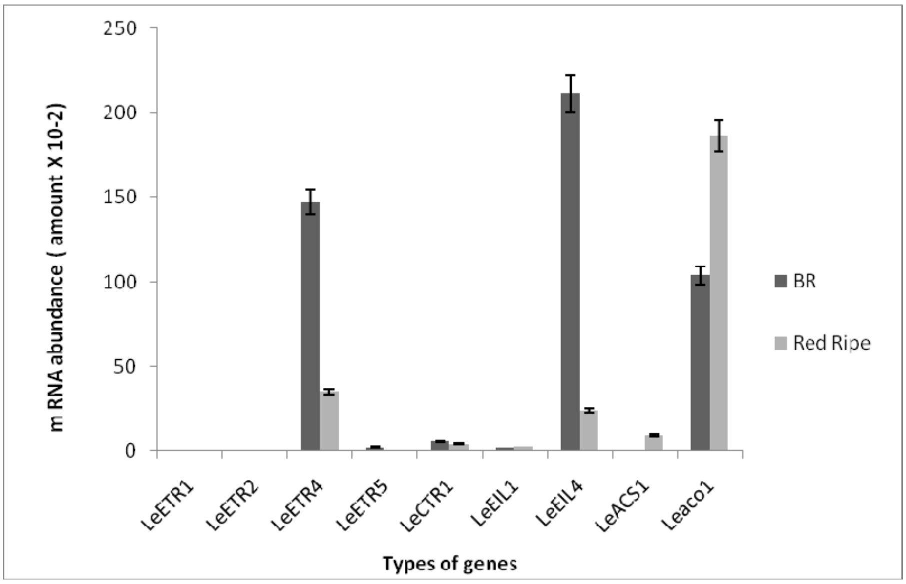

Fig. 1: Expression patterns of different genes involved in ethylene signaling pathway of tomato.

*Data represent the mean±SD.

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Post-harvest Changes in Bio-emulsion Treated Papaya Fruits at Ambient Conditions with Reference to Polygalacturonase and Xylanase

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Keywords: Papaya, mucilage, ripening, post-harvest loss.

Introduction

Due to lack of storage and processing facilities, post-harvest losses of fruits and vegetables are more for India's agriculture sector. Use of natural sources as edible coatings may help to reduce post-harvest loss and in preserving quality of fruits and vegetables. Work has been carried out to delay the fruit ripening, so that farmers will have the flexibility in marketing their fruits and ensure consumers of "fresh-from-the-garden" produce. In the current study, delaying the ripening process in papaya (*Carica papaya* L.) fruits by surface coating the fruits with mucilage prepared from cladode (modified stem) of *Opuntia dillenii* has been investigated.

Materials and Methods

Carica papaya L (Taiwan red lady variety) fruits at mature stage were harvested and divided into four groups (Untreated-Control; Cactus mucilage treated; Positive Control-1-MCP treated; Negative Control- Ethrel treated). Dry mucilage (1%) was used to prepare emulsion along with plasticizer to coat a thin film around fruits. Further, these fruits were evaluated for their ethylene liberation, texture and color. Chemical attributes such as total soluble solids (TSS), chlorophyll and β-carotene estimations were carried out. Polygalacturonase (PG) and Xylanase were estimated in fruits at different stages of ripening. Gene expression profiling of PG and Xylanase were also carried out using qRT-PCR.

Results and Discussion

The mucilage treated fruits at 100% ripe stage showed optimum ethylene liberation (1.1-1.2 ppm/500g/30min) on 16^{th} day of storage, whereas control and ethrel fruits attained 100% ripe stage at the end of 8^{th} and 9^{th} days respectively (~ 0.8-1.0 ppm/500g/30min). Though the ripening phenomenon of 1-MCP treated fruits appeared almost similar to mucilage treated fruits, its sensory parameter showed less aroma and rubbery texture indicating its unacceptability. In all the four treatments of papaya fruits, total soluble solids increased as ripening increased (4.2-9.9°Bx). Chlorophyll a and chlorophyll b was maximum at unripe stage and gradually decreased as ripening increased (0.1-0.005mg/g.f.wt). β-carotene was minimum at unripe stage and increased gradually as ripening progressed (0.2-0.7mg/g.f.wt). Enzymes such as PG and Xylanase were estimated in the experimental fruits at different stages of ripening. The PG and Xylanase activity increased (5.4-27.1µmoles/ml/min) and (7.6- 30.1µmoles/ml/min) with the rise in ethylene liberation and drastic fall was observed once after attaining 100% ripening in control fruits on 9^{th} day of storage. Cactus mucilage treated fruits also showed similar trend in PG and Xylanase activities (5.4-28.0 µmoles/ml/min) and (7.5-29.98 µmoles/ml/min) with the extension up to 16^{th} day of storage. To further evaluate the biochemical data, gene expression profiling of PG and Xylanase were carried out using qRT-PCR. Coordinated and parallel increases in the enzyme activity and expression levels of PG and Xylanase during the ripening of papaya were observed.

Table 1: Enzyme activities and gene expression of PG and Xylanase between control and treated fruits.

Days of ripening	Activity of cell wall degrading enzymes (µmoles/ml/min)				Fold change in gene expression of enzymes			
	PG		Xylanase		PG		Xylanase	
	Control	Treated	Control	Treated	Control	Treated	Control	Treated
Day 0	5.476±0.31	5.476±0.38	7.641±0.18	7.51±0.19	1.0±0.26	1.0±0.11	1.0±0.25	1.0±0.16
Day 4	18.915±0.26	11.726±0.16	22.814±0.58	14.189±0.22	3.045±0.16	2.186±0.26	3.940±0.11	3.940±0.22
Day 7	27.109±0.32	19.692±0.41	30.139±0.69	20.871±0.48	6.587±0.22	4.025±0.31	12.351±0.33	8.552±0.35
Day 9	11.323±0.11	22.353±0.48	12.842±0.22	24.156±0.44	1.367±0.29	5.728±0.29	1.589±0.10	12.616±0.54
Day 12		26.101±0.55		27.869±0.51		7.283±0.38		15.224±0.59
Day 16		28.026±0.71		29.981±0.59		11.023±0.41		18.166±0.44
Day 19		10.021±0.26		11.012±0.36		1.672±0.12		2.701±0.12

*Data represents the mean±SD of three replicates

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Effect of Different Post-harvest Treatments of Ethrel on Physical Characteristics of Mango (*Mangifera indica* L.) During Storage

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Keywords: Ethrel, mango, post-harvest treatments, storage

Introduction

Mango (*Mangifera indica* L.) most popular fruit among millions of people in India, grown on an area of 2516 thousand hectare with production of 18431.3 thousand metric tonnes (Annonymous, 2014). Mango fruits ripen unevenly on the tree and the natural ripening process can be very slow and unpredictable. To overcome this problem, fruits can be ripened artificially by exposing the fruits to certain chemicals, which initiate the ripening process. Ethephon/ethrel is an ethylene-releasing safe chemical, which can be used to improve fruit colour development and stimulates early and uniform ripening process of the fruit. Keeping in view the usefulness of ethrel treatments in fruits as revealed by various scientists, the present study was aimed to evaluate the effectiveness of postharvest immersion in different ethrel concentrations on the postharvest physical quality attributes of Dusehri mango fruit kept at ambient temperatures.

Materials and Methods

The present investigation was carried out at the Punjab Agricultural University, Regional Research Station, Gurdaspur in 2013-14 and 2014-15. A total four treatments of ethrel were applied to assess the ripening behaviour and post-harvest quality of mango during storage at room temperature. The experiment was laid out under completely randomized block design (CRD) with three replications. The physiological mature fruits of mango cultivar Dusehri having attained full size were washed with clean water, dipped for 30seconds in 0.01% Carbendazim and dried with muslin cloth before use. The fruits were dipped for five minutes in different concentrations of ethrel solution i.e. 500ppm,750ppm,1000ppm and 1250ppm and control. The treated fruits were wrapped in butter paper and packed in light weighed corrugated card board box for ripening purposes at ambient storage conditions. Data was recorded after 6th, 9th and 12th days of storage. Physical qualitative characters i.e. fruit skin colour, flavour/ aroma, organoleptic taste, and marketability were recorded with opinion of panel of 5 judges who scored according to hedonic scale suggested by Amerine *et al.*(1965).

Results and Discussion

Present investigation revealed that ethrel application had significantly influenced the sensory evaluation scores for flesh colour, flavour/aroma, taste and marketability. With increase in ethrel concentration from 500 up to 1000 ppm, there was significant change in skin colour i.e. greenish yellow to deep yellow on 6-12th day, while yellow colour was recorded on 9th -12th day of storage with 1250 ppm ethrel. While in control, yellowish green to yellow colour is noticed from 6-12th day of storage. The excellent flavour/aroma and organoleptic taste of fruits were observed with the fruits treated with ethrel 500 and 750 ppm on 6th, 9th day of storage, while ethrel 1000 ppm gave excellent flavor only upto 12th day of storage. But after 1000ppm treatment, it was found to be good at 9-12th day of storage. While in control it was good to fair at 6th to 12th day of storage. All ethrel treatments except 1250 ppm were significantly superior in improving the marketability of fruit with excellent acceptability at all the days of storage as compared to the control where poor acceptability was noticed on all days of storage. The fruit treated with 1250ppm ethrel are over ripened and hence its marketability is non-acceptable. Hence, it was concluded that Dusehri fruits treated with 1000 ppm for five minutes were found to be best in terms of colour, flavour/aroma taste and marketability.

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272.

Financial Profitability, Marketing Analysis and Technical Efficiency of Cabbage Cultivation in Jammu Region of J&K State

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Keywords: Cabbage, production, marketing

Introduction

In Jammu and Kashmir state numbers of vegetables are grown round the year. Vegetables not only give high returns but they are also a cheap source of essential nutrients. These vegetables have a definite market advantage and provide assured better returns to the farmers. Jammu, Samba and Udhampur districts of the state have become famous for the production of quality *Brassica oleracea*. Also, being short-duration crops, 3-4 crops of vegetables can be taken by the farmers to augment their income. We study the costs involved, returns obtained, marketing, and technical efficiency of cabbage producing farms of Jammu region of J&K state.

Materials and Methods

The present study was carried out in Jammu region of Jammu & Kashmir state during the year 2014. The primary data was collected by survey method using well designed and pre-tested schedules. The total number of farmers selected for the study was 120 (12 villages from 6 blocks and 10 farmers from each village. The data were analysed by CACP (Commission for Agricultural Costs and Prices) cost concepts, marketing analysis as well as Data Envelopment Analysis (DEA) model was applied for technical efficiency using DEAP (Data Envelopment Analysis Programme) software.

Results and Discussion

The per hectare overall total operational cost on cabbage production was Rs. 24519, Rs. 24303 and Rs. 24467, respectively for Jammu, Samba and Udhampur districts. Cost D after adding 10 per cent of the Cost C_2 as management cost came out to be Rs.43635/ha., Rs.41152/ha and Rs.42045/ha, respectively. The overall average yield of cabbage was found to be 237.5 q/ha, 225.00 q/ha and 225.00 q/acre, respectively (Table 1). The producers' of Jammu district received the net price of about Rs. 448.19/q, Rs. 488.98/q, and Rs. 550.25/q which were 49.15 per cent, 53.63 per cent and 94.42 per cent of the price paid by the consumer for channel I, II and III, respectively. In Samba, the net price received by the producer was found to be Rs. 433.90/q, Rs. 473.26/q and Rs. 537.21/q which was 50.32 per cent, 54.88 per cent and 95.33 per cent, of the price paid by the consumer in channel I, II and III, respectively. In case of Udhampur, it was Rs. 452.16/ q, Rs. 492.14/q and Rs. 547.60/q which was 52.88 per cent, 56.58 per cent and 95.89 per cent, respectively. The per quintal marketing margin of the retailer was about Rs. 215 in Jammu district followed by Rs. 200.00 in Samba district and Rs. 184.00 in Udhampur district (Table 2). While studying the technical efficiency in Jammu, Udhampur and Samba district under the assumption of constant returns to scale, 75 per cent of the farmers of Jammu and Udhampur district each and 77.5 per cent of Samba district were found efficient with values equal to or more than 0.90 (Table 3).

Table 1: Financial, Marketing and Technical efficiency analysis of Cabbage in various district of Jammu division (Rs./ha)

Particulars	Jammu			Samba			Udhampur		
	Bhalwal	Marh	Overall Avg.	Vijaypur	Samba	Overall Avg.	Udhampur	Chenani	Overall Avg.
Land Preparation	1566	1626	1596	1626	1517	1571	1745	1513	1629
Nursery/ Seedlings	8500	8094	8297	7635	7963	7799	7375	7875	7625
Irrigation	525	495	510	463	544	503	567	510	538
Fertilizers	3176	2961	3069	2689	2869	2779	3200	3075	3138
FYM	2938	3063	3000	2468	2533	2500	2475	2325	2400
Plant Protection	4214	3909	4061	3688	3868	3778	3900	3675	3788
Hired Human Labour	3500	3250	3375	4500	5250	4875	5125	4625	4875
Land Revenue + Depreciation on buildings equipments etc	537	684	611	481	515	498	476	474	475
Total	24956	24082	24519	23549	25057	24303	24863	24071	24467
Interest on working capital @6% p.a	366	351	359	346	368	357	366	354	360
Total Cost A1	25322	24433	24877	23895	25425	24660	25229	24425	24827
Cost A2	25322	24433	24877	23895	25425	24660	25229	24425	24827
Interest on amount of owned capital invested	1136	946	1041	1041	1085	1063	1264	1153	1208
Cost B1	26458	25379	25919	24936	26510	25723	26492	25578	26035
Rental value of owned land	6375	7625	7000	5750	7125	6438	7375	6500	6938
Cost B2	32833	33004	32919	30686	33635	32161	33867	32078	32973
Family labour	7500	6000	6750	5625	4875	5250	4750	5750	5250
Cost C1	33958	31379	32669	30561	31385	30973	31242	31328	31285
Cost C2	40333	39004	39669	36311	38510	37411	38617	37828	38223
	4033	3900	3967	3631	3851	3741	3862	3783	3822
Cost D	44367	42904	43635	39942	42361	41152	42479	41611	42045
Average Yield (q/acre)	220	255	237.5	212.5	237.5	225	200	250	225
Net returns (Rs/q)	399	496	448	395	473	434	424	478	452

Table 2: Marketing of selected vegetables through different channels in Jammu, Udhampur and Samba districts (Rs./q)

Particulars	Jammu			Samba			Udhampur		
	Channel I	Channel II	Channel III	Channel I	Channel II	Channel III	Channel I	Channel II	Channel III
Cabbage									
Net sale price	448.19	488.98	550.25	433.90	473.26	537.21	452.16	492.14	547.60
Marketing Margin	215.00	215.00	-	200.00	200.00	-	184.00	184.00	-
Consumer price	911.82	911.82	582.75	862.33	862.33	562.35	855.07	855.07	571.09
Producers' share in consumers' rupee	49.15%	53.63%	94.42	50.32%	54.88%	95.53	52.88%	56.58%	95.89%

Table 3: Efficiency measures and descriptive statistics for cabbage producing farms according to scale of operations in Jammu region

Scale of operations	Efficient farms (θ≥90)		Efficiency measures			
	No.	%	Mean	Std. Dev.	Max.	Min.
Udhampur						
Technical Efficiency (CRS)	30	75.0	0.8943	0.1145	1	0.794
Technical Efficiency (VRS)	34	85.0	0.9913	0.1231	1	0.811
Technical Efficiency (SE)	35	87.5	0.9012	0.1001	1	0.825
Jammu						
Technical Efficiency (CRS)	30	75.0	0.9918	0.0165	1	0.867
Technical Efficiency (VRS)	32	80.0	0.9453	0.0257	1	0.881
Technical Efficiency (SE)	33	82.5	0.9562	0.0123	1	0.892
Samba						
Technical Efficiency (CRS)	31	77.5	0.8863	0.1288	1	0.702
Technical Efficiency (VRS)	36	90.0	0.9012	0.0289	1	0.765
Technical Efficiency (SE)	35	87.5	0.8901	0.1387	1	0.791

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Analysis of Production Scenario of Fruit Crops in Jammu and Kashmir State

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Keywords: Fruit crops, production, diversification, secondary data.

Introduction

In the first few five year plans of India, priority was assigned to achieve self sufficiency in food grain production. Over the years horticulture has emerged as an indispensible part of agriculture, offering a wide range of choices to the farmers for crop diversification. It also provides ample opportunities for sustaining large number of agro based industries which generate substantial employment opportunities. Jammu and Kashmir (J&K) state offers good scope for cultivation of horticulture crops and is well known for its horticulture produce in India and abroad. It is the home for some world famous varieties of fresh and dry fruit, honey and saffron. There are around 7 lakh farm families comprising of about 33 lakh people which are directly or indirectly associated with horticulture (DES. 2014-15).In recent time horticulture has emerged as a growing sector in the state offering wide range of choices to the farmers for cultivation of horticultural crops such as *Malus domestica, Juglans regia, Pyrus communis, Prunus dulics, Mangifera indica, Citrus spieces, Ziziphus mauritiana, Psidium guagava, Emblica officinalis* and many more. Keeping in view the importance of horticulture sector a study was under taken to assess the year wise trend in area and production of fruit crops in J&K state.

Materials and Methods

The present study is based on the secondary data of fruit production from 2000-01 to 2014-15 (*i.e.* 15 years data). The data was collected from official records of Directorate of Horticulture, J&K. Statistical Digest and Economic Survey-2014. The data has been analysed and interperated through tabulation and simple percentage method.

Results and Discussion

Table 1 reveals that area under fruit crops in J&K state increased from 2.19ha in 2000-01 to 3.60 Lakh ha in 2014-15 an increase of 64%. Whereas production increased by 87% from 9.31 to 17.(up to 2012-13). Analysis of data further revealed that there is a significant decrease of 3.88 lac.MT in the overall production in 2014-15 which was due to heavy rainfall leading to unexpected flood in the state as per economic survey (DES -2015).

Table 1: Overall production trend of fruit crops in J & K state

Year	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2014-15
Area	2.19	2.21	2.31	2.42	2.58	2.68	2.83	2.95	3.05	3.15	3.25	3.42	3.47	3.60
Production	9.31	10.97	11.46	12.73	13.31	14.12	15.04	16.36	16.89	17.12	22.21	21.61	17.42	13.54

*Area in Lakh ha, Production in lakh tonnes

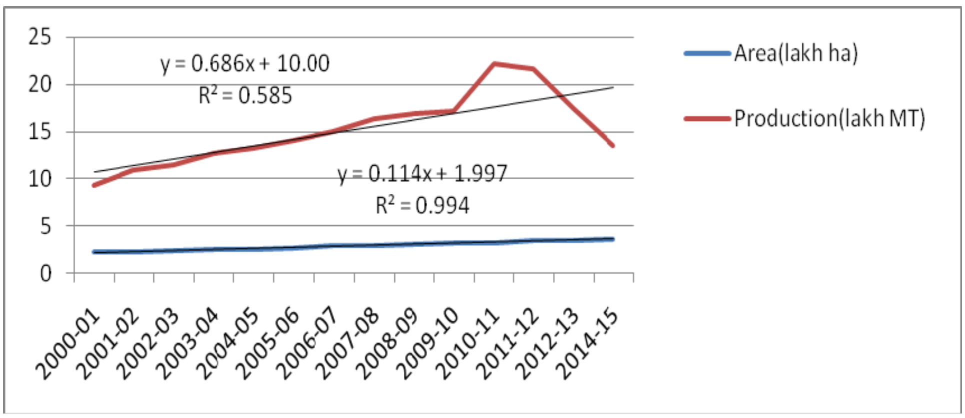

Fig. 1: Area and production of fruit crops since 2000. *Area under fruit crops increased (slope= 114 lakh ha; $R^{2=}$ 0.99) and production has increased (slope= 686 tonnes/annum; $R^{2=}$ 0.59)*

Reference

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Unexploited Potential of Underutilized Fruits and Vegetables for Sustainability Building

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Keywords: Underutilize, nutrition security, tribal.

Introduction

Sustainability is the endurance of systems and processes. The organizing principle for sustainability is sustainable development, which includes the four interconnected domains: ecology, economics, politics and culture. Underutilized fruits and vegetables can be characterized by the fact that they are locally abundant but globally rare. Absence of scientific information and scant knowledge about them leads to limit its utilization. Such fruits and vegetables play a vital role in day to day life of indigenous community. These fruits and vegetables are rich in necessary nutritional components like vitamins, minerals and dietary fibres besides antioxidants and phytochemicals. The supplementation of underutilized fruits and vegetables in diet may help in prevent ageing related diseases, obesity and various disorders of the body. Underutilized vegetables and fruits could be used to prepare various value- added products. The growing demand in developed and developing countries, for diversity and novelty in foods is creating new market niches for underutilized fruits and vegetables.

Materials and Methods

Investigation involved extensive review of the available literature for the substantial understanding of documented knowledge about underutilized fruits and vegetables. Various relevant aspects were explored such as contribution of these fruits and vegetables for livelihood support, nutritional significance and potential, medicine usage and properties, economic value and contribution to income generation, processed products production and commercialization possibilities.

Results and Discussion

Underutilized crops are grown more widely or intensively but consumers are using these crops less at global level. Their current use is limited relative to their economic potential. Underutilized fruits and vegetables have been found to form an integral part of the daily diets and provide a significant contribution in nutritional requirements of many rural households Fig. 1. The availability of uncultivated plants is indispensable for food security and closely linked to the conservation and enhancement of biodiversity and genetic resources. The nutritional value of traditional leafy vegetables found higher than several known common vegetables Table 1. Study conducted over five districts of the Orissa state in eastern India (a state with the second largest tribal population in the country, ca. 6.82 million) showed that tribal communities derive, on average, 15% of their gross family income from selling fruits, and that indigenous tribal families living within a 5-7 km radius of forests consume on average 82 kg / yr/ household of wild fruits, with about a quarter of households collecting regularly. Underutilized fruits and vegetables are considered as "minor foods" because they are less important than conventional fruits and vegetables in terms of global production and market value. However, underutilized vegetables embedded with rich nutrient potentials along with ability to stand against adverse climatic conditions can prove to be boon to all concerns - growers, consumers and environmentalists, provided that they are tamed properly. The reason for the low utilization of underutilized fruits and vegetables is lack of information and non-viability of indigenous vegetable production like the major cultivated species.

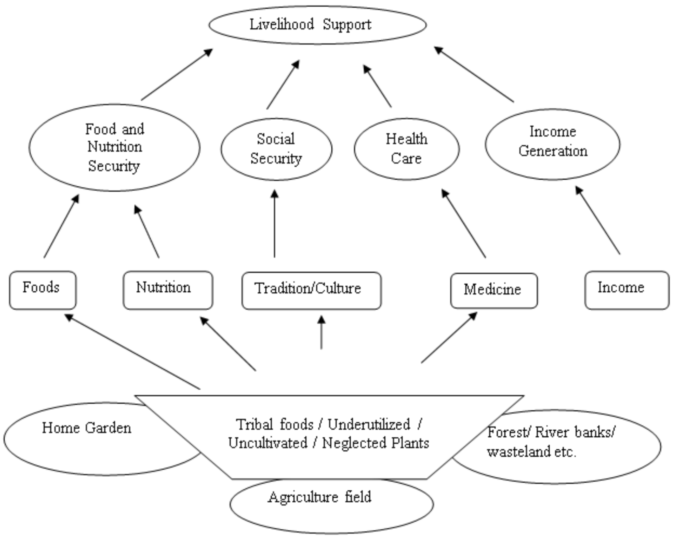

Fig. 1: Role of underutilized fruits and vegetables

Table 1: Major nutrients in edible portion of certain fruits (50g of edible portion of fruit) in livelihood support

Botanical name	Moisture per cent	Energy (Cal)	CHO (g)	Fibre (g)	Fat (g)	Protein (g)
Tamarindus indica	20.9	142	34	2.8	0.05	1.6
Manilikara elangii	54.7	80	18	2.2	0.5	0.9
Bambusa arundinacea	56.3	76	17.1	2	0.05	2
Phoenix dactylifera	59.2	72	16.9	1.9	0.2	0.6
Aegle marmalos Bael	61.5	68	15.9	1.5	0.15	0.9
Manilikara hexandra	68.6	67	13.9	-	1.2	0.3
Feronia limonia	64.2	67	9.1	2.5	1.85	3.6
F. indica	67.8	57	11.4	2.4	0.9	0.9
D. embryopteris	69.6	56	13.3	0.8	0.05	0.7
M. indica	73.6	56	11.4	-	0.8	0.7
Diospyros melanoxylon	70.6	56	13.4	0.4	0.1	0.4
Annona squamosal	70.5	52	11.8	1.6	0.2	0.8
Ficus bengalensis	74.1	36	5.9	4.3	1	0.9

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Study on Adoption of Marigold Practices among Floriculturist in Jammu District of J&K State

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Keywords: Socio-economic profile**,** knowledge status**,** adoption status, constraint

Introduction

Marigold (*Tagetes spp.*) is one of the most important loose flower crop cultivated commercially in India. It is used for making garlands, religious offerings and decorative purposes. Marigold belongs to family Asteraceae. African marigold (*Tagetes erecta*) and French marigold (*Tagetes patula*) are the two main species grown which have their origin in Mexico and South Africa, respectively. The popularity of marigold can be attributed to its ease of cultivation, wider adaptability to varying soil and climatic condition, profuse flowering, short cropping duration and attractively coloured flowers. In India, the area under floriculture production was 255thousand ha. Tamil Nadu is the leading producer with acreage of 55thousand ha contributing about 343.65 (000MT) of total production of loose flower in the country. India is the 2nd largest grower after China. The country exports of floriculture was Rs. 423.43 crores (NHB 2013-14)

Materials and Methods

The study was conducted in Akhnoor and Mudh district of Jammu division of Jammu and Kashmir state,with the total sample of 80 respondents who cultivate marigold. Interview schedule was used for the data collectio**n**

Results and Discussion

Average expenditure marigold crop, labour days for production of marigold crop, average yield, sale price, gross income, expenditure and net income from marigold crop, Income generated by adoption of Hybrid marigold cultivation by growers, average expenditure of marigold crop, average yield, sale price, gross income, expenditure and net income from marigold crop, average expenditure for Desi marigold crop/ha.

The data in Table 4.24 reveal that cost of seed per hectare of marigold crop was (Rs. 3643.5) followed by other costs viz. cost of tractor charge per hectare (Rs. 3681.9), cost of FYM per hectare (Rs 671.7), cost of fertilizer per hectare (Rs. 1621.19), cost of plant protection per hectare (Rs 813.20), cost of transportation per hectare Rs 130.6, and cost of labour per/ hectare (Rs 2556.5).

The Table 1 indicates that 132 labour days are required for production of marigold crop in one ha area. Among them 15 labour days are required for preparatory tillage with two ploughing and 7 labour days for the application of FYM 5 labour days for application of fertilizer, 25 labour days for the preparation of bed and sowing of seeds,35 labour days for interculture with one hoeing 3 labour days for irrigation, 7 labour days for plant protection measure and 35 labour days for harvesting of Marigold crop per hectare.

Table 2 depict that the average expenditure of marigold crop was Rs.13118.70/ha. As far as average yield of marigold crop was concerned, marigold crop gave an average yield of Rs.5479.50/ha and total average sale price of Marigold crop was Rs. 21.19/kg Average gross income from marigold crop was Rs. 116085.50/ha, where as the average net income from Desi marigold crop was Rs. 1029660.80/ha.

Table 1: Average expenditure for Desi marigold crop/ha, n= 100

Average expenditure(ha)	Rs./ha
Cost of seed	3643.5
Cost of tractor	3681.9
Cost of FYM	671.7
Cost of fertilizer	1621.19
Cost of plant protection measure	813.20
Cost of transportation	130.6
Cost of labour/ha	2556.5
Total	**13118.59**

Table 2: Average, expenditure, yield, price, income, gross income, net income from marigold crop, n= 100

Marigold crop(Desi)	Cost (Rs)
Average expenditure kg per ha	13118.70
Average yield kg per ha	5479.50
Average price kg per ha	21.19
Average gross income kg per ha	116085.50
Average net income kg per ha	1029660.80

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Role of Women in Organic Vegetable Cultivation- An Intervention Study

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Keywords: Organic vegetables, awareness

Introduction

India is the second largest producer of vegetables in the world, next only to China with an estimated annual production of about 73 million tones. Women have always played a very important role in backyard vegetable production to supplement their diets and income. However, commercial vegetable production has increased during the past few decades both for fresh market and for exports. When vegetables are produced for marketing more stress is laid on appreence rather than on taste and safety. In this study we identified women in vegetable cultivation and their awareness about organically grown vegetables especially from the health safety point of view.

Materials and Methods

The study was conducted in Belgaum district of Karnataka state. Belgaum district is popular in North Karnataka for growing a variety of vegetable crops, especially winter vegetables like cole crops, *Pisum sativum Daucus carota* subsp. Sativus etc. Three villages were selected for the study. Twenty farm women from land holding families actively involved in vegetable cultivation were further selected from each village, making a sample of 60 women. These women were trained for three days on organic cultivation of vegetables and data was collected by personal interview method on knowledge of various aspects of vegetable growing before and after the intervention.

Results and Discussion

The data in Table 1 shows the positive effects of intervention programme. Before intervention none were aware about the requirement of certification, a negligible percent were aware that organic vegetables require special packaging (1%), have more demand in the export market (2%) and are popular with high income groups (3%). Organic production leading to sustainability of agriculture and availability of separate markets to sell organically grown vegetables was known by only 5 and 7 women percent respectively. Another 15-45% women were aware of other facts. It is to be noted that after intervention a very high per cent (80-97) women became aware of the health benefits of organic vegetables, better shelf life, better quality and better price. Fifty three per cent women came to know that there were special markets to sell organic vegetables. The other aspects were remembered by a lesser percentage of women with the least (13%) being the requirement of certification. The results therefore reveal that after intervention were better registered in their minds than others. This is first time that women have been exposed to such training and probably three days were not sufficient enough to grasp the knowledge of organic farming in all its entirety. Moreover a gap of about a month after the training for the post test could have been one of the reasons for women to forget some facts. A beginning has been made and such programmes with follow up visits would better reinforce the concepts learnt by them.

Table 1: Growers awareness about vegetables grown organically

Items	Pre test	Post test
Organically grown vegetables protect health	32	80
Organically grown vegetables are more tasty than chemically grown vegetables	23	63
Organically grown vegetables have long shelf life	29	86
Organically grown vegetables have better quality	45	88
Organically grown vegetables fetch better price	15	96
Organically grown vegetables have no pesticide and chemical residue	19	40
Organic production process will lead to achieve sustainable production in agriculture	05	46
Organically grown vegetables have more demand in the high income group of domestic market	03	16
There is more demand for organically grown and packed vegetables in the export market	02	30
Requirement of certification by an approved certification agency is a must for the vegetables grown under organic practices	00	13
Availability of separate markets to sell organically grown vegetables	07	53
Packing material is required for packing organically grown vegetables	01	41

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Marketing Behaviour and Consumption Pattern of Flower Growers

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Keywords: Marketing behaviour, consumption pattern and flower growers

Introduction

Flowers being adorable creation of God, befits all occasions, be it at birth, marriage or death. One would grow flowers to fulfill his or her aesthetic desire. With the passage of time drastic changes have come about in the life style of people leading to commercialized cultivation of flowers. The Government of India has also identified floriculture as a niche area with vast potential for export. There are many incentives given by the Government for setting up of floricultural units as Export Oriented Units (EOUs) (Gowda, 2005). Being the city of temples Jammu itself is a big consumer of flowers also. There is potential for this activity to be propagated on a commercial basis. Jammu region of the state is going to play vital role in floriculture trade which may turn the economy of the state. The marketing efforts have been largely unorganized and sparse in nature. Hence, it is important to analyze the marketing practices that are being followed and to identify the market intermediaries and channels of marketing.

Materials and Methods

The study was conducted in Jammu region to study the technological gap and marketing of flowers. A list of villages where more than 10% of the area was under flower cultivation was prepared for each selected block. Out of these, four villages were selected from each block with the help of simple random sample technique. In this way 24 villages were selected for the study. Eighty flower growers each from three districts namely Jammu, Samba and Reasi were selected for the study to constitute a sample of 240 flower growers.

Results and Discussion

The marketing behaviour and consumption pattern of the respondents was broadly studied under ten components, which were further divided into different categories according to the nature of marketing, which included where, when, to whom and through which channel; they sell their produce and nature of consumption of marigold and gladiolus flowers. Most of the loose flowers (marigold) and cut flowers crop (gladiolus) are sold by the growers to the commission agents who are dominating the trade. During the study, the structure of the floriculture industry was examined to identify major production and consumption trends as well as the key market drivers, new product introductions and market channels. All the respondents sold flowers as raw, majority of the respondents market their produce in the main season without grading, in the nearby market. Most of the respondents among those not sold directly to market sold flowers to the small processor at the farm site itself. The respondents counselled outsiders and the neighbours and relatives to get knowledge about the market price, sold the produce immediately after harvest. Combinations of mode of transport were used to transport the flowers. Also respondents sold flowers for ready cash in the form of garlands to the markets as they fetch higher prices only. The systematic data is presented in Table 1.

Reference

Gowda B. T. 2005. A study on cultivation and marketing pattern of selected in Belghum district. *M.Sc.(Agri.). Thesis*. University of Agricultural Sciences, Dharwad, Karnataka.

Table 1: Marketing behaviour and consumption pattern of the flower growers (N= 240)

Particulars	Category	Percentage
Selling form	Raw	100
Selling tenure/ session	Main season only Festival	73.00 27.00
Grading	No grading According to colours According to Size Combination of size and colour	60.00 08.00 14.00 18.00
Marketing venues	Farm site Nearby markets Far off markets	23.00 59.00 18.00
Utilization of marketing channel	Direct to users Small processors (Garland makers/ Vehicles decorator for functions) Village level traders Commission agents	10.00 42.00 23.00 25.00
Market counseling	Neighbour and Relatives Family members Progressive farmers Extension agent Market officials Commission agents/traders	53.00 07.00 07.00 14.00 11.00 8.00
Marketing time	Immediately after harvest Whenever price is high	88.00 12.00
Means of transportation	Cycle Two wheeler Bus Combination of transport means	07.00 27.00 11.00 55.00
Marketing terms and conditions	Ready cash To settle the loan On credit On pledge loan	45.00 20.00 23.00 12.00
Value Addition	Garland Flower bouquets Vehicles decoration Ceremonies	52.00 28.00 12.00 08.00

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Antioxidant Potential of Leaf Extracts of Four *Myristica* Species

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Keywords: *Myristica fragrans, M. andamanica, M. malabarica, M. prainii*, antioxidant activity, phenols, flavonoids.

Introduction

Antioxidants are widely used as ingredients in dietary supplements and are exploited to maintain health and prevent oxidative stress-mediated diseases. Natural antioxidants are in high demand for application as nutraceuticals and as food additives because of consumer preferences. Although spices have great potential in this regard there are several species that have not received attention and *Myristica* is one such genus. The present study aims at evaluating the antioxidant potential of leaves of four *Myristica* species, namely, *M. fragrans, M. prainii, M. malabarica* and *M. andamanica* in relation to their phenolic and flavonoid content.

Materials and Methods

Leaves of *Myristica* species, namely, *M. fragrans, M. prainii, M. malabarica* and *M. andamanica* were collected from ICAR-Indian Institute of Spices Research Experimental Farm, Peruvannamuzhy. Dried and powdered leaf was extracted with petroleum ether and methanol in a soxhlet apparatus and the extracts were concentrated to dryness. The antioxidant activity of the extract was tested by three methods. The total phenols and flavonoids of the extracts were estimated by Folin-Ciocalteu's reagent and using aluminium chloride respectively.

Results and Discussion

The antioxidant activity of petroleum ether and methanol extracts of four *Myristica* species was determined by 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity, phosphomolybdate assay and ferric reducing power. Methanol extract of all species exhibited higher antioxidant activity than the corresponding petroleum ether extract by these three methods. The methanol extracts of *M. malabarica* (IC_{50}= 5.6 µg/ml) showed higher activity compared to other extracts which was on par with the standard antioxidant, butylated hydroxyanisole (IC_{50}= 5.4 µg/ml). Methanol extract of *M. fragrans* exhibited IC_{50} value of 6.9 µg/ml. Table 1 shows the results.By phosphomolybdenum assay, methanol extract of *M. fragrans* showed higher antioxidant activity than that of others. Methanol extract of *M. fragrans* exhibited higher ferric reducing power (1167.4 mM AAE/g) than *M. malabarica* (967.3 mM AAE/g), *M. andamanica* (139.0mM AAE/g) and *M. prainii* (244.0mM AAE/g). Among the extracts, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity was maximum for methanol extract of *M. malabarica* which was followed by methanol extract of *M. fragrans*.

Total phenols and flavonoids in the extracts varied from 11.1-153.0mg/g and 21.0-375.5 mg/g of the extract respectively. The phenol level was highest in methanol extract of *M. fragrans* (153.0 mg/g) which was followed by *M. malabarica* (143.4 mg/g). Methanol extracts of *M.fragrans* and *M.malabarica* contained high level of flavonoids as well. The relation between antioxidant potential and total phenols and total flavonoids is discussed.

Table 1: Antioxidant potential and total phenols and flavonoids content of leaf extracts of *Myristica* species

Extract details	Antioxidant activity by			Total phenols mg/g	Total flavonoids mg/g
	DPPH IC_{50} value (µg/ml)	PMA mM AAE/g	FRP mM AAE/g		
M. fragrans (Petroleum ether extract)	103.5	662.5	173.8	42.3	277.0
M. fragrans (Methanol extract)	6.9	1276.4	1167.4	153.0	374.5
M. andamanica (Petroleum ether extract)	306.0	63.9	40.7	14.5	21.0
M. andamanica (Methanol extract)	49.6	139.0	119.4	22.3	203.0
M. malabarica (Petroleum ether extract)	466.7	185.5	65.0	11.1	244.0
M. malabarica (Methanol extract)	5.6	716.0	967.3	143.4	375.5
*M. prainii (*Petroleum ether extract)	218.0	176.4	61.6	24.2	82.0
M. prainii (Methanol extract)	82.5	483.5	244.0	102.3	195.8
Butylated hydroxy anisole	5.4	-	-	-	-

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Proximate Composition and Essential Oil Content of Leaves and Stems of Different Cultivars of Various *Mentha* spp.

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Keywords: Composition, essential oil, *Mentha*

Introduction

Mentha is an important medicinal as well as commercial plant. Every part of this i.e. leaves; flowers and stems of *Mentha* spp. are frequently used in herbal tea or as additives in commercial spice mixtures for many foods to offer aroma and flavor. In addition, *Mentha* spp. have been used as a folk remedy for the treatment of nausea, bronchitis, anorexia and liver complaints due to its anti inflammatory, carminative, diaphoretic, analgesic, stimulant and anticatharral activities. Moreover, their essential oils are used in alcoholic beverages, cosmetics, perfumes, and mouthwashes.

Materials and Methods

Dried leaves and stems of all cultivars of various *Mentha* spp. such as *M. arvensis, M. citrata, M. piperita and M. spicata* were ground in an electric grinder separately and were stored in air tight glass containers at 3°C for further analysis. Essential oil of leaves and stems of all species was extracted using hydro-distillation method. Analysis for moisture, total minerals, crude protein, crude fat, crude fiber and carbohydrates was carried out according to their respective methods (AOAC 2006). All the tests were carried out in triplicates.

Results and Discussion

Proximate composition in leaves and stems of various cultivars of different *Mentha* species, namely menthol mint (*M. arvensis*) cv. Kosi, CIM-Saryu and CIM-Kranti; orange mint (*M.citrata*) cv. Kiran; peppermint (*M. piperita*) cv. Kukrail and spearmint (*M. spicata*) cv. MSS-5 revealed that the moisture content in leaves ranged from 67.52% in MSS-5 to 84.09% in Kosi (Table 1). The trend of moisture content in stems of different cultivars remained same as that of leaves. The findings suggest that cultivar Kosi was more succulent as compared to other cultivars. The protein content (%) in leaves (3.11-4.72%) of different cultivars of various *Mentha* spp. was significantly more to that of stems (0.58-1.49%). The leaves of cultivar Kranti (4.72%) contained the maximum protein content followed by CIM-Saryu, MSS-5, Kukrail, Kosi and Kiran while in stems it was maximum (1.49%) in MSS-5. The fat content (%) was also found more in leaves (2.20 in MSS-5 to 3.79% in Kukrail) of different cultivars as compared to corresponding stems (1.01in MSS-5 to 1.89% in Kosi). The leaves (6.90-7.91%) of different cultivars had significantly less fibre as compared to stems (10.81 in Kosi to 20.11% in MSS-5), however, the ash and carbohydrate content in leaves of different cultivars had the similar trend to that of moisture, protein and fat contents. But it is interesting to note that MSS-5 had the highest carbohydrate content in both leaves (16.58%) and stems (12.33%). Essential oil was found maximum in leaves of cultivar CIM-Saryu (3.02%) but in other cultivars it was quite low. The oil content was either very low or not detected in stems of different cultivars. The study concluded that leaves of different cultivars of various species had more moisture, protein, fat, ash, carbohydrate and essential oil content as compared to stems but fiber content was more in stems of all the cultivars.

Table 1: Proximate composition and essential oil content of leaves and stems of different cultivars of various *Mentha* species

Cultivars of different species	Per cent content in leaves and stems of different cultivars of various species						
	Moisture	Protein	Fat	Fiber	Ash	Carbohydrates	Essential Oil
Leaves							
Menthol mint cv. Kosi	84.09	3.29	2.21	7.52	2.00	0.91	1.78
Menthol mint cv. CIM-Saryu	79.41	4.08	2.21	7.31	2.19	4.12	3.02
Menthol mint cv. Kranti	76.92	4.72	2.21	7.50	2.20	6.46	1.76
Orange mint cv. Kiran	79.68	3.11	2.89	7.91	2.32	4.12	1.60
Peppermint cv. Kukrail	78.18	3.85	3.79	6.90	2.51	4.77	0.64
Spearmint cv. MSS-5	67.52	4.32	2.20	7.14	2.29	16.58	0.72
Stem							
Menthol mint cv. Kosi	85.75	0.58	1.89	10.81	0.54	0.51	0.14
Menthol mint cv. CIM-Saryu	82.67	1.15	1.30	10.92	0.60	3.38	-
Menthol mint cv. Kranti	84.42	1.05	1.09	11.90	0.51	0.95	0.08
Orange mint cv. Kiran	78.40	1.01	1.12	16.10	0.50	2.88	-
Peppermint cv. Kukrail	79.16	1.24	1.60	15.90	1.31	0.81	0.14
Spearmint cv. MSS-5	65.07	1.49	1.01	20.11	1.41	12.33	-

Reference

AOAC 2006. Official Methods of Analysis of Association of Official Analytical Chemist International. In.: Horwitz W (ed.), 18th Ed. AOAC Press, Arlington, VA, USA.

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Carotenoid Biosynthesis in Tomato (*Solanum lycopersicum)*

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Keywords: Tomato, carotenoids, HPLC

Introduction

Tomato (*Solanum lycopersicum*) is one of the most important vegetable crops in the world. It is the principal dietary source of carotenoids which play vital role in human health. Tomato being the richest source of dietary carotenoids, serves as the best model system to understand the regulatory mechanisms involved in carotenoid biosynthesis in plants. Different accessions of tomato were collected from various areas of Jammu and Kashmir (J&K) and their carotenoid (lycopene and β-carotene) content was determined in red-ripe fruits using HPLC.

Materials and Methods

A total of twenty different accessions of tomato were collected from various areas of J&K. The plants were maintained in the green house at School of Biotechnology, University of Jammu. Mature fruits were harvested and extraction of carotenoids was carried out from tomato fruits. Quantification of carotenoids was achieved using calibration curves generated with standards using five different concentrations.

Results and Discussion

Highest lycopene content was observed in accession TOM 10, while highest β-carotene content was observed in accession TOM 6 (Fig. 1). Three accessions namely TOM1, TOM 17 and TOM 18 were used as standards during the study. Out of all accessions analysed, highest lycopene and β-carotene content was observed in TOM 1. These lines are being studied further for identifying the mutations in important genes of the biosynthetic pathway. These resources will be utilized for breeding lycopene rich lines.

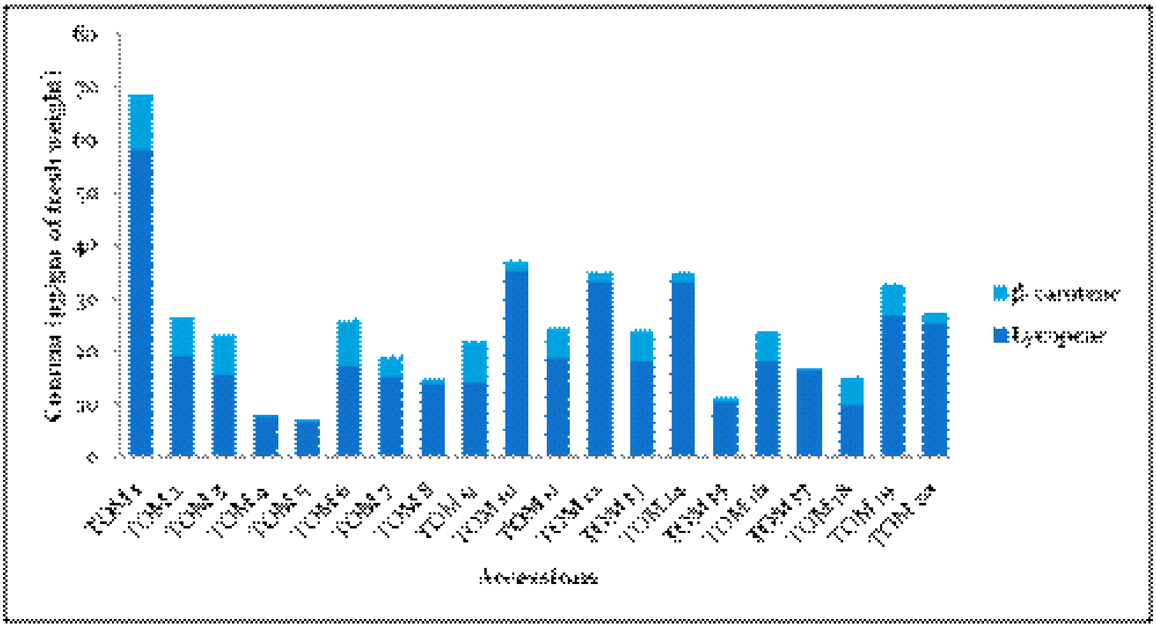

Fig. 1: Lycopene and β-carotene content in different accessions of tomato

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Plant Genetic Resource Management for Sustainable Development of Fruit Culture

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Keywords: Plant genetic resourses, climate change, gene erosion, plant genetic diversity

Biodiversity or biological diversity refers to all life forms i.e. plants, animals and microorganisms including the ecosystems in which they exist and interact. It is estimated that there are 5-30 million species of live forms on earth and only 1.5 million have been identified. Plant genetic resources refers to germplasm or genetic diversity of actual value that exists among individuals or group of individuals belonging to a species. Genetic diversity of plant species is a unique and irreplaceable source of gene for improvement and higher diversity of cultivars. Genetic material in total is the reproductive or vegetative propagating material of plants which include seeds, tissues, cells etc.. Through domestication of the wild plants human have narrowed down the genetic base of most of the crops plants by selecting the favourable plants and discarding the plants which are not required. It is often stated that only 30 species feed the world providing more than 90% of calories or protein to human nutrition. Major shift in climate in the coming time will necessitate aggressive action on adaptation as well as mitigation of the effects of climatic change. It will include adoption of climate resilient technology and development of stress tolerant crop varieties. There is no other source of stress tolerance other than the gene pool of a particular crop. This gene pool in whole is called plant genetic resource. The assemblage of individuals, different in one or other way has evolved through generation and has developed certain specific characters in them. These characters if properly conserved and utilized directly or indirectly in breeding programme can help in mitigation of climate change effects. A variety or a type represents a unique combination of gene and once lost, it can never be recovered. Therefore plant biodiversity in general has enormous importance in balancing ecosystem and plant genetic resources constitute the foundation upon which the future food security is based. India which is considered to be one of the hot spot for biodiversity contain about 18,000 species of higher plants in which 1,500 species belong to food plants. This diversity includes 375 species of fruit plants. Among fruit plants, mango, bael, aonla, citrus etc. are endemic to India, however large number of species of different fruit crops are also indigenous to India. Conservations and utilization of these plant genetic resources can ensure food security and mitigation of climate change effects on fruit cultivation in future. But prior to its utilization, fruit plant biodiversity is to be characterized, evaluated and conserved properly to minimize gene erosion. Besides, awareness generation and human resourse development in the area of plant genetic resourses management should also be given attention so that existing resourses could be saved.

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Conservation Horticulture: An Innovative Approach in Quality Fruit Production

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Conservation horticulture is a concept for resource-saving fruit production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. Conservation horticulture is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as chemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with, or disrupt, the biological processes.

Long term orcharding with perennial fruit tree component, in general, is a conservation horticulture practice which has the ability to negate the adverse effects of global warming. Fruit trees with more than 30 years longevity provide many environmental benefits and are currently receiving global focus for its carbon sequestration potential. The emergence of carbon credit payments benefits conservation horticulture (CH) adopters. Systems based on high crop residue addition and no tillage will accumulate more carbon in soil, compared to loss into the atmosphere resulting from plough based tillage. During the initial years of implementing conservation horticulture the organic matter content of the soil increases. This is decomposed slowly and much of it is incorporated into soil profile, thus release of carbon to the atmosphere occurs slowly. The environmental benefits of conservation horticulture are less erosion possibilities, better water conservation, enhanced orchard fertility, improvement in air quality and chance for thriving a larger biodiversity. Conservation horticulture safeguards the genetic resources, develop suitable cultivar of different crops, and augments the production, protection and enhance shelf life.

- Principles of conservation horticulture
    - i. Minimizing soil disturbance
    - ii. Maintaining land/soil cover
    - iii. Good agronomic management practices
    - iv. Incorporating nitrogen fixing trees and high value trees.

Degraded waste lands can be directly converted into potential orchards through systems approach by identifying with abiotic stress tolerant fruit crops/ varieties/ root stocks like mango, ber, pomegranate, custard apple, anola and tamarind integrating with other trees like teak, neem, hardwickia and gmelina and fodders like stylosanthes and cenchrus and short duration annuals as intercrops, rearing small ruminants like sheep or goat with specific abiotic stress tolerances in the orchards will enhance the orchard fertility and bring in regular incomes after adopting soil and waterconservation measures and applying integrated nutrient management practices age wise to withstand stresses and strains.

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Role of Biotechnology in Fruit Crops

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Conventional plant breeding being the backbone of the agricultural development, has appreciably contributed in the past to genetic enhancement of fruit crops. The quantum jump in population and increase in the occurrences of diseases and insect-pest attack has forced for the further enhancement to ensure ample production and productivity of fruit crops and nutritional security to the growing population. Advances in modern biology, especially biotechnology, offer many advantages over traditional techniques of plant breeding. The most compelling advantage of plant biotechnology is the ability to transfer foreign genes to confer novel traits. An entire array of traits viz. insect pest and pathogen resistance, abiotic stress tolerance, augmentation of nutritional qualities etc. have been successfully achieved by plant transformation. Another significant application of biotechnology in fruit crop improvement has been ‘marker-assisted selection (MAS). Development and integration of DNA-based molecular markers in the selection process has empowered the breeder to identify desired genotype without any interference of environmental effect of tissue specificity of expression. Moreover, some of the momentous techniques such as tissue culture and instruments such as PCR have paved a way towards a fast, less laborious method of fruit crop multiplication and easy detection of diseases. Integration of genomics and proteomics with metabolomics will enrich our understanding that can be utilized in achieving higher fruit crop improvement towards higher productivity.

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Integrated Nutrient Management in Fruit Production

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The increasing food demands of a growing human population and need for an eco-friendly strategy for sustainable agricultural development require significant attention when addressing the issue of enhancing crop productivity. For boosting crop productivity chemical fertilizers play a major role, but today, their increasing prices, soil health deterioration, sustainability and pollution consideration in general have led to renewed interest in the use of organic manures. However, it is not possible to supply all the nutrient requirements of crops fully through organic manures. So by taking into consideration the above facts, integrated nutrient management (INM) has been developed. Here we discuss the role of INM in resolving these concerns, which has been proposed as a promising strategy for addressing these challenges. INM has multifaceted potential for the improvement of plant performance and resource efficiency while also enabling the protection of the environment and resource quality. Lower inputs of chemical fertilizer and therefore lower human and environmental costs (such as intensity of land use, N use, reactive N losses and GHG emissions) were achieved under advanced INM practices without any negative effect on crop yields. A comprehensive literature research revealed that INM increases crop yields by 8-150% as compared with conventional practices, increases water-use efficiency and the economic returns to farmers, while improving grain quality and soil health and sustainability. Strong and convincing evidence indicates that INM practice could be an innovative and environment friendly practice for sustainable agriculture worldwide.

5

Forest Tree Plantations

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Functional Attributes of Herbaceous Vegetation along Altitudinal Gradient in Northwestern Himalaya

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Keywords: Herbaceous, biomass, Forb

Introduction

The pattern and relationship between species diversity and ecosystem functioning are the current areas of great ecological interest throughout the world. Thus, understanding the qualitative and quantitative information in relation to functional dynamics is essential for biodiversity conservation and sustainable management of fragile ecosystems. The contribution of the under storey vegetation to biomass in forest ecosystem is relatively low. However, as herbaceous plants have up to threefold higher density concentration than trees, their importance for ecosystem functioning enhances. A function relationship between diversity and carbon sequestration could play an important role for the management of reforestation projects that focus on forest conservation and management.

Materials and Methods

The study was conducted in Sirmour district of Himachal Pradesh with altitude ranging from 600m to 2700m amsl. Herbaceous vegetation in different forests along altitude was studied in the growing season (July to October) by harvesting fifteen quadrates of size 50cm x50cm each. Total biomass was calculated by adding above ground and below ground biomass of each species. Above ground carbon of herbaceous vegetation was determined by using carbon conversion factor of 0.45. Below ground carbon of vegetation was determined by multiplying below ground biomass with a conversion factor of 0.45. Total carbon of each species was determined by adding above ground and below ground carbon.

Results and Discussion

Vegetation in forests comprised of 89 species from 59 families that include 53 forbs, 22 grasses, 5 ferns, 5 sedges and 4 legumes. Distribution of species in different families revealed that most of the families were represented by maximum of three species only. *Poaceae, Asteraceae, Cyperaceae, Lamiaceae, Ranunculaceae* and *Rutaceae* were represented by multiple species in decreasing order. Cluster analysis based on genera and species in different forests revealed maximum number of genera and species in mixed forest followed by fir-spruce forest. Species composition in different forests revealed 50 species in mixed forest, 47 species in acacia forest, 49 in fir-spruce, 44 in deodar forest and 46 in chir pine in forest. Out of total 122 species, only 13 were common to all forests namely, *Agrostis pilosula, Avena fatua, Chrysopogon gryllus, Heteropogon contortus, Themeda anthera, Urochloa panicoides, Cyperus rotundus, Eriophorum comosum, Desmodium floribundum, Anaphalis busua, Bidens pillosa, Chenopodium album* and *Dicliptra bupleorides.* Biomass of herbage in different forests increased with the onset of growing season in July and attained their peak values in August and decreased thereafter. Biomass of herbage in different forests varied from 2.48 t/ha to 4.82 t/ha in Acacia forest, 1.49 t/ha to 4.90 t/ha in Chir pine forest, 1.67 t/ha to 2.74 t/ha in Mixed forest, 1.52 t/ha to 2.70 t/ha in Deodar forest and 1.27 t/ha to 2.68 t/ha in Fir-Spruce forest. In general, herbage biomass decreased with the type of forest in the order: acacia forest > chir pine forest > mixed forest variation > deodar forest > fir-Spruce forest.

Table 1: Interaction between above ground biomass (g/m^2) of herbs in different forests (T) and months (M)

Forest (T)	Months (M)				
	July	August	September	October	Mean
Acacia forest	39.78	60.17	30.33	29.27	39.89
Chir pine forest	20.56	40.40	64.49	13.93	34.85
Mixed conifer forest	24.47	38.71	25.48	17.54	26.55
Deodar forest	24.27	34.78	24.47	21.57	26.27
Fir-Spruce forest	14.45	31.19	32.53	20.56	24.68
Mean	24.71	41.05	35.46	20.57	

	$CD_{0.05}$
T=	4.64
M=	4.15
T×M=	4.71

286.

Variability in Different Sources of Glory Lily (*Gloriosa superba* L.) for Growth and Yield Parameters in Subtropical Plains of Jammu

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Keywords: *Gloriosa superba,* genetic evaluation, colchicine, variability

Introduction

Gloriosa superba L. a perennial climber belonging to family Liliaceae is an important medicinal species which is widely used in both traditional and modern therapies. It is a cosmopolitan species in India, distributed from Jammu & Kashmir to Tamil Nadu. Seed and tubers contain colchicine and are used for treating gout and rheumatism. The flowers are used as cut flowers due to their colour and shape. Due to its widespread use, the species was largely extracted from its natural habitat leading to its threatened status. Therefore, cultivation is the only alternative to conserve the species *vis-a-vis* to meet the demand of industry. To make the cultivation economically viable, it is necessary to identify genetically superior lines among the population. Eight sources of Glory Lily were evaluated for growth and yield parameters.

Materials and Methods

The present investigations were carried out at Experimental Farm of Division of Agroforestry, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu. The experiment was conducted under randomized block design with eight sources and three replications. Out of eight sources, four (Nagrota, Nandani, Nagbani and Dhiansar) were from Jammu and Kashmir (J&K) state, two (Giripul and Nauni) from Himachal Pradesh (H.P), one each from Madhya Pradesh (M.P) (Jabalpur) and Uttarakhand (Dehra Dun). Raised beds of size 1.8m x 1.2m were prepared and tubers were planted at a spacing of 60cm x 40cm, accommodating nine plants per plot. Observations for growth and yield parameters were recorded on 5 plants per replication per treatment. The data were analyzed and variability estimates for different characters were calculated using SPSS package.

Results and Discussion

Eight sources differed significantly from each other with respect to all the characters studied (Table 1). All the growth and yield characters recorded higher values in Nauni (HP) source, followed by Nandani (J&K) and Giripul (HP). Maximum number of fruits per plant was observed in Nandani (9.93) followed by Nauni (9.64) and both were found to be at par with each other. Maximum seed yield per plant of 5.32g observed in Nauni source was at par with Nandani (5.07g) and Giripul (4.49g) sources. The minimum seed yield per plant of 2.21g was recorded in Jabalpur (MP) source. Seed yield per plant varied between 2.21-5.32g with a mean value of 3.67g. Wider range was observed in the mean values of all characters except 100-seed weight, fruit length and diameter indicated the presence of good amount of variability. Higher heritability along with higher genetic advance was observed for plant height, number of leaves per plant and seed yield per hectare. Number of days taken to initiation of flowering, fruit length and 100-seed weight revealed low genetic gain whereas, plant height, number of leaves per plant, number of branches per plant, number of flowers per plant, seed yield per plant and estimated seed yield per hectare indicated high genetic gain. Out of eight sources, three (Nauni, Nandani and Giripul) were superior over others resulting in higher seed yield. Higher heritability and genetic advance observed in height, leaves, flowers and seed yield per hectare indicate ample potential for improvement in the species through selection of these traits.

Table 1: Mean performance of growth and yield parameters in different sources

Sources	Plant height (cm)	No. of flowers/ plant	No. of fruits/ plant	Fruit length (cm)	Fruit dia. (cm)	No. of seed/ fruit	100-seed weight (g)	Seed yield/ fruit (g)	Seed yield/ plant (g)
Nagrota (J&K)	80.93	19.30	6.20	4.21	1.37	15.01	3.11	0.46	2.70
Nandani (J&K)	139.47	30.00	9.93	4.51	1.56	17.01	3.12	0.52	5.07
Nagbani (J&K)	111.47	25.48	7.53	4.23	1.47	15.70	2.98	0.45	3.42
Dhiansar (J&K)	99.47	21.01	7.00	4.37	1.48	16.30	2.92	0.47	3.31
Giripul (HP)	98.13	23.14	8.51	4.54	1.59	17.51	3.10	0.53	4.49
Nauni (HP)	141.13	32.10	9.64	4.68	1.62	18.31	3.20	0.56	5.32
DehraDun (UK)	81.43	15.13	6.06	4.46	1.49	16.51	3.01	0.48	2.81
Jabalpur (MP)	72.24	11.51	5.30	4.12	1.34	14.50	3.00	0.43	2.21
$CD_{0.05}$	12.487	5.794	1.411	0.378	0.077	1.922	0.111	0.068	0.855

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Plus Tree Variation of Shisham (*Dalbergia sissoo*) in Different Agro-ecological Regions of Haryana

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Keywords: Plus trees, *Dalbergia sissoo*, agro-ecological, morphological characters, correlation, variation.

Introduction

Declining population of forest trees in their natural habitat increases the stress on existing forests and shifted the interest of land users towards agroforestry and clonal planting for which genetically superior planting stock is required. Selection of superior phenotypes or plus trees (PTs) is the first, most essential, critical and time consuming step in cloning process. In the present study *Dalbergia sissoo*, commercially important, multipurpose tree of the Indo-gangetic plains has been taken for plus tree selection and comparison of their morphological traits in different agro-ecological regions. Variation in morphological characters among different agro-ecological regions helps in identifying the promising individuals for a particular ecological site.

Materials and Methods

Three agro-ecological regions of Haryana namely arid, semi-arid and dry sub-humid were selected for study (Table 1). The selection criteria for plus trees vary from species to species, but many of the basic characteristics remain the same. The individuals having diseases, dead branches, or attacked by any pathogen and pests were rejected in the initial stage of selection. Major characteristics considered for the PTs selection for timber purposes were the straightness, cylindrical bole, non-forking, non-twisting bole, free from buttresses & flutes and minimum taper. Morphological characters namely diameter at breast height (DBH), total height (TH), clear bole height (CBH), straightness and crown spread (CS) were measured and CBH: TH and TH: DBH were calculated for forty five plus trees i.e. fifteen from each region.

Results and Discussion

Standard error, critical difference and coefficient of variation were calculated for each character to find out variation among characters. Average performance of seed sources from dry sub-humid region was found better than other two regions as highest values of each character i.e. 38.57cm diameter at breast height (DBH), 16.64m total height (TH), 9.40m clear bole height (CBH), 13.06m crown spread (CS) and visual index (VI) value 6 for straightness were observed for dry sub-humid seed sources. Straightness was significantly correlated with clear bole height and the ratio of clear bole height and total height. Maximum correlation was observed between diameter at breast height and total height (9.65).

Table 1: Geographical information of *D. sissoo* plus trees, Haryana.

Agro ecological region	Latitude (°N)	Longitude (°E)	Altitude (m)	Rainfall (mm/annum)	Temp. range °C (min- max)	N
Arid zone	28.08-29.54	75.03-76.58	200-264	319-490	5.3-41.7	15
Semi-arid zone	28.47-29.69	76.31-77.03	217-252	516-726	6-41	15
Dry sub-humid	30.10- 31	76.78-77.28	260-656	1029-1108	6.4-40.6	15

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Antioxidant Responses of *Jatropha curcas* (L.) to Arsenic (As)

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Keywords: *Jatropha curcas,* Arsenic, APOX, CAT, SOD and GPOX

Introduction

Arsenic (As) is ubiquitous in many environments and highly toxic to all forms of life. Being carcinogenic and powerful co-mutagen, their bioaccumulation in food web has posed several health related in urban and rural societies. In order to counter the detrimental impacts of As either strategies such as phytoremediation can be developed or safe crops that can be grown in contaminated soils can be selected. When a plant experiences environmental stress, the critical balance between the formation of reactive oxygen species (ROS) and the quenching activity of different antioxidants is disturbed. The main objectives of this study were to assess response of anti-oxidative enzymes in leaves of Jatropha under As stress.

Materials and Methods

Jatropha leaves exposed to series of As concentration (0, 25, 50, 75, 100,125 and 150 µg/l). Responses of four antioxidant enzymes were studied in leaves under nine concentrations of As treatment hydroponic experiment.

Results and Discussion

As shown in Table 1 all the enzymes significantly changed under arsenic (As) toxicity. Ascorbate peroxidase (APOX) increased as the concentration of arsenic increased but catalase (CAT) initially decreased and then increased at higher concentration of As. However, leaf superoxide dismutases (SOD) showed decreasing trend under As toxicity. Guaiacol peroxidase (GPOX) initially increased as compared to control but later decreased even below concentration in control. These trend suggest that when the Jatropha senses As stress, initially it tends to control toxicity through SOD and GPOX but at higher toxicity Jatropha combats As toxicity via APOX, CAT and SOD. APOX, CAT and SOD plays significant role in combating toxic effect of Arsenic in Jatropha.

Table 1: Enzyme activity with Arsenic toxicity

Arsenic concentration (µg/l)	APOX (µM/min/g Protein)	CAT (µM/min/g Protein)	SOD (U/g protein)	GPOX (µM/min/g Protein)
Control	20.02^{b}	10.43^{ab}	17.05^{e}	318.32^{bc}
25	28.32^{ab}	6.09^{d}	61.19^{a}	464.10^{a}
50	29.36^{a}	6.35^{d}	55.08^{ab}	421.74^{a}
75	30.94^{a}	7.16^{cd}	26.82^{de}	386.22^{ab}
100	32.36^{a}	8.88^{bc}	44.46^{bc}	369.80^{abc}
125	35.32^{a}	11.07^{ab}	40.08^{c}	281.07^{c}
150	35.04^{a}	11.63^{a}	33.79^{cd}	283.99^{c}

289.

Performance of Forest Resource Management in Community Conserved Forest of Uttarakhand, India

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Keywords: *Van Panchayats* (VPs), effective, ineffective, partially effective, forest management and performance.

Introduction

In the Uttarakhand hills in India, about 12089 *Van Panchayats* have been established. These *Van Panchayats* manage a forest area of about 54,4964 ha (7350.857 km^2) forming about 14% (actual 13.75%) of the total area of the state (UK Forest Statistics, 2013) in eleven hill districts in the state: Chamoli, Pauri, Tehri, Uttarakashi, Dehradun, Rudraprayag, Nainital, Almora, Pithoragarh, Champawat and Bageshwar. Most of the *Panchayat* forest cover an area between 05 to 2500 ha and provide the villagers with significant subsistence benefits such as fodder, leaves for animals bedding, grazing space for their animals, fuel-wood, and timber for house construction and agriculture implements.

This study aimed at evaluating the effectiveness of *Van Panchayats* in managing and implementing *Van Panchayat* (VP) system, in order to give an indication of the sustainability and equitability of this system of forest management.

Materials and Methods

The study area lies between 28°45' to 31°27' N latitude and 77°34' to 81°02' E longitude. Climatic conditions range from subtropical to temperate with considerable variation in slope, aspect and vegetation. A questionnaire was prepared to extract information from the VPs. Visits were made to selected VP villages and information was extracted from VP *Sarpanch*/members, village *Pradhan* as well as household survey.

Seven VPs were selected for detail analysis. In an attempt to provide an objective evaluation of the effectiveness of each VP, nine criteria were set and examined for each VP. The VPs performance was critically examined in technical and social terms. The technical assessment examined the nature of the forest management system adopted by the VPs: whether the forest was being protected, afforestation activities were carried out and harvesting of forest products is regulated or not. The social assessment involved the examination of VPs in terms of their abilities to make decision, make contribution to VP fund, and hold regular election, and check encroachment and measures to reduce pressure on forest utilization leading to its sustainability. Different scales were used to measure each criterion, scaling was dependent on number of measurable smallest possible unit for each criterion. Each VP was assessed accordingly and the marks obtained were used to categorized the VPs. VP scoring 45 and above were considered effective, 40-45 partially effective and scoring below 40 was considered ineffective (Table 1).

Results and Discussion

All the VPs were found to have an elaborate product distribution arrangement. On the basis of an assessment of the nine criteria (Table 1), only one VP was considered to be effective, three partially effective and three were totally ineffective. In case of Chopra, Gangwara and Parwari only quarterly meeting were held. Chopra hire watchman only for four months a year. Parwari, Budoli and Chopra have contributed only Rs. 10/household/month. Except Baniyari election were not held regularly in any of the VP.

Village	***Van Panchayat* performance**
Baniyari	Effective
Budoli	Partially effective
Makku	Partially effective
Chopra	Ineffective
Gangwara	Ineffective
Mali	Partially effective
Parwari	Ineffective

The study conclude that effective and partially effective performance of VPs is reflected in the greater number of meeting held each year, regularity in VP election, higher level of monitoring and enforcement, and even relatively more dense vegetative cover. It was suggested that poor management and poor performance of VPs is due to the lack of cooperation between the right holders and the Government officials, lack of knowledge of VP Act among communities, lack of political will on the part of the Government, lack of funding, poor enforcement of regulations, and lack of women's involvement.

Table 1: Evaluation criteria for *Van Panchayats* (VPs).

Evaluation criteria	Critical marks	Banyari	Budoli	Chopra	Gangwara	Makku	Malai	Parwari
Year of Formation	30's - 2000. 1 mark less for 7 yrs. in decreasing order	6	9	2	4	6	6	6
Number of Panchayat committee members	5-11 6 marks for 11 members & 1 mark less for 1 member increasing order	2	2	6	4	6	4	4
Average No. of meetings/ Year	4-12 meeting/yr 90 marks for 12 meetings and 1 mark less for decreasing meeting order	9	9	1	1	9	9	1
Size of Forest user group (No. of households)	40-80 households-10 marks 1 mark less for additional 40 households	8	10	7	7	6	8	8
Regularity in election (every 5 yrs. as stipulated in the rules)	5 yrs - 8 marks 5-10 yrs - 6 marks 10-15 yrs - 4 marks >15 yrs - 2 marks	8	6	6	6	6	2	6
Hiring of watchman/ha	10-12 months - 10 marks 8-10 months - 8 marks 6-8 months - 6 marks	0.22	0.05	0.03	0.06	0.01	0.12	0.08
Household contribution/ Month	Rs. 20 - 9 marks Rs. 15 - 6 marks Rs. 10 - 3 marks	9	3	3	6	6	9	3
Afforestation: Land ratio	VP area x Afforested area= Total village land	6.13	2.93	9.44	4.85	0.83	0.47	0.49
Encroachment	Yes: 0, No: 1	1	0	1	1	1	1	1
Total		49.35	41.98	35.47	33.91	40.84	39.59	29.57

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Potential of Improved Perennial Grasses for Sustainable Fodder Production under Rain-fed Conditions of Rajouri District of Jammu and Kashmir

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Introduction

In Jammu and Kashmir (J&K) state, the demand-supply scenario of the fodder reveals 7,459 thousand metric tonnes of fodder availability over the estimated requirement of 12,563 thousand metric tonnes with 40% deficit. Rajouri district is located on the South-western side of the J&K state supports agri-silvi-pastoral and silvi-pastoral systems its marginal and wastelands. Fodders trees are primarily grown for fuel-wood and small timber on the farm bunds, boundaries and sometimes grown scattered in the fields commonly known as *Gassnies.* Perennial grasses namely hybrid napier *(Pennisetum typhoides* x *P. purpureum)* and *Setaria anceps,* with the advantage of faster growth and more production of herbage has ability to grow on variety of soils. This provides an opportunity to the farmers of rain-fed hilly regions of the Rajouri district of J&K with an alternative cut and carry system of fodder production from their farmlands as per the requirements in order to overcome the effects of the seasonal shortages of fodder and to ensure fodder availability against risks of drought in Rajouri district.

Materials and Methods

Study was carried out in seven selected blocks namely Rajouri, Darhal, Manjakote, Sunderbani, Kalakote, Doongi and Nowshera in the Rajouri district of J&K state with altitude ranging between 550 - 1250 msl.. Rootslips of napier hybrid NB-21 *(Pennisetum typhoides* x *P. purpureum)* and *Setaria* anceps (PSS-1) grasses raised in the previous year were transplanted on the farmers field at seven locations during the last fortnight of July each year for consecutive three years up to 2014 for estimation of performance of perennial grasses under rain-fed conditions. The experiment was laid out in randomized block design and analysis was done following the standard procedure.

Results and Discussion

Analysis of variance depicted significant differences among survival percentage and the production (q/ha) for both the grasses at among seven locations under study. Appraisal of Table 1 depicts that maximum survival percentage of 82.78% of napier hybrid-NB 21 was recorded at Sunderbani followed by 80.78% and 80.56% at Manjakote and Darhal, respectively, whereas napier hybrid planted at Kalakote recorded minimum survival percentage (73.33%). Similarly data appended in Table 2 shows that on the basis of pooled data Sunderbani recorded maximum *Setaria* (PSS-1) survival percentage (80.11%) as well as herbage production (169.55q/ha) that was at par with herbage production at Rajouri (167.33 q/ha). Lowest survival percentage (66.89%) and green herbage production (159.11 q/ha) of *Setaria* grass was recorded at Kalakote. Regarding the extent of availability of green forage, napier hybid (NB-21) was able to provide green forage up to the ending November in low altitude locations namely Sunderbani, upto 2nd week of November, at Nowshera and Kalakote, till 1st week of November on mid-hills like Rajouri, Manjakote and Doongi whereas was farmers were able to harvest green forage till ending October in Darhal. On the contrary, farmers were able to harvest *Steria anceps* (PSS-1) green forage till 1st week of November at Sunderbani, Kalakote and Nowshera locations, up to last week of October at Rajouri and Manjakote having similar climatic variation pattern, and till 2nd week of October at Darhal being located at a higher altitude. The of extent of availability of green forage was considered to be highly dependent upon the clinal variation with growing season culminating as early as 2nd week of October at higher altitudes i.e. in Darhal as compared to the locations at lower altitudinal ranges namely Sunderbani, Nowshera and Kalakote.

Table 1: Performance of Napier Hybrid *(Pennisetum typhoides* x *P. purpureum)*-NB 21 under rainfed condition in Rajouri district of J&K

Locations	Survival percentage (%)			Pooled data	Production (q/ha)			Pooled data
	2011	2012	2013		2011	2012	2013	
Nowshera	81.67	73.33	74.0	76.33	253.0	245.67	221.67	240.11
Doongi	76.67	71.67	73.33	73.89	246.67	238.33	216.0	233.66
Sunderbani	80.0	83.33	85.0	82.78	260.33	253.67	221.0	245.0
Manjakote	80.0	81.67	80.67	80.78	248.0	241.33	212.33	233.88
Rajouri	71.67	80.0	83.33	78.33	247.67	238.67	219.67	235.33
Darhal	82.67	78.33	81.67	80.56	244.67	241.0	217.67	234.44
Kalakote	73.33	71.67	75.0	73.33	247.0	235.67	215.33	232.66
$Cd_{0.05}$	5.8	5.32	4.71	5.61	12.4	7.08	8.44	4.37
SE±	2.91	2.67	2.36	2.81	6.22	3.55	4.24	2.29

Table 2: Performance of *Setaria anceps* (PSS-1) under rain-fed condition in Rajouri district of J&K

Locations	Survival percentage (%)			Pooled data	Production (q/ha)			Pooled data
	2011	2012	2013		2011	2012	2013	
Nowshera	73.67	73.33	76.67	74.55	172.67	164.33	154.33	163.77
Doongi	73.0	77.67	82.0	77.55	174.67	168.0	155.0	165.89
Sunderbani	78.0	81.33	81.0	80.11	168.67	169.33	162.33	169.55
Manjakote	77.0	80.33	80.33	79.22	165.67	164.0	157.33	163.33
Rajouri	75.0	76.33	78.67	76.66	173.67	170.0	158.33	167.33
Darhal	67.67	68.33	70.33	68.77	164.67	162.67	156.0	161.44
Kalakote	66.0	67.0	67.67	66.89	177	161.67	151.0	159.11
$Cd_{0.05}$	3.59	3.82	4.01	2.3	5.92	5.16	5.12	3.28
SE±	1.80	1.91	2.01	1.15	2.97	2.59	2.57	1.65

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Forest Based Land Uses for Carbon Sequestration: A Climate Resilient Option for Sustainable Management of Natural Resources in Shivalik Region, India

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Keywords: Carbon sequestration, climate change, land use, Shivalik region

Introduction

Forests account for 80-90% of terrestrial plant carbon and 30-40% of soil carbon at global scale (Harvey, 2000). Soil organic matter has a disproportionate influence on nutrient dynamics, and resistance to degradation. Meteorological observations at Chandigarh reported that average *kharif* season annual rainfall, *rabi* season annual rainfall, annual maximum and minimum temperature were highly erratic over the years with coefficient of variation ranging from 30 to 58% (Agnihotri *et al.*, 2006). The study was conducted to determine the long term potential of forest based land uses in lower Shivalik on carbon sequestration for mitigating climate change.

Materials and Methods

Existing land–use systems were used for the study included 1) *Eucalyptus teriticornis 2) Zizyphus mauritiana 3) Embilica officinalis* 4) *Leucaena leucocephala* 5) *Terminalia chebula* 6) *Acacia nilotica* and 7) Agriculture (*Zea mays* L.- *Triticum aestivum* L.) rotation). Soil organic carbon was determined by wet digestion, available nitrogen by alkaline permanganate method, microbial biomass carbon by chloroform fumigation. Above ground biomass was estimated using non-destructive method. The diameter at breast height (dbh) and height were measured with caliper and Ravi's multimeter, respectively. Form factor was calculated with Spiegel relaskope to find out the tree volume using the formula.

Results and Discussion

Total carbon followed the order *Eucalyptus tereticornis* (472.37 Mg ha^{-1}) > *Acacia nilotica* (376.05 Mg ha^{-1}) > *Leucaena leucocephala* (121.37 Mg ha^{-1}) > *Embilica officinalis* (99.05 Mg ha^{-1}) > Zizyphus spp (86.96 Mg ha^{-1}) > *Terminalia chebula* (53.15 Mg ha^{-1}) and lowest in maize- wheat rotation (2.52 Mg ha^{-1}). In Uttar Pradesh, approximately 20 million t of carbon has been estimated to be sequestered by the farm forestry plantations. Lowest organic carbon was found under agriculture. Gradual decrease in soil organic matter with increase in soil depth has also been reported by earlier workers also. Available nitrogen in surface soil was highest (335.88 kg ha^{-1}) and lowest in agriculture (265.75 kg ha^{-1}). Available phosphorous was highest in *Eucalyptus tereticornis* (33.8 kg ha^{-1}) and lowest in *Terminalia chebula* (23.80 kg ha^{-1}). MBC was highest in *Eucalyptus tereticornis*. The study concluded that *Eucalyptus tereticornis* based system has highest potential in sequestering carbon and improving soil fertility and biological properties. However, *Acacia nilotica* based agroforestry systems are also well suited from the perspective of improving soil quality and crop production in lower Himalayan region.

Table 1: Above ground carbon sequestered under different land-uses

Landuse	Carbon in bole (Mgha^{-1})	Carbon in branches (Mgha^{-1})	Carbon in leaves (Mgha^{-1})	Carbon in Shrubs (Mgha^{-1})	Carbon in grasses (Mgha^{-1})	Total Carbon (Mgha^{-1})
Eucalyptus teriticornis	429.59	29.67	8.6	4.50	0.008	472.37
Zizyphus mauritiana	36.21	11.72	3.67	1.37	0.16	53.15
Embilica officinalis	54.42	7.51	56.10	33.42	224.62	376.05
Leucaena leucocephala	94.79	22.19	4.37	0.024	0	121.37
Terminalia chebula	84.73	11.98	2.34	0	0	99.05
Acacia nilotica	62.91	19.47	4.17	0.28	0.136	86.96
Agriculture	-	-	-	-	-	2.52

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Climate Change and Community Forestry in Sri Lanka: Policy Adoption, Popular Participation, Adaptation Strategies and Rural Development

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Keywords: Farmer woodlots, Forest Policy, community participation, Climate Change, rural livelihoods

Introduction

Climate change combined with unsustainable land use in Sri Lanka aggravated serious ecological losses due to lack of legislative and institutional capacity, and rural development efforts for effective management of forest resources. Sri Lanka has a paradigm shift in forest resource management refocusing decisions to more decentralized level of governance and moves toward a community based approach. Farmers' woodlot development as small scale-scale forestry programs implemented under community forestry approach have become critical for the integration of climate change adaptation through participatory rural development strategies depend on the household economy and production systems, while strengthening ecological systems.

Materials and Methods

Several scientists and institutions working on climate change adaptation, forest management and rural development were approached. A search methodology was undertaken to identify and review the literature. Key terms for analysis were developed based on concepts related to climate change adaptation, community forest management and rural development. Field observation was carried out to perform reliability checks. An informal interview of farmers' woodlot participants collected information concerning their practical experiences. The paper discusses the farmers' woodlot development programs in Sri Lanka in terms of policy adoption; popular participation of community; adaptation strategies for climate change; and contribution for rural development.

Results and Discussion

Climate change issues not a new trend but implies new conditions for forestry and rural livelihoods in Sri Lanka. Climate change policy issues; forest policy and institutional setting; and farmers' woodlot development programs mainly influence the policy adoption. Farmers' organization and community participation; empowerment of women and disadvantaged communities; partnership development; supporting services and capacity building promote popular participation of community through farmers' woodlot development programs. The main strategies for climate change adaptations by farmers' woodlots are revealed as: increased area and connectivity of vegetation; conserved and enhanced soil, water and environment; and maintained bio-diversity and forest health. Farmers' woodlots contribute for rural development through: supply of forest and agricultural products, and services; increase farmers' incomes; income distribution and poverty alleviation; promote rural services, diversify rural economies and improve rural livelihoods. The study makes the conclusion that the farmers' woodlots in Sri Lanka play an important role for adaptation of climate change as well as rural development by bringing the active participation of community under favorable policy environment.

Table 1: Policy Adoption, Popular Participation, Climate Adaptation and Rural Development through FWLs Development Programs

Adoption of Related Policy	Popular Participation of Community	Adaptation for Climate Change	Contribution for Rural Development
Climate Change Policy Issues ▪ Adopt main instruments agreed at UNCED and WSSD ▪ REDD+ Readiness Preparation Proposal ▪ National Action Plan for Haritha Lanka Program (saving fauna, flora and ecosystems) ▪ National Climate Change Adaptation Strategy **Forest Policy and Institutional Setting** ▪ Community-based forest management ▪ Participatory Forestry Project in 18 districts ▪ Non-forest tree planting **FWLs Management Programs** ▪ Woodlots in marginal state lands ▪ Plant timber trees with agricultural crops ▪ Socio-economic upliftment of rural poor	**Farmers' Organization and Community Participation** ▪ Community based organizations through operations empower local communities ▪ Official select location, land distribution, planting design ▪ Farmers select participants and species ▪ Review workable mechanisms for reinvesting benefits **Empowerment of Women and Disadvantaged Communities** ▪ Both men and women are traditionally experience tree-based agricultural systems ▪ Collection of firewood performed by women ▪ Legal ownership provide equal opportunities for women **Partnership Development** ▪ Government-community partnership ▪ Shift use rights to authority reframe ▪ Government supports community efforts **Supporting Services and Capacity Building** ▪ Legal provisions for leasehold forestry ▪ Individual leased land diluted customary rights ▪ Forest Officers provide technical backstopping and moderate conflicts ▪ Department of National Budget invested funds	**Increase Area and Connectivity of Vegetation** ▪ Establishment of woodlots in degraded forest lands due to long-term shifting cultivation ▪ Prevent small-scale farmers involve directly or indirectly on deforestation ▪ Greatly exceeded planting targets **Conserve and enhance soil, water and environment** ▪ Act as reservoirs of trees, carbon sinks and a source of clean water ▪ Increase crop yields, and conserve soil and water as windbreaks and shelterbelts ▪ control farm runoff preventing flooding and soil erosion ▪ Filter agricultural chemicals preventing contamination of water resources ▪ Cope with changing ranges and behaviors of native insects and diseases damaging agricultural systems ▪ Generate carbon offsets within rural supply chain **Maintain bio-diversity and forest health** ▪ Make forests resistant to pests and drought ▪ Predominant trees species make less contribution for biodiversity ▪ Suppress undergrowth of agricultural crops and regeneration of other plant species ▪ Need innovations to conserve traditional land use systems	**Supply of Forest and Agricultural Products, and Services** ▪ Grow trees on shifting cultivation lands, promote wood supply and improve livelihoods ▪ Agroforestry system harvested crops during first 3-4 years ▪ Provide fuel-wood, forage, water, esthetics and recreation and fire protection **Increase Farmers Incomes** ▪ Thinning in 8 and 15 years interval earned average Rs. 24,500 (US$ 318) and Rs. 66,000 (US$ 858) per hectare ▪ Expecting greater yield of timber from final harvest at the end of 25 years lease agreement ▪ As a carbon mitigation option benefits from carbon sequestration **Income Distribution and Poverty Alleviation** ▪ Selected only lower income groups of farmers as "poor" in rural areas ▪ Provided food ration and inputs at initial stage ▪ Have to wait for 25-year to obtain income from final harvest **Diversify Rural Economies and Improve Rural Livelihoods** ▪ Cash earned are used for community development related activities ▪ Promote wood based furniture and other cottage industries ▪ Potential of NTFPs contribute to rural economies

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Biomass and Carbon Sequestration Potential of *Simarouba glauca* under Dry Land of Hyderabad, Telangana

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Keywords: Biomass, Carbon Sequestration, Carbon Stock, *Simarouba glauca*

Introduction

In the present day scenario, the enhancement of atmospheric CO_2 coupled with the rise in temperature is the main reason behind the global climate change. Carbon sequestration through biomass seems to be a cheap and viable option to mitigate the increasing concentrations of green house gases. Plants can contribute to reduce atmospheric carbon dioxide concentration especially the terrestrial vegetation and soil which currently absorbs 40 per cent of global carbon dioxide emission from human activities (Adam, 2001). The most important solution is to grow forest for increasing terrestrial biomass to mitigate climate change. The present study was therefore designed to estimate that *Simarouba glauca* plantations have potential to significantly support carbon stocks and carbon sequestration and thereby mitigate CO_2 from the atmosphere.

Materials and Methods

The ten year old Si*marouba glauca* plantation was selected for carbon sequestration study with 6X6m spacing to estimate biomass and carbon allocation under different diameter classes in Central Research Institute for Dry land Agriculture, Hyderabad. The experiment was carried out during 15th November, 2014 to 15th February, 2015 in winter season. Entire plantation was divided into three diameter classes *viz,* 0-10 cm, 10 -20 cm and 20-30cm for measuring the growth parameters. These measurements were recorded as per established procedure. The trees were felled at ground level and roots were excavated to estimate the biomass of trees. Carbon stock and carbon per cent in above ground biomass and below ground biomass was estimated followed by Negi *et al.,* (2003) and Dhruw *et al.* (2009).

Results and Discussion

Higher total biomass recorded in *Simarouba glauca* was 169.0 kg tree^{-1} and 468.1 t ha^{-1}in 20-30 diameter class followed by 10-20 cm (57.81 kg tree^{-1} and 160.1 t ha^{-1}) diameter class. The average total carbon stock was recorded as 36.89 kg tree^{-1} and 102.2 t ha^{-1}. The carbon dioxide equivalent showed an increasing trend with increased diameter class among the different diameter classes. The average total CO_2 equivalent recorded in *Simarouba glauca* was 135.0 kg tree^{-1} and 374.1 t ha^{-1}. The total biomass of ten year old *Simarouba glauca* was 246.2 t ha^{-1}and carbon stock was 103.5 t ha^{-1}and a single tree accounts about 88. kg tree^{-1} and 36.89 kg/ha respectively. The above ground biomass components were contributed 71.82% and below ground components contributed 28.17% to the total biomass and carbon of the tree. In above ground biomass, secondary branches of *Simarouba glauca* were contributed highest biomass and carbon allocation of 31.92 per cent followed by primary branch, primary root and stem.

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Paradox of Leaf Phenology of *Calotropis procera* (Ait.) R. Br. found in Jega Local Government Areas of Kebbi State Nigeria, West Tropical Africa

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Keywords: Leaf phenology, *Calotropis procera* (Ait.) R. Br., Kebbi state, Nigeria

Introduction

Jega Local Government is approximately located at latitude 12°N, 43°N and 59°N and longitudes 4°N, 31°E. Jega is a Town of Kebbi State Nigeria, West Tropical Africa. Phenology refer to the study of cyclic and seasonal natural phenomena, especially in relationship to climate and plants life. Phenology is the study period of plants and animals life cycle event and how these are influence by seasonal. The study of how the biological world times natural events. The scientific study is of periodic biological phenomenal such as flowering, breeding, and migration a relation to climatic. The tasks of plant phenology is to observed and record the periodically recurring growth stage, phenology also a branch of science dealing with the relations between climate and periodic biological phenomena.

Materials and Methods

The choice of specimen trees, the random sampling method was applied. Five *Calotropis procera* (Ait.) R.Br. moderate tree stands were selected randomly in the study area to include stands of varying, ages having good foliage. This study lasted for 6 months. In the study site, four twigs (currently growing shoots of last order branches) on each of the four major branches (one on each direction) were marked with metal tags on five adult individuals of *Calotropis procera* (Ait.) R. Br. weekly counts of leaf were made from November to July (2014-2015) on the marked twigs. The following Phenological events were derived from the weekly leaf phenophase. Leaf flush period of an individual is the duration (days) from the first leaf flush to the last one. Leaf fall period of an individual represents the time (duration) from the estimated first leaf fall to the last one.

Results and Discussion

C. procera (Ait.) R.Br. moderate tree maintained significant foliage (reflect by leaf number) well beyond the rainy season. Seasonal reduction in foliage occurred during the period January - April, and minimum foliage was recorded in February in individuals which did not become leafless. New leaf formation began during the mid - dry season (March - April) and greater than 75% of total new leaves were produced during hot - dry summer, before the onset of rainy season (June). Leaf flushing, however, continued until September - October (following the rainy season). Two phonological variant of *C. procera* (Ait.) R.Br. were distinguished on the bases of contrasting leaf phenological events during March. During this month: (i) 60% individuals of (located at the low land the near university farm Gindi) showed completion of leaf fall and beginning of leaf flush in March variant (a); (ii) 40% individuals (located at Jega river side) showed a time gap between completion of leaf fall and initial of production on the new leaves, leaf fall phase was completed but the process of production of new leaves did not set in by the end of March variant (b) it is interesting to not in the annual cycle the entire population of *C. procera* (Ait.) R.Br. never become leafless, only about two - fifth individuals (variant b), situated in relatively dry and shallow soil, become leafless for a short period in March. (1). Conspecific trees of *C. procera* (Ait.) R.Br growing in the same environment showed different phenological patterns with respect to leafing. In contrast to the long duration of leaf flush (January - March), leaf fall duration (November - January) was much shorter. Thus, concentrated fall of leaves of varying longevity occurred during the mid - dry season, resulting in turnover of the total foliage annually. Shedding of old leaves was either accompanied or followed by leaf flush around spring equinox (January - March). In both variants leaf fall started in January during the annual cycle. Completions of leaf fall in variant (a) (60% individual) in April. Leaf flush was relatively more synchronous in conspecific trees (indicated by lower asynchrony) index compared to the leaf fall phonological event during the annual cycle.

Table: Diversity in seasonal duration of leafing, phenophase in two Phenological variant of *C. procera* (Ait.) R. Br. in tropical dry grass-land (Sudan savannah) in Jega local government area Kebbi state.

***C. procera* (Ait.) R.Br.**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**
Variant ‘A ‘ Leaf flushing	0.02	0.03	0.01	0.02	0.02	0.03	0.02	0.03	0.01
Variant ‘ B’ Leaf fall	0.03	0.04	0.02	0.02	0.3	0.4	0.3	0.01	0.02

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Nutritional Analysis of Locally Preferred Fodder Trees Leaf in Mid Hills of Himalaya

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Keywords: Animals health, fodder tree, Himalaya, nutrient values, winter season

Introduction

The production and availability of green fodder is not uniform throughout the year, available in plenty during monsoon and remaining period i.e. winter and summer are miserable in hilly areas of the Himalaya. The leaves of some identified evergreen fodder trees are given to animals during acute winter period (Bisht and Yadav, 2014). *Grewia optiva, Quercus leucotrichophora, Quercus dilatata, Quercus semecarpifolia, Ficus nemoralis, Ficus palmata,* and *Ficus roxburghii* etc. are the main winter fodder trees (Yadav and Bisht, 2013). The present study was therefore undertaken to explore nutrient contents of fourteen fodder tree leaves available in the mid hills of Himalaya.

Materials and Methods

This study was carried out at experimental farm Hawalbagh (29°36'N & 79°40'E, 1250 m amsl) of Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, India. For nutritional analysis, foliage samples of fourteen most preferred species were collected and made them composite and used the required samples for the lab test. Each sample was properly labeled, packed in plastic bags and taken to the laboratory. The green samples were air-dried, crushed with plant grinder and 100g of each sample was used for nutritional analysis. All the nutritional parameters of the samples were determined according to established Association of Official Agricultural Chemists (AOAC) protocol (1990).

Results and Discussion

Nutrient values of the sampled foliages have been displayed with their marked variations in their dry matter (DM), crude protein (CP), crude fiber (CFi), crude fat (CFa), crude ash and nitrogen free extract (NEF) (Table 1). The DM contents of various foliages used for feeding livestock in the study area varied from 37-78%. Most of the samples contained DM more than 45%, while only few of them contained more than 60% DM. The highest DM value was observed for *Bauhinia variegata* L. followed by *Prunus cerasoides* D. Don and *Quercus glauca* Thunb. The CP contents in these species varied from 10.5% to 27% with *Robinia pseudoacasia* L. containing the highest CP of 26.71% followed by *Morus alba* L. (24.69%), while *Grewia optiva* J. R. Drumtnond ex Burret having the lowest CP of 10.07%. Crude fiber content was high in *Grewia optiva* J. R. Drumtnond ex Burret leaves (33.04%) and low in *Melia azedarach* L. (12.72%). Whereas, Crude fat was high in *Quercus leucotrichophora* A. Camus (3.08%) followed by *Quercus serrata* Murray (2.82%) and low in *Grewia optiva* J.R. Drumtnond ex Burret (0.90%). The NFE contents of different fodder trees leaf varied from 35-58% and the highest NFE value was observed for *Prunus cerasoides* D. Don (58.2%) followed *Bauhinia variegata* L., *Melia azedarach* L. and *Quercus leucotrichophora* A. Camus respectively. The overall study indicated that fodder trees are an important source of protein and other dietary supplements such as crude fiber and fat for livestock and can be used as substrates deficit in either of these nutrients for livestock feeding.

Table 1: Nutritional value of fourteen locally preferred fodder tree species in mid hills of Himalaya

Fodder Trees	Moisture	Dry matter	Crude Protein	Crude Ash	Crude Fibre	Crude Fat	Nitrogen free Extract
Bauhinia variegata L.	22.12±0.86	77.88±0.86	17.60±0.34	8.31±0.08	22.14±0.20	1.38±0.03	50.6±0.4
Celtis australis L.	41.63±0.53	58.37±0.53	22.89±0.31	17.68±0.36	20.85±0.14	2.70±0.04	35.9±0.1
Ehretia Laevis Roxb.	50.82±1.03	49.18±1.03	14.82±0.44	15.51±0.21	25.25±0.25	1.87±0.02	42.5±0.3
Morus alba L.	55.40±0.69	44.60±0.69	24.69±0.60	18.75±0.38	16.77±0.22	1.25±0.03	38.6±0.8
Robinia pseudoacasia L.	47.72±0.66	52.28±0.66	26.71±0.27	5.61±0.18	31.17±0.57	1.06±0.01	35.4±0.7
Quercus glauca Thunb.	39.92±0.75	60.08±0.75	13.70±0.23	6.88±0.30	25.65±0.35	1.20±0.01	52.6±0.8
Prunus cerasoides D. Don	35.19±0.64	64.81±0.64	13.94±0.30	9.82±0.39	16.69±0.50	1.39±0.03	58.2±1.0
Quercus leucotrichophora A. Camus	27.55±0.35	72.45±0.35	10.56±0.40	5.73±0.32	31.67±0.59	3.08±0.05	49.0±0.6
Alnus nepalensis Don	45.20±0.87	54.80±0.87	15.81±0.58	7.88±0.15	25.96±0.25	1.90±0.01	48.5±0.6
Tushar	62.03±0.71	37.97±0.71	19.17±0.47	16.51±0.28	18.76±0.26	1.87±0.06	43.8±0.4
Bauhinia retusa L.	41.14±0.71	58.86±0.71	17.58±0.29	14.15±0.14	18.76±0.43	1.08±0.01	48.5±0.2
Grewia optiva J.R. Drumtnond ex Burret	46.86±0.76	53.14±0.76	10.07±0.65	10.91±0.23	33.04±0.75	0.90±005	41.6±0.1
Melia azedarach L.	60.20±1.05	39.80±1.05	20.30±0.39	19.06±0.28	12.72±0.40	1.94±0.02	49.3±0.5
Quercus serrata Murray	37.12±0.84	62.88±0.84	19.09±0.36	8.26±0.24	28.59±0.35	2.82±0.19	48.1±0.1

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Genetic Variability for Growth Traits of Different Half Sib Progenies of *Pinus Roxburghii* Sargent

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Keywords: *Pinus roxburghii*, heritability, growth traits, correlations, principal component analysis

Introduction

Pinus roxburghii Sargent, commonly known as "Chir pine" is the principal pine which is commercially tapped for oleoresin. Selection of superior genotypes and their mass multiplication is the need of the hour, for which evaluation of growth traits is required, which shall help in conservation and management of genetic resources of this species besides the formulation of advanced breeding strategies. For selection and advanced breeding to generate the best quality planting stock for plantation programmes, improve forest productivity to mitigate climate change and meet the demand of local people, the present study on this subject was carried out on a progeny trial of chir pine to study the variability for growth traits in chir pine and evaluation of different quantitative genetic parameters.

Materials and Methods

The Chir pine progenies under study have been raised in the mid-hills of western Himalayas in 1983 in the main campus of the Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, with the identification of plus trees all across the distribution range in Himachal Pradesh, India. The growth traits were measured according to standard procedures. ANOVA for each growth trait was performed based on the linear model, $y_{ij}= \mu + P_i + e_{ij},$ where y_{ij} is growth trait of *j*th replication of the *i*th progeny, μ is the overall mean, P_i the effect due to *i*th progeny (*i*= 1...21) and e_{ij} is the error. Different variance components, broad sense heritability, genetic advance, genetic gain (at 5% selection intensity), principal component analysis of the traits for the progenies were estimated, besides genotypic and phenotypic correlation coefficients among different traits.

Results and Discussion

There existed a significant variation for these growth traits, namely, height (18.08±1.83 m), Diameter at breast height (DBH; 34.76±2.7 cm), bark thickness (2.73±0.36 cm), crown height (7.8±1.5 m), crown length (10.28±1.36 m), among the different half sib progenies. Estimates of variability and genetic parameters for growth traits of among different half sib progenies of *Pinus roxburghii* have been presented in Table 1. This variability was found under genetic control, as all these progenies are growing under same environment, and are of same age. Crown height had maximum heritability (45.28%) with genetic gain of 22.45%, while traits which exhibited high heritability followed by higher genetic gain can be exploited quiet well in advanced breeding programs. Association analysis can be helpful in indirect selection, as was highly significant for crown height and height (0.70). Principal component analysis revealed that maximum weightage should be given to height, having high loading value in principal component I and good heritability (H^2= 32.49%). Since all the half sib progenies were originally collected from all over the state of Himachal Pradesh over a variety of sites differing with regard to locality factors, but at present these are growing at one site in the same environmental conditions in the progeny trial, so the differences in the performance of all the progenies are due to genetic factors. This further suggests the scope of selection of superior progenies and the progeny trial in to productive seed orchard for immediate genetic gains.

Table 1: Estimates of variability and genetic parameters for growth traits of among different half sib progenies of *Pinus roxburghii*

Trait	Mean	Range	S.D	Coeff. of variation (%)	C.V (%)		Heritability ($H^{2\%}$)	Genetic advance	Genetic gain (%)
					GCV	PCV			
DBH (cm)	34.76	29.43-39.33	2.70	9.37	5.63	10.93	26.55	2.07	5.98
Height (m)	18.08	13.00-20.50	1.83	11.22	7.78	13.65	32.49	1.65	9.14
Bark thickness cm)	2.73	2.00-3.27	0.36	14.04	10.64	17.62	36.47	0.36	13.24
Crown height (m)	7.80	5.33-11.00	1.50	17.80	16.19	24.06	45.28	1.75	22.45
Crown length(m)	10.28	7.17-12.67	1.36	14.66	10.15	17.83	32.38	1.22	11.9

DBH= Diameter at Breast Height

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Biomass Production of *Ulmus villosa* under Mid-hills of Himachal Pradesh- A Statistical Approach

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Keywords: *Ulmus villosa,* biomass, correlation coefficients, regression models

Introduction

Cherry-bark Elm (*Ulmus villosa* Brandis) is one of the distinctive Asiatic elms belonging to the family Ulmaceae. The species is highly valued for its multiple uses and fast growth rate. Estimation of woody biomass is a prerequisite for determining the state of flux for biological materials in an ecosystem and for understanding the dynamics of ecosystem. Information on biomass is not only important from the standpoint of fundamental ecology, but also relevant to planning for ecologically sustainable development of a region. An attempt has been made to predict the above ground biomass of *Ulmus villosa* under mid-hills of Himachal Pradesh.

Materials and Methods

Bagaur (Site-I) and Majhgaon (Site-II) were randomly selected at the main campus of Dr. Y S Parmar University of Horticulture and Forestry, Nauni (Solan), Himachal Pradesh. An optimum sample size of 135 trees was selected randomly by following a two-step approach as suggested by Stein (1945) and Cox (1958) for recording the observations on various growth parameters. Various regression functions linear and non-linear were fitted for biomass with diameter at breast height, tree height, crown height, crown length, crown width and bole height. Further multi-linear regression equations were also developed for tree growth characteristics on biomass of *Ulmus villosa*.

Results and Discussion

The results reveal that total dry biomass and total green biomass were positively and significantly correlated with all tree growth parameters. Total green biomass showed a highly significant correlation with DBH (0.944) followed by tree height (0.846) and the total dry biomass showed also a highly significant correlation with DBH (0.910) followed by tree height (0.812). DBH was also found to be positively and significantly correlated with tree height (0.906). Among different regression functions, exponential function ($Y=ae^{bx}$) was showing highest adjusted R^2 to predict green and dry by using growth parameters (diameter at breast height, tree height and crown length) separately. The use of diameter at breast height remained the best independent variable for estimating green and dry biomass of standing trees of *Ulmus villosa* in the present study, thus making diameter as most reliable and effective estimator. Tree height remained the second important independent variable to predict green and dry biomass. Crown height, crown width and bole height did not show any significant results for green and dry biomass prediction.

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Table 1: Correlation matrix indicating relationship between different tree growth characteristics

Characters	Total green biomass (kg)	Total dry biomass (kg)	DBH (cm)	Tree height (m)	Crown height (m)	Crown length (m)	Crown width (m)	Bole height (m)
Total green biomass (kg)	1.00							
Total dry biomass (kg)	0.964*	1.00						
DBH (cm)	0.944*	0.910*	1.00					
Tree height (m)	0.846*	0.812*	0.906*	1.00				
Crown height (m)	0.408*	0.396*	0.407*	0.459*	1.00			
Crown length (m)	0.773*	0.749*	0.798*	0.865*	0.095*	1.00		
Crown width (m)	0.474*	0.470*	0.549*	0.601*	0.365*	0.415	1.00	
Bole height (m)	0.384*	0.324*	0.443*	0.558*	0.628*	0.280*	0.412*	1.00

*significant at 1% level of significance

Table 2(a): Linear and non-linear functions for green and dry biomass with DBH

Green biomass	SE of estimate	Adj. R^2
GB=– 103.117 + 13.432 D	0.406	0.891
GB=– 359.614 + 173.753 ln D	8.414	0.760
GB= $e^{5.930-21.163/D}$	1.107	0.731
GB= 0.416 $D^{1.989}$	0.065	0.876
GB= 8.242 $e^{0.145 D}$	0.004	0.909
Dry biomass		
DB=– 69.115+ 8.417 D	0.333	0.826
DB=– 225.551 + 107.274 ln D	6.282	0.684
DB= $e^{5.423-22.130/D}$	1.193	0.719
DB= 1.479 $D^{2.073}$	0.073	0.856
DB= 4.177 $e^{0.151 D}$	0.005	0.892

GB= Green biomass (kg) DB= Dry biomass (kg) D= DBH

Table 2(b): Linear and non-linear functions for green and dry biomass with tree height

Green biomass	SE of estimate	Adj. R^2
GB=– 130.263 + 17.887 H	0.978	0.713
GB=– 383.142 + 192.598 ln H	13.580	0.599
GB= $e^{5.945-19.083/H}$	1.582	0.519
GB= 2.142 $H^{2.154}$	0.134	0.659
GB= 6.273 $e^{0.191 H}$	0.010	0.717
Dry biomass		
DB=– 85.573 + 11.167 H	0.696	0.657
DB=– 239.350 + 118.621 ln H	9.499	0.536
DB= $e^{5.391-19.396/H}$	1.731	0.482
DB= 1.455 $H^{2.203}$	0.141	0.620
DB= 3.254 $e^{0.197 H}$	0.012	0.684

GB= Green biomass (kg) DB= Dry biomass (kg) H= Tree height (m)

Table 2(c): Linear and non-linear functions for green and dry biomass with crown length

Green biomass	SE of estimate	Adj. R^2
GB=– 71.309 + 19.503 CL	3.792	0.595
GB=– 184.915 + 135.763 ln CL	13.875	0.483
GB= $e^{5.368-7.895/CL}$	0.850	0.389
GB= 916.220 $CL^{1.530}$	0.151	0.540
GB= 11.680 $e^{0.210 CL}$	0.042	0.604
Dry biomass		
DB=– 49.721 + 12.282 CL	2.480	0.557
DB=– 119.309 + 84.577 ln CL	9.086	0.443
DB= $e^{4.527-8.197/CL}$	0.905	0.377
DB= 27.669 $CL^{1.595}$	0.160	0.528
DB= 5.984 $e^{0.219 CL}$	0.044	0.595

GB= Green biomass (kg) DB= Dry biomass (kg) CL= Crown length (m)

Table 2(d): Linear and non-linear functions for green and dry biomass with crown height

Green biomass	SE of estimate	Adj. R^2
GB= 24.242 + 19.517 CH	1.386	0.160
GB= 20.349 + 63.270 ln CH	12.078	0.129
GB= $e^{4.604-0.863/CH}$	0.324	0.043
GB= 35.153 + 0.592 ln CH	0.122	0.097
ln GB= 37.186 + 0.178 CH	0.015	0.114
Dry biomass		
DB= 10.247 + 12.340 CH	0.943	0.151
DB= 8.663 + 39.341 ln CH	8.159	0.117
GB= $e^{4.031-0.855/CH}$	0.342	0.041
ln DB= 19.538 + 0.597 ln CH	0.130	0.088
ln DB= 20.653 + 0.180 CH	0.016	0.105

GB= Green biomass (kg) DB= Dry biomass (kg) CH= Crown height (m)

Table 2(e): Linear and non-linear functions for green and dry biomass with crown width

Green biomass	SE of estimate	Adj. R^2
GB=– 14.512 + 24.036 CW	3.873	0.219
GB=– 56.012 + 103.537 ln CW	18.051	0.192
GB= $e^{5.202-3.803/CW}$	0.729	0.164
ln GB= 13.236 + 1.138 ln CW	0.191	0.205
ln GB= 21.751 + 0.256 CW	0.041	0.218
Dry biomass		
DB=– 15.857+ 15.521 CW	2.524	0.215
DB=– 41.033 + 65.810 ln CW	11.806	0.183
DB= $e^{4.632-3.845/CW}$	0.775	0.150
ln DB= 7.164 + 1.160 ln CW	0.203	0.191
ln DB= 11.759 + 0.263 CW	0.044	0.207

GB= Green biomass (kg) DB= Dry biomass CW= Crown width

Table 2(f): Linear and non-linear functions for green and dry biomass with bole height

Green biomass	SE of estimate	Adj. R^2
GB= 30.955 + 16.509 BH	3.443	0.141
GB= 18.146 + 61.516 ln BH	13.139	0.135
GB= $e^{4.598-0.883/BH}$	0.256	0.075
ln GB= 29.350 + 0.690 ln BH	0.139	0.150
ln GB= 34.308 + 0.182 BH	0.037	0.151
Dry biomass		
DB= 20.585 + 9.067 BH	2.294	0.098
DB= 12.234 + 34.726 ln BH	8.718	0.101
DB= $e^{4.011-0.858/BH}$	0.272	0.063
ln DB= 17.341 + 0.651 ln BH	0.149	0.119
ln DB= 20.373 + 0.169 BH	0.039	0.115

GB= Green biomass (kg) DB= Dry biomass BH= Bole height

Table 2(g): Multilinear regression equations for green and dry biomass

Multilinear regression equations for green biomass	Adj R^2
GB= -102.507+13.703D - 5.306H+7.305CH+5.951CL - 1.888CW - 2.122BH (0.930) (2.370) (2.081) (1.960) (1.791) (1.701)	0.901
Multilinear regression equations for dry biomass	
DB= -70.593+8.431D- 3.591H+6.434CH+4.374CL- 0.740CW - 3.840BH (0.755) (1.923) (1.689) (1.590) (1.453) (1.380)	0.846

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Variation Studies in Growth and Biomass Characteristics of *Melia azedarach*

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Keywords: Mother trees, *Melia azedarach*, Progenies, Heritability, Genetic gain

Introduction

Among all plant families, the trees of Meliaceae are more useful to human beings, chiefly for their high quality timbers and for the ease with which they can be grown in plantations. Drek (*Melia azedarach* Linn.) is a deciduous tree belonging to family Meliaceae. It is a highly valuable species for its multipurpose importance and recognition as a species of agroforestry/ social forestry/ urban forestry. The species has been growing under the desert development project in Spiti in Himachal Pradesh. In Jammu and Kashmir J & K, it has been successfully used in the afforestation of bare south and south-western slopes on the Sankaracharaya hill near Srinagar under difficult site condition

Materials and Methods

The study was conducted in the Department of Tree Improvement and Genetic Resources, Nauni, Solan (H.P.). Seeds of *Melia azedarach* were collected from selected mother trees one each at twenty seven locations and progenies were raised in Randomised Block DesignRBD with three replications to study the extent and pattern of variation with respect to growth and biomass characters. Principal Component Analysis (PCA) was carried out taking 17 important parameters, proved useful in extracting the most important factors]

Results and Discussion

The variability and genetic estimates were computed for each trait. The Genotypic Coefficient of Variation GCV (%) ranged from 14.48-45.82, Phenotypic Coefficient of Variation PCV (%) from 14.75- 48.98 and heritability from 0.74 -0.96 among the traits. Genotypic correlation coefficients were also found greater than the phenotypic for most of the growth and biomass characters. Site S_{27} (Nauni) exhibited outstanding performance for the growth and biomass characters of progenies followed by S_{14} (Ropar), S_4 (Bhota), S_{23} (Subathu) and S_{11} (Jwala ji) and hence preference should be given to these sites while selecting trees for further improvement programmes. In Principal Component Analysis PCA 4 out of 17 components had eigen value greater than unity and they contributed 81.73% of total variation.

Table 1: Mean, range, Coefficient of Variation (CV), Genotypic Coefficient of Variation (GCV), Phenotypic Coefficient of Variation (PCV), heritability, genetic advance and genetic gain for growth and biomass characteristics of *M. azedarach* progenies

Character	Mean	Range	CV (%)	Coefficient of variance (%)		Heritability	Genetic advance (K= 2.06)	Genetic gain (%)
				Geno-typic	Pheno-typic			
Height (cm)	7.39	5.30- 10.82	9.04	22.95	24.67	0.87	3.27	44.27
Collar diameter (mm)	1.40	0.72- 1.82	5.42	31.83	32.41	0.96	0.80	64.37
Number of branches per plant	6.92	5.00- 8.25	9.02	17.95	20.62	0.76	1.98	32.21
Number of leaves per plant	26.08	17.50- 31.50	7.83	17.71	19.78	0.80	7.56	32.61
Petiole length (mm)	0.40	0.19- 0.57	13.07	29.98	33.48	0.80	0.19	54.11
Leaf area (cm^2)	9.88	7.50- 11.30	2.53	14.48	14.75	0.96	2.56	29.14
Root length (cm)	21.52	9.67- 31.20	7.21	29.02	30.13	0.93	11.04	57.72
Root- shoot length ratio	3.00	1.87- 4.28	7.46	26.38	27.69	0.91	1.38	51.83
Shoot fresh weight(g)	0.68	0.39- 1.18	11.49	33.43	35.87	0.87	0.39	64.84
Shoot dry weight (g)	0.24	0.15- 0.37	13.21	29.95	33.43	0.80	0.12	56.25
Root fresh weight (g)	0.92	0.38- 2.26	19.14	42.82	47.06	0.83	0.74	81.01
Root dry weight (g)	0.19	0.08- 0.44	15.45	45.82	48.98	0.88	0.15	88.49
Fresh root- shoot weight ratio	1.50	0.86- 2.57	9.66	27.04	29.15	0.86	0.69	51.85
Dry root- shoot weight ratio	0.87	0.54- 1.32	13.40	25.63	29.69	0.74	0.35	45.02

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Polysaccharides: Potential Source for Silver Nanoparticles Synthesis

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Keywords: Polysaccharides, plant exudates, gums, silver nanoparticles, synthesis

Introduction

Polysaccharides are macromolecules carrying relatively a large number of functional groups that are either charged or under suitable conditions, can be charged. They are complex polymers comprising of multiple monosaccharides units interlinked with glycosidic linkages to form a large, branched or unbranched chain. Natural plant gums are well-known polysaccharides which are very valuable and used as food additives, emulsifiers and pharmaceutical ingredients. They find applications in cosmetic, textile, paper, calico printing, paint, varnishes, car polishes, ceramics, explosives, mining and petroleum industries. The distinct advantages of natural gums over their synthetic counterparts are their bio-compatibility, safety, lower cost, low toxicity, eco-friendliness, renewability, relatively widespread availability, practically no side-effects, more efficacious and provide lasting cure for age-related disorders. During last few years, there has been an upsurge in the study of silver nanoparticles (AgNPs) on because of their immense importance and inherent anti-microbial efficacy and are already integrated into applications such as wound-treatment, sterilization, food, sanitation, antibacterial, textiles etc. In fact, silver nanoparticles exhibit a broad spectrum of anti-bactericidal and anti-fungicidal activities making them extremely popular in a diverse range of consumer products, including plastics, soaps, pastes, food thus increasing their market value. These are also being seen as future generation therapeutic agents against several drug-resistant microbes. Due to their high reactivity because of their large surface to volume ratio, nanoparticles also play a crucial role in water purification. The size, orientation and physical properties of nanoparticles have reportedly transformed the performance of any material as compared to their macroscaled counterparts.

Materials and Methods

The synthesis of silver nanoparticles (AgNPs) of gum exudates, collected from different agro-climatic zones, was carried out by autoclaving the reactants (gum and silver nitrate solutions), at 121°C and 15 psi. Before carrying out the synthesis, the protein content present in the gum exudates was determined by Lowry method taking Bovine serum albumin (BSA) as standard. Autoclaving makes the silver nanoparticles intrinsically safe and sterile in environmentally benign solvent water. After autoclaving, the appearance of yellow colour in the reaction mixtures is a clear indication of the formation of silver nanoparticles by the gum. The formation of the silver nanoparticles was monitored by UV-VIS spectra at 200 -700 nm, where at 425 nm, a band was detected corresponding to the typical surface plasmon resonance (SPR) of conducting electrons from the surface of silver nanoparticles.

Results and Discussion

Natural plant gums are important forest products. Green synthesis of silver nanoparticles using natural plant gums *viz*. ghatti (*Anogeissus latifolia*), cashew (*Anacardium occidentale*), kondagogu (*Cochlospermum gossypium*), arabic, tragacanth (*Astragalus gummifer*), *Sterculia foetida* and 11-keto-β-boswellic acid (KBA), one of the active constituents of *Boswellia serrata* (an oleo gum-resin) has been reported by a number of researchers for their numerous biological applications. The renewable and non-toxic components of natural phytoexudates play dual role as reducing and stabilizing agents for the silver ions. In a given gum concentration, the efficiency of nanoparticle synthesis increases with the reaction time, a property attributable to the greater reduction capacity of the gum. The hydroxyl and carboxyl groups of the gum facilitate the complexation of silver ions during autoclaving. Subsequently, these silver ions are reduced to elemental silver, possibly by *in situ* oxidation of hydroxyl groups; and by the intrinsic carbonyl groups, in addition to those produced by the air oxidation. Further, the easy availability of the gums make the green method amenable to large-scale production of silver nanoparticles. Once the silver ions are reduced to silver nanoparticles by the gum, proteins present in the gum, subsequently, encapsulate and stabilize these particles along with saccharide molecules. The surface reactivity, provided by capping enables these functionalized nanoparticles to qualify as promising candidates for various pharmaceutical, biomedical and environmental applications.

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Effect of Pruning Intensities of *Dalbergia sissoo* and Different Dates of Sowing of Turmeric on Carbon Sequestration in Agri - Silvicultural Based Agroforestry System

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Keywords: Managed agri-silvicultural system, carbon sequestration,

Introduction

Global warming and climate change are the major environmental issues affecting human and plant life. Worldwide, increased atmospheric CO_2 is attributed mainly due to fossil fuel combustion and deforestation. Trees act as a sink for CO_2 by fixing and storing carbon as biomass. Carbon sequestrated depends mainly upon the type of species, system, agro-climatic region, site quality etc. Agroforestry seems to be a potential and low cost method to sequester atmospheric carbon and is being recognized as a strategy for climate change mitigation (Alavalapati and Nair, 2001). The present investigation has been conducted under agri -silvicultural system at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur.

Materials and Methods

The treatment combination involved five pruning treatments of *D. sissoo* (viz., no pruning, 25%, 50%, 75% pruning) and one open (tree alone) in main plot and turmeric variety suroma with three dates of sowing in sub plot. The diameter at breast height (1.37 m from ground) was measured at fifteen years of tree growth by the following formula:

Basal area= $0.00007854 \times (\text{dbh})^2$

Volume of tree= Basal area × tree height

Carbon content in all the samples of tree and crop has been estimated as per the given formula:

Carbon sequestration= Biomass × carbon %

For calculating CO_2 sequestration rate of individual tree species, total CO_2 was divided by age of trees (15 years).

Results and Discussion

The rhizome yield (q/ha) of turmeric sown under tree were at par and varied significantly from the crop sown in open condition which had significantly minimum rhizome yield. The fixed carbon content (%) and carbon sequestration (t/ha) was significantly maximum in the crop alone under open condition and was significantly minimum in unpruned trees. The carbon sequestration in the crop was maximum in the open condition (Table 1).

As per effect of date of sowing of turmeric the carbon sequestered was significantly highest at mid date sowing (D_2). The rhizome yield was significantly highest under early sown conditions. The rhizome yield was least in the late sown turmeric.

A perusal of the data on *Dalbergia sissoo* revealed that the diameter at breast height, basal area, above ground biomass and Carbon sequestration in tree (tonnes/ha) were significantly higher in 25% pruned trees and at par with unpruned and 50% pruned trees.

The study revealed that carbon sequestration potential was significantly higher under managed agroforestry system. Turmeric in combination with 25% pruned *Dalbergia sissoo* sequestered maximum carbon and was at par with unpruned trees. The values were significantly lowest in open (crop alone). Owing to high energy conversion, *Dalbergia sissoo* resulted in higher biomass and carbon accumulation (Bohre *et al*., 2012).

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Table 1: Mean carbon sequestration in *Dalbergia sissoo* + Turmeric based Agrisilvicultural system of Agroforestry

Treatment	DBH (cm)	Basal Area (m^2)	Above ground biomass (kg/tree)	Carbon sequestration in the tree (t/ha)	Rhizome yield (q/ha)	Carbon sequestration in the crop (t/ha)	Mean Carbon in System
Pruning Intensities							
Po- No Pruning	23.8	0.046	347.75	71.26	29.09	1.3	76.4
P_1- 25% Pruning	24.1	0.046	431.47	91.78	31.98	2.6	105.7
P_2- 50% Pruning	21.5	0.037	320.56	71.82	31.19	2.1	67.7
P_3- 75% Pruning	16.7	0.023	179.36	39.90	28.39	2.5	44.3
Open	-	-	-	-	27.64	3.2	-
SEM ±	1.0	0.004	44.62	9.04	1.36	0.045	4.08
CD (P= 0.05)	3.2	0.011	142.73	28.93	4.2	0.14	10.64
Date of Sowing							
D_1 - 20 June 2013	22.2	0.040	386.68	82.20	34.77	2.2	67.9
D_2 - 27 June 2013	22.4	0.041	374.53	79.84	30.02	2.5	66.4
D_3 - 03 July 2013	20.2	0.032	239.34	52.14	24.18	2.3	44.0
Tree alone	21.3	0.038	278.61	60.58	-	-	-
SEM ±	0.9	0.0034	33.3	7.32	1.4	0.045	14.12
CD (P= 0.05)	NS	NS	NS	NS	4.3	0.15	37.89

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Domestication and Intensive Management of Poplar (*Populus deltoides*) Clonal Plantation Under Agroforestry to Maximise Yield and Improve Environment Through Carbon Sequestration and Climate Change Mitigation in North India- A Historical Perspective and a Case Study

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Keywords: Poplar agroforestry, High yield, Climate Change Mitigation

Introduction

WIMCO- a match stick manufacturing company faced difficulties in procuring raw materials, hence introduced *Populus deltoides* clones G3 and G48 from Australia in the 1980s, which laid the foundation of commercial poplar plantations under agroforestry in the states of Uttar Pradesh, Punjab, Haryana and Uttarakhand. Although WIMCO started planting poplars in farmer's land with assured buyback guarantee, they asked for finance, which was beyond it's capacity, hence approached NABARD for funding. Realizing it's importance, NABARD, partnering with WIMCO and 13 banks funded a big poplar plantation project from 1984 to 1995 in the above mentioned states which was a huge success.

Materials and Methods

To ascertain the present position of poplar plantings, availability of planting stocks, yield, income, intercrops, bank loan and marketing, the author undertook a study in Chahal village of Punjab along with WIMCO and other NABARD officials and held discussions with the farmers and wood industrialists. It was observed that excellent plantations were raised by many farmers procuring clones from WIMCO, which had produced high yielding clones through selection and breeding, but the most successful and high in demand was introduced clone G-48. Later, we met two progressive farmers, visited their plantations and measurements were taken on year wise basis (Table 1).

Results and Discussion

The farmers had 20 hectare irrigated land and planted G48 clones in such a way that every year they could harvest a minimum 2 ha plantation, when trees attained average height of 18m and girth of 90cm, yielding 180 tone wood per ha, clocking an income of INR 0.72 million based on a price of INR 4000 per metric tone in 2010. There was no marketing problem, because more than 1000 wood industries were established in Yamunanagar, Haryana. Today, it has the largest congregation of factories manufacturing wood products more than INR 50,000 million annually. It was further observed that although in NABARD scheme, harvesting was fixed at eighth year, the farmers harvested in sixth year, because of good growth and high demand. Today, the world's largest poplar plantation is in the north Indian states and which is growing. Many of the average poplar growers are now realizing around INR 1 million per acre per year net returns with timber prices touching an all time high of INR 11,000 per MT in Yamunanagar. National Agroforestry Policy (2014) stated that agroforestry could become an important tool to build resilience of farmers and rural people against threats of climate change and natural calamities. This could also help in greening India by creating agroforestry produce based economic activities. The study concluded that Poplar based agroforestry was highly successful. Besides, carbon sequestration potential of Poplars are high, hence mitigate climate change efficiently. Such programmes should be replicated with other trees in different parts of India.

Table 1: Average growth of plantations

Year wise growth of Poplar trees in a series of plantations (1 acre)						
Tree Nos.	**Years, Girth in cm**					
	1	**2**	**3**	**4**	**5**	**6 (Harvesting)**
1	17	38	55	60	76	
2	18	45	54	59	75	
3	21	40	55	51	78	
4	19	42	58	58	68	
5	16	46	69	62	78	
6	18	38	63	63	78	
7	20	50	52	63	75	
8	15	52	54	66	80	
9	18	47	51	65	95	
10	21	48	50	60	90	
Average girth in cm	18.3	44.6	56.1	60.7	79.3	

NB:

i) **Average height:** After 5 year's growth Poplar reached an average height of 18 m & girth of 80 cm.

ii) **Best girth:** Achieved 95 cm by Late Captain Ratan Singh, Average year wise growth was 18 cm/ yr./ tree.

iii) **Agricrops:**
- 1st year: Sugarcane
- 2nd year: Ratoon sugarcane
- 3rd year: Wheat onwards

iv) **Harvesting:** It was not done by the farmers, the middlemen visited the farms regularly & purchased the trees, cut into pieces, uprooted the stump and then carried to the plywood industries.

v) **Marketing:** Marketing was not a problem, since there was a good marketing network for industrial uses of poplar wood.

vi) **Industrial uses:**
   i. More than 50% of Poplar woods were consumed by industries in Yamunanagar, where 1000 plywood factories were established
   ii. 40% of Poplar wood went to Ludhiana and Jalandhar where more than 200 plywood factories were located
   iii. 10% used locally, mainly in Ropar

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Agroforestry Practices for Carbon Sequestration in the Mid Hills of Central Himalaya

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Keywords: Agro-forestry, agri-horticulture, carbon sequestration, high density plantation, Himalaya

Introduction

In Himalayan region several indigenous agro-forestry systems based on people's needs and site-specific characteristics have been developed over the years. Agro-forestry practices have wide and promising potential to store carbon and remove atmospheric carbon dioxide through enhanced growth of trees. However, little has been reported regarding carbon sequestration potential of agro-forestry systems in Indian Himalaya. In this scenario, it is imperative that the carbon sequestration potential for agro-forestry practices in the region is also investigated. The present study attempted to monitor biomass production, carbon stock and carbon dioxide mitigation potential of different agro-forestry systems in mid hills of central Himalaya, India.

Materials and Methods

The study was conducted at experimental farm Hawalbagh (29°36'N and 79°40'E, 1250 m amsl) of Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, India. Three land use systems were selected for the study: pecan nut based agri-horticulture system; fruit tree based agri-horticulture system and high density plantation of oak. Carbon stock estimated from biomass, CS= 0.45 × B, where CS is the carbon stock and B is biomass i.e. measured using the equation on the basis of stem diameter at breast height, height (h), wood density and the data analyzed using SAS System.

Results and Discussion

Tree density of *Carya illinoinensis* (Pecan nut) was 238 trees ha^{-1} and the total of 21.90 Mg C ha^{-1} was stored in the pecan nut stem biomass in pecan nut based agrihorti system (Table 1). The density of fruit trees viz., *Citrus lemon* (lemon), *Prunus domestica* (plum), *Pyrus communis* (pear) and *Prunus armeniaca* (apricot) was 277 trees ha^{-1} and it is found that carbon stock in pear was highest (12.7 Mg ha^{-1}) followed by apricot (7.33 Mg ha^{-1}), plum (5.78 Mg ha^{-1}) and lemon (3.79 Mg ha^{-1}) in fruit based agrihorti system (Table 2). The carbon stock of high density (1.0 m x 1.0 m) plantation of *Quercus leucotrichophora* (Oak) in energy plantation system could be 17.55 Mg carbon per hectare per year. Biomass carbon equivalent carbon dioxide (CO_2) come out to be 80.03 Mg C ha^{-1} for pecan nut, 46.61 Mg C ha^{-1} for pear, 26.90 Mg C ha^{-1} for apricot, 21.20 Mg C ha^{-1} for plum and 13.91 Mg C ha^{-1} for lemon in pecan nut and fruit based agrihorti systems, respectively. The above ground biomass and vegetation carbon density in present result is in accord with the result reported by Yadav *et al.* (2015); Yadav and Bisht (2014) for Himalayan agroforestry practices in mid hills situation. Carbon storage in plant biomass is only feasible in above mentioned type of perennial agroforestry systems, which allow full tree growth and where the woody component represents an important part of the total biomass.

Table 1: Aboveground biomass, carbon stock and carbon dioxide mitigation by pecan nut and fruit trees in agri-horticulture and oak high density plantation in Indian Himalaya

Systems	Above ground biomass (Mg ha^{-1})	Above ground biomass C (Mg ha^{-1})	Above ground biomass CO_2 (Mg ha^{-1})
Pecan nut in agrihorticulture system			
1. Pecan nut	48.7±0.76^b	21.9±0.49^b	80.0±1.77^b
Fruit trees in agrihorticulture system			
2. Hill lemon	8.6±0.81^b	3.8±0.35^b	13.9±1.24^b
3. Plum	12.8±0.58^b	5.8±0.49^b	21.2±1.42^b
4. Pear	28.4±0.57^b	12.7±0.67^b	46.6±2.20^b
5. Apricot	16.4±0.72^b	7.4±0.36^b	26.9±1.21^b
Oak high density plantation			
6. Oak	1170±56.72^a	526.5±28.17^a	1932.2±10^a

Means with the same letter are not significantly different (Duncan's Multiple Range Test), values after±sign are standard error.

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Biological Yield and Carbon Sequestration in Prominent Traditional Agroforestry Systems in Valsad District, Gujarat, India

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Keywords: Agroforestry, biological yield, carbon sequestration

Introduction

Release of carbon into atmosphere is one of the main causes of climate change. Ever since the Kyoto Protocol, agroforestry has gained increased attention as a strategy to sequester carbon (C) and mitigate global climate change. Quite a few studies have appeared in recent years that report carbon sequestration potential of traditional agroforestry systems. It is important to divulge the production as well as carbon sequestration potential of traditional agroforestry systems at regional level. Local carbon inventories will be helpful in estimation of carbon stocks and removal by particular tree-crop combinations. Our study presents the biological yield and carbon sequestration status under prevalent agroforestry systems in the Valsad District, Gujarat, India

Materials and Methods

The prominent agroforestry systems were identified following stratified random sampling in five Talukas (Valsad, Dharampur, Kaprada, Pardi and Umargoan) of Valasad district. Standing volume and biomass of trees was calculated with standard formulas. Biomass of fruit trees was estimated by calculating the volume of main stem and bigger branches and the biomass was calculated by multiplying volume with specific gravity. The below ground biomass of timber and fruit trees was calculated using Intergovernmental Panel on Climate Change (2003) default value (0.26.). To estimate the biological yield of agricultural crops, plants were uprooted to the depth possible in 1m2 plot (mean of three plots/system/intercrop) under each agroforestry system (AS).

Results and Discussion

Tectona grandis (teak), under AS system type teak + rice (*Oryza sativa*) crop attained higher above and below ground and total biomass to the tune of 40.15, 10.44 and 50.59 t/ha respectively, followed by *Mangifera indica* (mango) under AH [mango + banana (*Musa paradisiaca*)] system (25.41, 6.60 and 32.01 t/ha above and below ground and total biomass, respectively). Amongst intercrops, under different AS, banana under AS (teak + banana) system produced maximum above ground (23.60), below ground (6.13) and total biomass (29.73 t/ha) followed by sugarcane (*Saccharum officinarum*) under AS (teak + sugarcane) with values of 11.07, 3.04 and 14.11 t/ha for above ground, below ground and total biomass. Maximum total biological yield (53.12) was recorded from AS system with components teak + rice crop followed by mango + banana (52.88) and minimum (2.96) was from AH (mango + rice) system. Among woody components, maximum above ground (19.27), below ground (5.01) and total sequestered carbon (24.28 t/ha) was recorded for teak in AS (teak + rice) system, followed by mango under AH (mango + banana) system with 12.20, 3.17, 15.36 tons of carbon above ground, below ground and total, respectively. Amongst intercrops, highest above (11.32 t/ha), and below ground (2.94 t/ha) and total carbon (14.26 t/ha) was recorded for banana grown in AS (teak + banana) followed by banana under AH (mango + banana) system with respective values for above ground, below ground and total carbon as 7.95, 2.06 and 10.01t/ha. Maximum carbon to the tune of 25.48 t/ha was sequestered under AS (teak +rice) system, followed by AH (mango + banana) system type (25.37) and it was minimum (1.41 t/ha) from AH (mango + rice) system. The contribution of woody perennials to total biological yield and carbon sequestration was considerably more as compared to intercrops in systems with woody components having attained harvestable size or are in full fruit bearing stage.

Table 1: Biological yield (DM t/ha) and carbon sequestration by woody and non woody components under prevalent traditional AF systems in Valsad district, Gujarat

AF systems/ system types	Woody component						Intercrops						Total of AF system	
	Above ground		Below ground		Total		Above ground		Below ground		Total			
	BY	C	BY	C	BY	C	BY	C	BY	C	BY	C	BY	C
Agri-silviculture (AS)														
Teak+rice	40.15	19.27	10.44	5.01	50.59	24.28	2.01	0.96	0.52	0.24	2.53	1.2	53.12	25.48
Teak+sugarcane	5.75	2.76	1.49	0.71	7.24	3.48	11.07	5.31	3.04	1.45	14.11	6.76	21.35	10.24
Teak+banana	12.08	5.80	3.14	1.51	15.22	7.30	23.60	11.32	6.13	2.94	29.73	14.26	44.95	21.56
Teak+okra	3.72	1.78	0.96	0.46	4.68	2.25	8.80	4.22	2.28	1.09	11.08	5.31	15.76	7.56
Teak+okra	9.11	4.37	2.36	1.13	11.47	5.51	7.38	3.54	1.91	0.91	9.29	4.45	20.76	9.96
Agri-horticulture (AH)														
Mango+ rice	0.11	0.052	0.02	0.01	0.13	0.06	2.25	1.08	0.58	0.27	2.83	1.35	2.96	1.41
Mango +banana	25.41	12.20	6.60	3.17	32.01	15.36	16.57	7.95	4.30	2.06	20.87	10.01	52.88	25.37
Mango + chili	0.09	0.04	0.02	0.01	0.11	0.05	5.98	2.87	1.55	0.74	7.53	3.61	7.64	3.66
Horti-pasture (HP)														
Mango+maize	4.89	2.35	1.27	0.61	6.16	2.96	10.05	4.82	2.61	1.25	12.66	6.07	18.82	9.03
Mango+juwar	16.05	7.70	4.17	2.00	20.22	9.70	9.15	4.39	2.37	1.13	11.52	5.52	31.74	15.22

BY=Biological yield; C=Carbon; teak (*Tectona grandis*); rice (*Oryza sativa*); sugrcane (*Saccharum officinarum*); banana (*Musa paradisiaca*); okra (*Abelmoschus esculentus*); chili (*Capsicum annum*); maize (*Zea mays*); juwar (*Sorghum bicolour*).

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Productivity and Carbon Sequestration in Community Managed and Reserve Forest of Kumaun Himalaya

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Keywords: Soil organic matter, basal area, biomass, carbon sequestration, community forest management

Introduction

Among the greenhouse gases, increasing CO_2 concentration is blistering challenge for scientific world. The forests are the most convenient alternative for sink of CO_2 concentration in atmosphere. In 1992, Kyoto Protocol was purposed to some of industrialized countries, including India, for controlling and regulating the emission of greenhouse gases. Community managed forests in Himalayan region became an important strategy for enhancing carbon pool in the region for climatic perspective. Carbon sequestration reveals enduring storage of CO_2 to diminish global warming and avoid hazardous climate change. Community assisted active forest management can substantiate a significant aid to increase the carbon sequestration.

Materials and Methods

The studied sites of Kumaun Himalaya are located in Sunderkhal community forests and Paharpani reserve forests. For the estimation of Net Primary Productivity and Carbon Sequestration Ratein the studied forest sites, measurement of circumference at breast height of trees and marking for re-measurement was done in 2012. Biomass of trees was assessed on the basis of allometric equations (Chaturvedi and Singh, 1987). Carbon Stock and Carbon Sequestration rates were assessed as 50% of the dry weight of biomass and 50% of Net Primary Productivity respectively (Hamberg, 2000) and CO_2 alleviation by multiplying the total carbon storage with factor 3.67.

Results and Discussion

Soil carbon and soil organic matter presented in results were determined at two depth layers of soil measuring 0-15 cm and 15-30 cm. The soil of both the sites was found to be sandy loam textured and slightly acidic in nature. Biomass and carbon sequestration rate were observed to be higher in community managed forest as compared to reserve forest. The young trees accounted for more biomass and shared more carbon sequestration as compared to the old trees, because of more density of young girth class than old trees. The average value of soil organic matter and carbon was observed more in community managed forest than reserve forest. Average carbon stock in community and reserve forest was 277 and 228 t C ha^{-1} (Table 1) worth US$ 1385, US$ 1140 annually at the current rate of US$ 5 per ton. The Net Primary Productivity of the community and reserve forest ranged 13.8-25.1 $tha^{-1}yr^{-1}$, 7.9-17.7 $tha^{-1}yr^{-1}$ respectively. The carbon sequestration rate in community and reserve forest ranged 6.5-11.8 t $Cha^{-1}yr^{-1}$, 3.7-7.4 $tCha^{-1}yr^{-1}$ respectively. The participatory monitoring has proved to be flourishing, reliable and cheap, and improved the condition of community forest, community work more effectively. The conclusion of the present study reveals the efficient conservation and management of community forests and reserve forest. Inclusion of the local community for the forest management can prove more fruitful.

Table 1: Trees biomass (tha^{-1}) and carbon ($tha^{-1}yr^{-1}$) with shrub and herbs productivity in the studied forest sites. Shrub (tha^{-1}) & herbs (gm^{-2}) productivity is shown in with tree biomass as Above Ground and Below Ground biomass

Forest sites	Hill top sub-site		Hill base sub-site		Hill base sub-site	
	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon
Community forest (Tree)						
Above Ground	36.57±29.47	17.37±14.00	20.19±7.63	9.59±3.63	13.25±4.84	6.29±2.30
Below Ground	10.15±7.65	4.82±3.63	7.38±2.93	3.50±1.39	4.72±2.00	2.24±0.95
Total	887.51±14.46	421.55±6.87	529.42±4.03	248.8±1.92	341.41±2.57	162.16±1.22
Herbs	1.45±0.09	0.82±0.04	2.01±0.08	0.94±0.04	1.84±0.07	0.87±0.03
Sherbs	40.05±15.7	19.03±7.9	43.77±17.3	20.79±8.6	38.17±17.9	18.13±7.0
Reserve forest (Tree)						
Above Ground	22.21±16.08	10.55±7.64	29.80±16.84	14.15±8.00	16.86±10.52	8.01±5.00
Below Ground	5.29±3.25	2.51±1.54	6.81±3.96	3.24±1.88	3.92±2.18	1.86±1.04
Total	467.55±7.60	222.08±3.61	622.37±8.51	295.6±4.04	353.27±5.02	167.8±2.38
Herbs	0.97±0.08	0.46±0.04	0.95±0.05	0.45±0.02	1.70±0.09	0.82±0.04
Sherbs	33.84±8.00	16.07±4.02	36.03±4.10	17.12±2.05	30.29±3.9	14.39±1.96

(±represent standard mean error)

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305.

Assessment of Vegetation Structure and Above Ground Biomass Carbon Pools in Semi-evergreen, Dry Deciduous and Scrub Forests in Belgaum District of Western Ghats, India

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Keywords: Western Ghats, Belgaum district, biodiversity, above-ground biomass (AGB), carbon density

Introduction

Biodiversity loss and climate change due to habitat destruction and fragmentation are the current environmental challenges. Understanding the pattern of tree diversity and above-ground biomass (AGB) in natural forests is essential for conservation planning and climate change mitigation strategies. Recently biomass is being increasingly used to help quantify pools and fluxes of green house gases (GHGs) from terrestrial biosphere associated with land use and land cover changes. The importance of terrestrial vegetation and soil as significant sinks of atmospheric CO_2 and its other derivatives is highlighted under Kyoto Protocol. Vegetation especially, forest ecosystems store carbon in the biomass through photosynthetic process, thereby sequestering carbon dioxide that would otherwise be present in the atmosphere.

Materials and Methods

The study was conducted in Belgaum district of Karnataka to know the species diversity and AGB in three forest types i) semi-evergreen, ii) deciduous, and iii) scrub forests. Nested two-stage sampling approach was adopted to sample trees, herbs and shrubs. One super plot of 250 m x 250 m size was laid in each forest type. Four sample plots, each of 31.6 m x 31.6 m (0.1 ha) size, were laid in each super plot. Height and diameter at breast height (DBH) of all trees occurring in four sample plots within each super plot were measured and used for volume estimations using local volume equations. Tree biomass was estimated by multiplying volume with specific gravity. Shrub and herb biomass was estimated by destructive method. Biomass obtained from four sample plots (each 0.1 ha) in different stratum was summed up to obtain total AGB and multiplied with factor of 0.47 to obtain a total above ground carbon pool which is expressed as Mg C ha^{-1}.

Results and Discussion

Species richness, tree density and basal area varied considerably across different vegetation types (Table 1). Higher species richness and diversity (H') was recorded in semi-evergreen forest followed by deciduous and scrub forest. Semi-evergreen forests were found to be tall statured compared to dry deciduous and scrub forests as evident from mean tree height. On the other hand, maximum density of 350 stems ha^{-1} was recorded in dry deciduous forest followed by semi-evergreen (245 stems ha^{-1}) & scrub forest (220 stems ha^{-1}). However, higher basal area of 12.16 m^2 ha^{-1} was recorded in semi-evergreen forest and lowest in scrub forest (1.68 m^2 ha^{-1}). The biomass estimates we produced are within the range found for other studies in Western Ghats (Devagiri *et al.*, 2013). The tree layer contributed most (29.68 - 220.78 Mg ha^{-1}) to the total AGB among different vegetation types followed by shrub (10.13 - 21.19 Mg ha^{-1}) and herb layer (0.81 - 1.31 Mg ha^{-1}). The amount of total AGB found in the semi-evergreen forest in our study (243.48 Mg ha^{-1}) is slightly lower as compared to the biomass values in semi-evergreen forests (289.53 Mg ha^{-1}) of Uttar Kannada district of northern Western Ghats of India. Total above ground carbon pool ranged from 19.09 to 114.34 Mg C ha^{-1}. The majority of AGB and carbon pool in our study was found within taller trees and trees with a larger diameter therefore, their removal substantially alters the C storage and dynamics in this region. Land-use systems with higher C sequestration potential are currently supported under REDD and $REDD^+$ projects that focus on forest conservation and management.

Table 1: Tree diversity, structure and above ground biomass (AGB) and carbon pool in different forest types of Belgaum district

Vegetation parameters		Vegetation Type		
		Semi Evergreen Forest	Dry Deciduous Forest	Scrub Forest
Species richness		32	25	17
Shannon Weiner Index (H')		3.15	2.67	2.21
Simpson's Index (D')		1.04	1.10	1.18
Tree height (m)		13.08	4.48	3.20
Tree density (Stems ha^{-1})		245	350	220
Basal area (m^{-2} ha^{-1})		12.16	3.71	1.68
AGB	Trees (Mg ha^{-1})	220.78	79.54	29.68
	Shrubs (Mg ha^{-1})	21.19	18.25	10.13
	Herbs (Mg ha^{-1})	1.31	1.02	0.81
Total AGB (Mg ha^{-1})		243.28	98.81	40.62
Above ground carbon density (Mg C ha^{-1})		114.34	46.44	19.09

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306.

Scope of Carbon Sequestration and Carbon Finance in Arid Region of Rajasthan

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Keywords: Climate change, carbon trading, grid, interventions, CERs

Introduction

The increase in green house gas emissions caused by human activities is responsible for global warming. Deforestation is a major source of carbon dioxide, the most significant greenhouse gas in terms of its impact on climate. Climate change has emerged a serious challenge for survival and sustainability of mankind and climate is changing very fast in the last 15-20 years. Carbon trading is the fastest growing commodity market in the world and through clean development mechanism (CDM) based markets, only large companies have been benefitted from it. The small holder farmers who do sequester carbon and also reduce emission do not have capacity to comply with rigid market requirements. Therefore a grid based approach has been developed and validated by International Centre for Research in Agroforestry (ICRAF).

Materials and Methods

An area of 5000 ha has been selected under Mavli Block in Udaipur District (Rajasthan) where green house gas mitigation options are being implemented at farm level, house hold level and community level. Planting trees is one of the most cost effective ways of reducing carbon emissions. The important tree interventions made as agri-horticulture, agri-silviculture, industrial wood block plantations and waste land plantations. Energy based household interventions are smokeless stoves, Compact Florescent Lamps (CFLs) and solar lanterns. The field level emission reduction interventions included practices such as the zero tillage, minimum tillage, spot irrigation, mulches, incorporation of biomass in the soil, etc.

Results and Discussion

The potential certified emission reduction (CER) in grid area is more than 25000CERs whereas in three years interventions more than 3000 CERs were assimilated. The major tree based interventions are i.e. agroforestry and community based which will sequester about 2/3rd CERs (19033) and from energy measures 6225 CERs obtained from the Mavli area (table1). Through tree interventions more than 750 ha area was covered under plantations of *Citrus reticulata* (orange), *Aegle marmelos* (bael), *Punica granatum* (pomegranate); *Tectona grandis* (teak), *Thespesia populinea* (paraspipal) and mix forest spp. *tecoma*, etc intercrops with *Zea mays* (maize), *Pennisetum glaucum* (pearl millets), *Triticum aestivum* (wheat), *Cicer arietinum* (chickpeas), *Brassica juncea* (mustard) and *Hordeum vulgare (*barley*)*. Sustainable fund generated up to Rs. 2.90 lakhs is the most significant visible indicator for project sustainability. From zero to 750 ha area covered under tree interventions and generates 3000CERs which would benefit the farmers if interventions process continued, it would improve the livelihoods of small and marginal farmers without changing their current agricultural practices**.** For benefit sharing mechanism a cooperative society of 2500 beneficiaries was made as Gramyajaan Sahakari Paryavaran Samiti having own byelaws and responsibilities under Society Registration Act which coordinate all activities of interventions by farmers, validation, carbon trading and project sustainability. Generating sustainable fund in the grid is most unique experience. The federating tribal farmers for carbon sequestration and climate change are also equally encouraging.

Table 1: Energy efficient household systems t-CERs from Mavli grid

Kinds of interventions	Potential units (no.)	No. of units/households in the grid	Certified Emission Reduction
Energy efficient stoves	117	2500	5575
CFL	1800	5000	550
Solar lantern	44	200	100
		Total t CERs	6225

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Stratified Forest Soil Carbon Mapping in Kashmir Himalayan Region using Field Inventory Data and Geospatial Tools

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Keywords: Soil carbon, mapping, Kashmir Himalaya, geospatial tools, coniferous forests

Introduction

Soil carbon mapping and monitoring is important for all developing countries including India to improve reporting in national communications to be sent to United Nations Convention on Climate Change (UNFCCC). India being a signatory to emission reduction commitments in the recently held Conference of Parties (COP 21) at Paris, it becomes necessary to produce inventory on forest resources that are reliable, accurate and cost effective. Soil organic carbon (SOC) being one of the most important carbon pools in forests has assumed prominent role in mitigating climate change. SOC in forests varies to a certain degree under different strata and densities. The present study was taken up to quantify soil organic carbon and its variation under different forest strata in the southern region of Kashmir Himalayas.

Materials and Methods

A stratified sampling design was adopted for collection of soil samplesfrom pitswith a depth of (0-30 cm) under forest strata *Cedrus deodara* (closed), *Cedrus deodara* (open), *Abies pindrow-Picea smithiana* (closed), *Abies pindrow-Picea smithiana* (open), *Pinus wallichiana* (closed) and *Pinus wallichiana* (open). The samples were analyzed for soil properties including bulk density, moisture, coarse fraction and organic carbon %using standard methods. Stratified forest cover density map (Kappa accuracy >0.85) was also generated using landsat data (2009) and mapping software. Soil organic carbon estimated from laboratory analysis of field samples were brought into Geographical Information System (GIS) domain and stratified soil organic carbon maps were generated for the region.

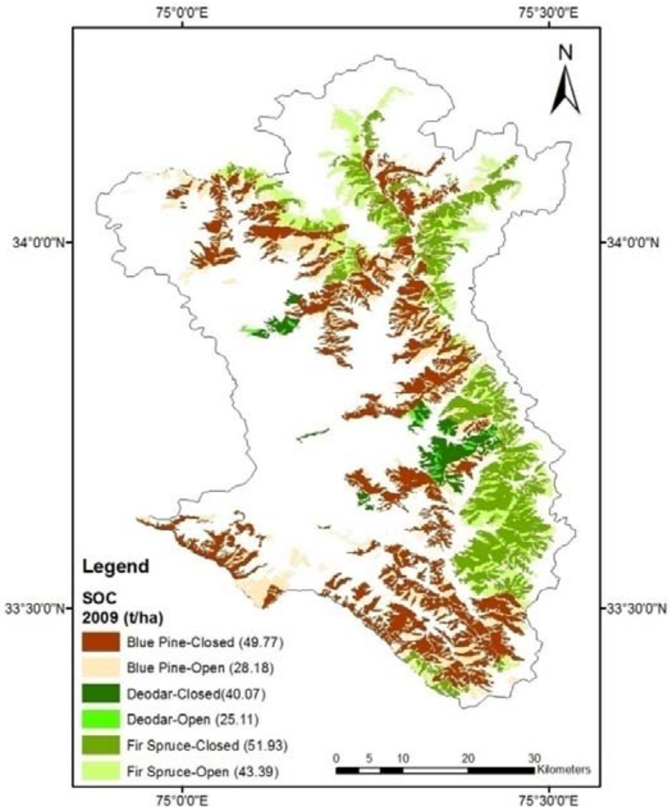

Fig. 1: Forest soil carbon map (t ha^{-1}) in the southern region of Kashmir Himalayas

Results and Discussion

Highest SOC density 51.93 t ha^{-1} (σ±5.24) was observed for fir-spruce (closed) and the least value of 25.11 t ha^{-1} (σ±5.41) for deodar (open). The highest total SOC (24.17 million ton) was found under blue pine (closed) and lowest (0.25 million ton) under deodar (open) (Table 1). The results of this study suggest that factors such as site quality, forest density, age, soil physical and chemical properties influence SOC density. The signs of disturbance observed in the field reflect the soil carbon status of the strata.

Table 1: SOC density (t ha^{-1}) under different forest strata in the study area

Strata	Avg. SOC	±σ	±SE
Blue Pine (closed)	49.77	6.35	2.40
Blue Pine (open)	28.18	6.51	2.46
Fir-Spruce (closed)	51.93	5.24	1.98
Fir-Spruce (open)	43.39	2.14	0.81
Deodar (closed)	40.07	8.10	3.06
Deodar (open)	25.11	5.41	2.05
Mean	39.74	5.63	2.13
CD (0.05)	6.73	-	-

308.

Anticipated Performance Index of Plant Species Growing Alongside the National Highway 21 of Himachal Pradesh in India

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Introduction

Air pollution is the most dangerous of its kind as its control is more complex than any other type of environmental problems. Plantations with suitable species have been considered as one of the suitable abatement techniques for its control. The evaluation of Anticipated Pollution Index helps to assess the capability of the plant species to reduce the atmospheric pollution and indicate their socio-economic benefits. In the region since no such studies have been done so far, therefore, the present investigation to categorize the plants growing on the National Highway on the basis of their tolerance levels and socioeconomic aspect has been undertaken.

Materials and Methods

A study was conducted on the National Highway 21, Himachal Pradesh to identify the tolerance levels of four plants species namely *Ficus carica*, *Morus alba, Toona ciliate* and *Melia azedarach*. The air pollution tolerance index was calculated using the formula (Singh and Rao,1983).

$$APTI = \frac{[A\,(T \pm P)] \pm R}{10}$$

Where, A- ascorbic acid (mg g^{-1} FW), T- total chlorophyll (mg g^{-1} FW), P- leaf extract pH

R- relative water content (%) of the leaves

Combining the APTI values with some relevant biological and socio-economic characters (plant habit, canopy & laminar structure, type of plant& economic values), the API was calculated.

Results and Discussion

Variation in the various physiological and biochemical aspects namely ascorbic acid, total chlorophyll content, relative water content and leaf extract pH, resulted in the variation in APTI values. The highest value (10.94) of APTI was recorded in *Toona ciliate* and lowest value (9.26) was found in *Morus alba* amoung the selected plant species. The comparison of the grading parameters by their summation for the API showed a variation in the plant species from a very poor to very good scale (Table 1). Among the selected plant species *Toona ciliate* with highest API was in the very good category of plants followed by *Ficus carica* and *Melia azederach* in the poor category and *Morus alba* in the very poor category. From the present investigation it can be concluded that all the biochemical, physiological, biological as well as socio-economic parameters of the plant species play an important role in determining the sensitivity and tolerance of plants to air pollution with reference to their tolerance and performance index. The study indicated that *T. ciliate* should be considered for plantation alongside the National Highway 21 in Bilaspur to Mandi stretch because of its highest tolerance capacity to pollution and very good anticipated performance index among the commonly growing species.

Table 1: Evaluation of plant species on the basis of APTI value and some biological and socio-economic characteristics

Common name	Scien-tific name	Assessment parameters				Laminar structure				Grade allotted		
		APTI	Tree habit	Canopy structure	Tree type	Size	Texture	Hardiness	Economic importance	Total plus	% Scoring	API grade
Fig	*F. carica*	+++	-	+	-	+	+	-	++	8	50.00	2
Mul-berry	*M. alba*	++	+	+	-	-	+	-	+	6	37.50	1
Drek	*M. azed-erach*	++++	+	+	-	-	-	-	++	8	50.00	2
Toon	*T. Ciliata*	+++++	++	+	-	++	+	-	+	12	75.00	5

Reference

Singh S K, Rao D N 1983. Evaluation of plants for their tolerance to air pollution. In: *Proceedings Symposium on Air Pollution Control*. Indian Association for Air Pollution Control, New Delhi, India **1:** 218-224

309.

Multi-location Evaluation of Variation in Growth of *Salix* Clones in Punjab

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Keywords: Willow, clone, environment, plant height, collar diameter, ranking.

Introduction

Salix is light demanding and deciduous tree and shrub species has adaptability to wide range of climatic and edaphic conditions. It is potentially used as source for fodder, fuelwood, timber, to control soil erosion, phytoremediation etc. But before to introduce any plant species for its potential use, the evaluation of their adaptability and growth performance under different environmental conditions is required. In this study, field trial was conducted during 2012-13 at three agro-climatic zones of Punjab. Growth performance of different genotypes of *salix* in terms of plant height, collar diameter and their interaction withagro-climatic conditions of selected sites was studied.

Materials and Methods

One year old nursery raised clones were planted at location 1 (Central plain zone), location 2 (North undulating foothill zone) and location3 (South-western semi-arid zone) of Punjab. Clones were planted in three replications at spacing of 4m × 4m and depth of 1m in randomizes block design. Genotype and site interaction was studied on the basis of the incremental ranking for plant height and collar diameter. Height of the plant was measured from the ground level to the apex of the leading shoot and collar diameter of the plant was measured at the collar region.

Results and Discussion

Height and collar diameter are the important morphological traits, clone UHFS-13 showed the maximum growth in height and collar diameter at location 1. Performance of other clones was in the order of UHFS-14, UHFS-3, UHFS-12 and UHFS-19. At location 2 clone UHFS-1 showed the maximum growth in height and collar diameter (Table 1). Performance of other clones was in the order of UHFS-11, UHFS-2, UHFS-4 and UHFS-7. At location 3 clone UHFS-19 showed the maximum growth in height and collar diameter. Performance of other clones was in order of UHFS-7, UHFS-3, UHFS-6 and UHFS-11. Minimum height was recorded of clone UHFS-21 under all three locations, whereas minimum collar diameter was recorded in clone UHFS-10, UHFS-17 and UHFS-18 and UHFS-21 at location 1, location 2 and location 3, respectively. Growth of collar diameter and height of different clones also showed large variation between different environments as the change in the ranking of clones for height and collar diameter was recorded between different location, except clone UHFS-18, UHFS-5 and UHFS-21 which registered almost similar growth for height under all three locations and clone UHFS-19, UHFS-8, UHFS-15, UHFS-17, UHFS-18 and UHFS-22 which were stable over all three locations for collar diameter. The values of genotypic variability for different traits were found between low to high and for phenotypic variability between moderate to high. Values of heritability and genetic gain were observed between low to high. Clones registered strong phenotypic and genotypic correlation between plant height and collar diameter under all three locations.

Table 1: Growth parameters of different *Salix* clones at three variable sites

Clone	University Seed Farm Ladhowal, Ludhiana*		Badhian forest, Range and Division, Dasuya		Alamwala forest nursery, Range Malout, Division Faridkot	
	Plant height (m)	Collar diameter (cm)	Plant height (m)	Collar diameter (cm)	Plant height (m)	Collar diameter (cm)
UHFS-1	3.24	2.87	3.62	2.52	3.48	2.97
UHFS-2	3.47	2.73	3.41	2.23	3.13	2.20
UHFS-3	3.48	3.27	2.69	1.88	3.56	3.27
UHFS-4	3.25	2.47	3.20	1.77	3.02	2.17
UHFS-5	3.30	2.90	2.70	1.77	2.74	1.87
UHFS-6	2.86	2.47	2.79	1.93	3.57	2.80
UHFS-7	2.82	2.57	3.15	2.17	3.70	3.03
UHFS-8	2.91	2.57	2.97	1.90	2.53	1.87
UHFS-9	3.21	2.97	2.92	1.85	2.55	1.90
UHFS-10	2.62	2.27	2.57	1.82	2.89	2.13
UHFS-11	3.22	2.47	3.46	2.39	3.54	2.77
UHFS-12	3.59	2.83	2.68	1.67	2.89	1.93
UHFS-13	4.00	3.57	3.17	1.93	2.77	1.90
UHFS-14	3.97	3.20	3.03	1.97	2.78	1.86
UHFS-15	3.21	2.63	2.55	1.72	2.55	2.03
UHFS-16	3.27	2.93	3.10	2.10	2.95	1.77
UHFS-17	3.48	2.73	1.95	1.53	3.36	2.27
UHFS-18	3.59	2.33	2.97	1.82	2.63	1.67
UHFS-19	3.10	3.30	2.46	2.03	5.39	4.82
UHFS-20	3.32	2.50	3.00	1.69	2.48	1.70
UHFS-21	2.24	2.63	1.86	1.70	1.78	1.67
UHFS-22	2.96	2.37	2.28	1.61	2.03	1.75
Mean	3.23	2.75	2.84	1.91	3.01	2.29
Range	2.24-4.00	2.27-3.57	1.86-3.62	1.53-2.52	1.78-5.39	1.67-4.82
CD (5%)	0.72	0.72	0.41	0.33	0.59	0.61
CD (5%) Environments (E)						0.12
CD (5%) Interaction (C×E) for Plant Height						0.58
CD (5%) Interaction (C×E) for Collar Diameter						0.57

*Data have been reported by Singh *et al.* (2015) but used here for comparison and interaction effect

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Are Non-Timber Forest Products (NTFPs) Contributing Household Level Adaptation to Climate Change in India? A Study in Drought Prone Areas of West Bengal

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Keywords: Adaptation, non-timber forest products, socio-economic factors, migration, self-help groups.

Introduction

Climate change is one of the major threats to sustainable development because of its effects on health, infrastructure, agriculture and food security, and forest ecosystem (IPCC, 2007a). In India 700 million rural populations directly depend on climate-sensitive sectors like agriculture, forest and fisheries. Forest resources are vulnerable to climate change but constitute an integral part of the social life of tribal people and others communities living in and around forest areas and contribute substantially to the food supply and livelihood security (Basu 2011). Thus about 300 million rural poor are dependent on Indian forest including the availability of non-timber forest products (NTFPs) like food, fuelwood, medicine, sal leaves, kendu leaves and mushrooms etc. These non-timber forest products offer a green social security to billions of people in the form of providing low-cost building materials, income, fuel, food supplements and traditional medicines. Under joint forest management (JFM), village communities are entrusted with the protection and management of nearby forests. Non-wood forest products (NTFPs) have a key role in JFM efforts. Given the backdrop, the objectives of this paper are to identify household adaptation strategies to reduce vulnerability and to estimate the factors responsible for decisions of household level adaptation to climate change in rural India.

Materials and Methods

West Bengal, one of the states of India is the study area. The total recorded forest area in West Bengal is 1.19 million hectares, which constitutes 13.38% of the geographic area. The study was carried out in the district of Bankura one of the drought prone districts of West Bengal. Data were collected by conducting field survey in the drought prone district of Bankura, West Bengal in 2011. This study was conducted in two villages in Sonamukhi forest area in the district of Bankura, one of the drought prone districts of West Bengal. A total of 120 structured household interviews were conducted. Data on socio-economic variables and adaptation measures like migration, non-timber forest products; self-help groups have been collected from the field survey. The study utilized analytical techniques to analyze data; Heckman's two stage Probit model whereby significant and the non-significant variables were identified.

Results and Discussion

Variables that positively and significantly influenced the adaptation to climate change include the age of the household, farm income, forestry income, temperature and family size. Income from forestry has significant and positive impact on adaptation. With higher income from forestry there is a possibility to enhance adaptation in order to minimize the risk of climate change. There is a negative association between operation holdings and adaptation. This means that the low holding farms have greater adaptation compared to the large holding farms. The negative association is also true in the case of physical asset value and wage income. These findings are contrary to the case of the adaptation of agricultural farmers. Variables, say age, the numbers of adult male and operational holdings are found to have significant and positive impact on the perception of temperature increase.

This paper has identified household adaptation options like migration; formation of Self-help Group (SHGs), accessibility of non-timber forest products and animal husbandry. Both socio-economic and climatic variables responsible for determination of adaptation to climate change. The Government of India implements a series of central and centrally sponsored schemes under different ministries and departments for achieving social and economic development.

References

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Table 1: Results of the Heckman Probit selection model

	Estimated coefficients outcome equation: adaptation model (Accessibility of non-timber forest products)		Estimated coefficients selection equation: perception model (Perception of temperature increased)	
	Regression		Regression	
Explanatory variables	Coefficients	P-level	Coefficients	P-level
Age	0.006519**	0.041	0.0063211*	0.067
Education	-0.064523	0.457	-0.135648	0.458
Marital status	-0.512364*	0.069	2.3684	0.647
Adult male			1.64782**	0.026
Operational holdings	-0.17568*	0.068	1.68241***	0.001
Physical asset value	-0.0000179**	0.019	0.000254	0.648
Livestock asset value	-4.56e-05	0.648	-0.0000897	0.237
Wage income	-0.0000478*	0.079		
Forestry income	0.0000387***	0.001		
Temperature	0.0785442**	0.018		
Family size	0.0679428**	0.041		
Cons	-3.23567*	0.054	-8.47512	0.254
Total observations	120			
Censored observations	70			
Uncensored observations	50			
Wald chi square(zero slopes)	80.75***	0.000		

Note: *** significant at 1% level, ** significant at 5% level and * significant at 10% level
Source: Field survey

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Ailanthus excelsa: An Important Agroforestry Tree Species for Arid and Semi-arid Regions

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Keywords: *Ailanthus excelsa,* progeny, agroforestry

Introduction

Rising population pressure and urbanization, coupled with land degradation and global warming are causing food insufficiency in large parts of World. Woody perennial-based production systems have the potential to arrest land degradation through interactions among trees, crops and livestock. *Ailanthus excelsa* (ardu) is an important agroforestry tree species for arid and semi-arid regions due to its wider adaptability, fast growth and higher tolerance to biotic and abiotic stresses, supplying leaf fodder and timber for plywood. Looking to the importance of *A. excelsa*, the present study was conducted to identify the best genotypes of *A. excelsa* and development of suitable agroforestry systems.

Materials and Methods

Thirty plus trees of *Ailanthus excelsa* were identified from Rajasthan and Haryana and sufficient seed was collected from these plus trees individually. Based on the nursery performance, twenty three progenies were transplanted in the field at a spacing of 5 x 5 m. Fifteen seedlings of each plus trees were planted in randomized block design with three replications. The data on height, diameter and leaf fodder yield were recorded. For *Ailanthus* based agroforestry systems six months old seedlings were planted at four spacings i.e. 10x20, 10x10, 10x6.5, and 10x 5 m. Two crop sequences namely pearlmillet (*Pennisetum americanum* (L.) R. Br) - mustrad (*Brassica juncea*) and cluster bean (*Cyamopsis tetragonoloba* (L.) Taub) -wheat (*Triticum aestivum* L) were raised in the interspaces of the trees. The crops were also raised as sole. The crops were harvested and data was recorded on grain and straw yield.

Results and Discussion

Significant differences ($P > 0.05$) were recorded among the progenies of *A. excelsa* for growth characters namely plant height, basal diameter and leaf fodder yield after 12 months of planting in the field (Table 1). Maximum growth in terms of height (244.00 cm) and diameter (86.11 mm) was recorded in progeny P23 after 12 months of planting. The leaf fodder yield also varied significantly. The top ranking progeny in terms of leaf fodder yield was P14 with 3.17 kg/tree followed by P13 (3.00 kg/tree).

The yield of pearl millet and cluster bean crops was not affected by different spacings of *Ailanthus excelsa* as compared to control (without trees) during the 1st year of plantation. However, average yield of pear lmillet and cluster bean was 32 q/ha and 10.5 q/ha, respectively that was at par with open field (Table 2). Same trend was observed for *rabi* crops (raya and wheat). The growth of *Ailanthus* was not affected by arable crops. Progeny P23 showed superiority over others in terms of growth. The yield of intercrops was not affected by the different spacing of *Ailanthus* plantation during first year of establishment. The study will be conducted up to the 7-8 years to draw firm conclusion.

Table 1: Growth and fodder yield variability in *A. excelsa* after 12 months of planting

Progeny	Plant Height (cm)	Collar diameter (mm)	Fodder yield (kg/tree)
P1	180.00	71.11	1.75
P2	184.00	69.55	1.70
P3	182.00	64.00	1.40
P4	185.00	65.66	0.75
P5	153.00	68.39	1.41
P6	124.00	51.77	1.89
P7	177.00	67.55	2.12
P8	207.00	71.44	2.00
P9	198.00	70.61	2.92
P11	213.00	74.21	2.55
P12	203.00	68.44	1.47
P13	195.00	76.77	3.00
P14	208.00	70.72	3.17
P15	200.00	71.66	1.82
P20	185.00	70.11	1.76
P21	146.00	61.44	0.91
P22	202.00	79.16	2.46
P23	244.00	86.11	2.11
P26	195.00	74.89	2.20
P27	195.00	60.77	2.37
P28	164.00	63.33	2.56
P29	238.00	61.43	2.12
P30	199.00	61.83	2.03
Mean	190.00	68.74	2.02
C. V.	20.95	12.51	19.66
CD($P<0.05$)	15.42	3.87	0.66

Table 2: Effect of different spacings of *Ailanthus excelsa* on the grain and straw yield of pearlmillet and cluster bean

Spacing (m)	Grain Yield (q/ha)			Straw Yield (q/ha)	
	Pearl millet	Cluster bean	Cluster bean (EPM)	Pearl millet	Cluster bean
10 x 20	32.32	10.61	60.63	56.56	11.75
10 x 10	31.39	10.24	58.51	54.93	11.33
10 x 6.5	32.10	10.84	61.94	56.18	12.00
10 x 5	31.51	10.50	60.00	55.15	11.62
Open	32.63	11.00	62.86	57.11	12.19
CD ($P=0.05$)	NS	NS	NS	NS	NS

312.

Effect of Different Tree Species on Soil Properties under Agroforestry System

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Keywords: Different agroforestry systems, soil properties

Introduction

Agro-forestry, one of the important alternatives for diversification is gaining importance in irrigated agro-ecosystem for production and economic upliftment of the farmers. Moreover, it is a natural resource conserving system and comparatively less resource depleting system than intensive agriculture. Tree plantations influence the soil physical, chemical and biological properties through litter fall addition and root turnover. Tree roots explore a large soil volume for water, nutrient, microbial population, increased soil porosity, reduced runoff, etc. Increased soil cover lead to higher water infiltration and reduction in soil profile and diversify the livelihood activities to buffer against income risk during adverse conditions.

Materials and Methods

To assess the effect of turmeric (*Curcuma longa*) based agro-forestry model on soil properties, the experiment was established at University Seed Farm, Ladhowal, Ludhiana, Punjab. The crop was raised in May, 2014 and harvested in February 2015 in open and under plantations. The experiment was laid out in completely randomized design (CRD) and replicated thrice times with four treatments i.e., three fast growing tree species (*Ailanthus excelsa*, *Gmelina arborea* and *Eucalyptus tereticornis*) and a control. The soil properties pH, EC, bulk density and organic carbon were estimated at different depths (i.e., 0-15, 15-30, 30-60 and 60-90cm).

Results and Discussion

The soil pH and EC were higher under *Ailanthus excelsa* and bulk density was maximum under *Gmelina arborea*. The highest organic carbon was recorded in *Ailanthus excelsa* (0.71%), followed by *Gmelina arborea* (0.70%), *Eucalyptus tereticornis* (0.55%) and in control (0.36%), however, it decreased with soil depth (Table 1). Under plantations, bulk density ranged from 1.31 to 1.44Mgm^{-3}. Maximum value was noticed in *G. arborea* followed by *A. excelsa* and *E. tereticornis*. The biomass carbon plus soil organic carbon (SOC) was recorded more under plantations than control i.e., *Gmelina arborea* (20.45tha^{-1}), *Ailanthus excelsa* (16.92tha^{-1}) and *Eucalyptus tereticornis* (14.75tha^{-1}). Higher value of pH was recorded in 60-90 cm layer, however, EC and OC were higher on the top layer and bulk density was higher 30-60 cm layer. From the investigation it has been concluded that agro-forestry system is superior to improve the soil properties.

Table 1: Combined effect of tree species and turmeric on soil parameters

Treatment	Soil properties			
	pH	EC (dSm^{-1})	BD (Mgm^{-3})	OC (%)
Ailanthus excelsa	8.70	0.26	1.36	0.71
Gmelina arborea	8.58	0.24	1.44	0.70
Eucalyptus tereticornis	8.68	0.25	1.31	0.55
Control	8.71	0.24	1.40	0.36
CD (p=0.05)	0.03	0.004	0.012	0.07
0-15 cm	8.71	0.27	1.33	0.85
15-30 cm	8.63	0.25	1.37	0.68
30-60 cm	8.56	0.25	1.41	0.56
60-90 cm	8.78	0.22	1.39	0.24
CD (0.05)	0.03	0.004	0.01	0.07

313.

An Economic Analysis of Tangible and Intangible Benefits in Agro Forestry Production in Tamil Nadu

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Keywords: Agro forestry, profitability, benefit cost ratio, IRR Value, tangible/intangible

Introduction

Forests provide a variety of tangible and intangible benefits to the economy. Earlier, the valuation of forests was carried out in terms of tangible benefits like timber, non-timber and forest products. The economic value of intangible benefits such as soil and water conservation and ecosystem services were under-estimated or ignored by the policy makers. This led to a biased decision in favour of a number of development projects such as construction of roads, industrial units, large dams, etc. As a result, many of the world's natural forests have been severely damaged. The benefits aimed by many projects have been overshadowed by the long-term ecological costs (Manoharan *et al.*, 1998). In India, the forest cover was 21.23% of the total geographical area has currently declined by 3.67 million hectare compared to the forest cover of 6.92 million hectare (State of the Forest Report in 2013). The less forest area coupled with the low productivity of Indian forest has ushered in a total mismatch between the demands and supply of both domestic wood and secondary timber besides creating environmentally disequilibrium and de-stability in India.

Materials and Methods

The study was carried out in the Dharmapuri district as it is the one of the major Agro forestry production in Tamil Nadu. Dharmapuri district occupies an area of 4497.77 square kilometers. The study used primary data. Primary data was mainly cross-sectional. It was collected from 240 agro forestry farmers randomly selected from a list of tree growers in the following taluks: Pennagram and Morappur for the 2013-2014 production seasons. In each taluks 120 tree growing farmers were randomly selected. Structured questionnaire was the main instrument used to collect the primary data. The data were analyzed by using multiple regression analysis to estimate the factors affecting the adoption rate of agro forestry technologies in the Dharmapuri district of Tamil Nadu

Results and Discussion

The economic valuation of agro forestry systems is dominated by intangible social benefits than tangible social benefits. The valuation components of tangible benefits were produces, grazing, agricultural productivity, timber and fruits which contribute 45.97% to the total economic value. Furthermore, valuation components of intangible social benefit are soil and water conservation, carbon bio mass, waste assimilation and oxygen supply which contribute 54.02% cent to the total economic value in the study area (Table 1). Earlier research suggested that indirect use value from agro forestry may be significant. At the same time, they must be interpreted with caution due to data limitations and lack of empirical studies on indirect use value on agro forestry. On the other hand, this valuation includes only a few indirect values, such as soil and water conservation, carbon bio mass, leaf litter and oxygen supply, and this may balance a potential overestimation. The indirect values used in this study are therefore most likely higher than average.

Table 1: Totals economic valuation - component value

Value components	Rupees (₹)
Direct use value	
Produces	261541
Grazing	32850
Agricultural productivity	11363
Timber	149950
Fruits	127883
Sub total	583587 (45.97)
Indirect use value- ecological services	
Soil and water Conservation	5706
Carbon biomass	32000
Leaf litter	642589
Oxygen supply	1882
Sub total	682177 (54.02)
Total	12,65,764 (100.00)

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Influence of Growing Media and Container Size on Germination and Plant Percent of *Ailanthus altissima* Mill.

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Keywords: *Ailanthus altissima,* germination, plant per cent

Introduction

Ailanthus altissima (syn. *A. glandulosa*) also called as Tree of Heaven is introduced species from Japan and China and cultivated in the plains and hills of north India. It is afforested in most of the states of India for soil conservation works particularly in Jammu and Kashmir (Luna,1995). Besides its use as an avenue, ornamental, medicinal plant, it is used as a host plant to feed silkworms of the moth *"Samia Cynthia*" (Hu, 1979). As no work has been done so far on the species, the present investigation was undertaken to determine the precise medium and container/root trainer size for germination and plant survival.

Materials and Methods

The study was conducted in the nursery site of Faculty of Forestry, Shere-e- Kashmir University of Agricultural Sciences and Technology -, K, Shalimar, Srinagar 2011. Seeds of *Ailanthus altissima* were collected from the university campus. In the experiment, growing media soil: sand: farm yard manure (FYM) in seven different ratios M_1 (1: 0: 0),M_2(1: 1: 0),M_3(1: 1: 1),M_4(2: 1: 1),M_5(2: 2: 1),M_6 (0: 1: 0), M_7 (1: 2: 1) were used in three container/ root trainer sizes of C_1(150cc), C_2(250cc) and C_3(300cc). The germination percentage of seeds were recorded up to 28 days as per the International Seed Testing Association (ISTA, 1999). The analysis of variance (ANOVA) was carried out to test the influence of media and containers on germination and plant per cent using Minitab.

Results and Discussion

The observations on influence of growing media and container/root trainer size are presented in Table 1. The results observed significant differences ($p \leq 0.05$) among the treatments for germination and plant per cent. The growing medium exhibited significant differences ($p \leq 0.05$) in germination percentage and plant per cent recorded. The growing medium M_4 (Soil: Sand: FYM: : 2: 1: 1) recorded maximum germination percentage and plant per cent of (88.18) and (69.83), respectively followed by M_3(Soil: Sand: FYM: : 1: 1: 1) as (80.69) and (63.91). Ahmadloo *et al*. (2012) also obtained best results in *Cupressus arizonica* and *Cupressus sempervirens* with growing mixture containing soil: cattle manure: Decomposed litter in the ratio of 5: 1: 1. Similar observations were reported by Sharma and Rana (2007) in *Jatropha curcus.* This corroborates to good soil structure, water holding capacity, FYM improving CEC, nutrient status of the soil and more aeration pore volume that could maintain higher levels of oxygen for better germination of seeds and to the developing seedlings towards maximum plant per cent.

Likewise, maximum germination percentage (77.77) and plant per cent (61.59) was observed in container/root trainer size C_3 (300cc) followed by C_2 (250 cc) as (73.75) and (58.41) respectively. The growing medium M_4(Soil: Sand: FYM: : 2: 1: 1) and container size C_3 (300cc) gained best results in respect of recorded parameters i.e. germination percentage and plant per cent when compared with other growing media and container sizes in concern. Reasons for maximum plant per cent in container/root trainer size 300 cc may be due to more growing media holding capacity, thus making more and regular supply of nutrient reserves available to the developing seedlings for longer time, big drainage hole for regular and higher levels of oxygen sufficient for root development on which seedling survival depends.

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Table 1: Effect of growing medium and container/root trainer size on seed germination and plant per cent of *Ailanthus altissima* Mill. under field conditions

Growing medium	Germination (%)	Plant (%)
M_1(Soil: Sand: FYM: : 1: 0: 0)	72.96	57.78
M_2(Soil: Sand: FYM: : 1: 1: 0)	65.92	52.21
M_3(Soil: Sand: FYM: : 1: 1: 1)	80.69	63.91
M_4(Soil: Sand: FYM: : 2: 1: 1)	88.18	69.83
M_5(Soil: Sand: FYM: : 2: 2: 1)	74.51	59.01
M_6(Soil: Sand: FYM: : 0: 1: 0)	60.36	47.81
M_7(Soil: Sand: FYM: : 1: 2: 1)	69.92	55.38
±SE(diff.)	2.64	2.09
$CD_{0.05}$	5.34	4.23
Container size	**Germination (%)**	**Plant (%)**
C_1 (150cc)	68.13	53.96
C_2 (250cc)	73.75	58.41
C_3 (300cc)	77.77	61.59
±SE(diff.)	1.73	1.37
$CD_{0.05}$	3.49	2.77

315.

Current Scenario and Tree Diversity of Sacred Groves in Kodagu District of Karnataka

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Keywords: Living tradition of nature worship, anthropogenic disturbances, and conservation ethoes.

Introduction

The tradition of nature worship has existed in ancient times since man lived in forests and do exists even today known by different names in different parts of the world. In olden days, area under forests was very vast, but our ancestors marked certain area of forest in each village as 'sacred'. Kodagu (Coorg) is a cool district in Karnataka state and is a unique landscape in central Western Ghats. Totally 2% land area of Kodagu is under 1214 Sacred Groves worshiping 121 deities (Kushalappa and Raghavendra, 2011) and can be called as 'Hotspot of biodiversity in the world'.

Materials and Methods

In order to study the tree diversity in the Sacred Groves of Kodagu, we have randomly selected 10 Sacred Groves. The data were collected on boundaries, settlements, roads accessibility, and occurrence of plastic-paper wastes within Sacred Groves. Sampling was done by line transact method and a check-list was prepared by counting number of tree species and its individuals present in the plot. Data was then studied using Shannon-Wiener Index of Diversity.

$$H = -\sum_{i=1}^{s} pi \ln pi$$

Here, 's' is the number of tree species, 'pi' is proportion of total sample belonging to i^{th} species and 'H' indicates high species diversity in the sample.

Results and Discussion

The results of the study indicated that the tree diversity was high in all the sacred forests. Among the ten selected sacred forest, it was found the tree diversity was as high as 26 species (H= 4.45) in Kuttichatia Sacred Grove at Mugutagiri compared to other Sacred Groves. It is observed that some Sacred Groves are having a smaller area such as 5.76 acres in Ayyappa Devarakadu at Kunda, the tree diversity is about 19 species (H= 4.05). This may be due to less disturbing factors to the tree diversity. This study is in conformity with Srinidhi and Sathish, (2009).

When we compare the anthropogenic disturbance factors such as forest boundary, settlements, accessibility to roads and availability of plastic and paper wastes, it is found that settlements in the vicinity of Sacred Groves is not promoting much diversity of trees. However, it is the biodiversity richness of Kodagu, that even these small patches of forests sustain a lot of biodiversity in it. Finally, the faith of traditional Kodavas in the deities helped in protecting and in conserving tree diversity through Scared Groves till today. This may be due to the Godfearing or devotion ethos of not going against nature.

In conclusion, tree diversity is high in the Sacred Groves having less anthropogenic disturbances. The nature worshiping ethos help in conservation of tree diversity in the Sacred Groves.

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Table 1: Current status and tree diversity in few Sacred Groves of Kodagu district in Karnataka

Survey No.	Name of sacred grove	Area in acres	Disturbance factors				Tree diversity	
			Forest boundary	Settlements	Accessibility to roads	Plastic/ paper waste	No. of Tree species in a plot	Shannon-Wiener Index of Diversity (H)
01	Ayyappa DK (Badaga-Kutta)	6.32	Not clear	Scattered	Slightly near	Common	15	3.79
02	Devarakadu (Kutta)	19.46	Not clear	Moderately dense	Very near	Common	14	3.47
03	Ayyappa DK (Halligattu)	19.55	Not clear	Moderately dense	Very near	Common	16	3.73
04	Ayyappa DK (Hudur)	16.54	Not clear	Scattered	Slightly far	Very rare	21	4.16
05	Bhadrakali DK (Hatur)	16.37	Moderately clear	Scattered	Very near	Very common	13	3.48
06	Ayyappa DK (Kunda)	5.76	Moderately clear	Scattered	Slightly far	Rare	19	4.05
07	Ayyappa DK (Echuru)	10.60	Moderately clear	Scattered	Slightly near	Common	15	3.73
08	Ayyappa DK (Aravathoklu)	16.74	Not clear	Moderately dense	Very near	Very common	11	3.26
09	Ayyappa DK (Mugutageri)	19.47	Moderately clear	Moderately dense	Slightly near	Common	17	3.84
10	Kuttichatia DK (Mugutagiri)	7.73	Not clear	Scattered	Slightly far	Very rare	26	4.45

316.

Effect of Different Plantation Techniques on Leaf Area of *Populus deltoides* on Degraded Sites of North Western Himalayas

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Keywords: Survival, growth, pit size, pit type, degraded site, mulch.

Introduction

Land is one of the most important resource on which human beings depend. The rate of soil degradation and destruction to forests is continuously increasing with the advancement of science & technology and population explosion (Pramod and Mohapatra, 2012). Plantations can conserve soil on degraded lands (Thapa, 2003). *Populus deltoides* are known for their fast growth, easy vegetative propagation and enriching the soil with litter, and provide high production on a short rotation. At present the knowledge about the planting techniques on problematic sites is very limited and moreover specific to specific areas. Therefore, this work was undertaken to develop plantation techniques in tune with the existing problems.

Materials and Methods

The plantation of *Populus deltoides* using different plantation and moisture conservation techniques was done in problematic (degraded) land of the Faculty of Forestry, Sher-e- Kashmir University of Agricultural Sciences and Technology in 2012-13. *Populus deltoides* was taken for experimentation because of its multifarious uses and abundant availability in the region. Two planting seasons were tested for finding out the best season for out planting i.e. Autumn planting and Spring planting with three pits types of different sizes i.e. Ordinary pit, Saucer pit and Ring pit. Also, three kinds of mulching were used for moisture conservation as M_0 (Control - No mulching), M_1 (Ordinary mulch -grasses) and M_2 (Black polythene).

Results and Discussion

The results regarding leaf area of *Populus deltoides* is significantly affected by planting season, pit types, sizes and different moisture conservation measures. The present study reveals that highest leaf area growth (915.81 cm^2) was recorded for autumn planting and minimum (907.40 cm^2) for spring planting as presented in Table 1. Leaf area increases with increase in branch size and number of branches. Also, pit types affected leaf area growth of *Populus deltoides.* Highest leaf area was recorded for PT_2 (saucer pit), followed by PT_1 (ordinary pit) and PT_3 (ring pit) in both the planting seasons. Pits of different sizes affected leaf area of *Populus deltoides* on problematic sites in both the seasons with highest recorded for PS_3 (60 x 60 x 60 cm^3), followed by (45 x 45 x 60 cm^3) and PS_1 (30 ×30 x 45 cm^3). Limited rooting space is considered a major problem for growth of trees. Pits of larger size provide greater space for root growth and development, which is largely responsible for above ground development of trees. All the three mulching treatments significantly affected leaf area in both the seasons. Highest leaf area was recorded for M_2 (black polythene), followed by M_1 (ordinary mulch) and M_0 (control).

Factorial means were also evaluated to determine the best individual factor for leaf area. It is evident from the Table 1 that the highest leaf area was recorded for M_2 (914.88 cm^2), followed by M_1 (911.76 cm^2) and lowest for M_0 (908.16 cm^2). Among the three pit types studied, PT_2 recorded highest leaf area (922.78 cm^2), followed by PT_1 (908.33 cm^2) and PT_3 (903.70 cm^2). The reason being greater moisture storage in saucer pits on degraded sloppy sites. It was also observed that all the three pit sizes affected leaf area, with highest recorded for PS_3 (912.79 cm^2), followed by PS_2 (911.50 cm^2) and lowest for PS_1 (910.52 cm^2).

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Table 1: Effect of planting season, pit shape, pit size and moisture conservation measures on leaf area (cm^2) of *Populus deltoids*

Pit type	PT_1			Mean	PT_2			Mean	PT_3			Mean
Pit size / Mulching	PS_1	PS_2	PS_3		PS_1	PS_2	PS_3		PS_1	PS_2	PS_3	
Autumn Planting												
M_0	906.53	906.88	907.12	906.84	923.30	925.11	927.15	925.19	903.10	903.19	904.42	903.57
M_1	910.42	911.09	917.58	913.03	927.81	929.52	930.01	929.11	904.98	905.13	905.77	905.29
M_2	918.40	920.13	922.22	920.25	931.13	932.43	932.98	932.18	906.51	906.82	907.03	906.79
Mean	911.78	912.70	915.64	913.37	927.41	929.02	930.05	928.83	904.86	905.05	905.74	905.22
Spring Planting												
M_0	900.01	900.54	900.98	900.51	910.13	912.43	916.31	912.96	899.12	900.09	900.53	899.91
M_1	902.32	903.10	903.77	903.06	917.33	917.98	918.13	917.81	901.12	902.58	902.98	902.23
M_2	905.23	906.12	907.53	906.29	918.81	919.30	920.10	919.40	903.16	904.48	905.53	904.39
Mean	902.52	903.25	904.09	903.29	915.42	916.57	918.18	916.72	901.13	902.38	903.01	902.18
Factor means												
Mulching	908.16	911.76	914.88									
Pit Type	908.33	922.78	903.70									
Pit Size	910.52	911.50	912.79									
Season	915.81	907.40										

CD ($p \leq 0.05$): M= 2.11, P_T=4.23, P_s= 0.48, S= 5.10, M× P_T= 2.50, M× P_s= 2.19, M×S= 1.48, P_T × P_s= 2.76, S× P_T=1.77, P_s ×S= 2.34, M× P_T × P_s ×S= 1.79

317.

Effect of Planting Season, Interval and Nitrogen Fertilizer on Survival of *Populus deltoides* Under Degraded Sites of North Western Himalayas

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Keywords: Populus, Growth, Altitude Interval, Fertilizer, Season

Introduction

Populus deltoides locally called as '*Fras'* make a striking and important contribution to the landscape and economy of Jammu and Kashmir. Poplars in the state have gained considerable importance in farm and plantation forestry. Poplars are known for their fast growth, easy vegetative propagation and enriching the soil with litter, and provide high production (10-30 M^3/hectare/ year) on a short rotation of 8-12 years (Chandra, 1986). The poplars have the potential for narrowing down the gap between demand and supply of wood. Therefore, various attempts have been made in the past for raising this economically important species on problematic lands in different parts of the world.

Materials and Methods

The plantation of *Populus deltoides* was done on degraded land of the Faculty of Forestry, Shere-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, Benihama Campus, Ganderbal, Jammu and Kashmir at an altitude of 5850 feet above mean sea level. *Populus deltoides* was taken for experimentation at spacing of 2×2 m. Two planting seasons were tested for finding out the best season for out planting (Autumn planting and Spring planting). Three planting intervals of 15 days (fortnight) duration in both seasons were tested. Four levels of nitrogenous fertilizers (urea) were selected to find out the optimum dose of nitrogen fertilizer for poplar plantation.

Results and Discussion

The main aim of evaluating planting seasons, intervals and nitrogen levels was to determine the best treatments and their interactions for *Populus deltoides* on problematic sites. Table 1 revealed significant variation among two seasons for survival percentage. Autumn planting record highest survival compared to spring planting. Among the planting intervals, planting interval "I" recorded highest survival percentage, followed by planting interval "II" and planting interval "III" in both the seasons. A total of four nitrogen levels were also studied. In both the seasons, survival percentage of *Populus deltoides* increased with increase in nitrogen dosage from N_0 (control) to N_2 (150 kg/hectare) and then decreases in both the seasons.

Table 1: Effect of planting season, interval and nitrogen fertilizer on Survival of *Populus deltoides*

Nitrogen levels Planting intervals	N_0	N_1	N_2	N_3	Mean
Autumn Planting					
I_1	66.66	83.33	100	83.33	83.33
I_2	66.66	83.33	83.33	66.66	74.99
I_3	66.66	66.66	83.33	66.66	70.82
Mean	66.66	77.77	88.88	72.21	76.38
Spring Planting					
I_1	66.66	66.66	83.33	66.66	70.82
I_2	66.66	66.66	83.33	50.00	66.66
I_3	50.00	66.66	83.33	50.00	62.64
Mean	61.10	66.66	83.83	55.55	66.66
Factorial mean					
Planting Interval	77.07	70.82	66.73		
Nitrogen levels	63.88	72.21	86.35	63.68	
Planting Season	76.38	66.66			
CD ($p \leq 0.05$): I=1.48, S=2.38, N=0.48, N×S=1.57, N×I=2.67, S×I=NS, N×S×I=NS					

Individual factors were evaluated to determine the best possible factor for *Populus deltoides* plantation on problematic sites. It was recorded that among three planting intervals, planting interval I having survival percentage (77.07%) was best for *Populus deltoides* plantation. It was because of the reason that ample moisture was present on the plantation site during planting interval I for establishment of seedlings. It was also that among four nitrogen levels applied to the plantation, N_2 recorded highest percentage survival (86.35%), followed by N_1 (72.21%), N_0 (63.88% and N_3 (63.68%).

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318.

Vegetative and Reproductive Pheno-phases of *Betula utilis* D.Don (Himalayan birch) in Western Himalayas along the Different Altitudes

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Keywords: *Betula utilis*, phenophases, flowering, seed maturation

Introduction

Betula utilis D. Don (*bhojpatra* birch) forms treeline vegetation all along the Himalayas, and extensive stands of this species can be found on northern/southern shady slopes and ravines (TISC 2002). It is the only broadleaved angiosperm tree species in the Himalayas which dominates an extensive area at subalpine altitudes (Zobel and Singh, 1997). *Betula* spp. show a high freezing tolerance (Sakai and Larcher, 1987) which enables them to form a treeline in the Himalayas (TISC, 2002). The species is endemic to Arunachal Pradesh, Himachal Pradesh, Jammu-Kashmir, Sikkim and Uttaranchal. However, the massive overexploitation for fuel wood, fodder and medicines (Sharma *et al.,* 2010) as well as the unscientific management of this species has caused loss of habitat in many of its native groves in the entire Himalayan range (Cuirong and Mark, 1998). Lack of sufficient regeneration is a major problem of mountain forests (Krauchi *et al.,* 2000). The species has already been declared as critically endangered in Kashmir by Environmental Information System (ENVIS) Centre on Conservation of Medicinal Plants and Foundation for Revitalization of Local Health Traditions (FRLHT), Bangalore (Anonymous, 2010). The phonological events, regeneration and spatial patterns of seedling distribution of *Betula utilis* stands in the Kashmir Himalayas have not been studied. Here we report the vegetative and reproductive events of the *Betula utilis* dominated stands in Sindh and Tangmerg Forest Divisions of Kashmir Valley. The *Betula utilis* forms treeline vegetation in these Forest Divisions between an elevation of 3000 and 3600 m amsl on South Eastern and South Western slopes.

Materials and Methods

Phenological and reproductive events of *Betula utilis* were monitored along the three altitudinal gradient in distinct ecological settings of Sindh and Tangmarg forest divisions of Kashmir (Shi *et al.,* 2000). The data was recorded at 10 days interval for ten individual trees at every altitudinal gradient (3000-3300m, 3300-3600m and above 3600m amsl) and described in different phases of growth through the seasons (phenophase). The parameters recorded included bud set, bud burst, leaf tint, leaf fall flowering, leaf initiation, flowering dehiscence (male), seed formation and seed maturation,

Results and Discussion

The observations recorded (Table 1) revealed high synchrony throughout the altitudinal gradients, especially for bud set, bud burst, peak flowering and seed maturation. All the phenological events began early at lower elevation as compared to higher elevation. The timing of snowmelt usually governs and is responsible for early phenological changes in the Northern Alpine habitats. The bud set started from 1st week of May at the lower altitude and one week later (i.e. 2nd week of May) at higher altitude. Similarly the bud burst started from 05th of May, flowering from 10th of May, leaf initiation from 15th of May, seed formation from 1st June and seed maturation from 10th September at lower altitude and around 5 to 10 days later at the middle and upper altitudinal gradients respectively. The spring phenophases are particularly sensitive to the temperature during late winter and early spring, which are also considered as accurate predictors of phenophase timing **(**Galan *et al.,* 2005**).** The dry period (snow-free soil) during April/May initiates bud swelling in this species, but bud break only takes place after the average temperature rises above 5°C. If this is delayed, there is a longer period from initiation of swelling to breaking (Rai *et al.,* 2011). Flowering occured in July- August in most of the growth forms on alpine zone (Vashistha *et al.,* 2009). The delay in the leafing, flowering and fruiting at higher elevation is accounted by the cold spring but this does not delay the fruit maturation in late summers (Lechowicz, 1995). The onset of flowering is crucial to the reproductive success of flowering plants particularly at higher elavations and in late flowering species, the entire seed production is often lost to colder or shorter summers rather than the average growing period (Henry and Molau, 1997). In case of leaf fall a reverse pattern starting earlier by 10th of September at upper altitude, 15th of September at middle altitude and 25th of September at lower altitude, Leaf fall in *Betula utilis* was associated with the drop in temperature during autumn at the higher altitudes and later at lower altitudes. A longer leaf life span is associated with potentially higher carbon gain by the plant (Kikuzawa 1994) and more efficient nutrient use (Eckstein *et al.,* 1999). The preceding results reveal that Phenological events are constrained at high altitudes by the short growing season and delimited by cold temperatures and snow cover. Thus the vegetative and reproductive cycles are accomplished more rapidly at high altitudes where snowfall occurs earlier and persists longer.

Table 1: Vegetative and reproductive Pheno-phases of *Betula utilis* in Western Himalayas along different altitudinal gradients

Reproductive and vegetative phases	Altitudes		
	3000-3300m	3300-3600m	above 3600m
Bud set	01 - 10 May	5-15 May	10-20May
Bud burst	05 -15 May	10-20May	15-25 May
Flowering	10 -20 May	15-25May	20-30May
Leaf Initiation	15-25 May	20-30May	25 May- 5 June
Flowering dehiscence (Male)	15- 25 May	20-30May	25 May- 5 June
Seed formation	1 -10 June	5-15 June	10-20June
Seed maturation	10 - 20 Sep	15-25 Sep	25 Sep- 10 Oct
Leaf tint	15 - 25 Sep	5-15 Sep	5-10Sep
Leaf fall	25 Sep. - 10 Oct.	15-30Sep	10-25 Sep

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319.

Status and Propagation of Black Locust (*Robinia Spp.*) in Temperate Kashmir of Western Himalayas

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Introduction

Black locust (*Robinia* spp.), family, Leguminosae, sub-family Papilionoideae, locally called 'Kiker' in Kashmir, is fast growing, short rotation species, makes it a biomass based fuel source of the future. It dominates early forest regeneration in many native forest stands where it occurs, Boring and Swank (1984). The natural distribution of *Robinia* include the Appalachian and Ozark mountain of the United States between 35-43°N latitude. In India, it was first introduced in Himachal Pradesh in 1890 and later to Jammu and Kashmir in 1919, largely to afforest the barren hills and does well even at an elevation range from 1,800 to 3,000 m above mean sea level, Muthoo and Kangoo (1965) and Luna (1996).

Materials and Methods

Above objective was achieved by conducting detailed survey (questionnaire, informal interview, transit walk methods) at block level in all districts of Kashmir Valley and observations with regard to status, distribution, concentration and identification of existing *Robinia pseudoacacia* trees in the area was recorded. The experiment was carried out at forest nursery Faculty of Forestry, SKUAST-K, Shalimar during the year 2009-2010. The cuttings of four diametric classes viz., D_1 (< 1.5 cm), D_2 (2.0 cm), D_3 (2.5 cm) and D_4 (3.0 cm) prepared each of 5 cm length, were planted horizontally at a spacing of 10 x 10 cm in the last week of February. Cuttings were covered with soil, pressed tightly and flooded just after plantation. The beds were regularly irrigated to ensure moisture availability. Weeding was carried out when required. The design was RBD with five replication of each diameter class. The number of cutting in each replication of each diameter class was 15. The observation were recorded for sprouting percentage, survival percentage, shoot length and collar diameter at the end of the growing season.

Results and Discussion

During the survey results revealed that the Black locust tree was found both on farm lands and wastelands, although sparsely in case of former. The species contributed significantly to the economy of the farmers. The maximum average annual income generation from kiker cultivation on farm lands was recorded as Rs. 1,428 per ha/family in district Anantnag. The average concentration and average land holdings were recorded as 23 trees/ha and 0.35 ha/family, respectively. The minimum average income from the species in district Srinagar was recorded as Rs. 650 per ha/family. The average concentration and land holdings were recorded as 8 trees/ha and 0.12 ha/family, respectively. On wastelands, trees were seen growing abundantly in all the districts with maximum concentration recorded as 110 trees/ha in district Kulgam (Table 1). The average income from kiker cultivation was recorded as Rs. 8,250 per ha/family. The average wasteland holding was observed as 0.09 ha/family which was recorded as its maximum value.

A detailed survey undertaken at village level in all districts of Kashmir Valley revealed that only one *Robinia* species identified on the basis of various phenotypical characteristics of the species such as tree form size and shape of the leaves, flower colour, seed shape, seed size etc. It is a medium sized deciduous tree with irregular crown. The average height was recorded as 19 m. However, under dense plantation, the average tree height increased and was recorded as 26 m. The bark was rough brown with deep longitudinal furrows. Leaves were 10 to 15 cm long, imparipinate, with oval shaped leaflets which ranged from 9 to 11. The flowers were 15 to 20 cm long. The flowers were pinkish or white in colour and appeared in auxiliary racemes. The pods when mature were dark brown outside and silver white inside. The seeds were either black or brown, the black being larger in size. The present study leads to conclusion that only one species identified as *Robinia pseudoacacia* was existing in Kashmir Valley. The species was growing sparsely on the Farm land under moderate climatic conditions. However, trees were found and can be grown in abundance on wastelands also in all districts of the Kashmir Valley to boost the economy of the farmers. The vegetative propagation by means of cutting of 2.3cm proved good in terms of all growth characters studies and can be alternative to seed multiplication, which often has failure due to their non-viability of seeds.

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Table 1: Status and distribution

District	Farm lands			Wastelands		
	Average farmland holding of surveyed family (ha)	Average number of black locust/ha	Average annual income (Rs.) from black locust tree/ha/family	Average wasteland holding of surveyed family (ha)	Average number of kikar tree/ha	Average annual income (Rs.) from kiker tree/ha/family
Anantnag	0.35	23	1,428	0.05	98	7,840
Budgam	0.27	15	900	0.07	90	7,142
Baramulla	0.35	19	1,142	0.05	105	7,950
Ganderbal	0.31	20	1,258	0.06	95	6,416
Kupwara	0.32	16	1,406	0..08	107	6,512
Srinagar	0.12	8	650	0.02	70	6,550
Bandipora	0.35	25	1,385	0.07	90	4,751
Shopian	0.46	15	978	0.08	87	5,212
Kulgam	0.38	17	1,131	0.09	110	8,250
Pulwama	0.46	16	782	0.06	93	6,166

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Growth Performance of Different Tree Species in Silviculture System

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Keywords: Tree species, silviculture, growth performance

Introduction

Agroforestry is often a promising land use option with considerable potential for commercial timber production. The prime concern in agroforestry studies has been optimization of various tree species for maximizing tree growth subject to the condition of minimum reduction in crop yield over sole crop. In agroforestry system, trees are intentionally used within agriculture system which can be advantageous over conventional agriculture and forest production method through increased productivity, economic benefit, social outcome and ecological goods and services provided. Hence, present investigation was undertaken to evaluate the performance of different timber producing tree species in silviculture system in shallow soil for suggesting best tree species for shallow soil.

Materials and Methods

The field experiment was undertaken at All India Coordinator Research Project on Agroforestry, Mahatma Phule Krishi Vidyapeeth, Rahuri from 1996 to 2011. The soil of experimental field was shallow. Experiment was laid out in randomized block design with seven treatments of tree species and replicated three times. Tree species were planted at 3 x 3 m spacing in each replication. One year old seedlings of tree species namely *Tectona grandis*, *Azadirachta indica*, *Hardwicki binata*, *Acacia nilotica*, *Melia azadirach, Zizipus mauritiana* and *Eucalyptus* sp. were planted in pits of 0.60 x 0.60 x 0.60 m, filled with top soil and 10 kg farm yard manure. Trees were pruned 50% of total height in July-August every year starting from third year onwards. The data on tree growth attributes namely tree height, diameter at breast height (DBH), bole height and bole volume of trees was recorded at the end of 12th year by using the formula r^2h (Radius^2 x height).

Results and Discussion

The growth performance of plant height, collar diameter, diameter at breast height (DBH) and bole volume was obtained significantly higher in Eucalyptus sp. The tree species Eucalyptus recorded significantly highest plant height (11.7 m) and bole height (7.1 m). While, *Acacia nilotica* var. *Cupriciformis* recorded significantly the highest collar diameter (21.7 cm) DBH (18.8 cm) followed by *Hardwika binata* as compared to *Tectona grandis, Azadirachta indica*, *Eucalyptus camandulensis*, *Melia azadirach* and *Zizipus muaritiana* tree species (Table 1). The results are in collaboration with Rai *et al.,* 2000. The pooled results indicated that *Eucalyptus* sp. recorded significantly the highest plant height (9.8 m) and bole height (6.2 m) whereas significantly the highest collar diameter (16.1cm) and DBH (13.9 cm) were recorded in *Acacia nilotica* var. *Cupriciformis* (Table 1). Similar growth performance of *Acacia nilotica* has been reported by Giri Rao *et al* (2003). The plantation of Eucalyptus in shallow soil of scarcity zone of Western Maharashtra found superior for obtaining higher timber yield at the age of twelve years.

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Table 1: Growth attributes and Timber yield as influenced by the different tree species.

Treatments	2011				Pooled mean of (12 years)				Bole volume/tree (m^3)	Bole volume/ ha (m^3)	Timber Yield (t/ha)
	Plant height (m)	Collar Diameter (cm)	Diameter at breast height (cm)	Bole height (m)	Plant height (m)	Collar Diameter (cm)	Diameter at breast height (cm)	Bole height (m)			
Azardiracta indica	6.6	15.0	11.8	2.3	5.51	12.68	10.05	2.32	0.034	37.75	22.213
E. camandulensis	11.7	18.3	14.5	7.1	9.88	14.99	11.84	6.22	0.273	304.01	178.863
Melia azadirach	6.5	14.2	12.5	3.0	5.45	11.94	9.87	3.01	0.052	57.72	33.823
Tectona grandis	6.2	14.0	10.1	3.3	4.88	11.09	7.65	3.15	0.039	42.83	25.197
Hardwickia binnata	8.7	20.6	16.9	4.8	6.46	13.97	11.54	4.57	0.134	149.50	87.960
Acacia nilotica	11.3	21.7	18.8	4.2	8.47	16.19	13.99	3.89	0.137	153.11	90.077
Ziziphus mauritiana	3.1	8.6	6.4	1.3	2.41	7.08	2.08	1.00	0.006	6.72	3.953
SE±	0.50	0.98	1.17	0.31	0.39	0.77	0.71	0.16	0.020	22.06	12.96
CD at 5%	1.52	2.97	3.56	0.94	1.12	2.16	2.00	0.46	0.061	68.01	36.96
General mean	6.8	14.0	11.4	3.2	6.15	12.56	9.57	3.45	0.096	107.38	63.15

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Growth and Above Ground Biomass Accumulation in *Populus deltoides* Barter Clones in Sub-tropics of Jammu, India

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Keywords: Above ground biomass (AGB), *Populus deltoides,* clones, sub-tropics

Introduction

Quantification and improvement of the biomass of natural, man-made forest plantations has been the thrust area in the present scenario. The Western Himalayan region of the Indian sub-continent consisting of Jammu and Kashmir (J&K), Himachal Pradesh and Uttarakhand is spread over an area of 33.85 m ha with a contribution of 14% to the soil carbon stocks of the country (Bhattacharya *et al.,* 2008). Poplar (*Populus deltoides* Barter) among the tropical fast growing species has emerged as the alternate option and dependable source of carbon stock in the region and ultimate choice for plantation forestry in the Indo-Gangetic plains. Poplar based agroforestry is prevalent among farmers of irrigated sub-tropical plains in North-West India and cater to nearly 45% of wood requirements for paper making and farmers earn good returns from the nursery as well as plantation activities (Dhillon *et al.,* 2001). Growth behaviour, biomass accumulation studies under different land uses has revealed that *Populus deltoides* significantly contributed to biomass and soil carbon pool in agroforestry plantations Chauhan *et al.,* 2007).

To provide impetus to genetic improvement, wide variety of improved location specific clones suitable for microclimatic situations have been evolved. Information on above ground biomass storage, carbon accumulation by these superior clones is of utmost importance in short rotation plantations of poplar. The study is required for research, commercial utilization and valuation purposes. Therefore present investigation was carried to study the growth potential and estimation of above ground biomass production (AGB) and its partitioning in superior clones of poplar in the irrigated sub-tropics of J&K.

Materials and Methods

The present investigation was carried in a block plantation comprising of different poplar clones at Chatha established by Division of Agroforestry, Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu and Kashmir during the year 2011-2012. For the present study five cones namely; WSL-22, WSL-32 WSL-39 KARANTI, G_{48}, S_7C_{15} and UDAI were selected for undertaking growth and biomass studies. The observations on plant height, diameter at breast height (dbh), number of branches, biomass allocation in tree components and total above ground biomass (AGB) on randomly selected sample trees in all the clones were recorded as per the standard procedure.

Results and Discussion

The growth characteristics namely plant height, diameter at breast height and mean volume ($m^3 tree^{-1}$) were significantly variable among different clones. The clone S_7C_{15} attained maximum plant height. Maximum values for mean volume ($m^3 tree^{-1}$) and DBH was observed in clone WSL-22 (Table 1). This could be attributed to superior genetic makeup, better adaptability, and genotype x environment interaction.

Above ground oven dry biomass (kg $tree^{-1}$) and its allocation among tree components revealed that mean tree above ground biomass was the maximum in WSL-22. Biomass allocation to different components was of the order; stemwood > branch + twig > leaf in all the clones (Table 2). Maximum contribution by stemwood to total above ground biomass can be ascribed to more accumulation in stemwood with age and diameter growth.

Among the different clones of poplar (*Populus deltoides* Barter.), the clone WSL-22, was the best performing clone with respect to above ground biomass (kg $tree^{-1}$) and growth parameters like DBH and per tree volume production in the sub-tropics of Jammu.

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Table 1: Growth of different poplar (*Populus deltoides*) clones in the sub-tropics of Jammu

Clones	Plant height (m)	DBH (cm)	Mean volume ($m^3 tree^{-1}$)
WSL-22	30.56	41.25	4.126
WSL-32	29.12	38.46	3.445
WSL-39	29.87	38.12	3.544
KARANTI	28.12	29.34	1.929
UDAI	28.37	37.80	3.249
S_7C_{15}	31.12	32.81	2.016
G_{48}	27.12	36.81	2.973
CD (5%)	2.13	3.71	0.676

Table 2: Above ground biomass (Kg/ tree) production and its distribution in different components of Poplar (*Populus deltoides*) clones

Clones	Leaf	Branch + twig	Stem	Total above ground biomass
WSL-22	19.0	37.0	91.0	147.0
WSL-32	16.0	28.0	68.2	112.2
WSL-39	20.0	34.0	90.0	144.0
KARANTI	07.0	15.0	40.7	62.7
UDAI	12.0	26.0	83.0	121.6
S_7C_{15}	8.0	16.0	42.0	66.0
G_{48}	16.0	24.0	86.0	126.0

322.

Fractionation of *Trema orientalis* in a Biorefinery Initiative

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Keywords: *Trema orientalis*, biorefinery, microfibrils, lignin, hemicelluloses and α-cellulose

Introduction

Bangladesh is a densely populated forest deficient country. So, it is hard to supply pulpwood from our forest to keep the growth of paper industry. To achieve this, plantation of fast growing species must be established to compensate for the decreasing supply of raw materials from natural forest. Recently, it is found that *Trema orientalis* is one of the fastest growing trees. It is a native species and grows naturally everywhere in Bangladesh. In this paper, *T. orientalis* was fractionated to cellulose, hemicelluloses and lignin by formic acid/ peroxyformic acid/ alkaline peroxide (FA/PFA/H_2O_2) treatment in order to produce dissolving pulp and fractionate dissolved biomass. Microfibrillated cellulose was isolated from the dissolving pulp and characterized.

Materials and Methods

T. orientalis chips were refluxed with 90% (v/v) formic acid (FA) for 120 min at the boiling temperature. The formic acid treated fibers were further delignified with peroxyformic acid (PFA) at 80°C. At the completion of 120 min, the fibers were filtered off and washed using 80% formic acid, followed by hot distilled water. Bleaching of the produced pulp was carried out by alkaline peroxide. Spent FA/PFA liquor, dissolved lignin and hemicelluloses during FA and PFA treatment were separated by distillation, precipitation and filtration. Microfibrillated cellulose (MFC) was prepared from the produced dissolving pulp by acid hydrolysis method with 64% sulphuric acid at 50°C for 5h. Isolated MFC was characterized by FTIR, XRD, TG and SEM.

Results and Discussion

FA/PFA/H_2O_2 treatment yielded 51.7% dissolving pulp with purity 94.8%, while 17.1% lignin and 14.2% hemicelluloses (sugars) were also recovered from the *T. orientalis*. Produced dissolving was used for extracting MFC. FTIR results indicate that the isolated microfibrils from the *T. orientalis* were rich in I_β. The crystallinity index of microfibrils was 64.5% and degradation temperature was above 330°C. Fractionated lignin can be the starting material for high value-added applications in renewable polymeric materials development and hemicellulosic sugars can be employed in biofuel production. It may be concluded that the *T. orientalis* can be fractionated by FA/PFA/H_2O_2 process in an Integrated Forest Biorefinery Concept and all fractions can be used in producing biomaterials, chemical and fuels.

Table 1: FA/PFA/H_2O_2 fractionation of *Trema orientalis*

Pulp fraction		Spent liquor	
Yield (% on original material)	α-cellulose (% on cellulose)	Total solid content (% on original material)	Lignin (% on original material)
51.7	94.8	25.2	17.1

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Maturity Indices and Cold Moist Stratification of Himalayan Maple (*Acer caesium* Wall.) Under Temperate Conditions of Kashmir

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Keywords: *Acer caesium*, Germination percent, Germination value.

Introduction

Himalayan maple (*Acer caesium* Wall.) is one of the important unevenly distributed deciduous trees has diverse cultural uses and economic importance in Kashmir. Maturity indices studies are important because of the fact that the knowledge of exact stage and time of seed maturity is essential for collection of abundant quantity of healthy and vigorous seeds. The seeds of *Acer caesium* have physiological dormancy. Despite intense socio-economic and cultural significance of the species, the mass propagation of the species remained a challenge for farmers, nursery growers and entrepreneur in Kashmir. Therefore, the present study on maturity indices and cold moist stratification was undertaken under temperate conditions of Kashmir.

Materials and Methods

The study was conducted in Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Wadoora, Sopore. Seeds were subjected to germination test, specific gravity, seed weight and change in fruit color. The specific gravity of seeds was determined by water displacement method (Oliver, 1974). The seeds were subjected to cold moist stratification at 4±1°C and 8±1°C under refrigerated conditions for a period of Zero (D_1), 15 (D_2), 30 (D_3), 45 (D_4), 60 (D_5), 75 (D_6) and 90 (D_7) days. The germination was carried out at a temperature of 25±2°C and each treatment was replicated four times having 100 seeds in each replication. Germination value was calculated as per Czabator (1962).

Results and Discussion

The results on cold moist stratification revealed that significantly higher germination percentage (62.66%) was recorded for seeds stratified for 60 days followed by stratification for 75 days (55.33%), 90 days (48.16%), 45 days (45.16%), 30 days (38.83%), 15 days (28.50%) and control (0.00%) (Table 1). For stratification temperature, the seeds stratified at 4±1°C showed better germination percentage (46.85%) as compared to the seeds (32.76%) which were stratified at 8±1°C. Interaction of stratification duration and stratification temperature revealed that maximum germination percentage (72.66%) was recorded when seeds were stratified at 4±1°C for 60 days.

Table 1: Effect of stratification temperature and stratification duration on germination percentage of *Acer ceasium* seeds

Stratification duration	Stratification temperature		
	4±1°C	8±1°C	Mean
D_1 (Control)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)
D_2 (15 days)	34.33 (5.94)	22.66 (4.86)	28.50 (5.40)
D_3 (30 days)	45.66 (6.83)	32.00 (5.74)	38.83 (6.28)
D_4 (45 days)	54.33 (7.43)	36.00 (6.08)	45.16 (6.76)
D_5 (60 days)	72.66 (8.58)	52.66 (7.32)	62.66 (7.95)
D_6 (75 days)	66.33 (8.20)	44.33 (6.73)	55.33 (7.46)
D_7 (90 days)	54.66 (7.46)	41.66 (6.53)	48.16 (6.99)
Mean	46.85 (6.49)	32.76 (5.46)	
	C.D. (0.05) S.E.±		
Temperature	0.071 0.024		
Duration	0.133 0.046		
Temperature × duration	0.189 0.065		

Note: Values in the parentheses show transformed values

Hence, the Himalayan Maple seeds should be collected absolutely mature when the colour of seeds changes from green to dark brown. Further, the seeds must be subjected to 60 days of stratification duration at 4±1°C stratification temperature to achieve the best results in terms of germination percentage and germination value.

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Variation in Chemical Components and Fibre Length in Wood of High Density Plantation of *Eucalyptus tereticornis* Smith

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Keywords: Eucalyptus, spacing, sampling height, holocellulose, lignin, fibre length

Introduction

Wood is the fibrous material in the trunk of trees, which is composed of a complex mixture of polymers. Quantitatively, the most important is cellulose, followed by lignin, hemicelluloses, and then extractives. Cellulosic fibres are deposited on cell walls along with lignin during the process of wood formation (Walker, 2006). Cellulose gives strength to the cell walls. Lignin supports the cellulosic fibres, provides the hydrophobic surfaces in vessels essential for water conduction. Fibre length is one of the quality parameters for pulpwood. It has been extensively studied in relation to tree age and within tree position (Hudson *et al.* 1995).

Materials and Methods

The experiment was conducted on high density plantation of 25 year old *Eucalyptus tereticornis*, raised at a spacing of 0.60 × 0.60 m (S_1), 0.90 × 0.90 m (S_2) and 1.20 × 1.20 m (S_3) in the of Dr. Yashwant Singh Parmar University of Horticulture and Forestry - Nauni, Solan in 2011. Chemical investigation was performed on 5 cm long stem sections removed from the main stem at 0% (H_1), 30% (H_2), 60% (H_3) and 10 cm at 90% (H_4) of total tree height in the laboratory using standard procedures and then data obtained was subjected to statistical analysis according to Chandel (1965) and Panse and Sukhatme (1967).

Results and Discussion

Lignin is the main chemical in wood which directly reflects its strength. It recorded a maximum value of 31.15% at the base and minimum of 25.80% at ninety per cent of the total tree height (Table 1). The decrease in lignin content from base to top of the tree may be due to its lesser deposition in juvenile tissues as lignin deposition is more in old tissues. The presence of holocellulose in the wood makes it a universal raw material. Holocellulose recorded a significantly highest value of 70.87% at ninety per cent of the total tree height and lowest of 66.13% at the ground level. It may be due to the varied production of dry matter at different sampling heights. The affect of sampling height on the fibre length was found to be statistically significant with highest value of 0.893 mm recorded at ground level (H_1) which was statistically at par with H_2 (0.865 mm). The lowest value of 0.767 mm was observed at 90% of the total tree height (H_4). The differences in fibre length associated with increase in height are mainly due to the differences in the juvenile and mature wood proportion in the tree. The effect of spacing and their interaction with different levels of tree heights on lignin, holocellulose and fibre length was found to be non-significant at 5% level of significance. Therefore, it can be concluded that the lignin content, holocellulose and fibre length observed a significant variation along the height of the tree.

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Table 1: Effect of spacing and sampling height on Klason-lignin, holocellulose content and fibre length in wood of *Eucalyptus tereticornis*.

Spacing Height	S_1 (0.60×0.60m)	S_2 (0.90×0.90m)	S_3 (1.20×1.20m)	Mean	S_1 (0.60×0.60m)	S_2 (0.90×0.90m)	S_3 (1.20×1.20m)	Mean	S_1 (0.60×0.60m)	S_2 (0.90×0.90m)	S_3 (1.20×1.20m)	Mean
	Lignin				Holocellulose				Fibre length			
H_1	30.81	31.16	31.49	31.15	66.01	66.06	66.33	66.13	0.886	0.895	0.899	0.893
H_2	29.43	29.37	29.48	29.43	67.29	67.57	68.11	67.66	0.845	0.875	0.874	0.865
H_3	27.38	26.76	28.22	27.45	69.88	70.31	69.45	69.88	0.829	0.794	0.875	0.832
H_4	26.50	24.66	26.25	25.80	70.04	71.94	70.64	70.87	0.792	0.743	0.766	0.767
Mean	28.53	27.99	28.86		68.31	68.97	68.63		0.838	0.827	0.853	
	SEd(±)	CD (0.05)				$SE_d(\pm)$	CD (0.05)			$SE_d(\pm)$	CD (0.05)	
S	0.425	NS			S	0.380	NS		S	0.009	NS	
H	0.491	0.999			H	0.438	0.891		H	0.011	0.022	
S × H	0.850	NS			S × H	0.759	NS		S × H	0.018	NS	

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Household Dynamics and Small Timber Consumption in Rural Kashmir, India

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Keywords: Consumption, extraction, forest resource, small timber, socio-economic, Kashmir

Introduction

Timber is a renewable, sustainable, attractive, strong, durable and cost effective natural building material that combines beauty, superior performance and environmental advantage (Binkley and Earhart, 2005). The extraction and consumption situation of small timber in rural sectors plays an important role in the socio-economic, cultural, farming and geo-environmental conditions of a region. The dependency of rural households on the forest resources for small timber procurement and their diverse use pattern has become an important topical issue in developing economies. The present study is an attempt to document the status of extraction and consumption of small timber and how it is influenced by the household's socio-economic and forest resource characteristics in the rural societies of Kashmir.

Materials and Methods

The study was conducted in district Ganderbal situated at 34°14'0" N and 74°47'0" E at an altitude of 1,619 m above mean sea level in the undulated surface of Kashmir. Multi-stage random sampling technique was employed to select the sample villages and the respondents for the field study. The data on extraction and consumption of small timber and socioeconomic-cum-forest resource characteristics among the rural households were gathered by personal interviews through a well structured pre-tested interview schedule and non-participant observations. Suitable statistical tools like mean (x), frequency (f), percentage (%), correlation (r) and multiple regression (b) were used for data analysis.

Results and Discussion

The average small timber requirement was worked out to be 0.42 m^3 $household^{-1}$ $annum^{-1}$, accounting for a total small timber demand of 47.88 m^3 $annum^{-1}$. Agroforestry alone contributed 42.57% of the total small timber requirement followed by forests (26.09%), homestead forestry (17.05%) and social/ community forestry (14.29%) (Table 1). Total extraction of small timber is about 39.46 m^3 $annum^{-1}$ that is 0.35 $household^{-1}$ $annum^{-1}$. The small timber extracted is mostly consumed in housing and roofing (39.63%) followed by cattle shed/ store house (15.25%), rural furniture/ packing cases (14.75%), agricultural implements (13.25%), fencing (12.50%) and others such as scaffolding/ ladder/ underground cold storage, sports goods, cremation *etc*. (4.62%) in the surveyed population (Table 1).

Table 1: Small timber extraction and consumption in the sample households (n=114)

Extraction			Consumption		
Source	**Quantity (m^3 $annum^{-1}$)**	**Percentage**	**Purpose**	**Quantity (m^3 $annum^{-1}$)**	**Percentage**
Forests	10.29	26.09	Housing/ roofing	18.98	39.63
Agroforestry	16.80	42.57	Agricultural implements	06.34	13.25
Social/ Community forestry	05.64	14.29	Rural furniture/ packing cases	07.06	14.75
Homestead forestry	06.73	17.05	Fencing	05.99	12.50
-	-	-	Cattle shed/ store house	07.30	15.25
-	-	-	Others (Scaffolding/ ladder/ underground cold storage/ sports goods *etc*.)	02.21	4.62
Total	39.46	100%	Total	47.88	100%
Mean±S.E.	0.35±0.01	-	-	0.42±0.02	-

Agroforests and forests jointly contributed 68.66% of the total small timber requirement while the remaining 31.34% of the small timber requirement is fulfilled by social/ community forestry and homestead forestry. There is a considerable pressure on forests for meeting the timber requirement of the local people.

References

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326.

Effect of the Fruit Extract (*Melia azedarach* L.) on Volumetric Srinkage of Nondurable Wood Species

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Keywords: Biopreservative, Fruit extract, *Melia azedarach* L., Non durable wood species, Shrinkage

Introduction

Wood, a hygroscopic material, undergoes dimensional changes in response to varying environmental humidity, i.e. it swells on wetting and shrinks upon drying. The present study was conducted to determine the effect of the fruit extract (*Melia azedarach* L.) on volumetric shrinkage of non durable wood species (*Bombax ceiba* L., *Celtis australis* L. and *Pinus roxburghii* Sargent). The focus of the study was to enhance the dimensional stability in some nondurable wood species and reduce the pressure on durable wood species. The difference in weights and dimensions before and after treatment was taken and further used in the calculation of volumetric shrinkage.

Materials and Methods

The study was conducted in the Department of Forest Products, Nauni, Solan (H.P.). Wood samples of *Bombax ceiba* L., *Celtis australis* L. and *Pinus roxburghii* S. of size 5cm x 2.5cm x 2.5cm±.25cm x.15cm x0.15cm (longitudinally x radially x tangentially) were treated with fruit extract at different concentrations (0.25%, 0.5%, 1%, 1.5% and 2% (w/v)) The experiment was conducted in completely randomized design (CRD) factorial with three replications i.e. $R_{1,}$ R_2 and R_3. The swelling and shrinkage in wood after treatment was observed.

Results and Discussion

The maximum value of 12.24 (3.50) per cent was recorded in S_3 (*Pinus roxburghii* Sargent) and the minimum value of 7.90 (2.81*) per cent was observed in S_1 (*Bombax ceiba* L.)(Table 1). Among the treatments highest value of 10.54 (3.24*) per cent was registered in T_6 (control) and the lowest value of 9.83 (3.12*) per cent was noticed in T_5 (2.00% concentration). The species and treatments interactions were also observed to be significant. The maximum volumetric shrinkage coefficient of 12.31 (3.51*) per cent was recorded in *Pinus roxburghii* Sargent in control which was statistically at par with S_3xT_4 [12.28%(3.51*)]. The minimum volumetric shrinkage coefficient of 7.67 (2.77*) per cent was observed in *Bombax ceiba* L. at 2.00 per cent concentration (Table 1).

Table 1: Effect of extract treatments on volumetric shrinkage coefficient in wood (%)

Treatment	(S_1) *Bombax ceiba L.*	(S_2) *Celtis australis* L.	(S_3) *Pinus roxburghii* Sargent	Mean
T_1 (0.25%)	7.905 (2.812)	10.761 (3.280)	12.168 (3.488)	10.278 (3.193)
T_2 (0.50%)	7.834 (2.799)	10.012 (3.164)	12.224 (3.496)	10.023 (3.153)
T_3 (1.00%)	7.760 (2.786)	9.606 (3.099)	12.256 (3.501)	9.874 (3.129)
T_4 (1.50%)	7.752 (2.784)	9.819 (3.134)	12.282 (3.505)	9.951 (3.141)
T_5 (2.00%)	7.666 (2.769)	9.611 (3.100)	12.207 (3.494)	9.828 (3.121)
T_6 (Control)	8.450 (2.907)	10.872 (3.298)	12.307 (3.508)	10.543 (3.237)
Mean	7.895 (2.809)	10.114 (3.179)	12.241 (3.499)	

*Values in parenthesis are square root transformed values.

327.

Plantation: An Integrated Approach of Resource Management- A Retrospective Study on Chipko Movement

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Keywords: Traditional knowledge, afforestation

Introduction

Chipko Movement was a milestone to raise voice against global plundering of forestry resources. During the last few decades, there has been rapid destruction of forest resources threatening the livelihood of millions of forest-dwellers. Environmental resource managements an issue of increasing concern in socio-political frameworks. This concern has also been addressed by a shift in environmental resource management approaches to incorporate different knowledge systems including traditional knowledge. It has now emerged as a challenging task to manage the valuable forest resources sustainably under ever increasing population pressure. Global warming or climate change is also responsible for causing environmental degradation.

Materials and Methods

This paper is based on perception of the local people, environmental activists and leaders of the movement. A retrospective study on the status of Chipko Movement was carried out. Stakeholders' perception is a powerful tool for policy analysis and has considerable potential in forestry tree plantation programme. It is an approach for understanding a system and relevant changes in it by identifying the stakeholders and assessing their respective interests in that system. Thus, people's perceptions were discerned through participatory discussions covering 100 respondents distributed in different villages like Gopeshwar, Mandal, Reni, Tapovan and Lata which are located in the climax zone (Chamoli district) of the Chipko Movement.

Results and Discussion

The respondents put maximum stress on safeguarding forest (Table 1) and forestry resources. Considering the fragile nature of the soil of Chamoli, the respondents gave emphasis on extensive plantation programme.

Table 1: Perceptions on different issues

Issues	Responses	% of responses
Perception on movement	Protect environment of this region	99
	Beneficial movement	86
	Ecological movement	60
Perception on main issues	Protection of forest	91
	Protection of livelihood	83
	Forest right to local people	77
	Commercialization of forest	56
	Stabilization of Himalayan ecology	51
	Flood control	44
Perception on main challenges	Consistency in plantation	66
	Environmental integrity / harmony	63
	Global warming / climate change	57
	Sustainable development	33
	Stabilization of Himalayan ecology	28
Perception on present activities	Afforestation programme	83
	Save seed movement	10
	Formation of own nursery	5
Views and suggestions	Conservation of seeds	59
	Plantation for stabilization of Himalayan ecology	51
	Species specific forest	37
	Forest right to Forest Protection Committee (FPC)	23
	Comprehensive planning for sustainable development	19

Here, the activists remain engaged in afforestation programme throughout the year. Dasholi Gram Swarajya Mandal (DGSM) took up the plantation programme at least twice in a year. The pioneer of Chipko Movement, Chandi Prasad Bhatt and Sunderlal Bahuguna put stress on plantation programme. Bhatt was worried about the mounting pressure on environment caused by global warming and climate change. Some activists also regarded global warming or climate change is responsible for causing environmental degradation. Such a crisis is not an isolated incident concentrated in the Himalayas but the virus of global warming is a world-wide menace. Consequently, Uttarakhand state had witnessed a significant impact of climate change in June 2013 where unprecedented cloud burst causing massive destruction to life and property.

Everybody advocated the necessity of plantation/afforestation programme. Bahuguna promoted that afforestation programme should be taken to the extent of social movement. Bhatt suggested that the environmentalist of the present generation should take a responsibility of developing forest for each village. Activists also suggest massive plantation programme which will maintain ecological balance. A common scientific concept and impetus behind environmental resource management is carrying capacity which refers to the maximum number of organisms a particular resource can sustain. The respondents recommended employing suitable management programme for natural resources to establish ecological harmony.

328.

Growth and Productivity of Isabgol (*Plantago ovata* Forsk.) Tree Born Oil Seed Based Silvi-agriculture System in Chhattisgarh

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Keywords: Productivity, silvi-agriculture, TBOs, isabgol, intercropping

Introduction

The integration between forestry and agriculture has been adopted in India long before the term Agro-forestry was coined. The production of medicinal plant as part of Agro-forestry systems has not been adequately studied in India, but this holds a large potential to be utilized. Demand for medicinal plants is increasing in both developing and developed countries surprisingly. Cultivation of medicinal and aromatic plants under Agro-forestry system exploratory studies made on inclusion of some medicinal plants in the cropping systems of North-western and Central India has shown that it can improve profitability. However, not much research efforts have gone into this field and it needs a strong research base to identify suitable varieties and ecotypes for different ecological conditions.

Materials and Methods

The experiment was laid out in a randomized block design with twelve treatments and three replications. The twelve treatments included equal quantity of phosphorus and different fertilizer level. The treatments are randomly distributed under alternate wise Tree born oil seeds (*Jatropha curcas* and *Pongamia pinnata*) of one year old plantation spaced at 6 x 3 m between row and tree. The seeds of Isabgol sown in line of 20 cm between lines. Manure and fertilizer application N_1, N_2 and N_3 doses of nitrogen are 108.70 kg/ha, 86.96 kg/ha and 65.22 kg/ha are applied respectively. For K_1, K_2, K_3 and K_4 doses of potash are 50.00 kg/ha, 41.57 kg/ha, 33.33 kg/ha and 25.0 kg/ha are applied respectively. The Morphological observation of plant like, Plant height, No of Leaves, No. of tillers /plant recorded. In post harvest phase, Spike length, Seed test weight, Seed yield, Seed husk yield and plant biomass was recorded.

Results and Discussion

A study entitled "Growth and productivity of Isabgol (*Plantago ovata* Forsk.) under tree born oil seed based Silvi-agriculture system was carried out at Research Farm, Department of Forestry, IGKV, Raipur (C.G.) during Rabi season. The TBO's *Pongamia pinnata* and *Jatropha curcas* were planted in vertisol soil to develop the Silvi-agriculture system. The effect of nitrogen and potash fertilizer on Isabgol crop intercropped with TBO's was studied. The growth characters of Isabgol *viz*. plant height, number of leaves, number of tillers, spike length and tillers height were found maximum under N_2 treatment (86.96 kg/ha) and K_1 treatment (50.00 kg/ha as compared to different level of N and K studied.

On the basis of results it can be concluded that under tree born oil saplings intercropped crop Isabgol gave significant results. The better growths of Isabgol plants and seed yield were found under N_2 (86.96 kg/ha) treatment. This treatment performed best regarding standardization of optimum nitrogen level. The K_4 (25 kg/ha) treatment proved to be the good regarding standardization of optimum potassium requirement. The combination of N and K level proved that the interaction of these two major nutrients were performed superior treatment N_2K_4 (N 86.96 x K 25.00 kg/ha) as shown in Fig. 1. The soil fertility and use of fertilizer from the soil revealed that after harvesting of the crop the N, P, K and organic carbon status were increased except nitrogen in the top layer. This shows that the residual nutrient will be made available to the trees in due course of time which will be significantly increase the growth of the plants and beneficial for the trees.

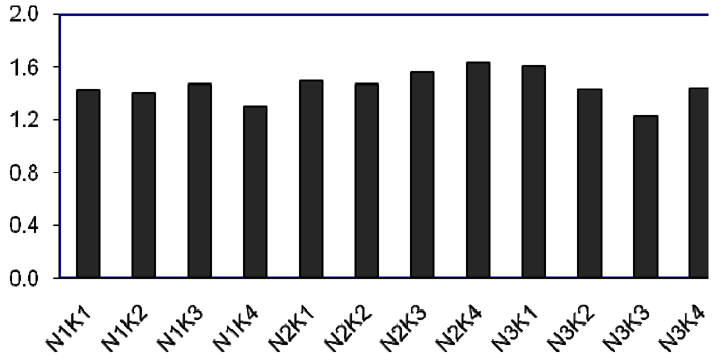

Fig. 1: Effect of fertilizer on Plantago ovate (Forsk.) intercropped under TBO's based silvi-agriculture system.

329.

Growth and Yield Attributes of Wheat and Paddy under *Populus deltoids* Based Agri-silviculture System

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Introduction

Agroforestry which integrates woody and non woody components on the same unit of land to produce more per unit area on sustainable basis, can bridge the yawning gap between demand and supply of the bothwood and food components. *Populous deltoides* is one of the suitable fast growing multipurpose tree species growing under wide spacing accommodating 400 to 500 trees per ha. Its stand density permits enough sunlight, air circulation, and therefore gives better crops yields. This study was therefore, planned to study the effect of different distances from tree base on wheat and paddy performance in *Populus deltoides* based agri-silvicultural system.

Materials and Methods

Seeds of three varieties of wheat (*Triticum aestivum*)) were sown under six year old *Populus deltoides* plantation on 15th November, 2011. However, seedlings of the three rice (*Oryza sativa*) varieties (Sarjooo-52, NDR-359 and Swarna) were raised in well prepared nursery bed during 30th May to 29th June 2012 and transplanted on 30th June. The experiment was laid out in factorial randomized block design with five replications. All cultural practices were adopted as per recommendation for cultivation of wheat and rice. The data on growth, yield attributes and yield characters was analyzed, standard error of mean (SEm±) and the critical difference (CD) were calculated at 5% level of probability.

Results and Discussion

Results revealed that wheat variety HD-2643 grown 0.5m away from tree base produced maximum plant height (90.90cm). Whereas, the maximum number of shoots (m^{-2}), number of grains (per ear) and test weight (1000-grain weight) were recorded in variety NW-1067, when the crop was grown in open condition (control). Wheat grown in alleys at 0.5m, 1.0m, 1.5m and 2.5m distance from tree base produced lower number of shoots (m^{-2}), number of ears (m^{-2}), number of grains (per ear) and test weight(1000-grain weight g) compared to control plot.

Grain yield was significantly influenced by both variety and distance treatment and the interaction between variety and distance also found significant. Our data indicates that the maximum grain yield (2.32tha^{-1}) is for variety NW-1014, which was closely followed by NW-1067(2.30tha^{-1}) in open condition. The maximum straw yield (2.89tha^{-1}) was found in case of variety NW-1014 at 0.5m away from *Populus deltoides* tree base. The variation in yield of different varieties at varies distance from treebase might be due to differential competition for light, soil moisture and nutrients.

In the growth of tree species, there was no significant effect of annual crops on the canopy width and canopy length of perennial woody plant (*Populus deltoides*),whereas the plant height and DBH were significantly increased. At the harvesting stage, the height of both the agricultural crops reduced in the open area. In case of wheat crop the maximum height was recorded in variety HD-2643 and in case of rice it was found in variety NDR-359, when the crops were grown in the whole area including plant basin. Maximum grain yield was recorded in NW-1067 (wheat variety) and in NDR-359 (paddy variety). The number of shoots (m^{-2}), number of ears/ panicle (m^{-2}), grain per ear/ panicle, test weight and grain yield were found to be maximum in control treatment (open area). Whereas, the plant height and straw yield were maximum when crops were grown in whole area including plant basin. On the basis of the yield potential, it may be concluded that NW-1067 was found to be the best variety of wheat under this system. In case of paddy, NDR-359 is a suitable variety in comparison to the other. Among all the three varieties of wheat and paddy, NW-1067 (wheat crop) and NDR-359 (paddy crop) gave better result under *Populus deltoides* based agri-silviculture system.

Table 1: Plant growth for wheat varieties under *Populus deltoides* based agri-silvicultural system

Distance from tree base (m)	Varieties			Mean
	NW-1067	NW-1014	HD-2643	
Plant height (cm)				
0.5	88.56	87.56	90.90	89.00
1.0	86.90	86.56	88.67	87.38
1.5	86.20	85.23	87.24	86.23
2.5	83.90	83.56	86.23	84.56
Control	80.23	78.90	82.32	80.48
Mean	85.16	84.36	87.07	
	Variety (V)	Distance (D)	V × D	
SEm±	0.11	0.14	0.25	
CD at 5%	0.32**	0.41**	0.71**	
Number of grains (grains ear^{-1})				
0.5	25.01	24.67	24.01	24.56
1.0	26.67	25.65	25.01	25.78
1.5	29.01	26.32	26.34	27.22
2.5	30.01	27.67	27.67	28.45
Control	32.34	28.99	30.32	30.55
Mean	28.61	26.66	26.67	
	Variety (V)	Distance (D)	V × D	
SEm±	0.19	0.24	0.42	
CD at 5%	0.53**	0.68**	1.18**	
Grain yield (tha^{-1})				
0.5	1.14	1.15	1.14	1.14
1.0	1.44	1.32	1.28	1.35
1.5	1.99	1.46	1.37	1.61
2.5	2.27	1.74	1.82	1.95
Control	2.30	2.32	2.25	2.29
Mean	1.83	1.60	1.57	
	Variety (V)	Distance (D)	V × D	
SEm±	0.21	0.27	0.46	
CD at 5%	0.59**	0.76**	1.31**	

** Significant at 1% level

Table 2: Plant growth for paddy varieties under *Populus deltoides* based Agri-silvicultural System

Distance from tree base (m)	Varieties			Mean
	Sarjoo-52	NDR-359	Swarna	
Plant height (cm)				
0.5	79.01	96.34	92.01	89.12
1.0	76.34	93.34	90.32	86.66
1.5	76.01	91.01	88.34	85.12
2.5	70.34	91.34	88.67	83.45
Control	65.67	85.34	82.67	77.89
Mean	73.47	91.47	88.41	
	Variety (V)	Distance (D)	V × D	
SEm±	0.37	0.48	0.83	
CD at 5%	1.06**	1.37**	2.37**	
Number of grains (per panicle)				
0.5	179.23	184.00	171.23	178.15
1.0	180.12	185.33	172.22	179.22
1.5	182.34	186.68	173.67	180.89
2.5	182.67	188.34	174.34	181.78
Control	194.33	204.45	186.54	195.11
Mean	183.74	189.76	175.60	
	Variety (V)	Distance (D)	V × D	
SEm±	0.35	0.45	0.77	
CD at 5%	0.98**	1.27**	2.19**	
Grain yield (tha^{-1})				
0.5	1.56	1.58	1.33	1.49
1.0	1.71	1.69	1.54	1.65
1.5	1.87	1.79	1.64	1.77
2.5	1.90	1.99	1.74	1.87
Control	2.21	2.31	2.18	2.23
Mean	1.85	1.87	1.69	
	Variety (V)	Distance (D)	V × D	
SEm±	0.15	0.19	0.33	
CD at 5%	0.43**	0.55**	0.96**	

** Significant at 1% level

330.

Evaluating Fate of *Viscum articulatum* on *Quercus baloot* using Multivariate Quadratic Surface Based Function Predictive Model

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Keywords: Hemi-parasite, *Viscum*, phorophytes, algorithm, prediction

Introduction

Prediction models and mapping of potential suitable habitat of plants has its own significance in restoring populations, introductions, selecting conservation sites and management of natural resources. Predictive modelling of species distributions now represents as an important tool in solving many ecological questions. *Viscum* sp. being a hemi-parasite on trees is responsible for heavy loss in growth rate of its host. During the study *Viscum articulatum* is recorded only on *Quercus baloot* in a forest of about 24 tree species in NW Himalaya. The number of *V. articulatum* individuals on its phorophyte has been predicted using an algorithm developed in MATLAB.

Materials and Methods

Viscum articulatum growing as hemi-parasitic parasite on stems of *Quercus baloot* has been reported in Kellar forest range of Bhadrwah Forest Division in NW Himalaya, India. Data on niche parameters (mountain aspect, bark pH, dbh, WHC and phenols) associated with *Quercus baloot* infected by *V. articulatum* are thought-out to predict the number of individuals of parasite on its phorophyte using multivariate quadratic surface based function (MQSBF) algorithm developed in MATLAB. The estimation of quadratic function has been executed in two different steps namely training phase and testing phase.

Results and Discussion

Study was designed to use the different niche parameters for predicting the number of parasites on its phorophyte. MQSBF algorithm using MATLAB has been developed in such a way that effects of one varied parameter is assessed while keeping other parameters/factors constant. Different niche parameters involved in the prediction of parasites are name of phorophyte (w1), diameter at breast height of phorophyte (w2), mountain aspect (w3), pH of bark of phorophytes (w4), water holding capacity of bark of phorophye (w5) and phenolic contents of bark of phorophyte (w6).

The quadratic function for 06 niche parameters has been denoted as:

$$\begin{aligned}(w_1 + w_2 + w_3 + w_4 + w_5 + w_6)^2 = {} & c_0 + c_1 w_1 + c_2 w_2 + c_3 w_3 + c_4 w_4 + c_5 w_5 + c_6 w_6 \\ & + c_7 w_1^2 + c_8 w_2^2 + c_9 w_3^2 + c_{10} w_4^2 + c_{11} w_5^2 + c_{12} w_6^2 \\ & + c_{13} w_1 w_2 + c_{14} w_1 w_3 + c_{15} w_1 w_4 + c_{16} w_1 w_5 + c_{17} w_1 w_6 \\ & + c_{18} w_2 w_3 + c_{19} w_2 w_4 + c_{20} w_2 w_5 + c_{21} w_2 w_6 + c_{22} w_3 w_4 \\ & + c_{23} w_3 w_5 + c_{24} w_3 w_6 + c_{25} w_4 w_5 + c_{26} w_4 w_6 + c_{27} w_5 w_6\end{aligned}$$

where C0, C1………..C27 are the coefficients which are estimated from equation which depicts the relation between niche parameters and number of parasites.

Quadratic relation of MQSBF algorithm estimated young age (low dbh) of the phorophyte as important factor for the luxuriance of the parasite and vice versa. The age of the phorophyte is responsible for regulation of number of other parameters like water holding capacity of bark, bark pH and phenols, however the most preferred mountain aspect for the luxuriance of the phorophyte on young individuals is western slope which is mostly a shady area.

331.

Statistical Investigation on Pure Stands of *Pinus roxburghii* in Himachal Pradesh

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Keywords: *Pinus roxburghii,* volume, variability

Introduction

Pinus roxburghii is one of the six pines of India. It is a tall tree with long clear straight bole usually reaching 30 m in height. Chir pine provides a variety of wide ranged goods and services to the people. It is a popular timber of North India, especially in hills and is used for various purposes including house building, as rafters, poles and posts, railway sleepers and in the manufacture of pulp and paper. Keeping in view the economic importance of the species, a statistical investigation on pure stand of *Pinus roxburghii* was carried out at Nauni-Solan, Himachal Pradesh.

Materials and Methods

Data on *Pinus roxburghii* was collected from the State Forest Department, Solan. Solan forest division was divided into three altitudinal ranges i.e. up to 1200 m amsl, 1200-1400 m amsl and above 1400 m amsl. Ten compartments of pure stand of *Pinus roxburghii* was considered from each altitudinal range. Trees on each compartment was divided into different diameter classes and data from all selected compartment on Area, Number of trees in each diameter class, Volume of tree in each diameter class was collected. Variability analysis for number of tress in different diameter class and altitudinal range was performed.

Results and Discussion

Mean volume of *Pinus roxburghii* was found to be maximum in III altitudinal range i.e. 3477.093 m^3 with 95% fiducial limits 1788.88-5165.30 $m^{3.}$ In altitudinal range I, the mean volume was 1782.33 m^3 with 95% fiducial limits 481.46-3083.19 m^3 and in altitudinal range II, mean volume was 1676.02 m^3 with 95% fiducial limits 631.99-2308.01m^3. Variance was calculated for each range with respect to volume. Maximum variance was found to be in altitudinal range III followed by altitudinal range I and II. Bartlett chi-square test was applied to test the homogeneity of variances among the ranges for volume. The result were significant indicated that there were significant different for variance among the ranges with respect to volume. Trees were divided into different diameter classes and volume showed increasing trend with respect to increase in Diameter class.

Table: Altitudinal Range wise Variability Analysis

Altitudinal Range	Mean Volume (m^3)	Standard Deviation	Fiducial limits
Upto 1200m (I)	1782.33	2968.17	481.46-3083.19
1200-1400m (II)	1676.02	1477.63	631.99-2308.01
Above 1400 (III)	3477.09	5379.02	1788.88-5165.30

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Statistical Investigations on Resin Yield Extracted from Chir Pine (*Pinus roxburghii)* Under Mid Hill Conditions of Himachal Pradesh

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Keywords: Resin, Diameter at breast height.

Introduction

Pinus roxburghii (Chir pine) yields a good quality oleo resin, which on steam distillation generates two industrially important products namely turpentine oil and rosin. Turpentine oil holds a wide variety of industrial uses in perfumery industry, pharmaceutical preparations, synthetic pine oil, disinfectants and denaturants. Rosin is extensively used in many industries namely soap, paper, detergents, cosmetics, paints, varnishes, rubber and polish industries. The yield of the oleoresin is affected by number of factors such as diameter, tree crown, growth rate, time of tapping, stimulants, depth of borehole, various anatomical characters like diameter of resin duct etc. Study of anatomical characters of each tree is very difficult to conduct in the field, particularly while dealing with large number of trees, so it is necessary to construct a method which allows us to know the high resin yielder on the basis of morphology.

Materials and Methods

The present investigation entitled, "Statistical investigations on resin yield extracted from *Pinus roxburghii* under mid hill conditions of Himachal Pradesh" has been carried out at University area under, Department of Forest Products, Dr Y S Parmar University of Horticulture & Forestry, Nauni, Solan Himachal Pradesh. Random samples of 146 mature *Pinus roxburghii* (chir pine) trees were selected. Secondary data on resin yield was taken from Department of Forest Products, and data was collected primarily for recording the diameter at breast height.

Trees were divided into 7 diameter classes.

Mean, standard deviation, confidence interval and coefficient of variation was calculated to develop the relationship between diameter and resin yield.

Results and Discussion

According to Table 1, the mean resin yield showed increasing trend with respect to diameter classes. The diameter at breast height was found significantly and positively correlated with resin yield. As coefficient of variation is minimum for diameter class 50-55, it is the most Consistent diameter class. As coefficient of variation is maximum for diameter class 65-70, it is the most variable diameter class.

Table 1: Resin yield statistics for different diameters.

Diameter (cm)	Mean yield in (gram)	Standard deviation	Coefficient of variation	Confidence interval	
30-35	202.4637681	168.3759431	120.2450685	162.7344083	242.1931
35-40	216.2540717	209.9100506	103.0222569	192.7728809	239.7353
40-45	292.6687117	237.4441339	123.2579246	256.2165142	329.1209
45-50	429.6666667	367.1053849	117.0417772	322.4059808	536.9274
50-55	430	437.3012776	98.33037816	314.4272432	545.5728
55-60	433.5	349.9032833	123.8913782	325.0638491	541.9362
65-70	584	411.4867912	141.9243612	436.7513429	731.2487

333.

Development of Regression Equation to Predict Foliage Biomass for *Albizia lebbeck* (L.) Benth. Tree in Elobied, Sudan

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Keywords: Prediction of foliage biomass, regression equation

Introduction

Dry land degradation is one of the most serious resource management problems facing the world today. The dry lands are rapidly being degraded through population growth, overgrazing, cropping of marginal lands, inappropriate irrigation and, not least, deforestation. The variation of climatic zones and different soil types is reflected in the main economic activities of the inhabitants in the study area, which are based on integration of agriculture and animal production (IFAD, 2002).

Materials and Methods

The study was conducted in Elobeid city, Shekan locality, North Kordofan State (29°.35 -30°.30) E and (12°.25 -13°.45)N during 2013-2014. Parameters ware measured such as Diameter at Brest height, foliage production, crown diameter of tree. Samples of trees were selected from 20 Trees of *Abizzia lebbeck* randomly, foliage was collected from two branches (one from the lower and one from the upper part of each tree's crown). Data were analyzed used to develop equations predicting foliage using SPSS 16 Package.

Results and Discussion

The foliage biomass was related to some growth parameter such as stem diameter at breast height (DBH), and crown diameter that were measured for each tree. The foliage biomass samples were calculated as tone/hectare. The estimated foliage biomass was correlated to the growth parameters measured. Regression equations were developed between the estimated foliage biomass and those growth parameters of the tree. The results indicated that trees in foliage production was (19.06) tone per hectare and high correlated with stem diameter ($R^{2=}$0.15) Fig. (1) and least correlation was observed between foliage and crown diameter($R^{2=}$0.06) Fig. (2). It is concluded that foliage biomass was correlated between stem diameter developed best regression equations for foliage estimation for *Albizzia lebbeck* tree in Elobeid. The study revealed that best equation to predict foliage biomass was: y= 0.165 DBH+0.609. Where y= production of foliage biomass production, while DBH=Diameter at breast height Fig. (2). The study concluded that strong relations ship between growth parameters and production of foliage from trees, Therefore it was recommended that more research be carried out in different location where this tree species is grown in different areas of the country.

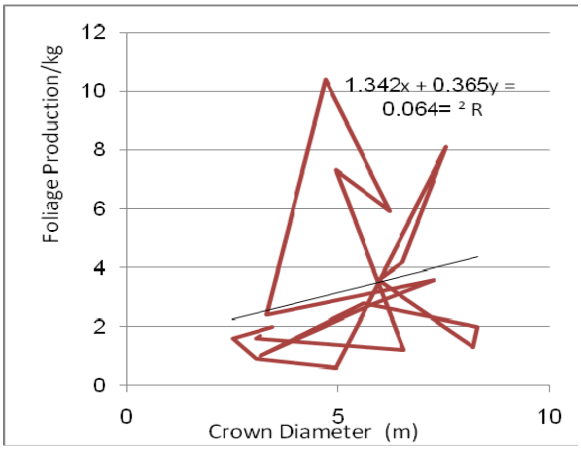

Fig. 1: Relationship between crown diameter and foliage production

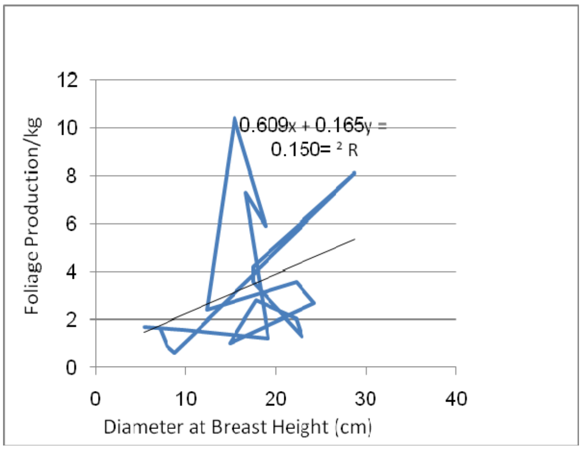

Fig. 2: Relationship between stem diameter and foliage production.

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334.

Role of Financial Inclusion amongst Weaker Sections in Promoting Tree Farming

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Keywords: Financial Inclusion, Kerala, Small and marginal farmers

Introduction

Small and marginal tree farmers - important weaker section in terms of contribution to production and in priority sector lending. Exclusion of such farmers from both formal / informal financial services is a cause for concern. Being a long term enterprise financial backing is necessary to empower the small and marginal farmers to venture into tree farming. Kerala has been recognised as a financially inclusive state, yet farmers there are yet to derive full benefits. The attempt here was to analyse the extent and nature of financial inclusion among small and marginal tree farmers and role of financial intermediaries in expansion of financial inclusion.

Materials and Methods

Primary data was collected by survey of 100 such tree farming households of Perumkadavila Panchayat in Thiruvananthapuram District (Kerala), India. The secondary data is from Reserve Bank of India, National Bank for Agriculture and Rural Development etc. Collected data was analysed with percentages and indices. The Financial institutions were ranked on the basis of index.

Results and Discussion

The major trees under given agro-ecological situation were Rubber (*Hevea brasiliensis*), Coconut (*Cocos nucifera*), Arecanut (*Areca catechu*) etc., with Rubber being the most profitable of them all. All the surveyed tree growers have bank accounts. The farmers hold bank account in a commercial or a co-operative bank. 10 banks are having their banking operations in the panchayat but Indian Overseas Bank is the only commercial bank which is having its branch office in the panchayat, where 90% of the farmers had account. Hundred percent of the accounts are savings bank account. Only 15% of the farmers had account with cheque facility. Primary consideration for selection of said bank is proximity from residence (Fig. 2). More than 50% of the farmers had a bank within 5 to 10 km and 40% had one in less than 5 km. It was found that 40% each of the farmers have deposits below Rs. 5000 and between Rs. 5000 and Rs. 25000 (Fig. 1). Seventy five percent of the farmers did open the bank account on their own initiative. Sixty five percent of the farmers had opened bank account to avail loans. Ninety per cent of the respondents were not regular in making deposits in the bank. Almost all of the farmers are aware of agricultural loan, gold loan and educational loan (Table 1). Survey revealed that only 30% of the farmers are having ATM card and that none of the respondents have credit cards. Sixty five per cent of the farmers do not have any financial asset holdings and Investments in chit are the only financial asset class held by the 35% farmers. It was found that 90% of the farmers/ family members were members in Self Help Groups (SHGs). It was found that all the farmers have developed savings habit after joining the SHGs. When 40% of the farmers had availed loans once, 26.5% had availed twice and 20% have availed thrice. It is evident that 60% of the farmers have taken Kissan Credit Cards (KCC), hundred percent of KCC holders who availed loan through the KCCs were of the opinion that KCC is the best agricultural delivery mechanism, satisfied with the co-operative behaviour of the bank employees, interest rate of KCC and subsidy for prompt repayment of loans. Another notable observation was the fact that none of the farmers have insured their crops.

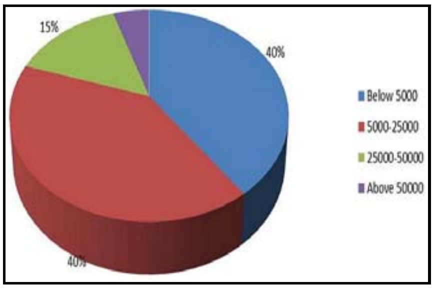

Fig. 1: Deposit of Farmers in Bank

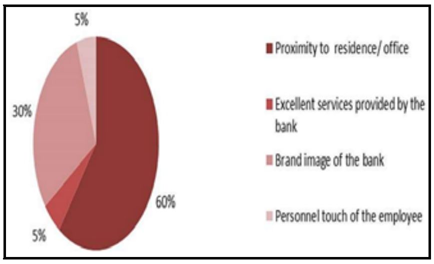

Fig. 2: Motive for selecting specific Bank

Table 1: Indebtedness among Farmers

Nature of Indebtedness	Farmers (%)
A) Agricultural Loan	25
B) KCC Holders	62.5
Mortgage Loan	--
Gold Loan	12.5

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335.

Socio-economic Dynamics of Forest Resources Extraction in Tribal Societies of Jharkhand, India

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Keywords: Socio-economic dynamics, forest resources, extraction, tribes, Jharkhand, India.

Introduction

Dependency of tribal households on forest resources and their socio-economic implications have become an important topical issue in developing economies. The forest resources play a central role in the socio-economic, cultural and political systems of tribal societies, and the entire lives and livelihoods of these people revolve around forests and forestry (Maske *et al.*, 2011). Understanding the relationship between people's forest resources based livelihoods and socio-economic implications in rural areas can help policy makers design and implement effective strategies for poverty alleviation, livelihood improvement, conservation and sustainable forest resources use. The current study investigated the dependency on forest resources for livelihood and food security and their socio-economic determinants in tribal households of Bundu block in Ranchi, Jharkhand, India.

Materials and Methods

The study was conducted in Bundu block of Ranchi district situated between 23°11'- 23°18' North latitude and 85°35'- 85°58' East longitude at an altitude of 337 meters above MSL in Chhotanagpur plateau of Jharkhand. Multi-stage random sampling technique was employed to select the villages and the tribal households. Personal interviews, direct observations, semi-structure interview with key informants and focus group discussion were the techniques used for data collection. The logistic regression model used for prediction of forest resources extraction was as follows: Y= a1 + b1x1 +b2x2 +…………..+b12x12

Where, Y= Forest resources extraction
a= constant or intercept
b1-b12$_{=}$ regression coefficients and
x1-x12$_{=}$ explanatory variables

Results and Discussion

The results indicated that the timber fetched highest earning per annum (Rs. 358400) among tribal households which was followed by cottage industry (Rs. 308500), fruit (Rs. 105981), fuel wood (Rs. 89600), tooth brush (Rs. 67200), fodder (Rs. 64000), *mahua* flower (Rs. 56760), oilseed (Rs. 52924), vegetable (Rs. 33885) and forest medicine (Rs. 6900) (Table 1). The average income earned from forest resources in the sample households was Rs. 6977 household^{-1} annum^{-1}. The forest resources play an important role in the livelihood support of tribal and forest dwellers in terms of subsistence, income and employment generation. The tribal people possess the traditional skill base, have access to the resource base and have supportive government policies on forest resources management and trade.

Table 1: Forest resources extraction in tribal households (n=164)

Forest resource		Households involved in collection	Collection (kg annum^{-1})	Consumption (kg annum^{-1})	Households involved in marketing	Sale (kg annum^{-1})	Rate (Rs. kg^{-1})	Income (Rs. annum^{-1})
Fuel wood		164 (100)	326.08$^{\Delta}$	598.60$^{\Delta}$	28 (17)	17.92$^{\Delta}$	5.00	89600
Fodder		162 (99)	1396.86$^{\Delta}$	2824.55$^{\Delta}$	20 (12)	12.80$^{\Delta}$	5.00	64000
Timber[a]		164 (100)	58.41$^{£}$	56.78$^{£}$	14 (9)	31.00$^{£}$	400 pole^{-1}	358400
Cottage industry	Sal leaf plate	81 (49)	56.05$^{\infty}$	4.05$^{\infty}$	16 (10)	52.00$^{\infty}$	0.32 plate^{-1}	208000
	Lac	67 (41)	670.00	0.00	67 (41)	670.00	150.00	100500
Fruit	Fruits (kg)	115 (70)	12533.50	3915.50	21 (13)	8618.00	5.00-20.00	102990
	Bel (No.)	30 (18)	1147$^{\Omega}$	150$^{\Omega}$	08 (5)	997.00$^{\Omega}$	3.00 Ω^{-1}	2991
Vegetable		121 (74)	4397.00	1260.00	31 (19)	3137.00	10.00-25.00	33885
Oilseeds		115 (70)	3220.00	345.00	108 (66)	2875.00	10.00-150.00	52924
Forest medicine		11 (7)	84.00	0.00	08 (5)	84.00	50.00-140.00	6900
Tooth brush		164 (100)	10656§	3936§	14 (9)	6720§	10.00§$^{-1}$	67200
Mahua flower		132 (80)	6666.00	990.00	115 (70)	5676.00	10.00	56760
Total		-	-	-	-	-	-	1144150
Average		-	-	-	-	-		6977

Figures in parentheses show percentages. Δ= tonne, £= m^3, ∞= lakh pieces, Ω= pieces, §= bundles. a Volume of timber= 0.0346 m^3.

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336.

Plus Tree Selection and Progeny Testing of Burma Dek (*Melia composita* Willd.)

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Keywords: Candidate plus tree, Burma dek, substantial variability, progeny

Introduction

The study was conducted to select the plus tree and progeny testing of *Melia composita* Willd. The main focus of the study was to collect genetically superior plus trees for genetic improvement of this versatile tree species so as to obtain a better planting material to fulfill the demands of different wood based industries. The study also aims to provide genetically superior genotypes to the farmers so that he would be able to earn good economic returns.

Materials and Methods

Intensive survey was conducted in different agroclimatic regions of Haryana, Punjab, Uttarakhand and Himachal Pradesh to select the plus trees of Burma dek in February and March 2013. The selection was made on phenotypic assessment of desirable characters of economic interest such as stem straightness, self-pruning ability; clear bole height, low branching habit, disease resistance, etc. A total of 24 morphologically superior trees (plus trees) were selected based on different morphological parameters. A sufficient amount of good quality ripened fruits was collected from these trees. For each plus tree progeny, 400 polythene bags (22 x 10 cm size) having equal proportion of farm yard manure (FYM): dune sand: clay ware arranged randomly in four blocks. Two seeds were sown in each bag during the 2nd week of March 2013. The observations on field emergence (%), seedling height, basal diameter, clear stem height, no. of branches per seedling and root shoot ratio were recorded at regular intervals.

Results and Discussion

The data on morphological traits of selected plus trees are presented in Table 1. It was observed that the height of trees ranged from 5.2 m to 17.5 m with an average height of 9.2 m. The assession MCP1 from Punjab was observed to have the maximum height of 17.5 m while minimum height was observed for MCBI1 assession from Bithmera, Haryana. MCPN1 assession from Pantnagar, Uttarakhand was recorded to have maximum clear bole height i.e. 10.2 m while minimum was recorded for MCS4 assession (Solan, Himachal Pradesh). Selected trees in the present study had fairly good straightness, compact crown and clear bole up to 60% of the total height. Association of different morphological characteristics of selected plus tree was studied. From the correlation studies, it was observed that straightness had positive and highly significant association with clear bole height (r= 0.522) of the tree. It was also observed that the age of the tree had a highly significant and positive association with the height, clear bole height and girth at breast height (GBH) of the tree while the height had a highly significant and positive correlation with clear bole height, GBH and height: GBH ration but had a highly significant but negative correlation with clear bole: total height ratio. The progeny performance of MCPN1 from Uttarakhand was found extraordinarily well with higher values for field emergence, total height, clear height and basal diameter and root shoot ratio. The findings of the present study may be helpful in identifying candidate plus trees in a scientific manner by taking into account the objectives as well as subjective assessment of the parameters in a simple and systematic way. Also, one can easily identify the best individuals or laying out the progeny trails and multi locational clonal trails.

Table 1: Morphological characters of selected Plus trees of *Melia composita*

Assession code	Geographical source	Latitudes & Longitudes	Age (yrs)	Height (m)	Clear bole height (m)	GBH (cm)	Clear bole: total height ratio	Height: gbh ratio	Height of crown (m)	Straightness (Visual index)
MCS1	Himachal Pradesh	30°50' N and 77°11'30" E	3	7.2	3.2	82.2	0.44	0.08	4.0	2
MCPN1	Uttarakhand	29°N and 79.29°E	7	16.5	10.2	60.3	0.62	0.27	6.2	3
MCBI1	Haryana	29°33'0" N and 75°56'0" E	3	5.2	2.5	33.1	0.47	0.15	2.7	2
MCBI2	-do-	29°33'0" N and 75°56'0" E	3	6.5	3.2	45.2	0.50	0.14	3.2	1
MCBI3	-do-	29°33'0" N and 75°56'0" E	3	5.2	3.0	47.4	0.57	0.11	2.2	4
MCBI4	-do-	29°33'0" N and 75°56'0" E	3	8.2	2.5	50.3	0.30	0.16	5.7	3
MCBI5	-do-	29°33'0" N and 75°56'0" E	3	8.2	4.2	51.4	0.51	0.16	4.0	2
MCP1	Punjab	30°65'N, and 75°69' E	8	10.0	3.2	90.9	0.40	0.10	6.7	4
MCP3	-do-	24°20' N and 72°44 E	3	8.5	3.5	26.4	0.41	0.32	5.0	1
MCP5	-do-	24°20' N and 72°44 E	5	9.5	3.5	116.1	0.36	0.08	6.0	4
MCP6	-do-	21°39'N and 73°43 E	3	7.5	2.5	62.1	0.33	0.12	5.0	2
MCP7	-do-	21°39'N and 73°43 E	7	17.5	8.7	185.5	0.49	0.40	8.8	5
MCP10	-do-	30°42'N and 75°18' E	4	8.5	3.2	79.2	0.38	0.10	5.2	1
MCP11	-do-	30°42'N and 75°18' E	3	10.2	4.2	81.2	0.41	0.12	6.0	2
MCP12	-do-	30°42'N and 75°18' E	5	11.7	5.0	131.2	0.42	0.08	6.7	3
MCP14	-do-	29°43'N and 76°13' E	3	8.2	6.5	50.4	0.78	0.16	1.7	4
MCP15	-do-	29°43'N and 76°13' E	3	7.5	6.2	45.7	0.83	0.16	1.2	5
MCPAU1	Punjab	30°90'N and 75°81'E	4	12.2	4.7	80.2	0.38	0.15	7.5	4
MCPAU2	-do-	30°90'N and 75°81'E	4	11.2	3.2	78.4	0.28	0.14	8.0	3
MCPAU3	-do-	30°90'N and 75°81'E	4	12.5	4.5	79.1	0.36	0.15	8.0	4
MCPAU5	-do-	30°90'N and 75°81'E	3	7.5	4.5	54.7	0.60	0.13	3.0	3
MCK1	Haryana	29.96°N, 76.83°E	5	8.5	2.7	76.3	0.32	0.11	5.7	2
MCK2	-do-	29.96°N, 76.83°E	3	7.5	3.5	46.2	0.46	0.16	4.0	1
MCB1	Punjab	30°10' N and 75°09' E	5	6.2	2.5	95.4	0.40	0.06	3.7	3
Range				5.2-17.5	2.2-10.2	26.4-185.5	0.28-0.83	0.06-0.40	1.2-9.5	1-5
Mean				9.2	4.1	74.8	0.44	0.14	5.1	2.8

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Studies of Soil Microbial Diversity and Physiochemical Properties of Tropical Humid Plantation in Western Chhattisgarh

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Keywords: Microflora, topsoil, soil bacteria, fungi, soil enrichment.

Introduction

Studies were conducted during the during 2014 January to January 2015 plantations raised in Tropical Humid Plantation in Bilaspur, Western Chhattisgarh to measure the diversity of culturable bacterial and fungal communities and Physicochemical properties. Three different Plantation namely *Peltophurm ferruginium Dalbeargia sisoo Eucalyptus globulous*. Physio-chemical prosperities of soil under tree plantations and their effects on soil microflora were studied. The plant species growing on the soil also equally influence the population and species composition of the soil fungi. Fungi and bacteria play a focal role in nutrient cycling by regulating soil biological activity. However, the rate at which organic matter is decomposed by the microbes is interrelated to the chemical composition of the substrate as well as environmental condition.

Materials and Methods

Soil sample were collected randomly from 10-15 places for each site(15cm depth) plantation of three species *Dalbergia sisso, Peltophorum ferruginium, & Eucalyptus globules.* Samples were mixed thoroughly, sieved(<2mm)and separated into parts; one part was air dried while the other was kept in sterilized polythene bags in field moist condition. Soil pH was determined by Potentiometer method. Organic carbon was determind by Walkley and Black's rapid titration method.Total N by using Kjeldahl digestion method and total P was estimated after Hclo4 digestion method. Available N was determined by steam distillation using devendra alloy and available P by ammonium molybdate-stannous chloride method. Available potassium in soils by flame photometer. Soil microbiological studies isolation and enumeration of bacteria and fungi from soil was done by the serial dilution-agar plating method. Fungal colonies were developed on Czapek-Dox agar medium. The numbers of colonies were calculated from each plate through ocular estimation.

Results and Discussion

Organic carbon percentage was found to be 57 mg/ha^{-1} for *Peltophurm ferruginium* whereas *Dalbergia sisso* and *Eucalyptus globulous* showed low level of organic carbon 48 mg/ha^{-1} and 39 mg/ha^{-1} respectively. N content of *Peltophurm ferruginium* contained 370.8 mg/ha^{-1} of N which is supposed to be of medium level and the remaining two species (*Dalbergia sisso* & *Eucalyptus globulous*) having low N content i.e., 230.7 and 215.5 mg/ha^{-1} respectively. The Phosphorus content *Eucalyptus globulous* were high level 15.1 mg/ha^{-1} whereas sample *Peltophurm ferruginium* has low content of Phosphorus12.3 mg/ha^{-1}. *Peltophurm ferruginium* showed higher content of K 445.6K mg/ha^{-1} and the other two species *Dalbergia sisso* 267.7 mg/ha^{-1} and *Eucalyptus globulous* 280.7 mg/ha^{-1} had relatively low values. In Bacterial colonies Dilution number 10^2 of *Eucalyptus globulous* showed the maximum number of bacterial colonies (5.38x10^2) whereas sample *Peltophurm ferruginium* has least number of colonies (7.5x10^2) on comparing the other dilution sample of *Dalbergia sisso* and *Peltophurm ferruginium* the trend was decreasing order. Fungal colonies *Dalbergia sisso* had greater number of fungal colonies 7.3x10^2 growing in each dilution as compared to *Peltophurm ferruginium* and *Eucalyptus globulous* 2.3x10^2, 2.9x10^2. The study concludes that it is very important to study the microbial population not only for basic scientific research but to understand species composition nutrient recycling for enrichment of degraded land.

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Opportunities and Constraints in Way of Biosaline (Agro) Forestry for Enhancing Efficiency of Marginal Landmasses

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Introduction

Biosaline (agro) forestry is an alternative landuse option for reclaiming salt affected soils by using the qualities of salt tolerant species combined with improved soil and water management practices. Conventional agriculture on severely salt-affected land is generally not economically viable because agricultural crop yields are low and physical remediation of the salts is very expensive. However, forestry and agroforestry systems on salt-affected soils may be an effective alternative land use option. Worldwide, approximately one billion hectares (Wicke *et al.,* 2011) and 6.75 million hectare area in India (Mandal *et al.,* 2010) are salt affected lands. The only option to bring such lands under serviceable functions through biosaline (agro)forestry. On the other hand, it is not possible to meet the demand of inflated population about tree and its products only from forest areas and there is need to bring more areas under trees. In logistic sense, it is not feasible to convert such fertile lands into trees based systems because feeding the population is the priority. The objective of the article is to discuss some useful models and dealt upon the various issues of opportunities and constraints coming in the way of biosaline (agro)forestry to make it more realistic and practical in the time when the world is experiencing the visible challenges of climatic adversities.

Materials and Methods

The ICAR-Central Soil Salinity Research Institute, Karnal, Haryana (India) is exclusively devoted to the reclamation of salt affected soils and poor quality water. The institute has done various breakthroughs in the past by transforming the life of farming communities facing the problem of salinity. The models suited as per the type of salt affected categories are illustrated in the present paper. The models based on economic tree species are under testing by the institute and discussed on the aspects like reclamation and productivity of the area. The efforts were also made to find out the various opportunities and constraints coming in the way of biosaline (agro) forestry. The information gathered from the combo pack of literature in referred research journals, reports of research institutions and informal discussion with the farming community.

Results and Discussion

Biosaline (agro-forestry) seeks to change the problem of salinity into an opportunity. It uses the productivity of plants capable to grow under saline conditions that is beyond the category of classical crops and halophytes. The cultivation of trees besides reclaiming of such lands also provides biomass and fodder and open the window for introduction of salt tolerant under crops namely food, fodder, medicinal and aromatic plants. The earlier recommended models by ICAR-Central Soil Salinity Research Institute as per the type of salt affected soils are as given Table 1.

Table 1: Models developed for salt affected soils by ICAR-CSSRI, Karnal, Haryana (India)

Name of model	Tree component	Under crop(s)	Remarks
Silvi-pastoral models for highly alkali soils	*Prosopis juliflora*, *Acacia nilotica* and *Tamarix articulata*	*Leptochloa fusca*, *Chloris gayana*, *Brachiaria mutica* and species of *Sporobolus* & *Panicm*	After four years palatable fodder species (*Trifolium resupinatum*, *Trifolium alexandrium* and *Melilotus parviflora*) were grown successfully. This system found to improve the soil to greater extent after 6 years.
Partial reclaimed soils	*Populus deltoides*, *Eucalyptus tereticornis* and *Acacia nilotica*	Rice-wheat, *Panicum maximum*, *Avena sativa*, Cowpea, pigeon pea/sorghum, mustard	Soil amelioration order Acacia>poplar>Eucalyptus>sole crops
Saline water logged soils	*Acacia farnesiana, Parkinsonia aculeata, Prosopis juliflora, Salvadora persica, Salvadora oleoides* and *Tamarix spp.*	*Fodder grass-Panicum, Cenchrus, Bracharia* Medicinal plants-Plantago ovate, Mentha, Aloe, Ocimum Aromatic plants- Cymbopogon, Periwinkle Flowering plants- Stock, Antirrhinum, Sweet William, Canditurt, Calendula, Marogold, Dahlia, Ornamental mustard	

Biosaline (agro)foresty models under testing by ICAR-CSSRI, Karnal (Haryana):

Model 1:

Trees: *Eucalyptus tereticornis* (clone 413) and *Melia composita*

Under crops: Pearl millet and mustard

Model 2:

Trees: *Eucalyptus tereticornis* (clone 413), *Melia composita, Azadirachta indica, Dalbergia sissoo, Terminalia arjuna*

Under crops: Medicinal and aromatic plants (*Aloe barbadensis* and *Cymbopogon citrates*)

Both the models are in initial stages but the trends are quite encouraging. The main opportunities are controlling soil salinity and sodicity, biomass production and reduction in the rate of soil degradation processes, improvement in salt affected soils, development of new & innovative approaches offering agronomic opportunity, production from areas not suitable for traditional agriculture, improving the yields of agriculture crops intolerant to water logging through positive effect of trees on water infiltration & soil moisture retention, retrieving the nutrients below the rooting zone of the crops and above all carbon moderation provides carbon credits. The constraints identified are as biosaline (agro)forestry is insufficiently investigated, the cost of establishment of suited system to such soils is high, invasiveness of salt tolerant species especially exotics, more research is needed to quantify bio-drainage may result in salt accumulation underneath the plantations, brackish water irrigation cause severe salinity problem, little information about the economic performance of the existing systems, low yield, limited tree species for such areas, gap between technology developers and stake holders, less applicability of the developed systems due to local factors and to avoid direct & indirect landuse changes in the existing systems to address the environmental & social consequences of the area. The study also advocates that there is lack of weightage to agroforestry in general as a landuse system than agriculture and forestry. The global community is realizing that agroforestry is the viable tool to address the present day problems.

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Studies on Screening of Maize Genotypes against *Chilo partellus* L. (Swinhoe)

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Keywords: Maize genotype, screening, insect damage

Introduction

Maize plant is attacked by 140 species of insects causing varying degree of damage. Out of these, only 10 species cause serious damage from sowing till storage, of which the stem borer, *Chilo partellus* (Swinhoe) is the most notorious pest, and causes heavy damage to maize crop in Asia and Africa (Kumar, 1997). Keeping in this view, use of eco-friendly approaches such as resistant varieties can be considered as safest and best management option.

Materials and Methods

The present studies were conducted on the agricultural farm of the Institute of Agricultural Sciences, BHU, and Varanasi during *Kharif* of 2011-2012 to screen the relative resistance/susceptibility of 82 genotypes of maize to the insect pest, maize stem borer (*Chilo partellus*). Five plants were randomly selected from each line of genotype.

Results and Discussion

The range of leaf injury rating was 1.8 to 4.6. Studies revealed the average LIR of these genotypes were 1.8, 1.8, 1.9 and 1.9; respectively Rest of the genotypes had leaf injury rating between 2 to 4.4. The performance of the some genotype was far better than susceptible one.

This resulted in very less dead heart symptom. Some genotype like CMH08-287, CMH08-337, JH 12157, BIO 9637, and HM 8 (C) had no dead heart symptom but more than one fourth of the sampled plants of genotypes, HQPM-22, EC-3161, PFMH-96 N46, HM 9(C), were suffering from such type of damage. Average yield of these genotypes were 10.49, 17.10, 18.04, 21.16, 22.99 and 23.32. q/ha, respectively. Rest of the genotypes had yield between 25.62 and 57.87 q/ha the performance of the some genotype was far better than susceptible one.Maximum occurrences of dead heart were in genotypes HQPM-22 and EC-3161. The mean leaf injury rating was recorded between 1.8 and 4.6 genotype. Maximum leaf damage was reported on genotype MHQPM-09-5. Minimum damage of leaf was reported on genotype CMH08-282 and NMH-713. Maximum yield was reported from genotype KNMH401061. Minimum yield was reported from genotype HM 9 (C).

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Improved Governance leads to Restoration and Protection of Pasturelands: Experience of Ajmer Commons Initiative in Rajasthan

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Keywords: Pasturelands, improved governance, livestock-based rural economy

Introduction

Commons or common property resources (CPRs), especially pasturelands, in villages of Rajasthan are still the mainstay of livestock-based rural economy. The commons primarily perform the functions of ecological restoration and sustainable livelihoods. The sharp decline in the ecological profile or common lands and the areas under pasturelands has been witnessed in entire country, with the proportional decay in Rajasthan too, where there is largest size of landmass under this category. Conservation and protection of commons is primarily required to halt further degradation of the natural resources in the pasturelands.

Materials and Methods

With the review of existing literature and documents available with FES Prakriti Karyashala Rural College, the method of case study research has been adopted to develop this paper. The case study research was conducted during November-December 2015, keeping in consideration the planned interventions were made over a period of nearly two years.

Results and Discussion

Even if the development of commons is pursued by using eco-restoration approach, there is still a need of conservation and protection of the commons. Without proper claiming and securing process by involvement of dependent communities, even the developed commons can be degraded, defragmented and possessed illegitimately. With this approach, the FES Prakriti Karyashala Rural College launched Ajmer Commons Initiative in early 2014 in nearly 1000 villages of entire district. About 50,000 hectares of pasturelands, out of over 100,000 hectares in entire district, have been addressed under the Initiative. Mapping, capacity building of elected panchayats, formation and facilitation of local institutions, strengthening institutionalization process, evolution of community bylaws, soil and water conservation, equitable sharing of benefits, and developing community-led protection systems along with secure tenures are some grounded measures taken up in 920 villages till end 2015. Present paper examines elaborately as to how the right mode of capacity building leads to institutionalization process and secured tenure of pasturelands, and how democratization of gram panchayats in relation to commons governance and evolution of robust village institutions lead to sustained process of commons restoration and to arrest of further degradation. It has been investigated that the institutionalization and democratization processes have changed the landscape of governing the common lands in villages of Ajmer district. Inclusive governance and secure tenures have been leading to revival of community-controlled fabric of systems and procedures around the utilization of natural resources in the pasturelands, and to speedy restoration and sustained mechanisms of protection of the pasturelands.

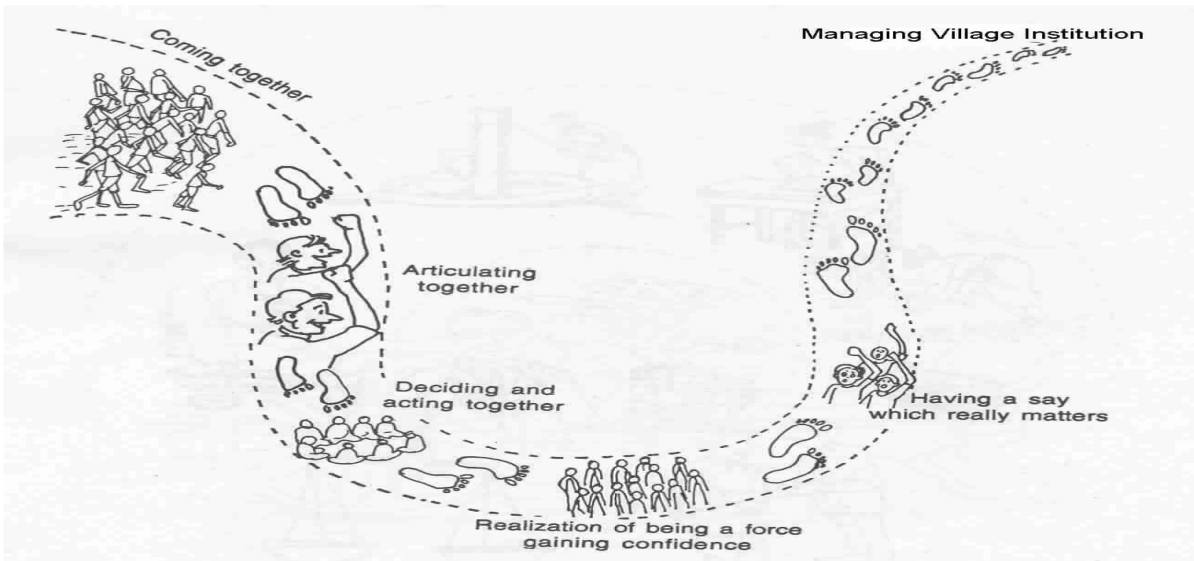

Fig. 1: Process of institutionalization and functioning of a village institution

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Ascorbic Acid Pre-treatment Mitigates Drought Induced Oxidative Stress in Wheat Seedlings

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Keywords: Ascorbic acid, drought, wheat

Introduction

Ascorbic acid is a major antioxidant that plays a vital role in the scavenging of excessive Reactive oxygen species produced in plants under abiotic stresses (Gallie, 2013). It also acts as a cell signalling modulator in numerous cellular processes including cell division, cell expansion and cell wall growth. Exogenous application of ascorbic acid positively affects the growth and physiological activities in different crops. Hence, application of Ascorbic acid (AsA) through seed priming may be helpful in promoting the antioxidative response in wheat (*Triticum aestivum* L.) seedlings grown under drought. This study was therefore conducted to evaluate the potential of AsA in improving the drought resistance in wheat.

Materials and Methods

The present investigation was carried out in two contrasting wheat cultivars namely PBW 644 (Drought tolerant) and PBW 621 (Drought sensitive). Seeds of both the cultivars were pre-treated with 400 µM of ascorbic acid for 12 hours and dried by placing them in incubator at 25±1ºC. For each treatment, three cups with 6 seeds in each were used. Plastic cups containing seeds were placed in an incubator at 25±1 ºC in the dark. Free radical scavenging capacities, polyphenol oxidase activity and total phenolic content were estimated in the control, stressed and treated stressed seedlings at 8th day after germination (DAG).

Results and Discussion

Imposition of water deficit stress had adverse effects on seedling growth of both wheat cultivars. In comparison to stress, pre-treatment of seeds with 400 µM of ascorbic acid enhanced the seedling growth of both the wheat cultivars and also improved the emergence index of the treated seedlings. Reduction of 2,2-diphenyl-1-picryhydrazyl by antioxidants results in the loss of absorbance. DPPH free radical scavenging activity reduced under stress, but it increased in treated wheat seedlings. Superoxide scavenging capacities decreased in stressed wheat seedlings except for the roots of tolerant cultivar where it remained unaffected. However, in comparison to stress, ascorbic acid treated stressed plants showed an increase in superoxide scavenging capacities capacity in both the cultivars.

Polyphenol oxidase (PPO) catalyzes the oxidation of phenols to quinones. Its activity reduced by 2.3 fold in roots whereas remained unaffected in the shoots of PBW 644 (Table 1). However, in PBW 621 it increased by more than 39% in the growing tissues. In comparison to stress, ascorbic acid treated plants showed an increase in PPO activity in roots of both the cultivars. Polyphenols are also considered as part of antioxidant defense system. In comparison to water deficit stress, total phenolic content increased in the treated wheat seedlings (Table 1). Correlation of PPO and total phenols clearly indicated that exogenous ascorbic acid treatment led to the activation of biosynthetic enzymes responsible for the biosynthesis of total phenols. Thus, ascorbic acid pre-treatment may be exploited for mitigating the adverse effects of deficit stress in wheat seedlings.

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Table 1: Effect of ascorbic acid pre-treatment on emergence index, free radical scavenging capacities, PPO activity and total phenols in stressed wheat seedlings at 8th DAG

Emergence index	Control	Water Stress	400 µM AsA + Stress
PBW 644	0.9	0.8	1.4
PBW 621	1.1	0.7	1.3
PPO (µnits/min/mg protein)			
PBW 644			
Shoots	1.8±0.4	2±0.3	1.2±0.2
Roots	6.5±0.5	2.8±0.7	2.9±0.3
PBW 621			
Shoots	1.5±0.7	2.7±0.3	4.6±0.3
Roots	3.1±0.7	5.1±0.3	7.2±0.4
Total phenols (µg/g FW)			
PBW 644			
Shoots	124.3±6.1	57.5±3.3	159.9±16.5
Roots	133.3±8.8	83.4±0.5	109.7±11.3
PBW 621			
Shoots	116.1±8.3	106.6±6.5	169.5±11
Roots	60±6.1	48.9±3.3	94.2±0.5
DPPH free radical scavenging activity (%)			
PBW 644			
Shoots	71.2±7.8	31.5±7.7	52.6±4.1
Roots	65.7±5.5	32.7±6.7	62.2±2.6
PBW 621			
Shoots	83.5±1.02	60.9±0.83	73.4±0.98
Roots	79.9±0.75	57.1±0.75	69.2±0.86
Superoxide anion scavenging activity (%)			
PBW 644			
Shoots	25.1±0.65	13.2±1.7	29.4±2.1
Roots	34.7±3.4	33.3±3.4	40.3±3.5
PBW 621			
Shoots	41.66±6.23	19.19±1.84	33.69±3.26
Roots	33.69±1.77	11.58±2.23	29.34±4.35

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Impact of Winter Rain on Oleoresin Production in *Commiphora wightii* (Arnott.) Bhandari in Central India

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Keywords: Abiotic stress, guggul, oleoresin, metabolites,

Introduction

Commiphora wightii (Arnott.) Bhandari is found in the semi arid and arid regions of India. Over exploitation of this species for its oleoresin has led to its decline in their natural stand. *C wightii* is a rare, endangered, threatened (RET) category plant in India having remarkable medicinal, ecological and economical importance (Pareek and Pareek, 2012). In Central India, the natural stand of *C wightii* is found in the Chambal ravines. Oleoresin i.e., guggul gum production in *C wightii* is due accumulation of secondary metabolites. Conversion of primary metabolites to secondary metabolites in the plant is governed by the abiotic stress (Ramakrishna and Ravishankar, 2011). Environmental stresses cause drastic changes in the growth, physiology and metabolism of plants leading to the increased accumulation of secondary metabolites in plants. Guggul gum is used in numerous ayurvedic drugs.

Materials and Methods

Chambal ravines are geographically located at the plateau of Central India in the northern part of (M.P.). In ravines, Malhar community, inhabiting on the banks of river Chambal are traditional tappers of guggul plants for gum. Seventeen people associated with guggul tapping in seven villages of Morena district were interacted for collection of data, with the help of a local NGO- Sujagrati Samaj Sewa Sansthan. The meteorological data of Morena for the year 2012-13 and 2013-14 was collected from the Automatic Weather Station of the Zonal Agriculture Research Station, Morena. The relationship between yield, tapping time, rainfall, temperature and relative humidity were examined using simple correlation analysis.

Results and Conclusion

During the guggul tapping season in 2013-14, the abiotic stress was less in comparison to 2012-13. Less abiotic stress due to winter rain on the guggul production in Chambal ravines. Mean production of guggul gum in 2012-13 was (385.30g), while it was (145.59g) in 2013-14. Thus the mean gum production per plant declined by 62.61% in 2013-14, besides this the viscosity of the guggul gum was affected due to winter rains 2013-14. The tappers observed that those plant tapped before rains in February 2014 produced more gum, similarly the proportion of tapped trees damaged was higher than those with untapped trees during the year. Gum production was positively correlated with temperature while rainfall was negatively correlated with other variables during both the years (Table 1 and 2). Tapping of guggul in MP is carried out from last week of February to March. In comparison to 2012-13 in 2013-14, the time of tapping was delayed by one week. The delay was due to low temperature and high humidity during the tapping period. It is concluded that gum production declined in 2013-14 as compared to 2012-13 and it was positively correlated with maximum temperature while negatively with rainfall. Winter rain had a positive impact on the health of natural stand of guggul plants during the year 2013-14. *C wightii* plants with good vegetative growth may be due to fewer metabolisms of primary metabolites to secondary metabolites due to less abiotic stress.

Table 1: Correlation co-efficient of gum production with weather parameters during the year 2012-13

Variables	Gum production	Temp. maxi	Temp. mini	RH morn	RH even	Rain fall	Evaporation	Wind speed
Gum production	1.00							
Temp. Maxi	0.34	1.00						
Temp. mini	0.31	0.97^{*}	1.00					
RH Morn	-0.46	-0.99^{**}	-0.97^{*}	1.00				
RH Even	-0.65	-0.92	-0.93	0.96^{*}	1.00			
Rain fall	-0.23	-0.48	-0.28	0.46	0.33	1.00		
Evaporation	0.17	0.98^{*}	0.97^{*}	-0.95^{*}	-0.85	-0.43	1.00	
Wind speed	0.25	0.98^{*}	0.99^{**}	-0.97^{*}	-0.90	-0.35	0.99^{**}	1.00

Table 2: Correlation co-efficient of gum production with weather parameters during the year 2013-14

Variables	Gum production	Temp. maxi	Temp. mini	RH morn	RH even	Rain fall	Evaporation	Wind speed
Gum production	1.00							
Temp. Maxi	0.17	1.00						
Temp. mini	-0.06	0.96*	1.00					
RH Morn	-0.35	-0.97*	-0.91	1.00				
RH Even	-0.07	-0.98*	-0.99**	0.95*	1.00			
Rain fall	-0.50	-0.20	-0.42	0.19	0.38	1.00		
Evaporation	-0.30	0.85	0.95*	-0.77	-0.92	-0.64	1.00	
Wind speed	-0.69	0.53	0.73	-0.41	-0.65	-0.78	0.89	1.00

Correlation significant at the 0.01 level (**) and 0.05 level (*)

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Allelopathy Effects of Endemic Plant *Strobilanthes ixiocephala* Benth. from the Forests of Goa

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Keywords: *Strobilanthes*, allelopathy

Introduction

The vegetation of Western Ghats is under enormous pressure as invasive species interfere with regeneration ability of plants. Though several studies have been carried out on such invasive species, studies on invasive behaviour of native species have been rarely attempted. *Strobilanthes* Blume species are endemic, plietesial, gregarious occupying the forest floor. In the present study the possible allelopathic influence was investigated.

Materials and Methods

Allelopathy potential of *Strobilanthes ixiocephala* Benth. (Donor plant) on the germination of *Raphanus sativus* L. and *Cyamopsis tetragonoloba*.(L.) Taub. (Receptor plants) was conducted using petriplate assay. 10 g of dried crushed leaves or soil was soaked in 100 ml of distilled water overnight at room temperature. Extract concentrations of 20, 40, 60, 80%, on the basis of volume was used; distilled water served as control. The seeds of receptor plants were soaked overnight in distilled water and surface sterilized prior to treatment. The germination tests were carried out on filter paper in sterile petridishes for a period of 7 days at 27˚C and 70-90% humidity.

Results and Discussion

The elongation ratio calculated following Rho and Kil (1986) showed varied results for soil extracts. The maximum inhibition (-30.5) was shown by *R. sativus* in 80% soil extract. Whereas the leaf extracts (60%) showed the highest inhibition of radicle both in *R. sativus* (-44.42) and *C. tetragonoloba* (-56.73). The hypocotyls of seeds showed a stimulatory effect (+) after treatments. The longest hypocotyl was recorded in *R. sativus* (+56.01) at 40% leaf extract treatment. The result showed a positive trend in hypocotyl length whereas negative trend of radicle by leaf extract. *S. ixiocephala* is undergrowth in moist deciduous forests of Western Ghats. They form gregarious patches in forest ecosystem slowly eliminating other undergrowth. The results of the present experiments provide possible clues to the allelopathic effect exerted by *S. ixiocephala*. Further experiments are being conducted to conclusively prove its effects both on undergrowth and trees.

Table 1: Effect of aqueous soil and leaf extract on *Raphanus sativus* L. and *Cyamopsis tetragonoloba* (L.) Taub.

	***Raphanus sativus* L.**				***Cyamopsis tetragonoloba* (L.) Taub**			
	Soil extract				**Leaf extract**			
	Hypocotyl (cm)	**Radicle (cm)**	**Hypocotyl (cm)**	**Radicle (cm)**	**Hypocotyl (cm)**	**Radicle (cm)**	**Hypocotyl (cm)**	**Radicle (cm)**
T_0	3.91±1.46, (0.46)	9.41±5.33, 1.69	2.15±0.98, 0.31	2.75±1.41, 0.45	3.91±1.46, 0.46	9.41±5.33, 1.69	2.15±0.98, 0.31	2.75±1.41, 0.45
T_1	3.62±1.65, 0.52 (-7.42)	11.31±6.41, 2.03 (+20.19)	3.09±1.40, 0.44 (+42.3)	3.10±1.35, 0.43 (+12.7)	3.55±1.68, 0.53 (-9.2)	7.24±3.82, 1.21 (-23.06)	2.38±1.04, 0.33 (+10.69)	1.76±0.88, 0.28 (-36)
T_2	3.96±1.95, 0.62 (+1.27)	7.78±3.68, 1.15 (-17.33)	2.66±0.60, 0.19 (+23.7)	3.61±1.40, 0.44 (+31.27)	6.10±1.81, 0.57 (+56.01)	7.04±1.69, 0.53 (-25.18)	2.26±1.30, 0.41 (+5.116)	1.58±1.33, 0.42 (-42.54)
T_3	4.58±1.42, 0.45 (+17.13)	9.19±2.03, 0.64 (-2.34)	2.63±1.09, 0.34 (+22.32)	2.26±1.73, 0.55 (-17.82)	5.03±2.08, 0.66 (+28.64)	5.23±2.32, 0.73 (-44.42)	2.72±0.85, 0.27 (+26.51)	1.19±0.98, 0.31 (-56.73)
T_4	3.88±0.90, 0.28 (-0.77)	6.54±3.55, 1.12 (-30.5)	2.20±0.44, 0.14 (+2.32)	3.50±1.08, 0.34 (+27.27)	5.69±2.45, 0.77 (+45.5)	5.30±2.51, 0.79 (-43.67)	2.60±0.98, 0.31 (+20.93)	1.40±0.82, 0.26 (-49.09)

±Standard deviation

344.

Effect of Varieties and Fertility Levels on Growth and Yield of Rice (*Oryza sativa* L.) under Aerobic Conditions

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Keywords: Aerobic conditions, fertility levels, rice, varieties,

Introduction

Rice is the staple food of about 3 billion people and the demand is expected to grow as population increases. Rice recuires more irrigation water than other grain crops therefore, there is need to focus our research on low water requiring rice growing technologies. Rice production system, without constant standing water in non puddled soils, referred to as 'aerobic rice' is considered one of the most promising water saving technologies. Keeping in view the apprehensions of water scarcity in coming times in rice growing belt of Jammu region, it seems that the aerobic rice production technology needs to be standardized with the use of fertilizers.

Materials and Methods

The present investigation entitled "Effect of different varieties and fertility levels on growth and yield of rice (*Oryza sativa* L.) under aerobic conditions" was conducted on an Inceptisol at the Research Farm of Division of Agronomy of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu during the *Kharif* season of 2014-15.The experiment was laid out in factorial RBD with four varieties viz. PR-115, DRRH-3, PAC-837 and PR-121, as one factor and four fertility levels viz. 0:0:0, 90:45:22.5, 120:60:30 and 150:75:37.5 kg N-P_2O_5-K_2O ha^{-1}, as second factor. Full dose of P and K along with one third of N were applied as basal dose at the time of sowing through inorganic sources of nutrients viz. urea, DAP and MOP, respectively and remaining two third of N was applied in two equal splits one at 30 DAS and other at 60 DAS. The soil of experimental field was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen and medium in available phosphorus and potassium.

Results and Discussion

Growth and yield characteristics of rice were significantly influenced by different rice cultivars (Table 1). Among rice cultivars, PAC-837 recorded highest plant height, dry matter accumulation, number of tillers m^{-2}, leaf area index at 120 DAS and grain yield followed by DRRH-3, PR-115 and PR-121. Rice hybrids (PAC-837 and DRRH-3) recorded higher growth and yield characteristics than PR-115 and PR-121. This might be due to differential genetic makeup of varieties and ability to accumulate the photosynthates in the vegetative plant parts as well as higher dry matter partitioning towards economic part. Significant differences in plant growth characteristics as influenced by various genotypes were also reported by Parashivamurthy *et al.* (2012).Yield variability among rice cultivars was attributed to genetic characters and environmental effects. Ramanjaneyulu *et al.* (2014) revealed that phenotypic expressions are largely dependent upon genotype's ability and environmental effect. Straw yield was also recorded highest in PAC-837 which was statistically at par with DRRH-3 and PR-115. Fertility levels had significant influence on the various growth and yield characteristics of rice (Table 1). Highest plant height, dry matter accumulation, number of tillers $m^{-2,}$ leaf area index, grain and straw yield were recorded with 150:75:37.5 N-P_2O_5-K_2O kg ha^{-1}. The abundant supply of N, P and K is considered essential for growth and development of rice. NPK fertilization leads to increase in plant height, number of tillers m^{-2} and leaf area index which leads to increase in grain yield as well as straw yield. Parashivamurthy *et al.* (2012) had also reported increased yield attributes with increased fertility levels. Rice hybrids DRRH-3 and PAC-837 recorded higher growth and yield characteristics under aerobic conditions over PR-115 and PR-121.

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Table 1: Effect of rice varieties and fertility levels on growth and yield on rice under aerobic rice.

Treatments	Plant height (cm)	No. of tiller m^{-2}	Dry matter accumulation ($g\ m^{-2}$)	Leaf area index at 120 DAS	Grain yield ($q\ ha^{-1}$)	Straw yield ($q\ ha^{-1}$)
Varieties						
V_1: PR-115	81.71	230.33	940.42	2.77	41.06	59.50
V_2: DRRH-3	88.86	255.08	965.95	3.23	43.37	58.65
V_3: PAC-837	92.48	270.25	978.33	3.49	45.65	59.98
V_4: PR-121	75.09	204.67	789.62	2.63	32.99	51.42
SEm±	1.26	6.80	16.55	0.11	0.68	1.04
CD (0.05)	3.65	19.63	47.80	0.31	1.96	3.01
Fertility levels ($N-P_2O_5-K_2O$ kg ha^{-1})						
F_1: $N_0P_0K_0$	72.69	165.33	488.32	1.60	20.86	31.33
F_2: $N_{90}P_{45}K_{22.5}$	84.94	239.58	879.45	2.92	39.22	54.85
F_3: $N_{120}P_{60}K_{30}$	88.98	271.25	1118.39	3.72	50.21	69.53
F_4: $N_{150}P_{75}K_{37.5}$	91.54	284.17	1188.15	3.88	52.78	73.85
SEm±	1.26	6.80	16.55	0.11	0.68	1.04
CD (0.05)	3.65	19.63	47.80	0.31	1.96	3.01

345.

Low Cost Bio Adsorbent to Remediate Toxic Metal Ions from Aqueous Environment

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Keywords: Biosorption, cadmium removal, *Pongamia pinnata* pods powder

Introduction

Water contamination by toxic metal ions has become a major challenging issue. Cadmium, a widely used heavy metal in manufacturing cadmium-nickel batteries, mining activities, electroplating and alloy industries are mainly responsible for water pollution (Mohan et al., 2007). Bioaccumulation of cadmium metal ions at higher trophic level causes various health issues such as cancer, hypertension and Itai-Itai diseases (Farooq et al., 2011). Nowadays, solving this problem has become a difficult task. Bio sorption is a process of sequestration of heavy metal ions by non-living biomass. Conventional method to remediate toxic metal ions from effluents is not an economical and environmental friendly. The bio sorption process offers an advantage of low operating cost and minimal use of chemicals (Farooq et al., 2011). Our research is focused on the use of *Pongamia pinnata* pods to remediate cadmium metal ions from aqueous environment.

Materials and Methods

The powdered biomass of pod of specific mesh size was used for the experiment. To observe the efficacy of the bio sorbent, experiments were carried out at different pHs, doses, contact time and temperatures (25, 35, 45°C). The bio sorption kinetic experiments at different doses were also conducted to know the effect of contact time on the bio sorption process. The isotherm equilibrium data (at different temperatures and initial concentrations) was also fitted by Langmuir and Freundlich models.

Results and Discussion

Effect of pH on cadmium metal removal is presented in Table 1. The optimized pH, for cadmium metal ions removal was 5.0 at bio sorbent dose of 10 g/L at 25°C. Cadmium adsorption has very insignificant effects of temperature on bio sorbent. Isotherm data for cadmium removal followed only Langmuir model. Low cost and locally available biosorbent (Pongamia pods powder) is effective to remediate cadmium. Thus, *Pongamia pinnata* pods powder could be an ideal substitute to remove cadmium metal ions from water and wastewater to sustain the environment.

Table 1: Effect of pH on cadmium removal

Initial pH	Equilibrium pH	Percent removal
2	2.32	4.05
3	3.4	38.78
4	4.4	82.22
5	4.8	88.90
6	4.98	90.60

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346.

Performance of Garlic under Agri-Horti-Silviculture System in Relation to Physiological Behaviour and Yield

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Keywords: Agri-Horti-Silviculture, garlic, physiological behaviour

Introduction

Agricultural crop inputs in India are subsidized (varies from state to state) and governments are under pressure to phase out the subsidies to reduce the fiscal burden. Therefore, farmers are looking for best alternative options, and fruit plants based integrated system with high value crops may be remunerative than traditional crop rotations. In this system, horticulture is emerging as one of the major growth engine in shifting large area from wheat-paddy cultivation. Commercial orchard involves a high initial investment but monetary gains are possible only after few years of juvenile period. Moreover, the modifications in micro-environment due to growing of timber trees, directly or indirectly influence various vital physiological processes of the inter-cultivated plants grown under tree canopy. Generally photosynthetically active radiation (PAR) and temperature are reduced, while the humidity is increased (Dhillon *et al*., 2011). Among these, PAR is important in governing inter-cultivated crop biomass production and yield. Therefore, this paper highlights the physiological response of under-storey crops and biological/economic performance of garlic under fruit tree based multi-cropping system.

Materials and Methods

The experiment was conducted at New orchard of Department of Fruit Science, Punjab Agricultural University, Ludhiana, situated at latitude of 30.45^o N, longitude of 75.85^o E and at an altitude of 244 m above mean sea level. The layout was prepared to accommodate different fruits and poplar plants between the recommended spacing of pear (6 m × 6 m) to make use of inter-spaces during the initial juvenile phase of fruit plants. Garlic was sown in the month of October in the inter-row spaces of different intercrops planted in north-south direction in completely randomized design with three replications. Control plots of garlic with pear were also maintained simultaneously for comparison. The statistical analysis was done with SAS. The data on yield and physiological parameters *viz.,* photosynthetic active radiation (PAR), stomatal conductance, intercellular CO_2 and transpiration rate, using portable photosynthesis system (CID 340, CID Inc., USA) on fully expanded leaves were recorded repeatedly at 10.0 am, 1.0 pm and 4.0 pm for both experimental as well as control plots.

Results and Discussion

Garlic grown under different tree combinations behaved differently for eco-physiological parameters but trend was uniform during both the years. Maximum PAR values (491.76 and 503.05) were observed for garlic when grown with pear as control and it was significantly higher than all other combination during both the years. All parameters viz., net photosynthesis rate, water transpiration, stomatal conductance, etc. were highly influenced by light interception. As far as monthly variation is concerned, the photosynthetic active radiation (PAR) and transpiration rate decreased initially up to January and increased thereafter irrespective of tree components. However, photosynthesis rate was higher initially and later on decreased with maturity of leaves and recorded minimum in the months of April under all tree combinations. Mean weight of garlic was also found maximum (34.41g) when it was grown along with pear as a sole crop, however, yield potential was found at par when grown with pear + plum and pear + kinnow combinations and it differed significantly from all the other intercropping system and minimum (21.81g) weight was under pear + poplar intercrop, which was 36.62% less. The yield reduction was more under 6 year canopy as compared to 5 year canopy in all the crop combination. Yield reduction of crops in agroforestry system is not only due to shading effect of system but also due to sharing of other important resources like moisture, nutrient, space, etc.

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347.

Nitrogen Fixation in Short Rotation Trees of the Temperate Zone

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Keywords: Diazotrophic bacteria, endophytic bacteria, nitrogen-fixation, *Populus*, *Robinia, Salix*

Application of Nitrogen (N) fertilisers is inevitable to achieve the yields expected in modern agriculture. However, the wide and intensive use of N fertilizers harbours severe environmental threats mainly by eutrophication of water bodies, warming of the atmosphere by N_2O emissions, and groundwater contamination by nitrate as critical loads are exceeded frequently. Therefore environmental protection policies aim to reduce N application and yet keep crop yields high. In this context plants showing high N use efficiency and especially N fixing plants like legumes are viewed as one solution for raising sustainability of crop production at low-input energy levels. The same is true for several fast growing trees and shrubs which are also able to fix N. The ability of poplars and willows as highly productive, widely grown, and well studied trees to fix N has only been discovered recently. In the endophytic flora of poplar and willow diazotrophic bacteria were identified in which N fixation could be verified. Details of the evidence is summarised and implications for N sequestration and retrieval of surplus N is discussed. Among their attributes, the ability to fix airborne N_2 is a major one giving poplars and willows unquestioned priority in the context of sustainability.

348.

Home Gardens: Drops to Sustainability

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Keywords: Family farming, home garden, homestead, resource starved small land owner

Home gardening is an ancient and widespread practice of deliberate mixing of field crops, herbs and shrubs with trees and livestock within the compound of a house, popular in regions with either high or low human population densities in developing and developed countries. They reflect the wisdom of traditional culture and ecological knowledge that have evolved over the years. The gardens resemble the structure of natural ecosystems i.e. they create a forest-like multi-storey canopy structure on a land marginal to field production and labour marginal to major household economic activities. The gardens are basic production units and the centres of social and cultural well-being of farm families particularly the indigenous communities. Featuring ecologically adapted and complementary species, household gardens are marked by low capital input and simple technology. Multiple environmental and ecological benefits are realised from home gardens in terms of ecologically friendly approaches for food production improving food security and enhancing economic growth along with biodiversity and natural resources conservation. The gardens can satisfy social, cultural and economic needs while providing a number of ecosystem services. As home gardens are a time-tested local strategy that are widely adopted and practiced in various circumstances by local communities with limited resources and institutional support, they can be a part of agriculture and food production systems in many developing countries and are widely used as a remedy to alleviate hunger and malnutrition in the face of a food crisis particularly in a climate change world.

349.

Micro-climate Modifications in Agroforestry Systems

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Keywords: Agrisiliviculture, agroforestry, humidity, light, microclimate

Trees are increasingly grown to suffice wood and biomass needs, in both temperate and tropical regions, as well as in developed and developing countries. In this book chapter we reviewed several studies explaining microclimate modifications in agroforestry systems from tropical to temperate regions. We systematically elucidate the effect of microclimate (light/solar radiation, temperature including air and soil temperature, soil moisture, relative humidity and wind speed) in these agroforestry systems. The microclimate changes caused by trees in tree–crop associations contain shading of the understory crops, increased relative humidity, reduced air and soil temperatures, and decreased wind velocity. The canopy cover also affects the microclimate of the understory. From the literatures we concluded that the microclimate has positive effects on the agroforestry systems to conserve the soil, maintain the soil moisture (because of shade) protect the crops from wind breaks, tree's shade improve the yield of understory crops such as coffee, turmeric, wheat, pastures etc. Microclimate also helps to improve the yields of trees.

350.

Weeds as a Source for Bio-energy Production

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Key words: Bioenergy, biomass, forest, weeds

Weeds are of major concern in modern agriculture for its ability to reduce crop growth and yield in crops as they compete with crops for environmental resources available in limited supply, i.e. nutrients, water and light. Further, aquatic and hardy weeds are also responsible for losses in different ways. As a standard practice, weeds are removed many a times manually. The biomass produced by weeds is seldom exploited, thus wasting potential energy content within it. On the other hand, finding renewable energy sources is necessary, considering the upcoming depletion of fossil fuels, and to reduce the impacts of global warming. In this regard, weed biomass can be the cheapest sources of clean energy, even rarely used and scarcely studied. The present paper discusses weeds as a potential source of bioenergy, various bioenergy routes where weeds can be utilized as a feedstock and a review of various weeds being successfully utilized as a source of feedstock for production of bioenergy and chemicals.

351.

Productive and Protective Potentials of Agroforestry

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***Keywords**:* Agro-forestry, tree-crop interaction, micro-environment

Green revolution led intensification of agriculture has made the country self sufficient in food grains, however, we ended up in deterioration of natural resources and other risks associated with indiscriminate use of agrochemicals and unscientific use of land. In spite of being aware of such impacts, conservation of natural resources remains the most neglected aspect of civilization's predicament. Paradoxically, meeting the basic requirements on one hand (food, shelter, income, etc.) and conservation of natural resource on the other (water, soil, biodiversity, etc.), beyond doubt are big challenges before mankind. It is the high time to develop technologies and landuse practices with potential to make both ends meet. The framework for achieving the same was acknowledged at the World Summit on Sustainable Development held at Johannesburg, South Africa by the participating nations. Five domain areas of Water, Energy, Heath, Agriculture and Biodiversity were identified as potential pathways leading the ways in the direction of achieving the Millennium Development Goals (MDGs) modified as Sustainable Development Goals w.e.f. January 2016 to be achieved in next fifteen years. Agroforestry is a land use system, which contributes directly or indirectly to materialize the sustainable landuse goal.

Agroforestry offers not only a sustained production, but also a progressive increase in productivity per unit area with additional environmental benefits. It buffers against the vagaries of climate through its unique way of amelioration of microclimate and reshapes the agro- ecosystem with enhanced stability and resilience. Global warming and associated problems of climate change has pressed the need for land use system that would be more dependable in production and more sustainable in terms of resource conservation to ensure food security. However, the negative aspects of trees in farmland such as competition for light, water, nutrients, allelopathy, etc. are equally important, which needs to be considered before introducing trees into farmland. These interactions arising at the interface between tree and crops are crucial as they decide the economic and environmental viability of the system. The selection of suitable tree component, which confer more of positive effects is one of the key factor deciding the success and adoption potential of any system/model. Some of the potential benefits and services provided by agroforestry technologies that virtually contribute towards achievement of sustainable development and ensure food security without depleting the natural resource are discussed in this paper with the support of updated scientific achievements.

352.

Industrial Agro forestry- A Sustainable Business Model that Resolves Issues from Production to Consumption System in Agro forestry

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***Keywords*: High yielding varieties, industrial agroforestry, mini clonal technology**

Agro forestry particularly industrial agro forestry has gained significant attraction due to policy guidelines and the growing demand for wood and wood products. The demanded wood products include pulp and paper, plywood, veneer, particle board, pencil, sports goods, match splints, boxes, packing cases etc. which required huge volume of wood. The existing forests in the country have been reserved and extend serious felling regulation which lead to wider gap between demand and supply. This has necessitated development of suitable model amenable under agro forestry system. Accordingly, the current research group at Tamil Nadu Agricultural University has designed and developed a value chain based agro forestry model which incorporated all stake holders in the Production to Consumption System. The incorporation of high yielding short rotation varieties has made significant productivity advantage over the traditional varieties coupled with augmented income generation. The average productivity of 150 t ha^{-1} in a short span of three years has released over Rs.7 lakhs of income which attracted many farmers towards tree husbandry. The development and adoption mini clonal technology and the associated rural clonal production center have assured quality seedling availability in time and ensured productivity and profitability. This value chain model has included various wood based industries like pulp and paper, match, plywood and veneer and dendro-power industries which resulted in assured buyback and price supportive mechanism to the tree growing farmers and assured and quality raw material to the wood based industries. Above all the financial institutions extended credit and insurance protection which attracted several farmers and other tree growers towards adoption of industrial agro forestry models. All these developments have resulted in establishment of over 45000 ha of industrial agro forestry plantations involving more than 25000 farmers and other beneficiaries which attested the successful establishment of industrial agro forestry models in Tamil Nadu.

353.

Effect of Different Spacings of Poplar Based Agroforestry System on Soil Chemical Properties and Nutrient Status in North-West India

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Keywords: Leaf litter, nutrient status, soil properties, poplar

Field experiment was conducted during rabi season of 2014-15 to evaluate the effect of different spacings of 8 years old poplar plantation on soil chemical properties and nutrients status. Poplar based agroforestry system performed better as compared to sole crop in respect of various soil chemical properties and available nutrients status. The organic carbon was observed highest under different poplar spacings as compared to control. Among different spacings organic carbon was found maximum under 5×4 m spacing. Soil pH and the electrical conductivity were also being lowered from its initial status under different spacings of poplar plantations. However the magnitude of decrease was maximum in 5×4 m as compared to other spacings and control. The available soil N, P and K increased significantly under different spacings of poplar based agroforestry system in all the treatments from its initial values. The highest available soil N (350.2 kg ha^{-1}), P(18.3 kg ha^{-1}) and K (364.3 mkg ha^{-1}) were recorded under 5×4 m spacing as compared to 10×2 m and 18×2×2 m spacings and sole crop under study. The leaf litter fall and nutrients added through it was recorded maximum under 5×4 m followed by 10×2 m spacing.

354.

Agroforestry for Livelihood Security, its Development and Adoption: The Ways Ahead

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Keywords: Agroforestry, livelihood security, environmental amelioration, biodiversity

Agro forestry as a scientific discipline has gradually evolved from 1970s onwards from initial identification of existing agro forestry systems and tree species, their role in livelihood security, development of agro forestry models, identification of constraints and potential of agroforestry adoption and recently to its role in climate change scenario. The current paper dwells on phases in the development of agroforestry as a scientific discipline, its role in livelihood security, carbon sequestration and trends in increase in area coverage at global and regional levels, and constraints in its development and promotion. Trees in agroforestry play one or more important role(s) in farmers' livelihoods- increased well-being, provide income and savings, reduce vulnerability to various vagaries and ensuring sustainable resource use. Besides, the trees in agroforestry recently have received additional impetus in climate change mitigation and adaptation and offsetting the losses due to deforestation and forest degradation. There has been an overall increase in area under agroforestry at the global level in the last decade. The area under agroforestry in all regions of the world, with the exception of North and Central Asia, and Sub-sharan Africa, has increased in 2000-2010. The overall population in the world living in agroforestry landscape has increased from 746.7 million to 837.6 million during 2000-2010 which implies that more farmers have realized the importance of agroforestry and consequently adopted it. Keeping in view the importance of agroforestry, there is need to further accelerate its adoption and its intensification to increase the area under agroforestry at the global level for overall benefit of the world community. The potential agroforestry practices for regions with different levels of factor constraints have been delineated. There is need to create favourable conditions to encourage agroforestry as sustainable land use at the global level which is to be augmented by a strong social and political determination of the world community.

355.

Effect of Storage on the Quality of Beverage Produced from Barley Malt

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Keywords: Barley malt, beverage production, quality, storage

Introduction

Cereal drinks contain many valuable and healthy components, including vitamins, minerals and trace elements. This is one of the key reasons for their popularity almost everywhere in the world and the introduction of the new non-alcoholic malt beverage is yet another example. Cereals for use in beverage production are usually sprouted and dried in the process known as malting [Pyler and Thomas, 2000]. This modifies the grains physically, chemically and biologically. Desirable changes such as the hydrolysis of starch and protein into sugars and amino acids, respectively that occur in malted cereals used for the production of beverages and other cereal-based food have been widely studied.

Material and Methods

The present investigation was carried out in Processing Laboratory of the Centre of Food Science and Technology, CCS Haryana Agricultural University, Hisar. The barley grain, bengal gram and peanuts were procured from local market, Hisar. Barley malt and malt beverage was prepared by addition of malt to the standardized formulation of barley based beverage [Sheetal, 2008]. Stored malt beverage at room temperature was evaluated for physico-chemical [TSS, acidity, fat, protein, total sugar, reducing sugar and tyrosine value], microbiological [total plate count] and sensory analysis. The details of methods can be obtained by full length paper.

Results and Discussion

Viscosity of 25min autoclave treated beverage significantly was lower than 15min. T.S.S. of the beverage was not showing any significant changes on storage. Crude protein and fat content of the beverage were not changed significantly during storage and the values obtained are as expected from extract of barley and fortification with Bengal gram and peanut. On storage total sugar content and reducing sugar content increased due to residual amylase activity and hydrolysis of starch. Tyrosine value of the beverage also increases on storage. It is of due to proteolytic activity. The product was chemically stable with respect to content of protein & fat. However, total sugar, acidity and tyrosine value increased. From the results of this investigation it can be concluded that highly acceptable beverage from malted barley at 15 Psi for 25min sterilization. The product was chemically stable with respect to content of protein & fat. However, total sugar and acidity value increased. Microbial content increased during storage. Beverage should be stored at low temperature to enhance shelf life.

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Performance of Wheat as Intercrop under Different Spacings of Poplar Plantations in Semi-arid Ecosystem of Northern India

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Keywords: Poplar, spacing, wheat, yield

The quantitative performance of wheat crop under different spacings of eight years old poplar plantations in semi-arid ecosystem was studied to ascertain the biological yield of tree and crop. The height of poplar was not affected significantly at different spacings under agroforestry. However, different spacings had significant effect on the girth of poplar. The growth and yield of wheat decreased significantly with the decrease in poplar spacing. The rate of decrease in grain yield of wheat crop was more under 5x4 m spacing. On an average, the grain yield decreased up to 51.2% under 5 x 4m spacing as compared to the sole wheat (4.3 t ha^{-1}). However, the rate of decrease in straw yield was comparatively lower than grain yield under different poplar spacings. Protein content in wheat increased with the decrease in spacing of poplar and maximum protein content (10.7%) in wheat was recorded under 5 x 4 m spacing closely followed by 10 x 2 m (10.4%) spacing and minimum in control. The gluten was significantly higher under different spacings of poplar based agroforestry than sole crop of wheat.

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An Agri-Silvi-Horticultural System to Optimize Production, Quality and Cash Returns in Indo-Gangatic Alluvial Plain of Haryana

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Keywords: Agri-silvi-horticultural system, economics, growth

The study was carried out to check the effect of agri-silvi-horticultural system on yield and quality parameters of wheat crop, under already established silvi-horticultural system with *Dalbergia sissoo* and *Prosopis cineraria* as timber component were taken as forest tree species, and *Psidium guajava* and *Embilica officinalis* as fruit trees at 6 × 6 m spacing. Wheat (var. WH-711) was sown in the interspaces. The numbers of tillers, plant height, dry weight per meter row length, yield of grains per hectare of sole crop were significantly higher than agri-silvi-horticulture systems. Guava+kehjri system exhibited highest wheat yield. All quality parameters *viz*. protein content, sedimentation value and gluten in wheat were significantly lower in crops grown as sole crop than the crops grown as intercrops with woody trees in different combinations. The protein content (11.60 and 11.33%) in sole wheat crop was significantly lower than agri-silvi-horticultural systems. The net return and benefit: cost ratio per hectare was recorded higher when wheat was intercropped with guava+*shisham* and followed by guava+*khejri combination* than sole cropping.

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Effect of Resource Conservation Techniques on System Productivity and Economics of Different Cropping System in Lower Foothills of Himalayas

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Keywords: Minimum tillage, rice-equivalent yield, cropping system.

Introduction

Rice-Wheat cropping system is predominant in sub-tropical and temperate zones of Jammu region (Hassan and Kanth, 1999) having less average yield of both rice and wheat in terms of productivity and profitability and therefore need to be reversed by diversification of crops (high value crops) which have the potential to increase production and economics due to high cropping intensity through addition of low volume high value crops over existing rice-wheat cropping system. Continuous and indiscriminate use of technologies even after attaining the purpose threatened our land, water and environment. However, modern agricultural production technology aims at maximization of productivity per unit area per unit time with intensive use of synthetic fertilizers, pesticides, fossil fuel based energy which are leading to degradation of natural resource i.e. Soil, water, environment and biodiversity.

Material and Methods

Field experiment was conducted at Research Farm, Main Campus, Chatha of SKUAST–Jammu during the year 2012-13 and 2013-14. The experiment was laid out in split-plot design with two crop establishment methods (Minimum/Zero tillage and conventional tillage) and three cropping systems (Rice-Wheat, Rice-Marigold-French bean and Maize + soyabean -Wheat) and two fertilizer rates (Rec. Dose of Fertilizer and 75% RDF + 25% N through FYM) with and without mulching (The mulching was done with rice straw @ 5t/ha for rabi crops only) in sub-plots with three replication under clay loam soil having alkaline in reaction (pH-8.1), medium in soil organic carbon, available P & K and low in available N. The crops were raised under recommended package of practices.

Results and Discussion

REY of different crops in a system showed a significant increase under different treatments i.e crop establishment methods, varying cropping systems, mulching and fertilizer dose treatments. However, it was observed that higher values of REY were observed during the 1st year than 2nd year of experimentation under the different set of treatments. Under crop establishment methods, conventional tillage recorded significantly higher rice equivalent yield(REY) than the minimum tillage recorded 12.04% and 17.5% higher during 2012-13 and 2.13-14, respectively. Similarly under various cropping system treatments, rice-marigold-frenchbean produced significantly higher REY (22.3 t/ha in 1st year and 19.8 t/ha in 2nd year) followed by maize + soyabean-wheat (10.2 t/ha in 1st year and 9.38 t/ha in 2nd year). The per cent increase was in order of 168% and 164% under rice-marigold - frenchbean and 21.68% and 25.06% under maize +soyabean-wheat over existing rice-wheat cropping system during 1st year and 2nd year, respectively. Under mulching with rice straw produced significantly higher REY values corresponding to 14.0 t/ha and 12.6 t/ha, respectively than under no mulch (13.2 t/ha and 11.8 t/ha) during 2012-13 and 2013-14 respectively thereby indicates 6.06% higher REY during 1st year crop cycle and 6.70% during 2nd year crop cycle. However, between the fertilizer application, 75% recommended dose of fertilizer coupled with 25% N through FYM to each crop in a cycle during both the years of experimentation resulted significantly higher REY(13.9 t/ha and 9.4 t/ha respectively) over 100% recommended dose of fertilizer application (13.3 t/ha during 1st year and 12.0 t/ha 2nd year.

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