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

Volume 2

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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Natural Resource Management: Ecological Perspectives

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

Acknowledgements

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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Panel Discussion

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Theme Papers

1

Emerging Issues of Plant Protection in India

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The ever increasing population, and negligible concurrent increase in available land for agriculture, effective crop protection is going to play a crucial role in safeguarding the world's future. The efforts put forth would essentially be on minimizing the crop losses due to ravages of insect pests, diseases, weeds, nematodes, vertebrate pests etc. Enforcement of Destructive Insects & Pests Act (1914) and Plant Quarantine Order (2003) for prevention of exotic pests, promotion of Integrated Pest Management (IPM) for economical, eco-friendly and sustainable management of the pests, Implementation of Insecticides Act, 1968 for regulating production and use of pesticides and Human Resource Development in Plant Protection through training are the major programmes in the gamut of plant protection. In order to tackle the issues of plant protection in India, the Government of India has set forth three major components viz.

- Strengthening and modernization of pest management approach in India (SMPMA)
- Strengthening and modernization of plant quarantine facilities in India (SMPQF)
- Monitoring of Pesticides Residue at National Level (MPRNL)

The backbone of any pest management programme is relentless pest monitoring and surveillance. This activity need to be further strengthened by three tier e-pest surveillance at District-State-National level, in order to issue quick advisories to the farmers. The existing 35 Central IPM Centers are to attain the status of best knowledge centres on IPM in each state. To minimize the dependence on hazardous chemical pesticides and keep pests below damaging levels, the Central and State Governments should adopt Integrated Pest Management (IPM) as the cardinal principle in Plant Protection for popularizing it, among the farmers and extension workers and conduct trainings at farm level through Farmers Field Schools. A proper coordination and harmony in working of all the related agencies like SAU/ICAR/State Agriculture & Horticulture Department/CIPMCs/KVKs is the need of the hour for unified and judicious use of resources at national level.

Locust invasion through international borders of Rajasthan and Gujarat always require attention for timely control of this pest. An effective locust monitoring system with real time response with the use of ICT and vibrant coordination with the neighbouring countries such as Pakistan, Afghanistan, Iran etc. as well as FAO for its control is of paramount importance.

The Central Insecticide Board and Registration Committee should promote registration of effective and safe bio-pesticides and botanicals. In order to promote concept of organic farming and Integrated Pest Management (IPM), the procedure to grant registrations for bio-pesticides shall be made simpler and their registration should be given priority. Excessive use of pesticides in agriculture increased residual problem in various food products. The State Governments should establish more numbers of laboratories to monitor maximum residue limit (MRL) of pesticides in/on vegetables, fruits, grains, spices, pulses, milk, honey, irrigated water etc. at Village/Panchayat/District. There have been country-wide issues about the inadequate knowledge of pesticides about the label claims and their utilization. These lead to presence of residues of those pesticides, which are not approved for use on particular crops. Much of problems, which are faced today are due to lack of awareness, lack of sensitivity and lack of seriousness on use of pesticides. It should be emphasized that if the pesticides are used sensibly, they are the most opportune system for increasing productivity.

In the present era of liberalized global trade, import/export of plants and plant materials are likely to go up manifolds thereby warranting fast track plant quarantine services. It is imperative to have strong vigil on the possible incursions of the pests of quarantine importance at all entry points. This is possible only with the state-of-the-art laboratory back up with technically sound manpower and Pest Risk Analysis (PRA). Hence, due emphasis is needed for capacity building of the human resources and strengthening of the Quarantine laboratories and stations. Government of India has adopted international standards conforming to the requirements of the importing country in accordance with IPPC, WTO & SPS Agreements. Apart from these, border pest surveillance/ monitoring programme need to be strengthened and effective regulatory measures need to be placed to protect country from bio-security threats.

2

Extension Priorities and Innovations for Sustainable Development of Agriculture

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Extension services in India have traditionally been funded and delivered by government. Organized attempts in this direction started after the country became independent in 1947. Pre-Independence efforts had been largely local attempts, driven mainly by the humanitarian essays of a few individuals and organizations. These were area-specific and had limited impact. Independent India acknowledged the relevance of extension quite early, attempted to strengthen agricultural extension research in the country. Extension is now becoming more diversified, technology intensive, knowledge oriented and more demand-driven. This requires the extension workers at the cutting edge level to be master of so many trades, which is neither practicable nor possible. Role of knowledge system and institutional mechanisms for input supply, credit, crop and livestock insurance, etc., would, therefore, be important in reducing both risks and uncertainties in order to attain the much needed resilience in Indian agriculture. Use of ICT in extension enables the extension workers to be more effective in meeting the information needs of farmers and other stakeholders. ICAR initiatives like agropedia, KVK-Net and KVK found very effective in capacity building of farmers and extension professionals. Several of the innovations in extension and institutional innovations that have come up in response to the weaknesses in public research and extension system, have given enough indications of the emergence of an agricultural innovation system in India. This has resulted in the blurring of the clearly demarcated institutional boundaries between research, extension, farmers, farmers groups, NGOs and private enterprises. Extension has to play a very important role of facilitating the nodes to generate access and transfer knowledge between different entities in the innovation system. It also has to create competent institutional modes to improve the overall performance of the innovation system. Inability to play this important role would marginalize extension further. Building sustainable impact on future of extension needs a very focused robust approach for strengthening the discipline through need based empirical research, identify potential challenges, prioritize suitable solutions and design appropriate interventions for bringing out desirable changes among the targeted clientele. There is a need to strengthen extension advisory for bringing out desirable change in behaviour and lasting impact.

3

Climate Change: Impact on Biotic Stresses Afflicting Crop Plants

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Effect of climate change on insect-pests and diseases of agricultural crops is multidimensional. Magnitude of this impact could vary with the type of species and their growth patterns. It may be assumed that the vegetation tolerating high temperature, salinity and having high CO_2-use efficiency could be better than other species. Intergovernmental Panel on Climate Change in its report of 1995 predicted that doubling the level of CO_2 could possibly increase yield in some crops by 30%. However, observations on changing pest and disease incidence over the twentieth century suggest that growing agricultural production and trade has been affected by their wide dissemination. There is some evidence for a latitudinal bias in range shifts that indicates a global warming signal (Bebber, 2015). The increased production could be off-set partly or entirely by emerging spectrum of insect-pest, pathogens or weeds. It is, therefore, important to consider all the biotic components under the changing pattern of climate.

Climatic changes provide challenges and opportunities for Indian agriculture. Though the effect of climate change is vast, only limited research on impact of climate change on plant diseases / insect-pests has been done under real field conditions. However, some assessments have been carried out in few countries on fewer crops and particular pathogens / insect-pests under field condition to counter the current as well as upcoming problems of crop insect-pests / diseases. Emphasis must shift from impact assessment to developing adaptation and mitigation strategies as also options thereof with special attention towards outbreaks. We need to critically revisit the efficacy of current chemical, physical and biological control tactics, including pest-resistant cultivars under climate change, and to include future climate scenarios in all research aimed at developing new tools and strategies. Research on host response and adaptation should be launched to understand better as to how forthcoming change in the climate could influence crop pests, coupled with pest risk analyses done regularly, based on host-pathogen / pests' interactions. India is fortunate enough to have such a diverse climate suitable to grow various types of crop plants with varied pest population, which can help counter the pest problems in the changed climate scenario to enable farmers cope with such uncertainties with confidence.

4

An Approach to Cancer Risk Assessment and Carcinogenic Potential for Three Classes of Agricultural Pesticide

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Sometimes, it is not for decades that the devastating effects of pesticides are recognized scientifically. Even then, specific substances can become clouded in controversy while their victims continue to suffer due to differing scientific opinions. Thus, a comprehensive approach to cancer risk assessment is required based on the latest models of carcinogenesis.

Pesticides are a broad category of chemicals including insecticides, fungicides, and herbicides which help to eliminate the various agricultural pests encountered in farming. There are a number of parameters that are relevant to investigations into the deleterious effects of chemical pesticides. The main ones include toxicity, mutagenicity, tumorigenicity, reproductive disruption, endocrine disruption, DNA damage, necrosis, apoptosis, and teratoginicity. Generally, the more of these categories a chemical profile fits, the greater the likelihood that it is potentially dangerous and carcinogenic. The greater number of species a chemical affects adversely, the more likely it is to have a negative impact on living organisms as a whole.

There are basically three major methods available to cancer researchers conducting experiments into specific pesticides. Firstly, there is epidemiology and statistics from farming communities or other populations at risk. However, it can be difficult and challenging to identify exposure to specific chemicals due to the diverse nature of farming activities. Secondly, animal studies can provide useful information, but sometimes these are limited in scope due to a completely different biochemical detoxification pathway in humans. Thirdly, there are human cell culture studies. These can be highly informative in healthy cells, but are of limited value in transformed or cancer cells since these also often display different biochemical pathways.

An approach to carcinogenic potential based on all these criteria is adopted in this paper for three classes of pesticides including organochlorines, organophosphates, and dithiocarbamates. One example is used from each category: DDT and some of its metabolites are the chosen example for organochlorines; chlorpyrifos is the example investigated for organophosphates; and, mancozeb is the example explored in the category of dithiocarbamates.

5

Integrated Nutrient Management- The Important Role of Organic Matter Living Soil as Common Ground for Agriculture and Nature Conservation

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The core process of any terrestrial ecosystem development is building up a soil-plant system, and by that establishing local water and nutrient cycles. It is known: Soil is the existential basis of land ecosystems. Soil sustains all terrestrial life, enables land biodiversity and therefore is the cradle of mankind, too. In addition, biodiversity within soils is by far higher than above ground! But in general perception the living soil often is mixed up with the solid earth surface below the surface. Too often soils are considered only as a plant-holding structure. In contrast the existential function of earth's rooting space, which is not at all granted, is too often ignored.

Initially, agricultural crops grow and feed themselves on or from a soil which has been built up by a proceeding natural ecosystem. This process naturally leads to soil degradation and human colonization of soils from more natural ecosystems. In agricultural systems, soil degradation can even boost ecosystem productivity for a transition period of variable duration- because by humus mineralization and mineral depletion crops "feed on their basis", which is part of the current paradigm of non-sustainability. This soil degradation may be veiled by mineral fertilizers and other means for only some years or decades, depending on its initial robustness. To avoid these destructive processes, very high requirements on agriculture are needed. Historically, sustainable agriculture had yet only existed in some parts of the world (e.g., some flood regimes and some rice cultures, and terra preta), and never in Europe up to now. That shows the size of the task. Certainly, the maintenance of a near-natural functional biodiversity within the soil, and enhancing plant biodiversity in the agro-ecosystem, are key requirements for resilient and sustainable agriculture.

The WWF (World Wide Fund for Nature) was founded in 1961 in Switzerland, and it is one of the world's largest conservation organizations. The WWF operates across a global network and is active in more than 100 countries with more than 5 million supporters throughout the world. The three main global goals of WWF are conserving biodiversity, conserving the climate and reducing environmental footprints of human activities. Therefore WWF Germany works in more than 70 conservation projects all over the world. And in many of these projects, "soil" plays a very important role as fragile key factor of the ecosystem. In 2014, we developed a first "soil discussion paper". We use it to further clarify the importance of living soils for WWF's priority areas and flagship species and to highlight its integral role for sustainable agriculture and fulfilling humanity's nourishment needs.

6

Sustainable Development of Farmers: A Success Story

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Indian Agriculture today is facing a biggest challenge than ever before particularly after the globalisation and commercialisation of agriculture. Although India is proud of achieving self sufficiency and even surplus in food production, but the question is how to sustain it. The GDP contribution from agriculture was 58 percent during 1950s and today it is going at 14 percent. Farmers are not only loosing interest in farming but also confidence. The impact is so much there is indiscriminate migration of Rural Youth in general and farm youth in particular to urban areas, in the process many families and villages are becoming old age homes. During 2011, the migration of farm youth to urban areas in India was at 45 percent. The trend is increasing year after year, there are no labours available in some families even to supervise the harvest of perennial produces on the farm, leave alone farm operations. It is said that migration is because of growing unemployment problem in rural areas while increasing labour scarcity for farm operations is a paradoxy. The agricultural growth rate didn't make significant breakthrough revolves around two percent in the last one and half decade. The major factors influencing the aforesaid issues are; constant decline in profit margin and indiscriminate increase in production costs besides over exploitation of natural resources, continuous decline in percapita land availability and fragmentation of holdings. The Rural Bio Resource Complex (RBRC) project funded by Department of Bio Technology- Government of India (DBT-GOI) was implemented by UAS Bangalore covering 8340 rural families in a Hobli located in Bangalore Rural district of Karnataka. The project was implemented with active participation of stake holders from April 2005 to March 2010 with the objective of enhancing income and improving standard of living of rural people through integrated farming approach deeply emphasising management perspectives and addressing end to end issues. The significant improvements brought about are; shift in cropping pattern from low income to high income generating crops, added net income of three folds, employment generation of 2.52 lakh man days annually with 11 percent growth rate in agriculture and minimising migration of youth to urban areas. The model was replicated by Government of Karnataka covering 1.25 Lakh farm families across the state during 2011-2014. The model holds a promise for sustainable development of agriculture in India and visitors from more than 23 countries of Asian and African continents have expressed its relevancy to all the developing countries.

7

Managing Wetland Ecosystems: A Polycentric Perspective

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India is endowed with extensive wetlands of different kinds. Multi-use water bodies (MUWBs)) or multiple use water systems are most important and valuable category of wetlands. MUWBs include small water storage bodies, village ponds, irrigation and multipurpose tanks. MUWBs constitute an important component of community assets in India. These water bodies have been used as traditional commons by village communities since centuries to meet their domestic needs, irrigating crops and practicing fish farming in many Indian States. Landscape of Chhattisgarh State is dotted by age old and recent numerous MUWBs. The issues related to management of MUWBs are complex due to different categories and characteristics of these de-facto common water bodies, scale, size and coverage of fisheries, agriculture, domestic, socio-cultural-religious activities and multiple agencies involved in water use. Taking an example from Chhattisgarh the extent of completion and conflicts over MUWBs and mechanism to resolve conflicts can be understood. Data used in this study have largely been taken from author's earlier published and unpublished work (between 1985 and 2015) pertaining to small scale wetlands (multi-use village ponds and tanks). Competition and conflicts over MUWBs have been observed at four levels i.e. within user groups (irrigators), across the user groups (irrigators, fisherman and villagers), inter-institutions (Fisheries Cooperative Societies, WUAs, Panchayat, Irrigation Department, Fisheries Department), and between stakeholders and institutions (irrigators Vs Water Resources Department, fishers Vs WUA or Panchayat). Governing MUWBs is intricate because it can create disproportionate spatial and temporal externalities due to technical socio-economic-cultural-political and environmental interdependencies. Issues regarding the role of traditional authorities, user groups, stakeholder committees, different departments of the State and Panchayat and the relationships among multiple authorities with overlapping working zones are highly complex. Given such a complexity, we have advocated in this paper for distributed governance or polycentric approaches to manage MUWBs. We have also suggested that the policies of different departments of the State and Panchayat need to be examined critically in view of the fact that many departments are loosely linked and intensely compete for water. A synthesis between traditional institutional mechanism and components of current policies can appropriately put into operation for distributed or polycentric governance for MUWBs.

8

Exploiting Chemical Ecology for Developing Novel IPM Strategies

Zeyaur R. Khan[1*], Charles Midega[1] and John A. Pickett[2]
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Lepidopteran stemborers and parasitic striga weeds are major constraints to efficient production of cereals in sub-Saharan Africa. Smallholder farmers are resource constrained and unable to afford expensive chemicals for crop protection. To develop novel approaches for integrated insect pest and weed management strategies for resource poor African farmers, appropriate plants were selected that naturally emit signalling chemicals (semiochemicals) and influence plant-plant and insect-plant interactions. These studies led to development of a cropping strategy, known as 'push-pull', which exploits the phytochemicals released by the companion plants grown in between and around the main cereal crops.

Plants highly attractive for egg laying by cereal stem borer pests (*Chilo patellus* (Swinhoe) and *Busseola fusca* (Fuller) were selected and employed as trap crops, to draw pests away from the main cereal crops. Of these, *Pennisetum purpureum* (Schumach) produces significantly higher levels of volatile cues (stimuli), used by gravid stem borer females to locate host plants, than maize (*Zea mays* L.) or sorghum (*Sorghum bicolour* L.). Despite its attractiveness to stem borer moths, *P. purpureum* supported minimal survival of the pests' immature stages. Plants that repelled stem borer moths notably, *Melinis minutiflora* P. Beauv., and forage legumes in the genus *Desmodium*, were selected as intercrops, which also attracted natural enemies of the pests through emission of (*E*)-*β*-ocimene and (*E*)-4,8-dimethyl-1,3,7-nonatriene. *Desmodium* intercrop suppressed parasitic weed, *Striga hermonthica* (Del.) Benth., through an allelopathic mechanism. *Desmodium* root exudates contain novel flavonoid compounds which stimulate suicidal germination of *S. hermonthica* seeds and dramatically inhibit its attachment to host roots. Push-pull system effectively addresses the production constraints to production faced by the farmers and is an appropriate system because it uses locally available companion plants rather than expensive inputs.

The push-pull system has been recently adapted for drier areas vulnerable to climate change. We identified and selected new drought and temperature tolerant trap (*Brachiaria* cv mulato) and intercrop plants (e.g. *Desmodium intortum*) suitable for drier agro-ecologies. The new trap and intercrop plants also have appropriate chemistry in terms of stem borer control and striga suppression. This has made the technology more resilient in the face of climate change as rainfall becomes increasingly unpredictable.

The companion crops in push-pull system provide valuable forage for farm animals while the leguminous intercrops also improve soil fertility and moisture retention. The system is appropriate as it is based on locally available plants, not expensive external inputs, and fits well with traditional mixed cropping systems in Africa. To date it has been adopted by more than 110,000 smallholder farmers in eastern Africa whose cereal yields have tripled.

Moreover, opportunities for semiochemical delivery by companion plants, including plant-plant signalling and early herbivore alert, are being explored for developing future smart IPM strategies for Africa and beyond.

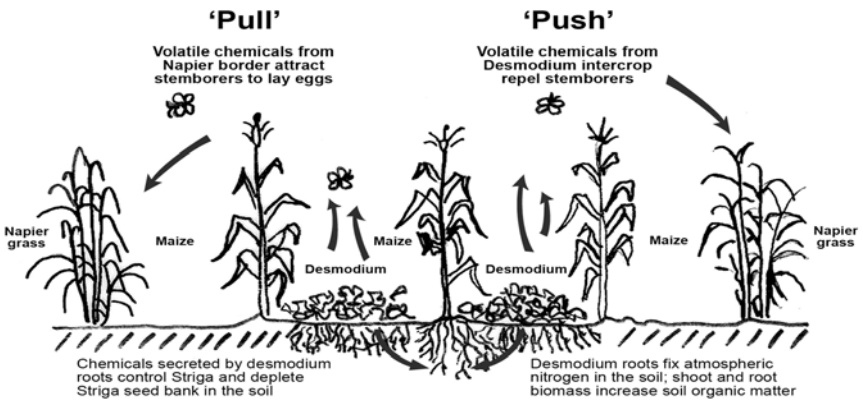

Fig. 1: How push-pull works?

Chemical ecology-based solutions to crop protection, which are environmentally sustainable and low cost, are urgently needed to address the real and increasing dangers of food insecurity without causing any ecological and social harm.

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9

Data on Insect Resistance Management to Bt Cotton in India

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Management of insect resistance to insecticides is an extremely important component of sustainable agriculture. The recent 'Bt cotton technology' lent stability to cotton production systems. Currently cotton production worth Rs 80,000 crores and textile production worth Rs 110,000 crores in India are dependent to a great extent on the continued efficacy of Cry1Ac and Cry2Ab in controlling *H. armigera* and *P. gossypiella.* Bollworm resistance to the Cry toxins will render Bt cotton vulnerable to the bollworms and can potentially lead to huge economic losses. Currently the refugia strategy recommended in India is not based on Indian data or experiments conducted in India. IRM strategies recommended in India for Bt cotton were derived from the recommendations made in the USA. The fragmentary information on resistance mechanisms, genetics, biology and ecology of insect resistance to Cry toxins may have prompted policy makers to draw heavily from published information available from studies conducted in the USA. Therefore it is extremely important to conduct detailed genetic and molecular studies on bollworm resistance to Cry toxins in India, which would form the basis of a science based strategic management of bollworm resistance to Bt cotton. There is an imminent need to generate appropriate data in India to design precise resistance management tools to ensure sustainability of all pest management technologies. There is also a great need for algorithms that may also be broadly applicable to several insecticidal toxins in any part of the world based on the specific biology, ecology of the target pests. It is important to elucidate the genetic information on resistant alleles in the two insect species *H. armigera* and *P. gossypiella*. Eventually, it would be useful to identify new genes and design novel gene constructs to ensure durable pest management and sustainable resistance management.

The current knowledge on the prevalence of diversity in resistance mechanisms; frequency of resistant alleles; mode of inheritance of resistance; variability of resistance mechanisms across insect populations and fitness costs associated with resistance of American bollworm, *Helicoverpa armigera* and the pink bollworm *Pectinophora gossypiella* to Cry1Ac and Cry2Ab is rudimentary in India. Therefore there is a need to generate new and useful information on the genetic and molecular aspects of bollworm resistance to Bt cotton in India.

In the context of sustainability it is important to understand that Bt cotton technology has been certainly very effective in controlling bollworms thus far, but there are scientific publications to show that insects are adapting to the toxins in India. Data show that Bollgard-II which was introduced in 2006 has contributed neither to the decline of insecticide usage nor to any yield enhancement. However, it is important to note our resistance prediction models show that if the two gene (cry1Ac + cry2Ab) based Bollgard-II may not have been introduced, the two bollworm species *H. armigera* and *P. gossypiella* may have developed resistance to Cy1Ac by now. However the pink bollworm has now developed resistance to Bollgard-II primarily because of the toxin segregation in bolls of the F-1 hybrid plants and extended crop phase, mostly in the irrigated regions of the country. Another major concern is the diminishing efficacy of neonicotinoid insecticides on sucking pests, primarily due to insect resistance to the new group of insecticides. Cotton productivity has been stagnant over the past 8-9 years and doesn't seem to be responding to any technology now. The following table highlights the concern.

Year	Quantity of insecticides in Metric tonnes					Cotton Area and Yield			
	Sucking pests	Bollworms	Other pests	Total insecticides on cotton	Total insecticides	Total area lakh ha	Bt area lakh ha	Bt area %	Yield Kg/ha
1999	4487	7522	320	12329	33398				
2000	3716	6647	625	10988	30120				
2001	3312	9410	454	13176	34910				
2002	2110	4470	283	6863	25962	78	0.294	0.38	331
2003	2909	6599	537	10045	32571	77.85	0.931	1.2	387
2004	2735	6454	178	9367	35432	89.2	4.985	5.59	463
2005	2688	2923	302	5914	32750	88.17	10.148	11.51	468
2006	2374	1874	375	4623	31363	91.73	34.61	37.73	519
2007	3805	1201	536	5543	35807	94.39	63.34	67.1	567
2008	3877	652	528	5057	26624	94.06	76	80.8	524
2009	5816	500	410	6726	35404	101.52	83	81.76	486
2010	7270	249	366	7885	36761	111.41	101.2	91.54	495
2011	6372	222	234	6828	34469	121.91	112	91.87	496
2012	6872	178	184	7234	42595	115.53	108.86	94.23	552
2013	11366	121	111	11598	45500*	119.78	114.58	95.66	567

*estimate

Cotton bollworms in India have demonstrated an immense capacity to adapt and develop resistance to insecticidal toxins. Tabashnik *et al.* (2013, 2014) reported field evolved resistance in the cotton bollworm, *Helicoverpa zea* and the pink bollworm, *Pectinophora gossypiella* to Bt cotton which resulted in reduced field control efficacy. Rajagopal *et al.* (2009) showed that the larval midgut juice from a Bt resistant strain of *H. armigera* Akola-R strain did not activate Cry1Ac protoxin properly, producing a mixture of 95 and 68 kDa Cry1Ac polypeptides instead of the biologically active 65 kDa toxin core. A proteinase (HaSP2) responsible for Cry1Ac activation, and downregulation of HaSP2 was implicated to cause improper processing of the protoxin. Recently Fabrick *et al.* (2014) showed that eight novel alleles (r5-r12) were associated with Cry1Ac resistance in two field populations of *P. gossypiella* from western India. For seven of the eight alleles, each produced two or more different transcript isoforms by alternative splicing.

Zhang *et al.* (2009) showed that a deletion mutation of HaAPN1 (at amino acids 938-1004) altered expression of APN to confer high levels of resistance to Cry1 toxins in a BtR strain *H. armigera*. A peptide fragment of HaAPN1 with the deletion expressed in Escherichia coli cells lost binding with Cry1Ac, whereas the peptide fragment without the deletion bound to Cry1Ac. Genetic analysis showed Cry1Ac resistance in BtR was incompletely recessive and polygenic (Liang *et al.*, 2008), thus indicating the possible presence of other resistance mechanisms in the BtR strain apart from the HaAPN1 mutation. Reduced expression of alkaline phosphatise ALP protein and mRNA was shown to be associated with Cry1 resistance in some strains of *H. virescens* and *H. armigera* (Jurat-Fuentes and Adang, 2004; Jurat-Fuentes *et al.*, 2011). A 10-fold increase in specific ALP activity in the midgut lumen was suggested as a resistance mechanism In a Cry1Ac-selected AR1strain of *H. zea*, It was hypothesized that the soluble form of ALP in midgut lumen may sequester some of Cry1Ac toxins to affect toxin binding with other receptors (Caccia *et al.*, 2012).

High levels of resistance to Cry1Ac in the three bollworm species *H. virescens, P. gossypiella* and *H. armgiera* was found to be mediated through two major genes, the cadgerins and the ABC transporter proteins (ABCC2). Heckel *et al.* (1997) found that a single major gene (BtR-4) is responsible for 40-80% of Cry1Ac resistance levels in YHD2 and was mapped to linkage group 9. Morin *et al.* (2003) reported that three mutated cadherin gene alleles (r1, r2 and r3) were genetically linked to resistance to Cry1Ac in the AZP-R strain of *P. gossypiella*. Subsequently Fabrick and Tabashnik, (2012) identified a fourth resistance allele (r4) from the Bt4R strain. However in *H. armigera*, a deletion between exons 8 and 25 of HaCad (r1 allele) was found to create a premature stop codon that was genetically linked to Cry1Ac resistance in the laboratory-selected GYBT strain (Xu *et al.* 2005; Yang *et al.*, 2006). Thus far 12 cadherin alleles in *P. gossypiella*, one in *H. virescens* and 15 in *H. armigera* were reported to be genetically linked to resistance to Cry toxins. Many of the 15 HaCad cadherin mutants (r1 - r15) are known to have mutations at the ectodomain to thus confer recessive resistance. Resistance alleles r10-r14 of HaCad were suggested to confer resistance through amino acid substitutions, although exact amino acid substitutions have not been functionally confirmed yet (Zhang *et al.*, 2012a). However Zhang *et al.* (2012b) found that the r15 allele of HaCad showed deletion of 55 amino acids in the intracellular domain of cadherin to affect post-binding of Cry1Ac with cadherin and cause non-recessive resistance to Cry1Ac in *H. armigera.* Gahan *et al.*, (2001) identified a mutation in the cadherin gene HvCad in the YHD2 strain of *H. virescens*, as a major mechanism that conferred high levels of resistance to Cry1Ac. Jurat-Fuentes and Adang, (2004) subjected the YHD2 strain to further selection pressure with Cry1Ac and developed the YHD3 strain, with much higher resistance levels to Cry1Ac than YHD2. Interestingly a 22-bp deletion in exon 2 in a novel gene HvABCC2 that produced a truncated ABC transporter protein in the YHD3 strain was reported to be responsible for higher resistance to Cry1Ac and also loss of binding capacity with Cry1Aa and Cry1Ab as well in addition to Cry1Ac. The second resistance gene HvABCC2 in YHD3 was a truncated 99-residue protein instead of the full-length protein comprising 1339 amino acids. Thus it was surmised that the ABC transporter has an important role as a functional receptor of Cry1Ac and Cry1Ab toxins.

Amongst the several approached to delay bollworm resistance to Bt cotton, maintenance of 5-20% non-Bt 'refugia' cotton in the vicinity of Bt cotton, is the most recommended all across the world. The refuge crop is expected to support susceptible insects that may mate with the rare resistant insects that survive on Bt cotton, to dilute resistance in field populations. The strategy is most effective if resistance is functionally recessive and if the Bt crop shows a consistent high toxin expression. Refugia strategy becomes less effective if resistance is non-recessive or partial recessive and if the toxin expression is not high enough to kill heterozygous-resistant larvae.

Indian strains of *H. armigera* were found to show semi-dominant inheritance of resistance. Studies across the world showed that *H. armigera* resistance to Cry1Ac is completely recessive in SCD-r1 strain (r1allele, with a truncated cadherin) and completely dominant in AY2 and QX7 strains at the diagnostic concentration of Cry1Ac (Jin *et al.*, 2013). Based on results from laboratory-selected resistant strains, Fabrick *et al.*, (2014) concluded that resistance to Cry1Ac cotton is expected to be recessive in *P. gossypiella* from India.

Critical gaps in knowledge on resistance of American bollworm, *H. armigera* and the pink bollworm *P. gossypiella* to Cry1Ac and Cry2Ab

1. Diversity in resistance mechanisms
2. Molecular characterization of mutant cadherins, ABC transporter proteins and other possible resistance mechanisms in resistant strains.
3. Frequency of resistant alleles in field populations across India
4. Mode of inheritance of resistance of different resistant alleles
5. Variability of resistance mechanisms across insect populations and
6. Fitness costs associated with resistance conferred due to different alleles
7. Algorithms to integrate ecology, biology and genetics of resistance with respect to different alleles conferring resistance to Cry1Ac and Cry2Ab
8. Information on gene combinations for durable pest management and sustainable IRM

In the absence of complete information on the above mentioned aspects of resistance, IRM strategies will not be based on science and are less likely to be effective. Therefore it is strongly recommended that research projects should be initiated at various institutions in the country to provide robust leads that can result in the formulation of effective resistance management strategies.

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10

Integrated Nutrient Management- A Boon for Sustaining the Productivity of Crops and Cropping Systems

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The climatic, edaphic and socio-economic diversity of the Indian crop production science is dotted with many cropping patterns and systems. The cropping systems considered to be major contributors to the national food basket are rice-wheat (10.2 m ha), rice-rice (5.9 m ha), peach millet- wheat (2.3 m ha), sorghum-wheat (2.3 m ha), maize- wheat (1.9 m ha) and systems where land was kept fallow either *kharif* or *rabi* season occupy 19 m ha area. Cropping systems comprise of growing crops in sequence along with their interaction effects with the resources available, other enterprises available at the farm and technological inputs that determine their make-up *w.r.t* water, nutrients and energy for sustaining the productivity and profitability. The inputs must be used in such a manner to achieve for better use efficiency with minimum losses and to make them environment friendly. Cropping system investigations have amply demonstrated that the appropriate choice of the crops and cropping systems play a crucial role to achieve the maximum return and efficiently use of inputs on one hand and to make the resource balance by developing cohesion among the resources applied. Choices of crops primarily focus on productivity; fulfil domestic requirement and better competitive quality products. Hence, the choice of cropping systems has to be examined carefully in the light of these factors prior to recommendations.

In the country like India, it is estimated that almost 50 per cent of the production is accrued through fertilizer management (FAO 1965-76) and majority of the farmers are using chemical fertilizers only mainly because of multiple use of FYM perticularly as fuel consumption. The integrated approach increases the organic matter available nutrients in addition to improvement of physical and biological properties. A conservative estimates entail the availability of approx 300-400 million tonnes of organic sources which may be used for agriculture.

Till date our country has witnessed the contribution of fertilizers to total grain production, 1% in 1950, 32% in 1980 and around 53% in 2000. Thus, clearly showing significance of fertilizers as key input for achieving targets of agricultural production and to feed the burgeon population pressure. Simultaneously, it is strongly felt that soil health has been deteriorated on account of excessive wet tillage, sole use of chemical fertilizer, growing of high nutrient requiring crops and less use of organic sources such as FYM, compost, green manure, crop residue management, biofertilizer etc. Thereby, inviting the immediate attention for the right choice of cropping systems and integrated nutrient management at focused areas for ensuring the eco-balance and enhancing the total unit productivity. An effort has been made to identify various cropping systems in different agro-ecological regions along with the input of integrated nutrient supply using different sensus for making an assessment about the scope of increasing productivity, its sustainability, and profitability in the coming time.

i. There are numerous options of alternative cropping systems in comparison to the existing one in different agro-ecological regions, which not only give better productivity but also ensure the utilization of resources more rationally. The productivity improvement varied from 25-117 per cent and warrant attention for creating awareness of those cropping systems among farmers coupled with incentivies as a policy matter.
ii. Under limited irrigation conditions, selection of crops and cropping system should be based on soil type, soil depth, rainfall pattern and make the use of inputs accordingly.
iii. Inter cropping /mixed cropping and inclusion of legumes in different cropping systems are the other tools for making cropping system profitable and stable.
iv. The integrated use of organic manures (FYM, green manures, compost, vermi-compost, crop residues etc.) not only help to increase the yield of crops over the sole use of chemical fertilizers but also help to make the fertilizer economy along with soil fertility build up in all the individual crops as well as crops grown in a system. Use of organic manures is only criteria for maintaining soil health; and to make the different cropping system more sustainable, productive, and profitable.
v. The yield barrier can be broken in the existing cropping systems by following site specific nutrient management concept.

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Role of Microbes in Sustainable Agriculture

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Sustainability in the agriculture production is utmost important to feed the ever increasing population of the word. The world's population is estimated to be doubled by the end of 2033. Resources including agricultural land are constantly shrinking due to civilization and soil sickness. Existing technologies have reached to its *plateau* and is hitherto extremely difficult to further increase the food production. Therefore, and is an urgent need for the exploring non conventional resources not only to increase the demand of ever increasing population but also to sustain our ecosystem from the further degradation. Sustainability in the agriculture production cannot be attained without the sustaining the microbial population in the soil under the present circumstances. Recent development in the agriculture science disturbs the microbial ecosystem. This can be estimated that merely the use of chemical fertilizers has increased 233 per cent after the green revolution. Excessive use of the chemicals has increased the yield of different agricultural commodities, however, has ruined the environment seriously. Production and use of chemical fertilizers especially nitrogenous fertilizers has increased level of nitrous oxide in the atmosphere. Improvements in nitrogen use efficiency and nitrogen inhibitors can substantially reduce emissions of N_2O and help in protecting environment. Biofertilizers are safest and cheapest source of different nutrients used in the agriculture. There are microorganisms who symbiotically (*Rhizobium* sp.), associative symbiotically (*Azospirillum* sp and *Acetobacter* sp.) and without any association with the other plants (*Azotobacter* sp.) fixed atmospheric nitrogen which is having high utilization efficiency. These microorganisms if utilized properly have potential to save 50 per cent chemical nitrogen and thereby helping in the reduction of deposition of toxic N_2O in the atmosphere. Similarly, the process of manufacturing phosphate and potash fertilizers are also adversely affect the environment and soil micro climate when applied in the soil. Growth of different flora and fauna is also affected adversely. *Bacillus megaterium* and *Frateuria aurantia* are the bacteria that soubise the chelated fixed phosphorous and de-mineralized potash respectively. Formulation made up with these bacteria have potential to replace 50 per cent of phosphorous and potash fertilizers and helps in the reduction of deleterious effect of chemical fertilizers to the atmosphere. Application of biofertilizers and subsequent amendment of organic matter especially in the long duration horticultural crops in the proper proportion help in establishment of these microorganisms in the soil ecosystem. These microorganisms also act as PGPR and helps plant in stand better in various biotic and abiotic stresses. *Pseudomonas fluorescens*, *Trichoderma harzianum* and *T. viride* are efficiently used for the management of various diseases caused by the various fungi and bacteria. *Paecilomyces lilacinus* and *Beauveria bassiana* is very effective in managing nematode diseases in the various crop ecosystem. *Metarhizium anisopliae*, *Verticillium lecanii*, NPV, *Bacillus thuringiensis* are ideal candidate for the management of many insect pest complex. *Pseudomonas strutzeri* and *Chromobacterium violaceum* are used for the Bioremediation- heavy metal degradation. *Serratia marscenence* many species of *Bacillus*, *Aspergillus* and *Actinomycetes* are extensively used for the organic carbon recycling and waste management. Consortia of effective microorganism with differential properties is the ideal way for the replenish the soil microbiota and help in sustainability of the agriculture.

12

Understanding the Diversity in Lac Insects of *Kerria* Spp. in India and the Nature of Insect-host Plant Interaction

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India is the foremost lac producing country of the world with an annual production of about 20,000 tons and the home to richest biodiversity of economically important lac insects. Lac of commerce is derived from a few species belonging to the genus *Kerria*. Lac insect yields three basic components of economical value, *i.e*., resin, wax and dye. Lac insects belong to the Family Tachardiidae (=Kerriidae) of the Order Homoptera. They are phytosuccivorous and prefer certain species of plants called lac hosts. They remain attached to the host plant throughout their life with exception of crawler and adult male stages. Lac insects prefer warm climate and are therefore, distributed in the tropical and subtropical regions between the latitudes 40°N and 40°S. Lac production is restricted to few South, East and Southeast Asian countries like India, Thailand, China, Indonesia, Bangladesh, Myanmar, Laos and Vietnam. Due to unique biology, host preference and dispersal mechanisms lac insects are expected to differentiate locally, forming geographic and host races without adequate morphological differentiation. This has been substantiated through recent studies using RAPD and ISSR primers among forty-eight geographic races and other cultivated lac insects of *Kerria*. It was, therefore, important to develop more reliable markers for easy characterization of such variation in the lac insect collections. Plant sap is the sole source of nutrition for the lac insect. The factors governing the selection of only few host taxa by the lac insect in general and preference of specific host species by different lac insect strains and species needed to be investigated. Presence of endosymbiont *Wolbachia* was suggested by the preliminary investigations. Detailed studies aimed at detection, identification and characterization of endosymbionts were desirable as they are likely to play important role in host metabolism, reproduction as well as biosynthesis of the constituents of lac. Therefore, an understanding of lac insect-host plant relationship required for lac production was far from complete without the knowledge on endosymbionts. The study employed a multi-faceted approach to analyze and document the lac insect germplasm collections. The aspects studied included characterization parameters which encompassed morphology, karyology as well as biochemical and molecular profiles and economic parameters, *i.e*., qualitative and quantitative variations in the resin, wax and dye produced by these insects.

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A Journey of *Helicoverpa armigera* (Hubner)

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The gram pod borer *Helicoverpa armigera* (Hub.) is major key pest on many economic important crops like cotton, pulses, oilseeds and vegetables. It is a polyphagous, opportunist and multigenerational pest causing severe economic losses in many important crops. The pest gained paramount importance in last decade due its repeated outbreaks in several states of India which led to social-economic consequences. In many cropping systems it easily attains a major pest status due to its physiological, ethological and ecological characteristics viz., high polyphagy, wide geographical range, migratory potential, facultative diapause and high fecundity and has caused severe economic losses, apart from which it has also caused serious ecological and sociological problems. In the case of this important pest, considerable amount of work has been done and in the present paper summarized information on biology, ecology, ethology and certain aspects of management has been covered. Extensive studies on biology, host range, seasonal incidence, management practises have provided an insight to overcome the menace. Various management strategies such as biological, microbial, insecticides, pheromones and integrated pest management have been developed to control this pest. But certain ecological and ethological parameters like polyphagy, facultative diapause, long range flight ability and high fecundity have provided ecological edge to become most obnoxious and destructive pest and high inclination for developing resistance to all the chemicals deployed for its control make it a very formidable enemy.

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Climate Change: New Challenges for Pest Management

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Climate changes are occurring rapidly at both regional and global scales. Current estimates of changes in climate indicate an increase in global mean annual temperature of 1°C by 2025, and 3°C by the end of the next century. The doubling of CO_2 is estimated to be between 2025 and 2070, depending on the level of emission of greenhouse gasses. But this much is clear that global warming is likely to alter production of rice, wheat, corn, soybeans and potatoes which constitute staple food for billions of people and are major food crops. Due to the enormous uncertainties surrounding global climate change, estimates of cropland reductions vary from 10 to 50 per cent. Losses due to insect damage are likely to increase as a result of changes in crop diversity and increased incidence of insect pests due to global warming. Climate change will have serious consequences on geographical distribution, diversity and abundance of insect pests and extent of losses. Pest outbreaks might occur more frequently, particularly during extended periods of drought, followed by heavy rainfall. Under the projected warming trend in the farmers can expect a 25 to 100 per cent increase in losses due to insects, depending on the crop.

The temperature is will be most important environmental factor influencing insect behaviour, distribution, development, survival and reproduction. With a 2°C temperature increase, insects might experience 1-5 additional life cycles per season and fecundity/female may go up to 500. Rising temperatures will lengthen the breeding season and increase the reproductive rate and will raise the total number of insects attacking a crop and subsequently increase crop losses. With warmer climate at mid-latitudes there would be an increase in the carryover of pests and build up of higher population density of a number of important agricultural pests early in season resulting in larger populations as a base for a build-up in numbers within the season. Rising temperatures are likely to result in availability of new niches for insect pests. There may also be increased dispersal of airborne insect species in response to atmospheric disturbances. The low temperatures are also more important than high temperatures in determining geographical distribution of insect pests. Increasing temperatures may result in a greater ability to overwinter in insect species limited by low temperatures at higher latitudes and extending their geographical range. The sudden outbreaks of insect pests can wipe out certain crop and also encourage the invasion by exotic species. Spatial shifts in distribution of crops under changing climatic conditions will also influence the distribution of insect pests in a geographical region. In addition to the direct effects of temperature changes on development rates, and improvement in food quality may result in dramatic increases in growth of some insect species, while the growth of certain insect pests may be adversely affected. Pest outbreaks are more likely to occur with stressed plants as a result of weakening of plants' defensive system, and thus, increasing the level of susceptibility to insect pests. Insect host plant interactions will change in response to the effects of CO_2 on nutritional quality and secondary metabolites of the host plants. Increased levels of CO_2 will enhance plant growth, but may also increase the damage caused by some phytophagous. Gradual continual rise in atmospheric CO_2 will affect pest species indirectly via interactions with other environmental variables. The CO_2 effects on insects are usually indirect in terms of insect damage that results from changes in the host crop. Generally, elevated CO_2 levels induce increased consumption rates in insect herbivores. In atmospheres experimentally enriched with CO_2, the nutritional quality of leaves declined substantially due to dilution of nitrogen by 10 to 30 per cent. Rising carbon dioxide will increase the carbon-to-nitrogen balance in plants, which in turn will affect insect feeding, concentrations of defensive chemicals in plants, compensation responses by plants to insect herbivory and competition between pest species. The change will also affect the defense mechanism in host against insects. These include. carbon-based compounds (phenolics and tannins) and nitrogen-based compounds (alkaloids and cyanogenic glycosides) which alter the suitability of host for feeding, oviposition and development that tend to slow insect growth, often by binding with proteins to reduce the insect's ability to digest the food. Moisture is essential for survival and development of insects and therefore changes in precipitation may also affect the distribution and abundance of insects. But excessive rainfall is harmful for many soft bodied insects like thrips, aphids and whiteflies. Flooding may have a negative impact on soil-dwelling insects, while drought could increase plant carbohydrate concentration making host plants more attractive to insects.

Biodiversity plays an important role in abundance of insect pests and their natural enemies. Changes in cropping pattern as a result of climate change will drastically affect the balance between insect pests and their natural enemies. Since climate change will lead to a shift in cultivation of crops in non-traditional areas and crop rotations, this may influence the prevalence and importance of specific pests. Main effects of climate change on insect communities result in decreased abundance of decomposers and predators, and increased herbivory, which may have negative consequences for structure and services of the entire ecosystems.

The analysis of various studies in the USA on climate change and insect damage indicate that insect pests may be more active and will result in greater economic losses. Insects will respond to higher temperature with increased rates of development and short duration of generations. Warmer winters will increase carryover of insects and consequently there may be increased insect populations in subsequent growing seasons. Additional insect generations and greater populations encouraged by higher temperatures and longer growing seasons will require greater efforts of pest management. In India, conditions will be more favourable for the proliferation of insect pests in warmer climates. Longer growing seasons with warmer winter will result in greater infestation during the following crop season. Some of the insect pests which are likely to assume serious proportions due to the changing climate and cropping patterns include American bollworm, *Helicoverpa armigera* (Hubner); tobacco caterpillar, *Spodoptera litura* (Fabricius); cotton whitefly, *Bemisia tabaci* (Gennadius); brown planthopper, *Nilaparvata lugens* (Stal); (Wood-Mason); pink stem borer, *Sesamia inferens* (Walker); wheat aphid, *Macrosiphum miscanthi* (Takahashi); serpentine leaf miner, *Liriomyza trifolii* (Burgess); diamondback moth, *Plutella xylostella* (Linnaeus);and tea mosquito bug, *Helopeltis antonii* Signoret. *In* Europe the climate change will affect the distribution, phenology, susceptibility and the interrelationship of insects drastically, which emphasize the risk of sustainable crop protection by losing the control on pests-natural enemies populations.

The prediction of sustainable pest management strategies with the climate change is very complicated. Host plant resistance, microbial pesticides, natural enemies, and synthetic chemicals are some of the potential options for integrated pest management. However, these will be rendered less effective as a result of increase in temperatures and UV radiation, and decrease in relative humidity. Adverse effects of climate change on the activity and effectiveness of natural enemies will be a major concern in future pest management programmes. Relative efficacy of many pest control measures is likely to change as a result of influence of global warming and extension of geographical range of insect pests due to increased over-wintering and rapid population growth, changes in insect-host plant interactions, increased risk of invasion by migrant pests, impact on arthropod diversity and extinction of species, changes in synchrony between insect pests and their crop hosts, introduction of alternative hosts as green bridges, and reduced effectiveness of crop protection technologies. The possible increased use of insecticides resulting from an increase in pest outbreaks will likely have negative environmental and economic impacts for agriculture. The effectiveness of current IPM and other pest management strategies will be challenge to reduce the losses due to insect pests. Climate change may make IPM solutions less effective and harder to implement.

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Integrated Pest Management: An Analysis of Challenges and Future Strategies

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A spouse indicated the marriage partner, he or she called "our wife or our husband", not "my wife or my husband," Closing gaps in crop yield while enhancing sustainability is among the greatest challenges for achieving food security. Ecological intensification, the improvement of crop yield through ecosystem services provided by biodiversity, may be a sustainable pathway. However, data supporting such an approach are missing, especially for two billion smallholders, many of which are undernourished. It is beyond doubt that Integrated Pest Management is the powerful tool in the hands of farming community engaged in sustainable agriculture. In one hand, it has played a crucial role in enhancing the yield potential in the sustainable way to meet out the burgeoning population demand and on the other to keep the natural resources (land and water) and environment safe for the future farming generations to come. But, the scenario has been different in many developing countries having small area to feed or support the rapidly growing population, where IPM has started some 20 years late rather than developed countries and could not keep the essence of IPM intact in achieving the mandate of an IPM programme. Chemical pesticides have been set as the last resort in IPM practices, but farmers still applying the pesticides as the first resort for getting quick results. At the same time, pesticides proved to be more dangerous due to their indiscriminate and excessive use, contaminating food (milk, honey, cereals, vegetables, and fruits) and the environment (ground water, soil, etc.), resulting in pest resistance, pest resurgence, loss of beneficial fauna, pesticide poisoning and frequent localized pest outbreaks. We have travelled a long way of five decades since the inception of economic threshold level by Stern *et al.* in 1959 and at this juncture we have to redefine and analyze the challenges and strategies of IPM particularly in developing countries to boost the safe and sustainable food production. Growing population pressure has hastened environmental degradation and depletion of essential natural resources. Nearly 1 billion people in the world are undernourished or suffer from chronic diseases as a result of food insecurity due to population growth, climate change, and urban development. In the next 50 years, the global population is expected to reach 9 billion, doubling the demand for food, feed, and crop. According to World Health Organization (WHO), more than 20,000 unintentional deaths and 3 million poisonings occur due to misuse of pesticides in the Third World every year. Available estimates reveal that global pesticide use has increased 50-fold since 1950, and 2.5 million tonnes of agricultural pesticides are now used each year worldwide. No doubt pesticides are credited to have saved millions of lives by controlling diseases, such as malaria and yellow fever which are insect borne; however, their use causes a variety of adverse health effects and environmental pollution as described above. Alternate pest control methods and the restricted use of pesticides can minimize the risk of pesticide usage. Pesticides can prove to be the most effective instruments in crop protection and if correctly used, their effect is fast and complete, which makes them applicable against nearly every pest. However, the introduction of high inputs of agro-chemicals during the Green Revolution era have proved to be more dangerous due to their overuse, which resulted in the deterioration of soil and plant health, pesticide contamination of food and the environment, and pesticide resistance and pest outbreaks. Consequently, the need arose for IPM strategies to produce safe food and reduce the negative externalities caused by pesticides. In the near future, these challenges are expected to worsen further if measures are not taken to address them.

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Role of Eco-friendly Seaweeds based Bio-stimulants in Sustainable Agriculture

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Seaweed based biostimulants and its different formulations are used to soil and plants to stimulate the crop's physiological processes and to improve crop yields and quality. Role of seaweed based biostimulants in improving agriculture productivity and quality of produce has a significant impact on agriculture. Biostimulants market has shown an emerging trend in use of biostimulants. Seaweeds biostimulants are also used in organic farming. The market for biostimulants has a significant impact on not only human health, but also on the environment. Biostimulants can be applied in a variety of methods in agriculture and horticulture such as by foliar, seed, and soil application. There has been a tremendous increase in the demand for biostimulants for greater yield of crops. The application of biostimulants application is increasing in developing countries. The players in this market have developed a range of innovative products to target specific crop needs. Thus, the biostimulants market is gaining more global presence and acceptance among customers.

The study was conducted through market survey, literature search to collect the data on, different seaweeds used in biostimulants production, what are their benefits in sustainable agriculture. Who are the market leaders and are the challenges of bio-stimulant industry.

There are many companies' worldwide engaged in the development, production and marketing of seaweed based biostimulants which are contributing in sustainable agriculture development. Huge data is available on biostimulants effects on different crops. In India Biostadt India Limited is pioneer in the research, manufacturing of biostimulants products and leader in marketing of quality Seaweed based biostimulants to improve crop productivity. Biostimulants market trends have shown that biostimulants market has grown in past and continue to grow in coming years at compound annual growth rate (CAGR) 12.5-13.0%. There are number of benefits of seaweed biostimulants like improve soil health and quality, improvement in soil micro flora, protection against stress, improved nutrient uptake by plants and better yield.

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Composting of Organic Wastes in Rural Areas for Improving Plant Nutrition and Soil Health

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Soil health holds the key for the income and livelihoods security in the rural areas where the economy is predominantly agriculture based. There are various studies, which show that the soil health has deteriorated over time owing to faulty land use and soil management practices. Lack of organic matter reduces the water retention capacity of the soils, which also affects the crop productivity. Practices of applying farm yard manure, crop rotation, mixed cropping, inter-cropping, keeping land follow, and summer ploughing gradually stopped/reduced over time as increased attention was given to the use of chemical fertilizers and monocultures aided by government policies.

Comopost/Organic manure benefits the soil by recycling nutrients into it. It improves soil structure, texture and aeration along with its water holding capacity. It loosens clayey soil and increases water retention in sandy soil. It encourages healthy and abundant root development; plants grow with more resistance to disease and pests in the long run.

Excel technology aimed to improve the soil health and farmers' farm productivity by rapidly converting rural biomass/waist into well matured organic manure and compost and using this in their fields. This technology is suitable for all kinds of organic waste and Agriculture biomass.

1. Advantages of Our Technology

- Fastest conversion of organic waste into Organic manure. It takes about 45 days
- It is aerobic composting and we does not need any pit or special place, this operation can be done in any open field.
- No Nutrient loss, rather it preserves all maco and micro nutrients.
- No Weed Seeds.
- No Pathogens.
- No Termites.
- No White Grub or any resting stages of Insects.

We had unique waste treatment substrate/culture comprising of Bio-organism and herbal extracts. The material is known as MADHYAM. MADHAYAM is a synergistic blend of non pathogenic bacteria, fungi, herbal extracts, capable of rapidly converting organic waste into useful organic plant nutrient. It contains required food substrate for useful micro - organisms and provides them an ideal living condition which helps in accelerated breakdown of cellulosic, proteinaceous and fatty materials to minimize their purification properties and accomplish rapid Bio-conversion cycle.

2. Functional Benefits

- Accelerates aerobic composting of bio degradable organic waste.
- Preserves plant nutrients and minerals in the end product.
- Very safe to handle and easy to apply.
- An eco-friendly product to solve, waste management problem in rural areas and providing better, fully matured organic manure.

3. Success Stories

An aerobic composting pilot project was carried out at IARI campus fields with the help of Madhyam and tractor operated mixing and turning equipment (provide by Excel Crop Care Ltd), which has made this possible. The long heaps of cowdung and crop residue was composted in short span of time. The compost obtained is fully digested and sterilized as the temperature during the process goes to 50-70°C. Thus pathogens, weed seeds and resting stages of lepidopteran pests including white grub & termite along with foul smell is eliminated. This tractor operated mixing & turning machine has come very handy for faster converter, time & labour saving, & more economical for IARI.

3.1 Success Stories- Sikkim

The role of Excel in the promotion of the Sikkim Organic Mission has been exemplary. This has been achieved largely through dissemination of information, knowledge and promotion of Aerobic composting through Excel's Product, 'Madhyam'. In Sikkim Excel is working in villages along with Agriculture and

Horticulture Departments and helping them to create interest in organic farming, and providing training at Krishi Vigyan Kendras and also at the Panchayat level, aiding the farmers greatly in taking up organic farming with compost made by Excel's product, 'Madhyam'. Training is provided to them in how to make organic manure in bulk with the help of 'Madhyam'.

3.2 Use of this Technology in Other States

Punjab, Chhattisgarh, Gujarat, Maharashtra, Madhya Pradesh and Uttar Pradesh are other states where 'Madhyam' is being used by leading and progressive farmers for improving their farm productivity and maintaining soil health. These success stories & composting process can be extended to large no. of farmers through various KVKs' working under IARI and state agriculture universities in collaboration with Excel Crop Care Limited.

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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.

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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-a-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, pomegranate, 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.

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Strategy for Optimization of Higher Productivity and Quality in Field Crops through Micronutrients

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Micronutrients or Trace elements are essential for plant growth & development but it is needed in very small quantities in the plant system. It includes Fe, Cu, Cl, Mn, B, Ni, Zn & Mo. The accumulation of these micronutrients by plants generally follows the order of Mn>Fe>Zn>B>Cu>Mo. This order may change among plant species and growth conditions (e.g.; flooded rice). Zinc deficiency is the most ubiquitous micronutrient problem throughout the world affecting many crops including the staples maize, rice and wheat which reduces not only grain yield but also nutritional grain quality (Graham and Welch, 1996). Copper deficiency is important in some parts of the world, such as Europe and Australia where cereals are most affected. Micronutrient constitutes in total less than 1% of dry weight of most plants. Micronutrient availability is greatly influenced by soil pH. As pH increases from 4-7. Zn, Fe, Mn & B decreases in solubility & availability while Mo increases in solubility & availability (Jacobsen, 2009). Incidence of micronutrient deficiencies in crops has increased markedly in recent years due to intensive cropping, loss of top soil by erosion, losses of micronutrients through leaching, liming of acid soils, decreased proportions of farmyard manure compared with chemical fertilizers, increased purity of chemical fertilizers, and use of marginal lands for crop production. Micronutrient deficiency problems are also aggravated by high demand of modern crop cultivars (Bell, 2006). Plant factors such as root and root hair morphology (length, density, surface area), root induced changes (secretion of H^+, OH^-, $HCO3^-$), root exudation of organic acids (citric, malic, tartaric, oxalic, phenolic), sugars, and non-proteinogenic amino acids (phytosiderophores), secretion of enzymes (phosphatases), plant demand, plant species/ cultivars, and microbial associations (enhanced CO2 production, rhizobia, mycorrhizae, rhizobacteria) have profound influences on plant ability to absorb and utilize micronutrients from soil (Clark and Zeto, 2000). Water shortages are another problem, as access to groundwater has diminished in several areas. It showed that a small amount of nutrients, particularly Zn, Fe, and Mn applied by foliar spraying increases significantly the yield of crops (Sarkar *et al.*, 2007).

The micronutrients that practicing agronomists and crop production people can reasonably do something about are zinc (Zn), iron (Fe), manganese (Mn), boron (B), chlorine (Cl), copper (Cu), and molybdenum (Mo). Zinc is likely the most common micronutrient that is in short supply. Iron is perhaps the most difficult to make available because it is needed in relatively large amounts and soil chemical processes sometimes quickly make it unavailable. Knowing how an element functions in the plant and some of its associated soil chemical interactions helps diagnose problems and prescribe solutions.

World over micronutrients are gaining much importance not only for their role in sustaining higher crop yield but such increased nutritional deficiency in soil, seed and/or feed, is more affected animal and human health. Micronutrients are required relatively in smaller quantities (<100 ppm). These include: B, Fe, Zn, Cl, Mn, Mo & Ni whenever, the supply of one or more of these elements is inadequate, yields will be reduced and the quality of crop is impaired, but crop species, cultivars vary considerably in their susceptibility to deficiencies. Micronutrients may be minor in terms of the amounts needed by the crop, but they can be major in terms of their impact on crop growth (Zayed *et al.*, 2011). Micronutrients often act as co-factors in enzyme systems and participate in redox reactions, in addition to having several other vital functions in plants. Micronutrients are vital for plant growth and human health. Soil and foliar applications are the most prevalent methods of micronutrient addition but the cost involved and difficulty in obtaining high quality micronutrient fertilizers are major concerns with these in developing countries. Micronutrients are essential to plant growth, yet are required in much smaller amounts than macronutrients. Studies of the roles of nutrients in plants have involved several diagnostic criteria that address the accumulation of nutrients and their roles in plants. These criteria include visual diagnosis, plant analysis, biochemical tests, and soil tests. Factors such as soil pH, organic matter, temperature, moisture & light are important in determining the availability of micronutrient (Fageria *et al*, 2001). If micro nutrient deficiency will occur, some fertilizer sources will correct them e.g; in case of boron, fertilizer source is sodium tetraborate (14-20% B), in case of Zn, fertilizer source is Zinc sulfate (23-36% Zn) & Zn-chelate (9-14% Zn) and in case of iron, fertilizer source is ferrous ammonium sulfate (14% Fe) & ferrous ammonium phosphate (29% Fe), (Hansch, 2009). Methods of correcting micronutrient deficiencies for field crops can be either by soil application or foliar application, but foliar application is more efficient than soil application because it is quickly taken up by the plants (Fageria *et al.,* 2001). Micronutrients are required in very small quantities by the plant for their function. To manage micronutrient deficiencies, spraying of suitable chemicals at recommended levels by foliar application will alleviate the deficiency which in turn improves crop yield.

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Livestock Resource Management: Recent Trends, Future Prospects

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Livestock farming systems inhabit about 30 per cent of the world's terrestrial area and is a significant global asset with a value of at least USD1.4 trillion. Livestock farming and associated market chains employ at least 1.3 billion people worldwide and contributes directly to the livelihoods and food security of 600 million poor smallholder farmers in the developing world. Livestock products contribute 17 per cent to kilocalorie consumption and 33 per cent to protein consumption globally. However, there is a long gap in terms of energy and protein consumption from livestock products between developing and developed countries. In developing countries, livestock is one of the fastest growing agricultural subsectors. Its contribution to the total agricultural GDP is already 33 per cent and is showing signs of further increase. This growth is a consequence of rapidly increasing demand for livestock products. Increase demand for livestock products is multi factorial and includes population growth, urbanization and increasing incomes in developing countries. Much of this growth was concentrated in countries that experienced rapid economic growth, particularly in East Asia.

Livestock is an important sub-sector of the agriculture of Indian economy, supporting livelihood and food security for rural households, supporting agriculture in the form of critical inputs, supplementing incomes, offering employment opportunities, and finally being a dependable "bank on hooves" in times of need. India is blessed with a rich biodiversity of livestock resources evolved over a long time in varying agro-climatic conditions and production systems. They provide milk, meat, egg, fibre, wool, leather, draught power and organic fertilizers to agriculture and employment to rural masses as well as many stakeholders engaged in management and improvement of these resources.

It is thought that humankind's association with domesticated animals goes back to around 10000BC, a history just about as long as our association with domesticated plants. The global trend indicates a necessity driven flux of livestock sector that may well undergo radical change in the future. However, the key fact remains that contribution of small and marginal farmers is still critical to the wellbeing of millions, possibly billions, of people in the country. Government policies, strategic and applied research have made significant and proactive development for them, nevertheless, emphasis is amply worthy for extension personnel for instigating the message of skill development and technology transfer to the farmers.

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Climate Change and its Impacts on Fisheries

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Climate change is a change in the statistical distribution of weather patterns which lasts for an extended period of time (ranging from decades to millions of years). It has unequivocally been considered as one of the most serious threats to sustainable development with possible adverse impacts on natural resources, thereby affecting food security, human health and economic activities. Factors that shape climate include variations in solar radiation, earth's orbit, mountain-building, continental drift, changes in greenhouse gas concentrations and certain anthropogenic activities. The most notable and significant changes associated with climate change are the gradual rise of global mean temperatures and a gradual increase in atmospheric green house gases. *Intergovernmental Panel on Climate Change* (IPCC, 2014) reported that global surface temperature increased about 0.74±0.18°C (1.33±0.32°F) during the past 100 years and global surface temperature will probably rise a further 1.1 to 6.4°C (2.0 to 11.5°F) during the end of twenty-first century. The year 2014 was declared as the warmest year across global land and ocean surfaces since 1880.

Fisheries and aquaculture contribute significantly to food security and livelihoods. Fish provides essential nutrition for 3 billion people and at least 50% of animal protein and minerals to 400 million people from the poorest countries. Over 500 million people in developing countries depend, directly or indirectly, on fisheries and aquaculture for their livelihoods. Aquaculture is the world's fastest growing food production system, growing at 7% annually and fish products are among the most widely traded foods, with more than 37% (by volume) of world production traded internationally.

Though precise consequences cannot yet be forecast, climate change is likely to affect fisheries and aquaculture, their dependent communities and related economic activities along three main pathways viz direct physical effects (e.g. sea level change, flooding, storm impacts), biological and ecological responses to physical changes (e.g. productivity, species abundance, ecosystem stability, stock locations, pathogen levels and impacts) and indirect wider socio-economic effects (e.g. fresh water use conflicts affect all food production systems, adaptation and mitigation strategies in other sectors impact aquatic systems in general or fisheries and aquaculture directly).

Major impacts of climate change include sea level rise, storm severity, salinity alteration, acidification, temperature rise etc. Small rivers and lakes are most vulnerable followed by large rivers, lakes, estuaries and high seas. The major impacts on marine fisheries include change in sea temperature, sea level rising and associated ecological changes, changes in circulation pattern, change in sea temperature etc. which may effect on fish physiology through retarded growth and reproduction failure which ultimately affect seed availability and fish biodiversity. There may be seasonal shifts in the breeding period, migration pattern of fish stock in natural water bodies.

In recent years climate is showing perceptible changes in the Indian subcontinent, where the average temperature is on the rise over the last few decades. In India, observed changes include an increase in air temperature, regional monsoon variation, frequent droughts and regional increase in severe storm incidences in coastal states and Himalayan glacier recession. India has 2.02 million sq km of marine resources comprising including 8118 km of coast line, estuaries, backwaters, lagoons etc Coastal fisheries sector is one of the most vulnerable sectors as far as impacts of climate change are concerned. Marine fishing communities mostly reside within 2-3 hundred meters of the coastline and are the most vulnerable group of people with respect to storms and cyclones, rogue waves and of course rare events such as the tsunami.

The impacts of climate change can be addressed through adaptation and mitigation. Climate change related adaptation measures and disaster management for extreme weather events such as cyclones, sea level rise, coastal erosion, etc need to be put in place by taking into consideration the uniqueness of the different coastal regions. Some of the adaptation strategies including site specific and species specific strategies to combat impacts of climate change in inland and marine fisheries may help to cope up with the changing situation. However, adaptation may be costly and limited in scope, so that mitigation of emissions to minimize climate change remains a key responsibility of governments and societies.

As the climate change is an additional pressure on top of the many (fishing pressure, loss of habitat, pollution, disturbance, introduced species) which fish stocks already experience, so its impact must be evaluated in the context of other anthropogenic pressures, which often have much greater and more immediate effect.

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Does Climate Change Affect Early Embryonic Survival in Ruminants?

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Climate change has become a major concern with livestock farmers struggling to cope with changing temperatures and rainfall patterns and increased flood and drought risks. Early embryonic mortality is a main cause of repeat breeding resulting in reduced pregnancy rate, slower genetic improvement and substantial economic loss to farmers. Approximately 20-30% of the embryo mortality occurs between days 8 and 16 of pregnancy in ruminants. Understanding and unraveling the secrets of embryo development and implantation will lead to alleviation of early embryonic loss in sheep. Heat stress-induced hyperthermia has been found to decrease the pregnancy rate in cows during the summer in regions associated with elevated ambient temperatures. Mortality of preimplantation embryos increased when the pregnant cows were kept under heat stress, and the conception rate increased when heat stress was mitigated in summer. Direct exposure of bovine oocytes to elevated temperature during in vitro maturation reduced embryo development coincident with alterations in the oocyte. Specifically, de novo protein synthesis was reduced by approximately 30% after exposure to 41ºC for the first 12 h of meiotic maturation, coincident with a 65% reduction in blastocyst development. In sheep the expression of COX-II, PGES and Osteopontin mRNA was found to decrease during early pregnancy following heat stress. Upregulation of expression of Integrin mRNA was observed in endometrium of heat stressed ewe on Day 11 and 13 of pregnancy but Galectin and PGFS mRNA was higher on 13 and 15 of pregnancy following heat stress. In vitro heat shock at 40.5°C for 18 hrs has been found to result in shedding of cumulous cells and oocyte degeneration with decrease in protein, glucose, chloride, urea and calcium content of matured sheep oocytes *in vitro*. The expression of PGES, PGFS, Integrin and Galectin mRNA decreased at 12 hr and 24 hr following exposure to higher temperature (40.5°C) in buffalo endometrial epithelial cells. It is concluded that heat stress adversely affected the utero-ovarian function during early pregnancy and elucidation of the molecular and cellular dialogues at embryo-uterine interface in response to climate change will develop strategies to augment embryo survivality.

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Status of World's Unique Animal Genetic Resource of Ladakh

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Ladakh is the only typical cold arid zone of our country with extreme climate and hostile condition, the area makes its floura and fauna a unique one and distinct from rest of the country. Around 60% of the farmers of Ladakh are Pastoralist and 40% of the farmers are agriculturist and the majority of the economic income comes from animal rearing in Ladakh. It has some of the world's best animal genetic resource in the form of Pashmina goats, Changthangi Sheep, Semi domesticated Yak, Bactrian (Double Humped Camel) Zanskari horse and Bos Taurus in the form of Local cattle. All this livestock contribute a lot to the income of the farmers of Ladakh and the Changthangi people are completely dependent on this livestock rearing**.** All this livestock are reared on extensive system on high altitude pastures grasses. During the past few decade these unique germplasm are facing several threats for its eco friendly existence with the human populations. These threats and constraints are figured with possible recommendation and solution in the present study. One of the basic reasons is that Ladakh has been deprived of basic research facilities in animal science sector for so many years due to which this unique genetic resources are declining in terms of numbers as well as in production. If necessary steps are not taken immediately a time will reach that all this precious animals will be lost forever. The present article describes the present status and critical issues pertaining to animal genetic resource of Ladakh. The local cattle which is a non-descriptive breed is very well adapted to the hypoxic condition of Ladakh, it can thrive very well on meagre feed and highly resistant to most of the contagious disease. Certain reports on the local cattle indicate it to the Bos *taurus* species. In Ladakh the performance of Jersey crossed with these local cattle is very much appreciated by the farmers and more than 80% of the Ladakhi cattle are cross between Jersey and Local with an overall average milk production of 5-6 litres per day. There is complete trend of increase in cattle population of Leh district since 1992 (24836 Nos.) to 2008 (36231 Nos.) leading to a sharp increase in total milk production of the district. Presently (2014) the cattle population of Leh district is 12977 with a static milk production. This data reveals the decrease in local non descriptive cattle which produce around 1-2 litres of milk per day with no input expenditure on feed and medicines. The local cattle which are adapted to Ladakh condition are being replaced by Jersey cattle which have many management and health issues regarding their adaptation in Ladakh. If this trend continues then this local genetic resource in future will be lost forever.

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Long Term Options for Groundwater Sustainability in Indian Agriculture

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Natural resources play an important role in agricultural production and productivity comprising essential ingredients of the production process by transforming inputs into outputs. Water is critical for any biological process and has rainfall, surface water and groundwater as its three important components. Agriculture in any region draws water for production through diverse combinations of these three sources. Though Indian agriculture is predominantly rain-fed, the most productive regions have shown an increased dependence on the groundwater resource. The overdependence on the groundwater in these regions has led to its overexploitation and hence in falling groundwater tables. This paper looks into various options for ensuring long-term sustainability of groundwater use in agriculture. The paper has broadly classified the options into i) policy, ii) technologies and iii) practices. It highlights electricity pricing, pricing of water for irrigation, promotion of crop diversification, water allocation and water rights as important components of policy. Based on the review of different technologies and production practices, the paper has highlighted the potential of irrigation scheduling using moisture sensors and other related devices, drip and sprinkler irrigation, mulching, laser land leveling, direct seeding of rice, system of rice and wheat intensification, etc., in realizing significant reduction in groundwater use in agriculture. While some technological options and crop production practices have been widely adopted by the farmers in various regions of India and other countries, many options have not been adopted at a wider scale to ensure a larger impact. The paper highlights the need to device strategies for faster and wider up-scaling of technologies and practices to ensure long-term sustainability. The costs and returns associated with the use of technologies and practices, the ease of use and access to the options, a renewed focus of the extension agencies on resource conservation, and other factors such as cultural aspects of use, equity impacts of the technology as well as the socio-economic characteristics of the user farmers are important factors affecting their large scale adoption. The development of a package of incentives for the farmers in the form of weather, markets and input use and linking it to water saving technologies may also help. The paper also concludes that rational policy instruments aimed at conserving the groundwater resources have relatively larger potential to ensure long-term sustainability by generating larger impacts and also enhancing the chances of better adoption of the technologies and practices.

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Return from Investment in Agricultural Education, Research and Outreach Extension Systems for Community Development: Some Policy Guidelines in the Context of Pacific Island countries

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This paper reviewed some past studies on the contribution of investment in education specially higher education, research system and community extension services in agriculture over the years in different countries. Experiences of the PNG University of Technology also described as a case study for the Pacific island countries. Finally recommendations are made for policy guidelines for future investment. Increased investments in higher education, research system and extension services for community development in agriculture are desirable as economic success in the global market plays key roles by the out puts of these activities. Estimated real net benefit of higher education from graduates' income to the government exceeds the cost of higher education in the last two decades or more. There are also quantitative and qualitative benefits of higher education. The main quantitative benefit is the enhanced earnings of the graduates. They pay higher tax on earnings to the government. Qualitative benefits are improved equity, "spill over benefits" and direct external benefits to the community. The spillover benefits from the investment in university education, research system and community extension services are enormous. Because the university system provides more opportunities to make their outputs public instead of keeping them private through excess to media and networking. Geographical clustering of innovations in these sectors also results international knowledge spill over. Studies from several countries over three decades and more support the high return from investment in agricultural extension services for community development, even quite often without considering the impact of inter farmer communications. Apart from yielding significant financial returns, extension advisory services have also yielded positive social returns, particularly for women, people with low literacy levels, and farmers with medium landholdings. Investment in higher education, research, extension and innovations through university system pays off. Its value is borne out by history across time and space. The disadvantaged geographical locations as isolated island countries and not easily accessible need special attention for investment in these sectors. Policy guidelines to address these issues need to be updated in the context of changing environment.

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Sustainability of Himalayan Environment: Issues and Policies

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The Himalayan region has three major areas of interest, mountain environment, forest resources and fresh glacial water. Mountain people mostly follow agricultural livelihood system for their sustenance and economic well being. However, contraction of resources and climate change demand a shift from the conventional to improved management system of resources. The process of economic growth is reaching the unreached mountain societies which are seen as a transition from total dependence to partial dependence on farming, through improved education, skill development and exploitation of potential niche areas for development. The unpredictable weather, fast depleting resources, inadequate infrastructure, low productivity of animals and heavy disasters witnessed during recent past are some of the challenges to be met in Himalayas. However, there exist opportunities for resilience to these challenges through cultivation of high value off-season vegetables, medicinal/aromatic plants/ flowers and a path of reversing the shift from desirable to undesirable ecology. To enable the Himalayan people to promote sustainable farming, achieve sustainable livelihood, maintain mountain ecosystem services, these people need access to the natural resources and empowerment of their women, which are supposed to be the key determinants for their development and are required to be extended to them under specific legislations. Public investment in education, health, transport, research, extending credit, extension services, compensation for watershed management and conservation of biodiversity are some of the policy options suggested to achieve sustainable Himalayan development.

The Himalayas account for most of the vastly distributed mountainous areas spread over 12 states of India, viz., Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and West Bengal and extend up to 2,500 km in length and 250 to 400 km in breadth. Longitudinally, Himalayas are classified as Shiwaliks flat summits (600-1200m msl altitude), middle Himalayas (65-75km width, average height 3,000 m), Greater Himalayas (average altitude 5,200 m, 92 peaks over 8,000 m) and Trans-Himalayas (average width 60 km, average altitude 4,500 m) in addition to the mighty Himalayas. The Himalayan region is inhabited by 51 million people covering 18% of Geographical area and 6% of Indian population.

Himalayas have dispersed land available for cultivation with huge altitudinal variations having diverse micro-climatic conditions, with lesser amount of potential for commercialization. However, nature has bestowed Himalayas with niche areas that possess vast potential for production of exportable commodities that are by nature organic and get accommodated under WTO regulations, like SPS, etc. In addition the Himalayas provide valuable eco-system services like Fresh water, capacity to reduce disasters, huge bio-diversity and a lot of space for tourism and recreation.

Considering the poor scope of Industrialization in mountains and perspective of rural livelihood, agriculture remains an important source of livelihood and economic growth, despite its declining share in the economy. However, in developing countries poor accessibility to the basic amenities like education, health, communication, road network, markets, transport and extension services remain always the major problems in the development of mountain farming. These problems are referred as the mountain specificities. Being away from the economic, political and power centers, these people have almost no role in decision making and thus these populations get marginalized. In addition being insecure, these areas are affected by outmigration. Although those who leave can provide remittances, however, it results into heavier workloads for those remaining behind like women, children and the elderly persons. Limited availability of land that often has low productivity coupled with poor marketability, these fragile ecosystems get transformed into unsustainable maintain systems owing to over exploitation of natural resources.

Himalayan ecosystem is at a disadvantage for expanding livelihood opportunities. With the outmigration, while men migrate for earning livelihood, the farming land get deprived of labour force to cultivate it, therefore, need to mobilize family labour for agricultural operations. This results in poor schooling of children as they become most likely individuals to perform such tasks. Further, the global climate change is more pronounced in the Himalayan regions having rich environments. Therefore, these regions require equally more attention for their preservance, sustenance and also fast response to the changes compared to downstream areas.

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Impact Evaluation of Development Programmes with Special Reference to IPM

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Impact evaluation of research and developmental programmes is expensive in terms of money and efforts. Perhaps because of this reason, evaluations are rarely conducted in professional manner in the developing countries. In the case of the Green Revolution technologies, namely fertilizer use and pesticide use resulted in desired and undesired consequences going side by side but the studies measuring the undesired consequences received no attention especially in the developing countries.

The theory of impact evaluation is meant for a rigorous and economical organization of the concepts required to map the assessment of impact. Impact evaluation results based on scientific quasi-experimental designs, the most dominant evaluation strategy, can be used to improve the delivery of programmes. The informal evaluations being conducted by the stakeholders of the programmes (implementing agencies) are unsystematic, the criteria and evidence used in making judgments are implicit. The trustworthiness - internal as well as external validity and reliability of results can therefore be biased.

The three purposes of evaluation research can be evaluation for accountability, development and knowledge. There are different models used in measuring these purposes. The most appropriate models for planning evaluation studies are the logic model and Bennett's model. These two models are extensively used in planning extension evaluations studies. The quality of impact evaluation study depends on proper planning and implementation of the study. Planning is helpful for achieving evaluation objectives cost effectively. Planning evaluation can be described as the organizing steps to systematically answer the questions i)who wants to evaluate the programme?, what are their information needs?, iii) how much resources are available for conducting the evaluation?, and what is the best design for collecting and processing this information within the limits of available resources?

Integrated pest management (IPM) programmes focus on programme development and implementation. IPM has become one of the most frequently used catchwords in national and international development. Among stakeholders in crop protection - be in research or extension, public or private institutions, and donors or recipients of development assistance - there is unlikely to be anyone who would not claim to support IPM. There is widespread disagreement over what IPM really is, what its goals should be and how it should be used. There is little doubt, however, that IPM was developed as an alternative to the over-reliance of crop protection on chemical pesticides. This is the why governments, agricultural research systems and donors invest in public-sector IPM.

Inadequate attention is paid to IPM evaluation. Evaluation is a systematic approach by which the programme process and results are compared with set goals and objectives to make value judgments about the programme. In this regard, the evaluation of IPM programmes is vital for making proper programmatic decisions. The quality of an IPM evaluation can be improved by proper planning and selection of appropriate research design. Planning is helpful for achieving the evaluation objectives cost effectively. When the IPM evaluation studies are planned, it is important to consider the social, economic and environmental context of the farming community for achieving the practicality and the usefulness of the evaluation study. The IPM programme evaluation is meaningful only if the results are communicated and utilized to achieve the evaluation objectives.

Evaluation designs can be divided into three basic types: experimental, quasi-experimental, and ex-post facto. There are two main attributes that distinguish experimental designs with other two categories-that is randomization. There are two factors to consider when selecting an appropriate design for the evaluation study. First, the design should be practical within the limits of budgetary provisions and other resources. Second, the design should be adequately accurate to rely on evaluation results. Randomized experimental designs are more accurate than quasi-experimental designs. However, randomized experimental designs are not practical in many extension settings due to various factors such as randomization difficulties, ethical issues and budget limitations. There are different quasi-experimental designs. These are one-group before and after comparison design, one-group time-series design, nonequivalent control-group design (before-after and with-without comparison) and difference-in-differences with and without comparison.

The indicators (variables) to assess the impact of IPM programmes can be adoption of non-chemical pest management practices, pesticide use by treatment frequency index, pesticide use by weight (a.i) per unit area, reduction in use of more toxic pesticides, and field use environmental impact quotient. These indicators will answer the most pertinent question. Is the investment in IPM research effective in terms of its adoption and impact?

2

Eco-responsive Livestock and Fisheries Production

1.

Anti-helmentic Activity of Selected Tannin Containing Browse Biomass on Parasites in Sheep of North Kordofan, Sudan

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Keywords: Acacia species, tannins, desert sheep, anti-helmentics

Introduction

Sudan owns large livestock population and a top animal producer in Africa. It has great livestock potentialities if production constraints are alleviated. Livestock feed is the main production limiting factor in development of livestock production systems in Sudan. The feed is scarce and its quality is poor. Diseases and parasites are also serious constraints to animal production in the country. Since animals are mainly dependent on natural grazing and tree browse for feed, it was reported that some flora species do not only supplement the low quality grazing from rangelands with the needed nutrients but they also affect on the internal helmintic parasites that are other production constraint. The browse biomass is generally of higher tannin contents. This study was proposed to examine the anti-helmintic characteristics of extracts of some flora species that are traditionally used for treatment of the parasitic infestations.

Materials and Methods

The Biomass of Acacia species was collected from Sheikan locality which is in North Kordofan State, Sudan (latitudes 11.5° and 13.75° N and longitudes 27° and 29.5 ° E). The area receives 200-500 mm rainfall annually with minimum (10°C) and maximum temperature (40°C). The soils are sandy to sandy loam with clay deposits in seasonal streams. The flora species used as source for the experimental biomass were *Acacia millifera*, and *A nilotica* and *Cassia obtusifolia* seeds. The collected biomass samples (leaves of *Acacia mellifera*, *A. nilotica*) and seeds of *Cassia obtusiflora* were washed thoroughly in distilled water, dried, crushed in mortar pestle and exhaustively extracted by percolation using distilled water as solvent in hot extraction process. The 100 mg/ml concentration extracts were prepared as a solution of 10% where 100mg of plant material was added to 900 ml of distilled water. This extracted liquid was stored in water bath for further use within 24 hours. The worms were collected from the digestive systems of the slaughtered sheep at Elobeid abattoir, washed to remove all fecal materials before being identified and persevered for laboratory *in vitro* test used for the *in vitro* anti-helmintic study. The live parasitic samples were distributed in the four petri-dishes with four replicates for each plant extract and four replicates petri-dishes for the distilled water as control.

Anti-helmintic activity of the plant materials was evaluated by exposing the parasitic samples to the four plant extracts. Observations were recorded on the basis of motility/survival of worms. This anti-helmintic activity test was performed according to the method adopted by Williams *et al.* (2014) on adult Indian earthworm *Pheritima posthuma*. The extraction and treatment was also carried out according to the methods of adopted by Nojod (2011) in control of earthworm in Sudan. Leaves of *Acacia nilotica, A. mellifera,* and seeds of *cassia obtusiflora* were analyzed using proximate analysis as described by AOAC(2002). Biomass of the mentioned plants and seeds of *Cassia obtusiflora* were also analyzed for their tannin content. The chemical composition of the Acacia species is shown in (Table 1) Data on mortality of parasites within time of *in vitro* trial were designed as complete randomized design and analyzed.

Table 1: Chemical composition of some tannin containing Browse plants

Botanical name	Vernacular	Dry matter	Organic matter	Crude protein	Crude fiber	Ether extract	Nitrogen free extracts	Ash
Acacia mellifera	Kitr	94.77	85.730	10.04	27.43	4.10	44.16	9.040
A. senegal	Hashab	93.82	82.590	09.80	34.17	3.70	34.92	10.230
A. seyal	Talh	94.60	80.520	12.20	28.29	3.80	36.23	13.080
A Nubia	Loat	93.63	82.520	11.10	27.09	4.30	39.28	11.110
Acacia torttilis	Sunut	93.89	81.770	12.42	28.79	4.50	36.06	12.120
Acacia nilotica	Garad	93.45	80.30	11.04	27.43	5.10	36.72	13.150
Cassia obtusifolia	Alkawal	92.23	79.98	14.80	34.17	7.30	33.71	14.250

Results and Discussion

Within all flora species extracts, helminthes mortality rate was 100% after 12 or 24 hour. In distilled water the mortality of the worms was 25 and 25% respectively (Table 2). The rangelands at north Kordofan are of great biodiversity on its flora and the region has large animal wealth. Many indigenous browsing trees could provide good fodder for animals during the dry season. The four *Acacia species* are of good nutritive value with high degradability. They showed their effective treatment against internal parasites parasite of sheep which are

usually heavily infested with parasites. It was therefore recommended that acacia leaves be collected during the rainy season and kept for use during the dry season when rangeland conditions are greatly deteriorated and animals are faced with scarcity of pasture. Seeds and leaves' extract could be used for treatment of internal parasites.

Table 2: Helminthes mortality rate as affected by type of extract at 12 and 24 hours.

Time of observation	*Acacia mellifera*	*Acacia nilotica*	*Cassia obtusifolia*	Distilled water
After 12 hours	100	100	100	10
After 24 hours	100	100	100	25
Sig.	***	***	***	***

*** (P<0.001).

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2.

Age-Gender-and Tissue-Dependent Transcriptional Responses of *cyp19a1* and *vtg* in Murray Rainbow Fish *Melanotaenia fluviatilis* Exposed to 17β-estradiol

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Keywords: Murray rainbowfish, steroidogenic pathway, reproductive pathway, xenoestrogen

Introduction

Estrogen, a key steroidogenichormone, synthesizedmainly in reproductive organs (gonads), and its synthesis involves two different cells hence referred as 'two cell hypothesis'. Vitellogenin, a *female specific* and key reproductive protein synthesized in the liver. However, gene is also present in males and juveniles, but normally it is silent. Upon exposure to estrogenic chemicals it gets activated. Though endogenous estrogen is produced in males and juveniles it is tightly regulated and utilized for normal physiological functions. When exogenous estrogen disrupts this tightly regulated mechanism, thereby normal expression of *cyp19a1* and *vtg* will get altered.

Materials and Methods

Reproductively active adults and juvenile rainbow fish were chosen for the exposure experiment. Then exposure experiment was conducted by exposing to either 100 or 400 ng/L E2 for 14 days. After 14 days of exposure, fish were anaesthetized using AQUI-S. Fish tissue samples for Real-Time qPCR were collected and analyzed as described earlier. Primers for qPCR for *cyp19a1a*, *cyp19a1b*, *vtg* and *gapdh* were designed and synthesized based on the cDNA sequences obtained. The real time data was tested for normality, and subsequently analyzed by one-way analysis of variance (ANOVA) followed by post-hoc test between the treatments for each transcript expression and the significance was set at $P<0.05$.

Results and Discussion

The *cyp19a1* in the head and trunk region of juveniles, brain and gonads in both sexes of adult fish were studied using qPCR. *Cyp19a1a* was not detected in tissues tested in both adults and juveniles, except for ovary and in ovary it decreased with increase in E2 concentration. *Cyp19a1b* was significantly elevated in the head and trunk region of juveniles at 400 ng/L E2 exposure but not at 100 ng/L. In adults, *cyp19a1b* significantly up-regulated at 400 ng/L in brains of both sexes and in testes, but not in 100 ng/L E2. *Vtg* showed concentration dependent increase in expression in the trunk regions of juveniles. In males, *vtg* was significantly up-regulated in both concentrations of E2. Collectively, E2 at environmental concentrations can have a disruptive effect on the steroidogenic and reproductive pathways.

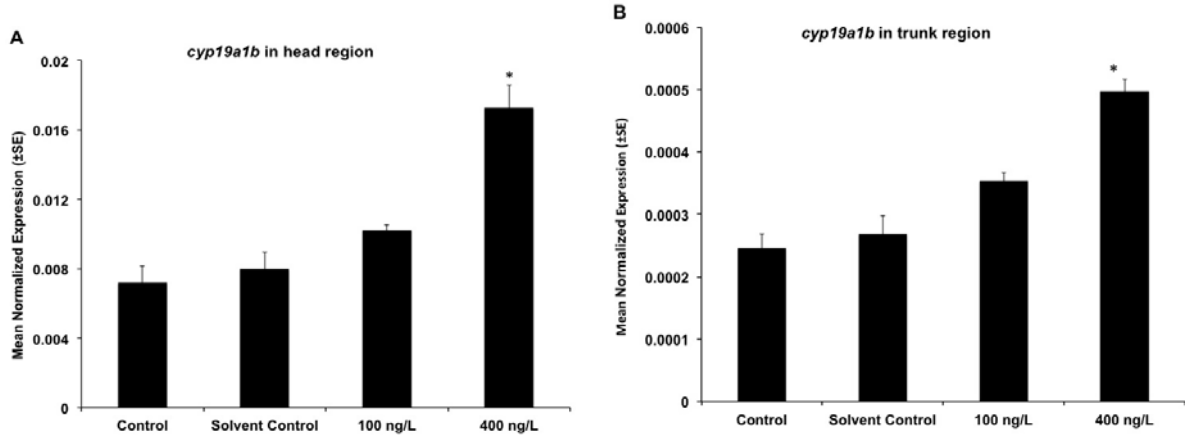

Fig. 1: Expression of cyp19a1b in head (A) and trunk (B) regions of juveniles exposed to E2. *Indicates significantly different to others.

3.

Expression Pattern HSP Genes Tharparkar Cattle Different Seasons under Two Climatic Regions India

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Keywords: Tharparkar, HSP genes, environmental temperature, summer and winter seasons.

Introduction

Heat stress is the one of the major stress in animals like cattle and other livestock species. Cellular temperature of animals are determined largely by ambient temperatures. Cattle is an endothermic species, which have evolved complex and energetically expensive metabolic and physiological processes to maintain body temperature in the face of temperature variation. The literature related to genes responsible for the resistance of cells to thermal stress in different breeds of cattle are limited. Therefore, the present study was carried out on Tharparkar breeds of cattle at Bikaner (Rajasthan) and Chitrakoot (Madhya Pradesh).

Materials and Methods

Blood samples were collected using sodium ethylenediaminetetraacetate (EDTA) tubes from Tharprakar cattle of Bikaner (Rajasthan) and Chitrakoot (Madhya Pradesh) during winter and summer seasons. Ribonucleic acid (RNA) was isolated using RNeasy mini kit as per manufacturer protocol and the cDNA was synthesized by reverse transcriptase enzyme. cDNA was used as template for further Real Time Polymerase Chain Reaction. The following genes HSP-10, HSP-60, HSP-70.1, HSP-70.2, HSP-70.8 and HSP-90 were analyzed by $2^{-\Delta\Delta}$Ct method.

Results and Discussion

The real time quantification of HSP-10, HSP-70.1, HSP70.2, HSP-90 genes showed higher ($p>0.05$) expression in Tharparkar of Madhya Pradesh than Rajasthan during summer compared to winter season. Whereas HSP-60 gene expression showed reverse trend i.e. higher expression during winter than summer. The expression of HSP-60 was higher in Tharparkar of Chitrakoot than Bikaner. In Tharparkar of Rajasthan HSP70.1 and 70.2 expression showed reverse trend i.e. higher during winter as compared to summer season. HSP-70.8 expression was higher ($p<0.05$) in Tharparkar of Madhya Pradesh during winter as compared to summer season. Whereas Tharparkar of Rajasthan showed reverse trend i.e. higher during summer compared to winter. Based on the results of the study, it can be stated that Tharparkar breed of cattle Bikaner (Rajasthan) having better tolerance to heat stress compared to same breed kept at Chitrakoot of (Madhya Pradesh) (Table 1). This better adaptability may be due to their home tract in hot and arid area of India.

Table 1:

Breeds	Geographical Regions	Number of Animals	Source of Sample
Tharparkar	Rajasthan (Bikaner)	6	Blood
Tharparkar	Madhya Pradesh (Chitrakoot)	6	Blood

Acknowledgements

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4.

Micrometrical Studies on the Tongue of Goat Foetii (*Capra hircus*)

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Keywords: Micrometry, prenatal development, tongue, goat

Introduction

Many studies have analysed the morpho-functional characteristics of the mammalian tongue in order to evaluate and define the factors that are basis for various alimentary habits and gustatory functions. Most of the work on tongue has been reported during postnatal life in buffalo, pig, sheep and bovine. During prenatal life, the reports are available on: morphogenesis of rat lingual filiform papillae, taste bud morphology in fetal and neonatal dog, prenatal development and inneration of the circumvallate papilla in the mouse, morphogenesis of circumvallate papillae and differentiation of taste buds in pig, embryonic origin of amphibian taste buds, scanning electron microscopy of the morphogenesis of lingual papilla in mouse, scanning electron microscopical studies of developing gustatory papillae in human, and morphogenesis of tongue in pig foetuses.

Materials and Methods

The present study was conducted on the tongue of 18 goat foetii ranging from early pregnancy to near full term in age. The approximate age of the foetii were calculated by putting the body weight values in the formula (Singh *et al.*, 1979) for estimation of age in goat foetus. As mentioned below

$W^{1/3} = 0.096\ (t-30)$.

Where, W= body weight of foetus in gm

t= age of the foetus in days

The collected foetii were then divided into three groups based on their estimated ages viz.- Group I (below 50 days of gestation), Group II (between 50-100 days of gestation) and Group III (above 100 days of gestation to up to full term) containing 6 number of foetii in each group. The micrometrical observations were recorded on Hematoxylin and Eosin stained sections with the help of ocular micrometer duly calibrated with stage micrometer.

Results and Discussion

The thickness of lingual epithelium was recorded as 29.6±2.57 µ in group I. In group II, the mean thickness of the lingual epithelium was recorded to be 65.71±6.80 µ, 78.94±9.59 µ, 128.33±10.10 µ and 71.74±13.64 µ at the level of the tip, body, torus linguae and root of the tongue, respectively. Similarly, in group III, the mean values for thickness of lingual epithelium were recorded as 118.86±11.55 µ, 130.50±13.98 µ, 161.27±5.25 µ and 127.16±6.48 µ at the level of the tip, body, torus linguae and root of the tongue, respectively (Table). The mean height of fungiform papillae in the goat foetii of group I, II and III were recorded to be 35.15±2.82 µ, 72.33±5.61 µ and 184.55±20.26 µ, respectively. Again, the mean diameters of the fungiform papillae were recorded to be 22.50±2.15 µ, 91.04±15.6 µ and 179.66±15.19 µ in group I, II and III, respectively. The mean values in regard to height of circumvallate papillae in the goat foetii of group I, II and III were recorded to be 28.05±4.00 µ which increased significantly ($P \leq 0.05$) to 128.33 µ±9.84 in group II and then to 231.57±20.36 µ in group III. Similarly, the mean diameter of the circumvallate papillae were recorded as 36.07±2.73 µ, 161.03±17.52 µ and 395.5±33.50 µ in group I, II and III, respectively. The various micrometrical parameters conducted in this study showed significant ($P \leq 0.05$) difference and hence increases with an increase in gestational age.

Table: Thickness of lingual epithelium (Mean±S.E. in µ) of the tongue in goat foetii at different age groups.

Epithelium thickness (µm)	Group I	Group II	Group III
Tip	-	65.71^{a}±6.80	118.86^{b}±11.55
Body	29.6±2.57	78.94^{a}±9.59	130.50^{b}±13.98
Torus Linguae	-	128.33^{a}±10.10	161.27^{b}±5.25
Root	-	71.74^{a}±13.64	127.16^{b}±6.48

Mean with common super script do not differ ($P<0.05$) significantly.

5.

Assessment of Fodder Requirement in Malwa Region of Punjab

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Key worlds: Fodder, livestock, requirement, supply

Introduction

Livestock rearing along with agriculture is an integral part in rural India. Animal husbandry is playing a vital role for sustainable and profitable crop farming and ensuring livelihood security for rural poorer as provide triple benefit namely milk, meat and manure and considered as "Bank on hooves". Paddy-wheat (*Oryza sativa-Triticum aestivum*) is the main cropping pattern in Punjab and crop residues are major source of roughage for livestock in the state. Availability of crop residues are affected by number of factors. Assessment of fodder demand for existing livestock population is essential to ensure availability and future planning.

Materials and Methods

Present study was conducted in Malwa region of Punjab with aim to assess the fodder demand to sustain the livestock population in the region. Malwa region comprising with 13 district out of total 20 district in the state. The study was based on secondary data pertaining to livestock population, per day and per year fodder requirement for each livestock were collected from various published sources. Livestock population in the region were converted in standard adult cattle unit (ACU) as per Ramachandar *et al*., 2007 and Livestock Census, 2012(State Department Animal Husbandry, Punjab) is considered to find out the adult cattle unit (ACU). District wise fodder requirement for ruminants (cattle, buffalo, sheep and goats), equine and camel are calculated on the basis of standard cattle unit(ACU) of 350 kg body weight by assuming 2% dry matte intake perday for every adult cattle unit(@7 kg dry matter for350kg body weight) than dry matter requirement was converted into fodder (90% dry matter in dry fodders). The dry fodder availability from different crops were assessed from production data for the year 2013-14 (Statistical Abstract, Punjab 2014)by grain to straw ratio as per Ramachandar *et al. (2007)*.For assessing green fodder availability were also estimated by using production potential per unit hectare from land classification data.

Results and Discussion

Analysis of the data revealed that Malwa region consisting 64.69% livestock population of the state. A total 10.35 million tonnes dry fodder is required in Malwa region per year and estimated 28.36 thousand tonnes per day to sustain total livestock population in the region. District wise analysis of Malwa region depicted that annual dry fodder requirement was maximum in Firozpur district (15.79 lakh tonnes) followed by Ludhiana (15.22 lakh tonnes), Sangrur (13.99 lakh tonnes), Patiala (10.04 lakh tones), Bathinda (7.64 lakh tonnes), Moga (6.96 lakh tonnes), Mansa (6.61 lakh tonnes), Muktsar (5.68 lakh tonnes), Barnala (4.87 lakh tonnes), Rupnagar (4.58 lakh tonnes), Fatehgargh Sahib (4.49 lakh tonnes), Faridkot (3.94 lakh tonnes) and Saheed Bhagatsinghnagar (3.63 lakh tonnes). Overall availability of dry fodder from different crops are 23.59 Million tonnes. Wheat and paddy contributing 12.48 and 10.63 million tonnes dry fodder, respectively in total dry fodder production in Malwa region. Green fodder availability is around 8.20 million tonnes in the region. It clearly indicates that dry fodder production is surplus as compare to demand in the Malwa region. Wheat straw was staple roughage for dairy animals being practiced by majority of the farmers round the year. Paddy straw is fed to the animals in scarcity & is being burned after harvesting of crop. Among green fodder Berseem (*Trifolium alexandrinum*), Oat (Avenasativa) and mixture of Berseem/oat and mustard (Brassica nigra) was main green fodder grown by most of the farmers during Rabi season and Maize (Zea mays), Bajra (*Pennisetumtyphoidcum*), Napier-bajra Hybrid (*Pennisetumperpureum*) and multicut sorghum (Chari) (Sorghum bicolor) is grown and fed to the animals from March to till October.

Table 1: Fodder demand and supply in Malwa region of Punjab

Livestock population (ACU)	Dry fodder Requirement	Dry fodder supply	Green fodder available
3.64 Million	10.35 Million tonnes	23.59 Million tonnes	8.20 Million tonnes

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6.

Biodiversity Distribution of Bivalves and Gastropods along Ratnagiri Coast, Maharashtra India

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Keywords: Molluscs, gastropods, bivalves, Konkan coast

Introduction

Among the three major habitats of the biosphere, the marine realm covers 70% of the earth's surface provides largest inhabitable space (Spalding, 1997). The mangrove ecosystem in Konkan region is really a God's gift, which provide bread and butter to the local communities (Yeragi, 2014). In India, till today, 5,070 species of molluscs have been recorded of which, 3,370 are from marine habitats (Subba Rao, 1991). It is reported that among the 200 estuaries on the east and west coasts of India, only few ones have been surveyed for biodiversity. The present work is based to reconnoiter the diversity of the bivalves and gastropods from different localities off Ratnagiri coast.

Materials and Methods

Study area was divided into four localities to cover entire area of the mangrove along Ratnagiri coast namelyMirya, Shirgaon,Sakhartarand Alawa. Samples were collected by handpicking including mangrove associated bivalve and gastropod species during low tide. Five quadrates of nylon rope each 1^{-m^2} was prepared, randomly at each locality just over the bed (Schoeman, 2003). The shells were identified from Zoological Survey of India, Kolkata. Also using the following references: annotated checklist of Indian Marine Molluscs (Cephalopoda, Bivalve and Scaphopoda) Part-1 (Ramakrishna and Dey, 2010) and FAO Species Identification Sheets for Fisheries Purpose (1998).

Results and Discussion

Bivalve species found higher 09 with 16 gastropods at Mirya. While 25 gastropod species was found as higher with 05 species of Bivalves at Shirgaon. At locality Sakhartar, 05 bivalve species and 08 gastropod species were recorded, and at Alawa06 bivalve species and 22 gastropod species were recorded (Fig. 1). The gastropod species number was recorded higher as 48 species from 14 families i.e. 77% than bivalves; 14 species from 05 families that contributed 23% in selected localities of Ratnagiri coast (Fig. 2).

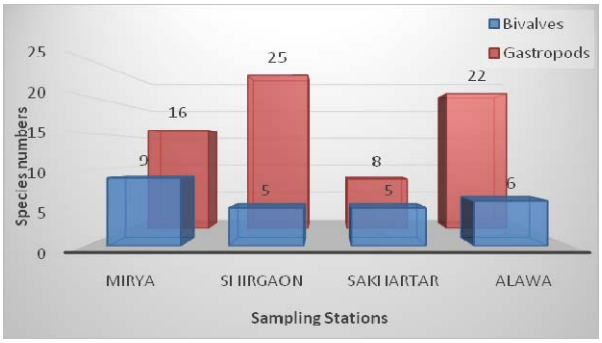

Fig. 1: Distribution of Bivalves and Gastropods

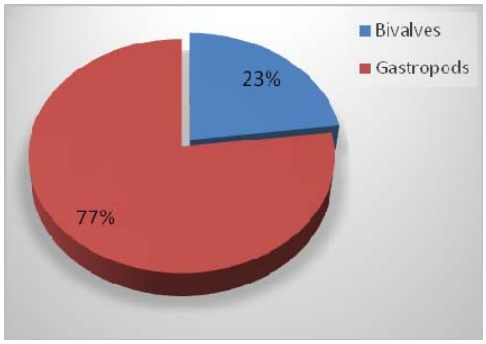

Fig. 2: Molluscan Species Diversity (%) along Ratnagiri

Diversity of molluscs varies significantly at four localities of Ratnagiri coast. The unique characteristics of these ecosystems are the shallowness, high temperature, high oxygen content, and semi-enclosed nature of the habitat. The present study revealed that all recorded molluscs are indigenous species at Mirya and Sakhartar have greater commercial value and biodiversity importance. Molluscs are probably influenced by habitat and geography. It is necessary to document the biodiversity of threatened ecosystems.

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7.

Comparative Study on Quality of Pashmina from Different Areas of Changthang Region of Ladakh

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Keywords: Area, Changthang, Pashmina, fibre.

Introduction

Pashmina, the prince of specialty hair fiber is well known for its fineness, warmth, softness, desirable aesthetic value, elegance and timelessness in fashion. In India, pashmina is obtained from Ladakh region of Jammu and Kashmir with 95% of the total pashmina production of the country from Changthangi breed of goat. These goats produce the finest fibre in the world (12μ) and keeping in view the variation in the quality of pashmina, the present study was conducted with the objective of accessing the comparative quality of Changthangi pashmina obtained from different areas of Changthang region of Leh Ladakh.

Materials and Methods

Nine potential pashmina producing areas Dungti, Tsaga, Sumdo, Hanley, Chumur, Kharnak, Korzok, Koyal and Samad from Changthang region of Leh Ladakh were selected for the study. The average distance between these areas were 43km. Pashmina fibre samples from 20 pashmina goats from each selected areas were procured from Changthang region by field staff during their routine visit to these areas in the month of September 2014. The fibre samples were collected randomly from pashmina goats belonging to different families of the selected areas after the harvesting season.

Results and Discussion

All the quality parameters for Pashmina fibre from different areas studied showed significant difference except for grease content. The undercoat, guard hair and dusting loss percentages (evaluated manually) were reported highest in pashmina of Tsaga (67.55±2.27) followed by Sumdo (28.76±5.83) and Samad (54.37±2.48) respectively. Fibre diameter (μ) and fibre length (mm) ranged from 12.94±0.21 (Koyul) to 14.49±0.29 (Dungti) and 56.28±3.05 (Koyul) to 75.76±2.05 (Kharnak) respectively (Table 1). The grease content (%) showed non-significant difference with a range from 5.75±1.38 to 8.64±0.35. The study revealed that the quality of pashmina varies from place to place within Changthang itself, the reason being difference in their environmental conditions viz; temperature, wind velocity, altitude, vegetation cover etc. Further the ranking of pashmina production area based on best fibre quality was done as a, b and c grade (Table 2).

Table 1: Performance of Pashmina goats of Nyoma Block

Area	Fine fibre percentage	Guard Hair percentage	Dusting loss percentage	Fiber diameter (μ)	Fiber length (mm)		Grease (%)
					Fine fibre	Guard Hairs	
Dungti	60.11±12.83	26.79±11.02	13.09±4.11	14.49±0.29	59.64±3.75	69.32±7.56ab	6.40±2.72
Tsaga	67.35±2.27	19.78±1.98	12.87±2.49	14.42±0.54	57.34±3.26	63.65±3.08a	7.51±0.83
Sumdo	61.10±5.24	28.76±5.83	10.15±1.20	13.50±0.29	57.91±3.22	70.63±5.48ab	7.58±0.35
Hanlay	48.60±6.55	14.11±2.87	37.29±4.32	14.50±0.21	60.40±5.17	72.32±6.08ab	8.64±0.35
Chumur	54.27±2.99	12.60±1.64	33.10±3.38	13.07±0.35	63.19±9.34	81.19±10.71ab	5.75±1.38
Kharnak	43.85±2.56	10.30±1.06	45.85±3.52	13.98±0.22	75.76±2.05	81.44±2.84 ab	6.34±0.32
Korzok	49.86±7.08	15.53±1.05	39.76±9.45	13.35±0.31	63.76±5.13	75.34±8.03 ab	7.89±1.76
Koyul	46.66±3.67	14.53±3.53	38.80±7.14	12.94±0.21	56.28±3.05	78.82±8.32ab	6.35±0.34
Samad	35.80±2.27	9.88±0.33	54.32±2.48	14.21±0.42	69.39±4.16	86.58±5.71b	7.22±0.42
Overall mean	**51.76±2.22**	**16.75±1.55**	**32.16±2.87**	**13.93±0.14**	**67.03±1.57**	**76.66±1.87**	**7.08±0.38**

±Std. mean error

Table 2: Ranking of Nomadic Areas of Nyoma Block according to the quality of Pashmina fibre

Area	Rank	Class	Fine fibre Percentage	Guard Hair Percentage	Dusting loss Percentage	Fiber Diameter (μ)	Fiber length (mm)	Grease (%)
Kharnak	1st	A	43.85±2.56	10.30±1.06	45.85±3.52	13.98±0.22	75.76±2.05	6.34±0.32
Samad	2nd	A	35.80±2.27	9.88±0.33	54.32±2.48	14.21±0.42	69.39±4.16	7.22±0.42
Chumur	3rd	A	54.27±2.99	12.60±1.64	33.10±3.38	13.07±0.35	63.19±9.34	5.75±1.38
Korzok	4th	B	49.86±7.08	15.53±1.05	39.76±9.45	13.35±0.31	63.76±5.13	7.89±1.76
Koyul	5th	B	46.66±3.67	14.53±3.53	38.80±7.14	12.94±0.21	56.28±3.05	6.35±0.34
Sumdo	6th	B	61.10±5.24	28.76±5.83	10.15±1.20	13.50±0.29	57.91±3.22	7.58±0.35
Tsaga	7th	C	67.35±2.27	19.78±1.98	12.87±2.49	14.42±0.54	57.34±3.26	7.51±0.83
Hanley	8th	C	48.60±6.55	14.11±2.87	37.29±4.32	14.50±0.21	60.40±5.17	8.64±0.35
Dungti	9th	C	60.11±12.83	26.79±11.02	13.09±4.11	14.49±0.29	59.64±3.75	6.40±2.72

±Std. mean error

8.

Constraint Analysis of Tuna Fisheries in Lakshadweep

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Keywords: Lakshadweep, constraint analysis, RBQ, pole and line and tuna fishery

Introduction

Tunas are among the largest, most specialized and commercially important of all fishes. Tuna landings in Lakshadweep account to 15.83% of Indian total tuna landings. It is estimated that about 13% of the total population of Lakshadweep are active, full-time fishermen and fisheries sector provide a livelihood for about 60% of the people of Lakshadweep. Tuna is one of the most economically underutilized fisheries in Indian waters, and more than ½ of the potential tuna stock is located around the Lakshadweep waters. The present study is a systematic study targeting the constraints and device strategies for mitigation of existing shortcomings.

Materials and Methods

Of all the group of Lakshadweep islands, three islands viz., Minicoy, Androth, Agatti have been reported to have most of the tuna catch and Kavaratti being the capital of Lakshadweep islands, these four islands have been considered for the present study. In this manner 63, 41, 54 and 46 fishers who were predominantly boat owners from the islands viz., Agatti, Androth, Minicoy, and Kavaratti respectively were interviewed for the purpose of performing constraint analysis. Rank Based Quotient was used to quantify the constraints as given by Sabarathnam and Vennila (1996).

Results and Discussion

In relation to production constraints, majority of the respondents from all the islands reported escalating fuel cost as the major constraint followed by high cost of other inputs (Table 1). A government support in the form of subsidized fuel and government fuel outlays matching the fuel demand of fisheries could possibly effectively tackle escalating fuel cost, a major constraint. Government outlays or fisheries department providing other inputs like bait net and tank at reasonable price which is currently purchased from main land could reduce the impact of high cost of input which is second major constraint in production. As a whole, lack of cold storage facilities (95%) was analysed as the major marketing constraint. Poor marketing facilities were also observed as one of the major constraint (second) followed by lack of supply chain facilities (third). Though in recent years several cold storage facilities came into existence, the numbers are still far behind the required number. A network of cold chain and adequate numbers of fish transport vessel is prerequisite for a successful supply chain system channeling surplus catch to the main land having better price realization.As far as constraints in government policy, infrastructure and extension are concerned; lack of co-operation and support of fisheries officers was reported as the major constraint by all the islanders under study. Involvement of fishers in local level fisheries policy framing by fisheries department officials and regular interaction among fishers and officials could bridge the gap between them which will smoothen the functioning of fisheries.

Table 1: Production constraints for tuna fishery in Lakshadweep

Constraints	Lakshadweep		Kavaratti		Agatti		Minicoy		Androth	
	RBQ	Rank	RBQ	Rank	RBQ	Rank	RBQ	Rank	RBQ	Rank
Escalating fuel cost	98.32	1	99.22	1	99.43	1	96.3	1	98.26	1
High cost of inputs	93.52	2	94.88	2	96.49	2	87.83	2	94.95	2
Uncertainty about good volume of catch	89.18	3	90.84	4	90.59	4	86.11	3	89.2	4
Intrusion of foreign vessel	89.18	3	91.77	3	92.63	3	82.67	6	89.55	3
Lack of meteorological information	86.38	4	87.27	5	88.89	5	82.14	7	87.11	5
Weather disturbances	84.31	5	82.45	10	86.62	6	81.35	8	86.76	6
Lack of mechanization	84.24	6	84.78	7	84.47	9	84.39	5	83.1	9
Poor economic condition	83.09	7	81.99	11	85.03	8	79.76	9	85.71	7
Poor quality management of catch	82.91	8	85.56	6	85.15	7	76.72	10	84.67	8
Lack of skilled manpower	81.65	9	81.21	12	79.59	13	85.05	4	80.84	13
Timely availability of credit	80.57	10	83.23	8	82.31	12	75.26	12	81.88	11
Non-availability of credit	80.46	11	82.61	9	82.43	11	75.4	11	81.71	12
Small size fishing	80.29	12	81.06	13	83.9	10	73.94	13	82.23	10
Stringent terms and conditions for leasing a boat	71.81	13	71.43	14	71.54	14	72.75	14	71.43	14

Reference

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9.

The Effect of Supplementary Feeding on Camel Calves Growth Rate and Daily Gain

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Keywords: Camel calves, supplementary feeding, growth rate, daily gain, Sudan.

Introduction

Camels in the Sudan are spread in a belt known as camel belt. Camels Migration to the southern parts of the country is limited by diseases such as Trypanosomosis, internal and external parasites and the unsuitability of the clay soils with camel pads (Bakheit, 2006). Camels dependent mainly on natural vegetation for feed, camel growth rates and productivity in general is reflected by availability and quality of feed available each year. After weaning camel calf growth rates are in turn affected by feed availability and their nutritional value. To develop sustainable feeding systems of camel production there is a need envisage alternative feeding pattern.

Materials and Methods

This study was conducted at the University of Kordofan camel's farm, in North Kordofan State, Sudan. The study aimed to investigate the impact of supplementary feeding on the young camel calves' growth rate and daily gain. A total of 16 heads of young male camel calves from the Arabic camel breeds were selected and divided into four equal groups (1, 2, 3, 4) four heads of camel calves in each group, their body weight ranged from 176-220 kg. Experimental animal in group one was control supplemented nothings just depend on the natural range land, group two was feed on watermelon seeds, group three was allowanced concentrated diet composed of ground nut cake and the animals in group four intake mixture diet consist of watermelon seeds and ground nut cake 50% for each. The body weight of the experimental animal was determined biweekly using table balance. The random complete experimental design was used and the Analysis of variance and Tukey test were applied for data analysis and means separation. The data were subjected to statistical analysis programme using SIGMA- STAT. Soft ware computer Package described by Analysis of Variance (ANOVA) according to Senedecor and Cochran (1967). Tuky test were used for means separation.

Results and Discussion

The changes in live body weight of camel calves in the four treatments were shown in Table 1 and Fig. 1. In this study the results showed that the average Body weights of the camel calves in the four groups were 174.75±3.3, 275.93±9.0, 241.50±8.5 and 236.50±8.2 kg, in group one, tow, three and four respectively. On the other hand the less camel calves' body weight was obtained in the (control group). The results of the present study showed that there were high differences ($P<0.01$) in the body weight between the groups (Table 1 & Fig. 1). The result indicated that the higher body weight was recorded in group two (275.93±9 kg) which the animals feed on watermelon seeds and followed by group 3 and four (241.50±8.5 and 236.50±8.2). On the other hand the less camel calves body weight was obtained in group one (control) that experimental animals not intake supplementary feeding. The result of the present study showed that there were high differences ($P\leq0.01$) in the bwt between the groups. The results of the present study showed the daily gain of the first group and the second, third and fourth were 214±12 g, 624±28 g, 542±19 g and 528±12g, respectively, while no significant differences between diets groundnut cake 242 kg and mixture diet 237 kg ($P \geq 0.01$).

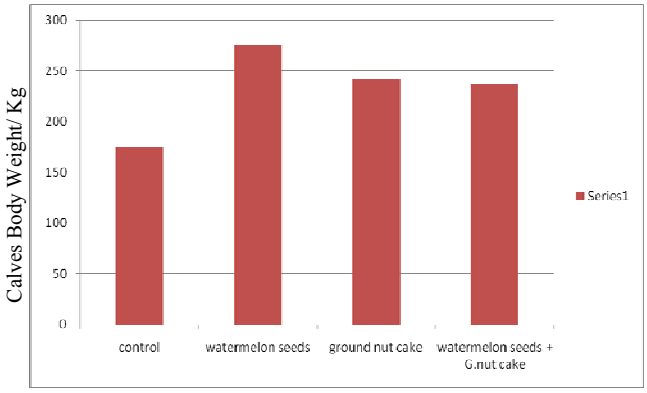

Fig. 1: The effect of supplementary feeding on camel calves' body weight

Table 1: The Weight of Calves at different sources of feed

Sources of Feed	Average weight (kg)
Control	3.3±174.75[a]
Water melon seeds	9.8±275.93[b]
Ground nut seed cake	8.5±241.50[c]
Water melon seeds +Ground nut seed cake	8.2±236.50[c]

Values with different superscript on the same column are significantly different ($P<0.01$)

Reference

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10.

Constraints in Mixed Dairy Farming in Jammu District of Jammu and Kashmir

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Keywords: Constraint analysis, mixed dairy farming, dairy farmers, economic constraints.

Introduction

Mixed dairy farming system constitutes the dominant land use system in the developing countries (Iiyama *et al.*, 2007). The livestock revolution is stretching the capacity of existing production, but it is also exacerbating environmental problems. Therefore, while it is necessary to satisfy consumer demand, improve nutrition and direct income growth opportunities to those who need them most, it is also necessary to alleviate environmental stress. Conventional agriculture is known to cause soil and pasture degradation because it involves intensive tillage, in particular if practiced in areas of marginal productivity. Technologies and management schemes that can enhance productivity need to be developed. At the same time, ways need to be found to preserve the natural resource base. Within this framework, mixed dairy farming system represents a key solution for enhancing livestock production and safe guarding the environment through prudent and efficient resource use (Dikshit and Birthal, 2013). Many constraints exist in mixed dairy farming system simultaneously in several stages of development from one area to another depending upon time, place and other sets of conditions. Keeping this in mind, the present investigation was planned to identify the constraints in mixed farming with reference to dairy sector in Jammu district of Jammu and Kashmir state.

Materials and Methods

Two blocks of Jammu and Kashmir were randomly selected from Jammu district using simple lottery method. A comprehensive list of villages of the selected blocks (Bishnah and Akhnoor) was prepared. Two villages were selected randomly from each of the two selected blocks. Thus, a total of four villages were selected in all. The selected villages were Chak-Avtara and Bhatyawari (Bishnah) and Dasgal and Balgara (Akhnoor). Thirty farmers were selected from each of the four selected villages constituting a total sample size of at least 120 dairy farmers. A schedule consisting of 63 pretested items/ statements was used for the measurement of constraint perception of the farmers. The possible range of constraint perception score was 63 to 189 and the observed range was 97-161 with mean score of 123.91. The constraints perceived by the farmers were divided into six main areas general, management, feeding, breeding, health care and economic constraints. The respondents were asked to rate the constraints on a three point continuum, based on seriousness of the perceived constraint. The constraints were then ranked based upon their mean percent score which was calculated using the formula; MPS= Obtained score/ Maximum possible score.

Results and Discussion

Economic constraints were perceived as most serious, followed by general constraints with a mean percent score of 67.92 and 67.59 respectively. On the other hand, health care and breeding constraints were perceived as least serious by the farmers with a mean percent score of 63.92 and 64.30 respectively (Table 1). Overall medium level of constraint perception was observed. Constraints like, increasing input costs making it difficult to achieve profitability, non-availability of green fodder throughout the year, and growing problem of infertility in the animals were rated as most serious constraints by the farmers. Whereas constraints like, lack of drinking water sources for dairy animals, labour availability, non-availability of veterinary surgeons, and lack of proper knowledge of sanitation and hygiene of milking barn were considered as least serious.

Table 1: Constraint perception score of farmers in different areas of dairy farming

Constraints	Total statements/items	Score Obtained	Mean	Mean Percent score	Rank
General	15	3650	2.03±0.26	67.59	II
Management	10	2330	1.94±0.19	64.72	III
Feeding	10	2315	1.94±0.25	64.31	IV
Breeding	12	2778	1.9±30.26	64.30	V
Health care	8	1841	1.92±0.22	63.92	VI
Economic	8	1956	2.03±0.21	67.92	I
Overall	63	14870	1.97±0.86	65.56	-

On the basis of present study it can be advocated here, that we need to identify the actual underlying issues and put efforts to improve crop residues availability by encouraging such crops which may yield higher residues, changing crop rotation to facilitate fodder production and improving unconventional feed utilization. To overcome the adverse effect of rising input costs, better credit facilities can be given to support dairy farmers. Motivating the young generation, streamlining of research and development system, improving feed and fodder supply, streamlining of extension services, dis-incentivizing the urban and peri-urban dairying by way of regulatory and policy measures can prove beneficial in overcoming the constraints with regard to mixed dairy farming system.

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11.

Sero Prevalence of New Castle Disease in Village Chicken of Mizoram, India

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Keywords: New Castle disease, sero prevalence, haem agglutination inhibition, village chicken.

Introduction

Mizoram is a hilly state of North East India. The poultry industry in the state is still dominated by village chicken production. The total chicken population in Mizoram is 12.34 lakhs with production of *desi* eggs of 191 lakhs and commercial eggs of 180 lakhs. High incidence of diseases is the top ranked constraint in village chicken production. New Castle disease is the most devastating disease and frequent outbreaks are reported causing even up to 100% mortality in affected flocks. This study reports serological detection of New Castle disease virus in village chicken and slaughtered local chicken.

Materials and Methods

The detection of New Castle disease virus (NDV) specific antibody was carried out on 170 randomly collected sera samples from surviving birds of New Castle disease affected flocks or in-contact birds (45), apparently healthy unvaccinated birds (70) and slaughtered local chicken in market (55) in Central Mizoram (Aizawl, Kolasib and Mamit districts) by using haem agglutination inhibition (HI) test. The HI titre of each serum sample was expressed as reciprocal of the highest serum dilution showing the inhibition of haem agglutination. The geometric mean antibody titres were calculated and expressed in log 10 scale.

Results and Discussion

The overall sero prevalence of NDV in village chicken was recorded as 35. 88% with 86.67% in in-contact/ surviving birds, 17.14% in unvaccinated apparently healthy birds and 18. 18% in slaughtered birds. The distribution of antibody titre (log2) was found in the range of 0 to 9 which could be due to different stages of infections. The geometric mean titre (log 10) was found to be highest in in-contact/ surviving birds (1.75) followed by slaughtered birds (1.67) and apparently healthy unvaccinated birds (1.21). The low levels of antibody titre revealed the endemic nature of the virus and was also suggestive of inter outbreak phase or early phase of an infection.

The higher sero prevalence of NDV in in-contact and surviving birds of the disease might be due to the sero conversion of the viral infection in the surviving birds and due to effective transmission of the virus during the outbreaks to in-contact birds of the affected flocks. The sero-prevalence of NDV in unvaccinated-unaffected healthy birds indicated the circulation of the virus in the environment and exposure of the birds to the virus in low grade without causing clinical disease. However, the local chicken in the markets were supplied from different sources within and outside the state and sero-prevalence of NDV in slaughtered birds might be attributed to vaccination or natural exposure of the birds to the virus. Appropriate vaccination programme of village chicken is advocated for controlling the disease and sustainable production of village chicken in Mizoram.

Table: Sero-positivity and geometric mean (GM) titre of New Castle disease virus in village chicken and slaughtered local chicken from three districts of Mizoram

Group of birds	Tested/ Positive/ GM Titre in HI test	Aizawl	Kolasib	Mamit	Overall
Incontact/ survivors	Tested	20	10	15	45
	Positive	19 (95. 00)	9 (90. 00)	11 (73.33)	39 (86.67)
	GM Titre (log10)	1.76	1.74	1.75	1.75
Unvaccinated/ unaffected	Tested	34	23	13	70
	Positive	5 (14. 71)	4 (17. 39)	3 (23. 08)	12 (17. 14)
	GM Titre (log10)	1.14	1.28	1.20	1.21
Slaughtered	Tested	30	15	10	55
	Positive	6 (20.00)	2 (13. 33)	2 (20. 00)	10 (18. 18)
	GM Titre (log10)	1.70	1.66	1.66	1.67
Total	Tested	84	48	38	170
	Positive	30 (35. 71)	15 (31. 25)	16 (42. 11)	61 (35.88)

12.

Broiler Chicken Bug Meal to Effects of Feeding Different Levels of Watermelon on Growth Rates in North Kordofan Sudan

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Keywords: Broiler, watermelon, bug meal, body weight.

Introduction

Poultry industry is considered as the second largest industry in many African countries (Austic and Nesheim, 1990). Most of the chickens eaten today come from broiler chickens that grow very rapidly and have been selected for traits that are desirable for meat production (Maxwell and Robertson, 1990). Poultry is now by far the largest domesticated animal species worldwide (FAO, 2000) accounting for more than 30% of all animal protein consumption (Permin and Pederson, 2000). Feeding cost accounts for 60-70% of total production cost. The major constraint facing poultry industry in the developing countries is attributed to dependence of this industry on inclusion of conventional feedstuffs in rations and those feed sources are characterized by competition for between human and livestock making the poultry business unproductive (Lawrence *et al.,* 2008). The watermelon bug (*Aspongopus viduatus*) is distributed over the Middle East and Africa in general and has a wide distribution in the Sudan occurring in all regions of the country. Watermelon bug is a notorious pest to cucurbitaceous plants in general and particular to water melon.

Materials and Methods

The experiment was conducted at poultry farm of the General Directorate of animal production, Administration of Animal Wealth of North Kordofan State, Sheikan locality, Elobeid, Sudan. The insect lot was obtained from farmers in Sheikan locality, it was collected, and sun dried then packed in sacs and get to the ration mill at the administration. The insect lot was ground and thoroughly mixed prior formulation of the rations**.** Amino acids content of baobab meal will be determined using HPLC, according to AOAC, (2000) protocol; additionally minerals contents will be determined. Five rations are formulated I, II, III, IV, and V. Rations I is considered a control with 0% watermelon bud meal and 60% sorghum grains, ration II with contained 15% watermelon bud meal and 45% sorghum grains concentrate, ration III was formulated containing 30% watermelon bud meal and 30% sorghum grains while ration IV was formulated with 45% watermelon bud meal and 15% sorghum grains. The last or V ration contained 60% watermelon bud meal and 0% sorghum grains. Five hundred one day old of broiler chicks hybrid will be purchased. All chicks will be vaccinated against Newcastle and Goumboro diseases, and then it will be fed the same diet for a week as adaptation period. Birds will be divided randomly into five groups I, II, III, IV and V. each group will be fed different level of watermelon bug meal and sorghum, the experiment took 60 days. The data collected was analyzed by using SAS (1997) General Linear Model's procedure**.**

Results and Discussion

The weekly live body weight change of the experimental birds during the experimental period was presented in (Table 1) during the experimental period. Birds fed rations containing different levels of WMBM had significantly ($P<0.05$) higher weight gains, compared to those on the control diet. Within the WMBM rations, the feed that contained 15, 30 and 45 percent caused significantly ($P<0.05$) higher weight gains compared to those on a ration containing 60% WMBM, The present results proved that, watermelon bug meal (WMBM), enhance growth rate when it used in broiler ration formulation in different levels.

Table 1: Mean weekly live body weight of the experimental chicks fed on rations containing different level of water melon bug meal during (0-6 week's period).

	Weeks				
Level of WMBM %	**1st**	**2nd**	**3rd**	**4th**	**5th**
A	110	98.8b	170c	258.7c	328d
B	108.75	108.8a	296a	476a	560.7ab
C	105	109.3b	291.3a	429.7a	586.5a
D	105	104.9b	303.8a	478a	536.8a
E	103.75	93.75b	252.5b	416.25b	473.8c
Total mean	106.5	103.10	262.7	411.75	493.5
±SE	1.03	3.21	12.22	19.48	24.1

Values in the same column with different letters are significantly different at $P<0.05$
WMBM= Watermelon Bug Meal SE= Standard Error of the mean.

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13.

Effects of Supplementation of Taggar Goat Bucks on Sorghum Straw with *Dichrostachys cinerea* (Kadad) Pods on Feed Intake, Nutrients Digestibility and Dressing Percentage in Dilling South Kordofan, Sudan

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Keywords: Taggar goat, bucks, *Dichrostachys cinerea*, feed intake

Introduction

Sudan owns a large livestock population that make it an important economic sector. The main feed source for the animals is the natural rangelands. The natural grazing from that rangeland is poor quality roughage that needs to be supplemented with concentrates. The traditional producers cannot secure supplements because they are expensive. Trees provide browse biomass and pods as alternative sources for supplementation rather than using grains and legume seeds. Browse biomass and pods from natural forests are not competed for between animals and humans. The problems associated with provision of pods and tree biomass is that they may contain anti-nutritional substances. Phytatdes and tannins are among the compounds that must be detected prior utilization of a source as animal feed. *Dichrostachys cinerea* is one of the natural shrubs in Sudan that produces large amounts of pods. The chemical analysis has shown that the pods contain substantial amounts of crude protein, ether extract, nitrogen free extracts and minerals. Together with these, they also contain tannins. No studies were conducted to evaluate performance of different classes of animals when supplemented with *Dichrostachys cinerea* pods. The present study was conducted to study the effects of: supplementation of desert goat bucks with *Dichrostachys cinerea* on feed intake, nutrients digestibility, live weight gain and dressing percentage.

Materials and Methods

Twenty five intact (un-castrated) bucks were divided into five equal groups. The animals were ear tagged, drenched with a broad spectrum anthelmentics, vaccinated against diseases endemic to the study area, weighed and penned individually. The first group was assigned to the basal feed of the natural grazing only. The other four groups were offered the basal grazing supplemented with 200, 300, 400 and 500g of *Dichrostachys cinerea* pods. After ten days for adaptation, feed intake was monitored for 80 days. Thereafter feces voided were collected to estimate nutrients digestibility. The bucks were slaughter after 100 day and the dressing percentage was determined for each group.

Results and Discussion

As presented in Table (1) feed intake increased significantly with addition of *Dichrostachys cinerea* pods to bucks' ration. Similarly their nutrients digestibility, energy intake, body weight, body measurements and carcass or dressing % increased with supplementation. Table (1) summarizes the performance of bucks as response to supplementation with *Dichrostachys cinerea*.

Table 1: Performance of Taggar bucks as affected by level of *Dichrostachys cinerea* in the ration

	Treatments				
Parameters	**I**	**II**	**III**	**IV**	**V**
No .of animals	**5**	**5**	**5**	**5**	**5**
Days on trial	100	100	100	100	100
Daily feed intake(g/d)	380	566	660	753	880
Initial body weight	11.25±0.21	11.27±0.22	11.24±021	11.26±0.22	11.25±0.21
Final body weight	12±0.25	13.8±0.64	14±0.81	14.42±0.54	12±0.25
Total Weight change(g/d)	20	60	70	75	90
Feed conversion ration	19	10	9.250	9	8
Daily Weight change	20	60	70	75	90
Initial body length	44.4	44.6	44.5	44.4	44.4
final body length	47.2	50.4	50	48.2	51.2
Initial body height	52	52.1	52.	52.2	54
Final body height	56.2	56.2	55.6	58	60.2
Initial heart girth	52	52	54.8	55	52
Final heart girth	54	54.	54	54.2	55
Energy intake (kcal/kg DM)	504	755	994	1152	1224
Dressing percentage	35.82	41.12	42.05	44.85	55.82

14.

Integrated Fish cum Duck Farming- Scope and Importance

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Keywords: Integrated fish farming, duck, Punjab

Introduction

Aquaculture is a diversified production sector with different production systems and practices. Fish cum duck farming is one of the integrated farming systems traditionally practised in many countries. Integrated farming systems not only helps in lowering input cost but also keeps the environment clean through waste recycling. In Punjab, integrated fish cum duck farming has recently been introduced. Therefore, the present study was undertaken to study economic viability of fish cum duck farming in Punjab.

Materials and Methods

Khaki Campbell variety of duck was reared at the rate of 400 ducks/ha with freshwater carps (catla, rohu, mrigal, grass carp and common carp 3: 3: 2: 1: 1) stocked at 15000/ha in a fish cum duck farming unit at college of fisheries, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana to investigate effect of ducks on the fish production. The ducks were fed with farm made feed at the rate of 80gm feed/duck/day), while fish was fed at the rate of 0.5% body weight (during summer season only). The experiment was carried out for a period of one year.

Results and Discussion

At the end of the experiment, fish were harvested. The average weight gain was recorded highest (572.2gm) and lowest (82.2gm) in common carp among all the fishes harvested from duck cum fish pond. Whereas, among Indian major carps, the average weight gain of rohu recoded was highest (507.5gm). The total fish production from the fish cum duck pond was 6.05t/ha during one year of experiment with 80.8% fish survivality. Economics of fish cum duck farming were calculated (Table 1) at the end of the experiment based on anticipated values, total cost was 3.19 lakh/ha/year, whereas total income was 7.25 Lakh/ha/year and net calculated profit was 4.06 lakh/ha/year. Based on the present study, it can be concluded that the fish cum duck farming not only increased fish production but also reduced the input costs of fish culture operations considerably and this kind of integrated farming system should also be encouraged due to its role in reducing environment pollution as well.

Table 1: Economic analysis of integrated fish cum duck farming

S.No	Particulars	Cost in Rs. (for 1.0 ha area)
A	Fixed cost (pond on lease)	50,000
B	Variable cost	2,69,000
C	Total cost (A+B)	3,19,000
D	Returns	
	Sale of fish	6,05,000
	Sale of egg,	70,449
	Duck meat	50,000
E	Gross return,	7,25,449
F	Net return (E-C)	4,06,449
G	Benefit: Cost ratio	2.27

15.

Integrated Fish Farming Technology Introduced in Doda District of Jammu & Kashmir- A New Approach to Enhance Farm Income

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Keywords: Fish farming, integrated, chinese carp, vegetable crops, mulching, poly-film.

Introduction

The aim of establishing Krishi Vigyan Kendra (KVK) in all districts of India is to address local agricultural problems by bringing local problems to the laboratory and to come up with a suitable solution. In so far as fisheries is concerned, entire Doda district of Jammu & Kashmir is considered as remote area with a geographical area of 91374 ha which supports agriculture and allied sectors and provides subsistence to majority of the population, while most of the farmers are not aware of recent technological advancement in fisheries sector. They believe in the fact that the fishes cannot be grown in the manmade ponds therefore, they depend on the natural water bodies to capture fishes, results unauthorized fishing and finally biodiversity threat.

Materials and Methods

To address these specific issues, KVK-Doda planned to educate local farmers about various fish farming technologies such as trout (exotic and indigenous) culture, carp (exotic) culture technology, composite fish farming technology, integrated fish farming technology, etc., and established a low cost small integrated fish farming (IFFU)cum demonstration unit (earthen pond) at KVK farm at Bhaderwah. The main focus of this demonstration unit is to raise Chinese (exotic) carps in the pond, while the secondary focus is to utilize pond dykes to grow locally grown vegetable crops.

This type of culture model is first time so ever introduced in the district. The common carp (*Cyprinus carpio*) semi-fingerlings, of the size of 3-4cm, weight of 2-4gm, were procured from J&K state Fisheries Department's farm at Gatha, Bhaderwah and introduced into the pond in the first week of October, 2015, while the pond dykes were used to grow local varieties of vegetable crops (garlic, onion, mustard, spinach, coriander, peas, reddish) for demonstration to the district field functionaries as well as to the farmers. The pond water is also utilized for irrigating the crops on the dyke. Line-sowing and recommended distance for each crops were properly followed while cropping the vegetable crops, while low cost poly-film was used for mulching in garlic crop to avoid weeds and also retain soil moisture. No chemical fertilizers were either used on pond dyke or in the pond, while cow dung was used to fertilize the pond and lime to balance the pond pH.

Showing newly constructed IFFU to field functionaries

Results and Discussion

Results of last three (about) months are encouraging, and the vegetables cropped on pond dyke are flourishing well and the growth is regular/proper, while the growth of the cultured fishes is a bit slow because of the extreme cold condition in winter. However, it is surprising that the fishes are surviving well even though the upper water layer freezes for 6-8 hours in the morning. It is expected that the cultured fishes will recover their growth after March. Mulching with poly-film in garlic crop resulted in retention of soil moisture for an extended period and also suppressed growth of weeds, which finally resulted in better growth in the crop.

The technology was demonstrated to Doda district field functionaries and also to some of the farmers, and they were of the view that as the pond is of earthen type without any permanent water supply therefore the technology is very much economical particularly to the district farmers. By spreading this technology of growing fish even in small backyard ponds, the farmers can be enabled to grow fishes in their own land and boost farm income in one hand.

16.

Development of Framework for Modelling Recirculating Aquaculture System

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Keywords: Mathematical model, recirculating aquaculture system; water quality; mass balance

Introduction

The technique of recirculating aquaculture system (RAS) offers a scope for large scale ecologically sustainable fish production. This technique is very much relevant and required in commercial aquaculture sector where proper maintenance of water quality variables necessitates water exchange. The typical RAS consist of: i) rearing unit, ii) solid removal unit: a) mechanical filter and b) foam fractionator and iii) nitrification unit: a) trickling filter. The present study is aimed to develop a modelling framework for an RAS assuming that make up water for maintenance of nitrate-nitrogen concentration in the culture tank is added only when its concentration reaches its permissible limit.

Materials and Methods

The present study was conducted at Indian Institute of Technology, Kharagpur, West Bengal. Model expressions were formulated based on simple mass balance approach for determination of various important water quality variables namely total ammonia nitrogen, nitrate-nitrogen, dissolved oxygen, suspended solids in the culture environment as a function of time in a typical RAS without a denitrifying unit. Recirculation flow rate (Q_r) plays a major role in maintaining the water quality of RAS. Losordo and Hobbs (2000) provided a method for calculation of recirculation flow rate based on mass balance analysis. Following the Losordo and Hobbs (2000) procedure, Q_r was calculated by setting the time derivative to zero for each of the mass balances and assuming the appropriate permissible values of the above water quality variables. The model would forecast the important water quality parameters in a typical RAS, thus enabling the user to go for timely adoption of management programs which are otherwise difficult to decide.

Results and Discussion

The developed model expressions were discretized using the central finite difference technique. The time step was chosen to be same as that of the detention time of the biofilter. Thus, within each time step, the recirculated water enters and leaves the biofiltration chamber. Therefore, the variation in concentration of the nitrogenous compounds along the length of biofiltration chamber did not matter in the modeling process and thus was not considered in the model. The discretized forms of the model expressions are presented in Table 1.

Table 1: Formulated model equations for various components of RAS

RAS component	Water quality parameter	Model equation*
Rearing unit	Total Amonia nitrogen (TAN)	$C_{cTAN\_out}(t+\Delta t)=[Q_r\{C_{fTAN\_out}(t)- C_{fTAN\_in}(t)\}+(1-k_b)\ PR_{TAN}]\ 2\ \Delta t/V + C_{cTAN\_out}(t-\Delta t)$
	Nitrite nitrogen (NO_2-N)	$C_{cNO2\_out}(t+\Delta t)= \{\ Q_r(C_{fNO2\_out}(t)- C_{fNO2\_in}(t)) + k_b.PR_{TAN}\ \}\ 2\ \Delta t/V + C_{cNO2\_out}(t-\Delta t)$
	Nitrate nitrogen (NO_3-N)	$C_{cNO3\_out}(t+\Delta t)= \{\ Q_r(C_{fNO3\_out}(t)- C_{fNO3\_in}(t)) + k_b.k_c PR_{TAN}\ \}\ 2\ \Delta t/V + C_{cNO3\_out}(t-\Delta t)$
	Dissolved oxygen (DO)	$C_{cDO\_out}(t+\Delta t)= [Q_r\ \{C_{fDO\_out}(t) - C_{cDO\_out}(t)\} + PR_{DO}(t) - (k_{oxy} + k_{BOD})\ W(t)\ N(t)\ \forall\ \%BW - 4.57\ k_b\ PR_{TAN}.]\ 2\ \Delta t/V + C_{cDO\_out}(t-\Delta t)$
	Suspended solid (SS)	$C_{CTSS\_out}(t+\Delta t)= [Q_r\{C_{CTSS\_in}(t) - C_{CTSS\_out}(t)\} + PR_{SS}]2\Delta t/V + C_{CTSS\_out}(t-\Delta t)$
Screen filter	Suspended solid (SS)	$C_{mfSS\_out}(t+\Delta t)= [Q_r\ \{C_{mfSS\_in}(t)- C_{mfSS\_out}(t)\} - E_{mf} PR_{SS}]\ 2\ \Delta t/V + C_{mfSS\_out}(t-\Delta t)$
Foam fractionator	Suspended solid (SS)	$C_{cfSS\_out}(t+\Delta t)= Q_r\ \{C_{mfSS\_out}(t)\ (1- E_{cf}) - C_{cfSS\_out}(t)\}\ 2\ \Delta t/V_{cf} + C_{cfSS\_out}(t-\Delta t)$
Trickling filter	Nitrite nitrogen (NO_2-N)	$C_{fNO2\_out}= (Q_r C_{fNO2\_in}(t) + k_1 C_{fTAN\_in}(t) - k_2\ V_f\ C_{fNO2\_in})/Q$

*Where, k_b= fraction of nitrification occurring in rearing tank, C_{cTAN_out}= concentration of total ammonia nitrogen in rearing tank (mg/L), C_{fTAN_out} and C_{fTAN_in}= concentration of total ammonia nitrogen at the outlet and inlet of trickling filter respectively (mg/L) and PR_{TAN}= production rate of TAN (mg/L), V_f= volume of trickling filter (L) and k_1= reaction rate constant (day^{-1}) for conversion of TAN to nitrite-N, C_{cNO2_out}= concentration of nitrite-nitrogen in rearing tank (mg/L) and C_{fNO2_out} and C_{fNO2_in}= concentration of nitrite-nitrogen at the outlet and inlet of trickling filter respectively (mg/L), k_2 represents reaction rate constant (day^{-1}) for conversion of nitrite-N to nitrate-N, k_{oxy} and k_{BOD}= g of oxygen required for fish respiration per kg of feed applied and g of oxygen required for consumption of carbonaceous waste per kg of feed per unit time, k_c= fraction of NO_2-N converted to NO_3-N, C_{cNO3_out}= concentration of nitrate-nitrogen in rearing tank (mg/L) and C_{fNO3_out} and C_{fNO3_in}= concentration of nitrate-nitrogen at the outlet and inlet of trickling filter respectively (mg/L), PR_{DO}= production of DO inside the rearing tank (mg/L), C_{fDO_out}= concentration of DO at the outlet of trickling filter and C_{cDO_out}= concentration of DO inside the rearing tank as well as at the outlet of the rearing tank, PR_{fDO}= production of oxygen in the trickling filter(mg/l), C_{CTSS_out} and C_{CTSS_int}= concentration of suspended solids in water in foam fractionator outlet and inlet (mg/L) respectively, V_s= effective volume of mechanical filter (L), C_{mfSS_out} and C_{mfSS_in}= concentration of suspended solids in mechanical filter outlet and inlet respectively (mg/L), E_{mf}= efficiency of screen filter and PR_{SS}= production of suspended solids (mg/day), C_{cfSS_out}= concentration of suspended solids in water in foam fractionator outlet (mg/L), V_{cf}= effective volume of foam fractionator column (L) and E_{cf}= efficiency of foam fractionators, W(t) and N(t)=weight and no of fish at time t, % BW= percentage body weight.

The main idea behind this model is to reduce the pumping cost by adding make up water only when nitrtate-nitrogen concentration in culture environment reaches its permissible value. The model expressions, once calibrated and validated for a particular fish species, can be used in the prediction of major water quality variables at any instant of the culture period, thus enabling the user to go for timely adoption of management programmes which are otherwise difficult to decide.

Reference

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17.

Impact Evaluation of Front Line Demonstrations on Fish Farming in Sub-tropical Region of Jammu & Kashmir

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Keywords: Fish farming, FLD, technological gap, extension gap

Introduction

Aquaculture is the fastest growing food-producing sector in the world as well as in India. Total fish production of India in 2013-14 was 9.58 million metric tonnes with a contribution of 6.14 million metric tonnes from inland sector and 3.44 million metric tons from marine sector. Jammu and Kashmir (J&K) is occupying 22nd position in total fish production among the Indian states with 20000 tonnes in which Jammu district production contribution was 1075.17 tonnes only. The Jammu district is having sizeable area under fish production but the productivity level is very low in comparison to the neighbouring states of Punjab and Haryana. The fish production practices in Jammu from the farmers' perspective have not been optimally understood and practiced. The current study aimed at providing better understanding of fish farming systems, fish species reared and production practices by conducting Front Line Demonstrations (FLDs) on farmer' field with the objective of showing the production potential of the scientific technologies under actual farm situation.

Materials and Methods

The present study was carried out by the Krishi Vigyan Kendra Jammu in the farmers' ponds in adopted villages between 2011-12 and 2014-15. During the study period, 46 fish farmers who possess fish pond of 0.10 ha having dimensions of 40x25x1.5m were covered under FLDs. A total of 4.6 ha area was covered from 11 different villages namely Karotanakalan, Beaspur Bangla, Vidhipur, Raipur Sajda, Taliyan, ChakChimna, Chak Bhagwana, Treva, Makhanpur, Jazzowal and Bisnah. The data output were collected from experimental (FLD plots) as well as control plots (farmers practices) and finally the extension gap, technology gap, technology index along with the benefit cost ratio were worked out to compare the effects of the technical interventions.

Results and Discussion

The results of front line demonstrations conducted between 2011-12 to 2014-15 indicated that the fish farming practices followed under FLDs namely: precautions for good water quality management, precautions for transportation of live fish, species combination and stocking density, fish pond fertilization and supplementary feeding to fish in pond produced an average yield of 42.22 q/ha which was 42.74% higher than the control practices (29.75q/ha). Thus, it is summarized that farmer obtained 30.4% more economic benefits by following scientific practices in fish farming. Moreover, it has also been found that there is still an extension gap of 12.47 q/ha in fish production which indicates that more impetus should be given to enhance the farmers' technical know-how regarding scientific fish farming which shall result in higher economic benefits. The technological gap of 17.78 q/ha reflects that there is need to fine tune the available technology for its better adoptability.

Table 1: Production, Technology gaps, Extension gaps, Technology index and Benefit Cost ratio of fish farming

Year	Area (ha)	No. of farmers	Yield (q/ha)			Increase over control (%)	Techno-logy gap (q/ha)	Exten-sion gap (q/ha)	Techno-logy index (%)	B: C ratio	
			Potential	Experi-mental	Control					FLD	Control
2011-12	1.3	13	60	43.56	33.00	32	16.44	10.56	27.4	3.1	2.3
2012-13	1.1	11	60	43.52	32.00	36	16.48	11.52	27.5	3.1	2.2
2013-14	1.5	15	60	42.80	26.00	64	17.20	16.80	28.6	3.5	2.7
2014-15	0.7	7	60	39.00	28.00	39	21.00	11.00	35.0	2.3	2.0
Average				42.22	29.75	42.75	17.78	12.47	29.625	3.0	2.3

#Technology gap=Potential yield - Demonstration yield
#Extension gap=Demonstration yield - Farmers yield
#Technology index={(Potential yield - Demonstration yield)/ Potential yield} x 100
#B: C ratio= Gross return / Gross cost

18.

Differentiation of Deep Sea Crabs (*Charybdis feriatus, Portunus pelagicus and Portunus sanguinolentus*) Using Conventional Data from Ratnagiri Coast, India

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Keywords: Blue swimming crabs; species discrimination; conventional morphometry.

Introduction

Marine crabs forms an important component of the crustacean fisheries. Crustacean contributed 13% of total marine fish landings of India from which crabs contributed 0.46% (CMFRI, Annual Report, 2014-15). Conventional morphometrics find diverse applications in fisheries such as, describing allometric patterns in body shapes, growth pattern, predicting puberty moult, assessing geographic variation and determining condition factors (Cardoso and Fransozo, 2004). Hence, in the present study morpho species of Portunidae family was characterized based on conventional morphometry.

Materialsand methods

180 specimens of crabs were collected from Ratnagiri coast. Specimen were digitized on vertical and horizontal grid (cm^2) for complete archive of body shape and repeated measurement. Utility programs were used to extract data Hammer *et al.* (2012). Between species variations in size and shape of the three species were analysed by PCA and CVA.

Results and Discussion

Student's t-test yielded significant difference ($p < 0.05$) between the means of conventional. All correlation coefficients were positive and significant for all the three species. Principal Component Analyses (PCA) performed on conventional morphometric traits shows that only two principal components together accounted for 98.74% of the total variance (Table 1). PCA discriminated *C. feriatus* from other two species that are having almost same shape that was not detected by PCA using conventional data (Fig. 1). As against PCA, CVA results showed the existence of three separate species with the differences between them being very highly significant ($p < 0.0001$) and discriminated clearly indicating existence of the different species (groups) (Fig. 1).

Table 1: Eigen values of the correlation matrix associated with PCA

Conventional data; Total= 9; Average= 1				
Components	**Eigen value**	**% variance**	**Proportion**	**Cumulative**
PC 1	8.24351	91.595	0.916	0.916
PC 2	1.642637	7.1404	0.0714	0.9874

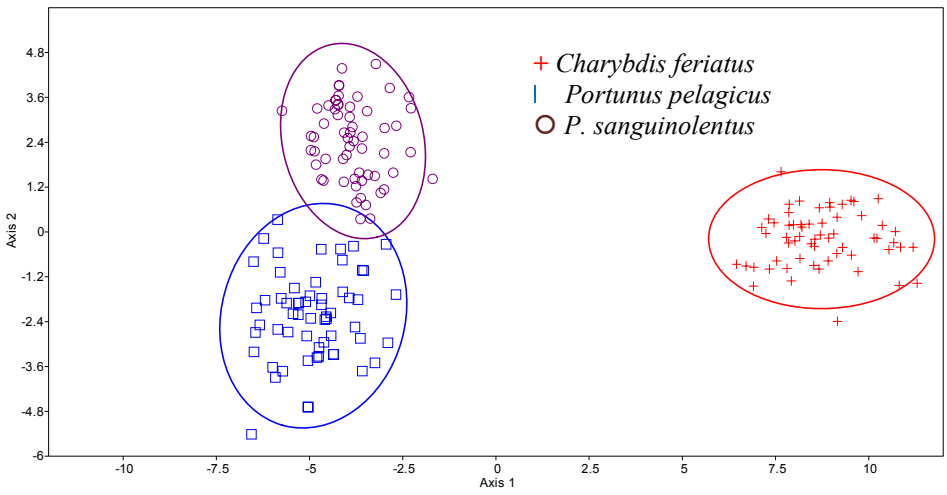

Fig. 1: Scatter plot for dorsal side

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19.

Prospects and Constrains of Pangas catfish, *Pangasius pangasius* Culture in Punjab- A Case Study

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Keywords: Aquaculture, diversification, *Pangasius pangasius*, productivity

Introduction

A field trial of Pangas catfish, *Pangasius pangasius* culture was conducted in district Fazilka (Punjab). *Pangasius* is a vulnerable cat fish with single bone (without intramuscular spine) thus it is a delicacy for fish eaters of Punjab; who otherwise hesitate to consume fish with spines. The fish is highly resistant to crowding and low oxygen. *Pangasius* catfish has been introduced in many countries and have proved to be extremely successful in becoming important food fish. This study was conducted with the objective to standardize the culture practice of *P. pangasius* in local climatic condition of the state to achieve maximum biomass per unit area.

Materials and Methods

Experimental site was located at village Panchawali, district Fazilka, Punjab. In the month of May 2014 fry of *Pangasius pangasius* (length 5.00±0.1 cm and wt. 0.9±0.04g) was procured from Kolkata, West Bengal and stocked in a 1 acre earthen pond at the rate of 37500/ ha. Fish was fed with commercially available pellet floating feed at the rate of 2.5% of body weight daily in split doses thrice a day. Fish was harvested after six months at the end of second week of November, 2014. Water quality parameters, survival rate, total fish production, Feed Conversion Ratio, Specific Growth Rate and economics of the culture were analyzed.

Results and Discussion

During the culture period water temperature in the trail pond varied between 19 to 34°C, where favourable temperature for growth of *P. pangasius* was recorded 23- 28°C. As the species is very temperature sensitive, the problem was solved by addition of fresh water during day time in summer months and during night hours in winters. After six months of culture period, fish was harvested with 93.33% survival (Specific growth rate 5.26) and apparent FCR of 1.32. Maximum and minimum weight of fish was recorded as 750 g and 450 g, respectively. Average weight of fish at the time of harvest was 500 g and total 7 tons of biomass was harvested, which corresponds to the productivity of 17.5 tons/ha/ 6 months. Productivity targets achieved in the present study reveals voluminous scope of diversifying carp culture with Pangas catfish for vertical expansion of aquaculture sector, as three times higher productivity than carps can be achieved through Pangas catfish culture. Total recurring expenditure was estimated around Rs. 9, 69,750/ha including feed, seed, labour, electricity, medicine and miscellaneous cost with a net profit of Rs 2.55 lakh/ha. Due to oversupply of iced *Pangasius* from Andhra Pradesh, restricted the cost of Pangas catfish within the state, otherwise it is possible to earn a net profit of about Rs. 5.0 lakh/ha from the same area. Although estimated net profit is higher as compared with other finfish species (carps) generally cultured in Punjab. Thus *Pangasius* may be considered as an alternative candidate species for diversification of carp culture as well as aquaculture productivity enhancement in Punjab.

Table 1: Economics of culture of *Pangasius pangasius* (1 ha pond with stocking density at the rate of 37500/ ha and six months culture duration)

Parameters	Values in INR
Cost of fish seed (Including transportation cost form Kolkata)	67,250/-
Cost of feed	7,90,000/-
Miscellaneous cost (including labour, electricity, medicine and others)	1,12,500/-
Total recurring expenditure (a+ b+ c)	9,69,750/-
Gross Income (on farm fish selling price @ INR 70/ Kg) (Total fish produced 7 tons)	12,25,000/-
Net Income (e - d)	2,55,250/-

20.

Ecological Aspects of Artificial Reef Construction at Miyani Estuary, Gujarat

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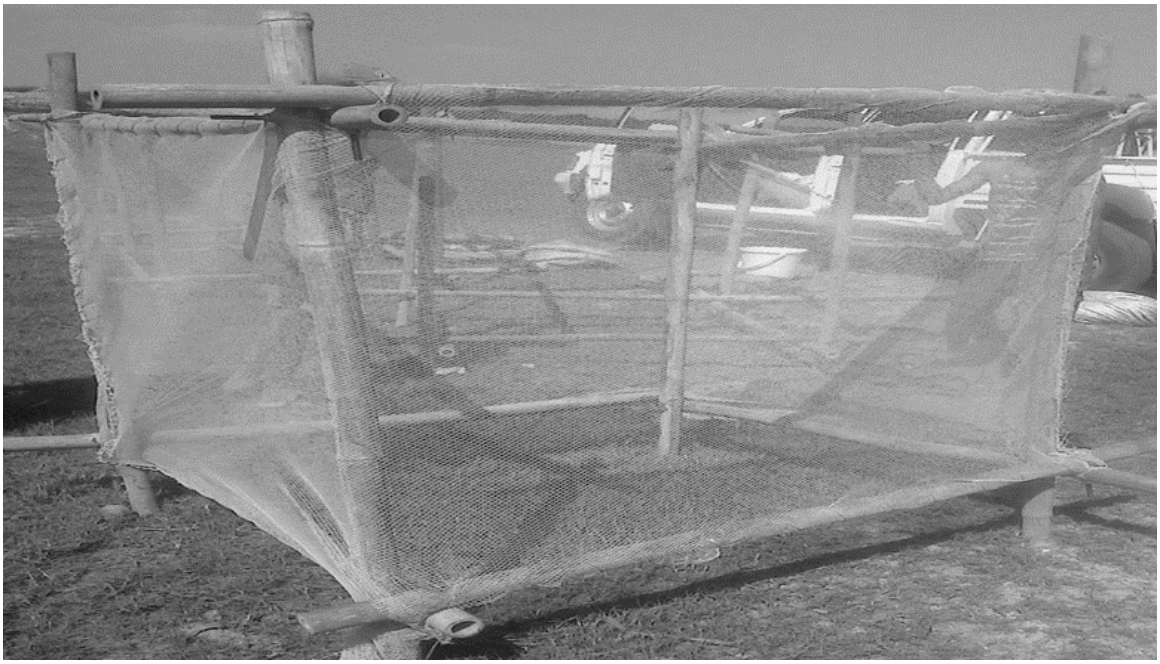
Keywords: Artificial reefs, Ecology, Benthic communities, Restoration, Man-made substrates.

Introduction

Artificial reefs are man-made structures deployed on sea bottoms with the main aim of protecting and increasing biotic resources by preventing trawling and supporting sessile filter feeders, which can colonize on the hard substrata. Biodiversity is the variation in the genetics and life forms of populations, species, communities and ecosystem. It affects the capacity of living system to respond to changes in the environment and is essential for providing goods and services from ecosystems (e.g. nutrient cycling, clean water). Traditionally, artificial reefs were constructed from a wide variety of materials including car tyres, bamboo and general waste material. An artificial reef is a device installed to provide a habitat for marine life to encourage and establish new fishing grounds for small-scale fisheries and sport fishing. Estuarine ecosystems are one of the most important coastal life. Studies on the diversity and richness of fishes of estuaries are very scanty. Hence, the present study was taken up to study the aquatic flora and fauna associated with artificial reef at Miyani estuary, Gujarat.

Materials and Methods

Artificial reefs made of traditional materials namely bamboos, fishing net pieces, rubber, etc. Structure prepared of size convenient to install at the actual site. Location surveyed for this installation is Miyani estuary. This is due to the vast differences in the ecological factors that operate upon the tide pool populations during the period of emergence as compared to their counterparts on the open inter tidal and estuary.



Results and Discussion

A total of 46 species were found in wooden structure at study site. Out of these, 38 species found in natural habitat. Phylum Mollusca is classified into six major classes. Dominant species found categorized under 2 classes of Bivalves pelecypoda and Gastropoda. Six families and 9 species were recorded under the bivalves or pelecypoda. Eleven families and 16 species were recorded under the Gastropoda. Generally, other 13 species were found in dominant and artificial reef structure. Artificial reefs when constructed on a large scale covering a vast area with scientifically designed structures will increase fish production significantly by creating a fertile ecosystem in such areas. Artificial reefs are created to achieve a wide range of goals-replacing natural coral reefs damaged by environmental degradation or ship groundings, breakwaters to protect beaches and coastal lands, and even as creative memorial sites for cremated human remains. The same ecological processes apply on natural and artificial reefs.

21.

Culture of Brackish Water Shrimp, *Litopenaeus vannamei* in Inland Saline Water of Punjab: Status and Scope

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Keywords: Vannamei shrimp, inland saline water, Punjab

Introduction

South-west districts of Punjab (Mukatsar, Ferozepur, Fazilka, Faridkot, Bathinda and Mansa) are affected by underground water salinity and water logging and the affected areas are becoming unfit for agricultural activities. Aquaculture is one of the suitable options for utilizing these waste lands, where water is abundantly available. After developing aquaculture technologies for rearing freshwater carps in inland saline water, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU) took over the challenge of rearing brackish water shrimp (*Litopenaeus vannamei*) in affected areas of district Fazilka.

Materials and Methods

Specific pathogen free (SPF) post larvae (PL) of 'Vannamei shrimp' (*Litopenaeus vannamei*) were reared under aerated conditions (4 aerators 2.0 HP each) in one acre earthen pond at a stocking density of 50/m^2 for a period of 97 days. Before stocking of PL, the pond was treated with fermented prebiotic media to develop plankton bloom. Micro and macro mineral supplements were also supplied to prevent any osmoregulatory stress and the shrimp was fed with commercial starter feed at the rate of 3 kg per 1 lakh PL, four times a day for first month followed by grower feed at the rate of 6% of the body weight, three times a day. Periodic sampling through check tray was done to check growth and health status of shrimp. Water, soil and feed probiotics were also used to maintain a healthy culture environment.

Results and Discussion

About 1.2 tonnes of shrimp was harvested (Feed conversion ratio 1.21) in the month of October having an average body weight of 22±0.5 g. Net profit in the tune of Rs 97,530 was recorded after a short period of 97 days, which is much higher than any other aquaculture practice, with special reference to freshwater aquaculture. During the culture period salinity of water ranged between 2-3 ppt and estimated survival of shrimp was found to be 60%. 'Vannamei' is a cold sensitive high export commodity, however two crops (100-120 days each) of 'Vannamei' can be reared in Punjab from April to October and it holds ample scope to give an intense push to the 'Blue Revolution' in the state.

Table 1: Economics of Pacific white leg shrimp *Litopenaeus vannamei* culture in 1 acre of Inland saline area

Parameter	Value in Rs
Seed Cost (For 2 Lakh seed at the rate of Rs 1.20 including freight charges)	2,40,000
Feed Cost (1476 kgs at the rate of Rs 70/kg including transportation)	103,320
Labour Cost	40,000
Electricity Cost	20,000
Medicine Cost (Soil & water probiotics, Sanitizers, Disinfectants, Zeolites etc.)	45,000
Gross Expenditure	**4,48,320**
Total Production 1213 Kgs	5,45,850 (Sold at the rate of Rs 450/kg)
Net Profit	**97,530**

22.

Cost and Return Analysis of Sheep Rearing in Rajouri District of J&K state

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Keywords: Sheep, costs, returns

Introduction

Livestock form an important economic and ecological niche in agricultural systems. Rajouri district being a hilly area falls under intermediate zone having potential of sheep rearing. The sheep supplies the wool for domestic use and also leads to better employment opportunities. We worked out cost and return analysis of sheep rearing and its income pattern.

Materials and Methods

The study was conducted in Rajouri district of Jammu and Kashmir state during the year 2013. The total number of rearers selected for the study was 180 (6 villages from 3 blocks and 10 rearers from each village). These rearers were categorized into small with less than hundred sheeps, medium with one hundred one to one hundred seventy five sheeps and large category having more than one hundred seventy five sheeps. The data were analysed by applying a cost and return concepts viz., cost A (wages of hired labour, medical expenses, mineral (salt) cost, private grazing charges, government grazing charges, shearing expenses, miscellaneous expenses, interest on working capital, depreciation/appreciation on fixed capital (value of equipments and flocks), Cost B (cost A + interest on fixed capital (value of equipments and flocks), Cost C (cost B + imputed value of family labour) and Cost C* (cost C + 10 per cent of cost C on account of management cost).

Results and Discussion

The overall per animal rearing cost of sheep in Rajouri district was Rs.914. The cost was highest in medium rearers due to higher imputed value of family labour. The cost A was highest in medium rearers due to higher depreciation on fixed capital. The cost B was highest in medium rearers (Rs.366) and lowest in large rearers (Rs.243). The cost C was highest in medium rearers (Rs.934) and lowest in large rearers (Rs.730) and cost C* was highest in medium rearers (Rs.1027) and lowest in large rearers (Rs.803). The overall return per animal was Rs.919. The per animal gross return was highest in medium rearers and lowest in large rearers. The flock business income was highest in small rearers and lowest in large rearers. The family labour income was highest for small rearers and lowest in large rearers. The net income over cost C was highest in small rearers and lowest in large rearers and the net income over C* was highest in small rearers and lowest in large rearers (Table 1).

Table 1: Overall cost and return of sheep rearing in Rajouri district of Jammu and Kashmir

Particular	Per animal				Per flock			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Average flock size per household					57	120	228	135.00
Variable cost								
Feed cost								
Green fodder	54.47	63.68	54.16	57.44	3105.00	7641.00	12348.00	7698.00
Dry fodder	18.16	21.23	18.05	19.15	1035.00	2547.00	4116.00	2566.00
Mineral nutrient	51.51	64.66	57.61	57.93	2935.80	7759.50	13135.33	7943.55
Veterinary expenditure	11.69	11.87	9.67	11.08	666.54	1424.50	2205.83	1432.29
Total variable cost	135.83	161.43	139.50	145.59	7742.33	19372.00	31805.17	19639.83
Fixed cost								
Depreciation	68.79	87.60	48.33	68.24	3921.00	10512.00	11019.00	8484.00
Government grazing charges	0.00	45.45	15.53	20.33	0.00	5453.67	3541.50	2998.39
Cost A	213.04	304.79	209.50	242.44	12143.33	36575.17	47765.67	32161.39
Interest on fixed capital	48.16	60.90	33.72	47.59	2745.33	7307.67	7688.17	5913.72
Cost B	261.20	365.69	243.22	290.04	14888.67	43882.83	55453.83	38075.11
Imputed value of family labour	568.63	568.23	486.77	541.21	32412.17	68187.42	110983.83	70527.81
Cost C	829.84	933.92	729.99	831.25	47300.83	112070.17	166437.67	108602.89
Cost C*	912.82	1027.30	802.95	914.36	52030.61	123276.52	183071.90	119459.68
Return								
Wool yield (kg)	1.01	1.13	1.02	1.05	57.55	135.57	231.51	141.54
Value of wool	100.97	112.99	101.54	105.17	5755.23	13558.46	23151.17	14154.95
Value of animal sold	1720.56	1758.81	1612.32	1697.23	98072.16	211057.33	367608.33	225579.28
Value of added stock	299.83	287.80	248.99	278.87	17090.37	34535.67	56769.33	36131.79
Gross returns	1867.34	1920.47	1713.86	1833.89	106438.43	230456.70	390759.50	242551.54
Flock business income	1654.30	1615.68	1504.36	1591.45	94295.09	193881.53	342993.83	210390.15
Family labour income	1606.14	1554.78	1470.64	1543.85	91549.76	186573.86	335305.67	204476.43
Net income over cost C	1037.50	986.55	983.87	1002.64	59137.56	118386.45	224321.83	133948.61
Net income over cost C*	955	893	911	919	54408	107180	207655	123081

23.

Improving Marketing Efficiency of Broiler for Small Production Units in Jammu District of J&K State

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Keywords: Broiler farms, marketing channel, marketing cost, marketing efficiency, price spread

Introduction

Boiler chicken is an important source of high quality nutrients and therefore is a very essential part of the human diet. Broiler farming is an important source of income for a large number of marginal land holders in underdeveloped countries. Production and marketing of broiler also provides gainful employment to rural youths. An increase in per capita consumption by one egg and 50 grams of poultry meat can create employment for about 26,000 persons per year (Kazi, 2003). The state of Jammu & Kashmir (J&K) and particularly, the Jammu district has favourable environment for broiler production. However, due to the marginal and small size of land holdings, the majority of the broiler production operating in the district is small in size, with capacity of birds ranging between 100 and 5000 at a particular point of time. Marketing of broiler like any other agricultural enterprise is an important activity, as the marketing practices would determine the real returns from the whole business. This study on broiler's marketing has been conducted for small scale broiler units with the same objectives in Jammu district of J&K State.

Materials and Methods

A majority of broiler farms in Jammu district have existed in and around Jammu city. A list of such broiler farms was collected from State Department of Animal Husbandry which was then categorized into different categories. Sixty broiler farms were randomly selected in total (20 from each category) in order to study the marketing practices and marketing channels for estimation of marketing cost, marketing margins and marketing efficiency in broiler's marketing. Besides, two big traders of Jammu city and ten retailers were also selected randomly for estimation of price spread in the marketing of broiler.

Results and Discussion

Marketing efficiency is the effectiveness with which the market performs its designated functions. Table 1 reveals the marketing efficiency of broiler in and around Jammu city under three different channels identified in the present study. The marketing efficiency was found to be highest under channel 'I' which is the direct channel of "producer to consumer". Marketing efficiency of channel 'II' which includes "producer to retailer to consumer "was estimated to be 4.90 and marketing efficiency in case of channel 'III': "producer to trader to retailer to consumer" was 4.63. Thus, channel 'II' was found to be more efficient and feasible marketing channel among the three identified for marketing of broilers in and around Jammu city. Under channel 'II', producers have to search for different retail outlets to sale their entire produce under this channel. The channel 'I' has highest marketing efficiency due to the absence of any middlemen, however practically adopting this channel is impossible for large amount of produce, especially for broiler which cannot be sold in bulk to an individual consumer. The second channel was found to be more efficient and more feasible channel among the three identified for marketing of broilers in and around Jammu city.

Table 1: Marketing efficiency of different channels

Particulars	Channel I (Rs.)	Channel II (Rs.)	Channel III (Rs.)
Producers' price	10152.02	11000.00	11000.00
Net price received by producers	10001.52	9136.14	9046.67
Net marketing margin	0.00	1570.56	1692.83
Marketing cost	150.50	293.30	260.50
Total marketing cost & margin	150.50	1863.86	1953.33
Marketing efficiency	66.45	4.90	4.63

Specify channel I, II and III in the foot note of the table
Channel I - Producer to Consumer
Channel II - Producer to Retailer to Consumer
Channel III - Producer to Trader to Retailer to Consumer

24.

Effect of Duckweed (*Lemna minor*) Incorporated Diets on Growth Performance and Flesh Quality of Carps in Semi-intensive Culture System

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Keywords: Carps, duckweed, *Lemna,* non-conventional feed resources, fish growth.

Introduction

Duckweed, such as *Lemna, Spirodela, Wolfia* etc. (free floating aquatic plants, family - Lamnacae) are one of the most promising non-conventional feed resources due to their superior nutritive value, exceptionally fast growth rate and worldwide distribution. Although, among all the duckweeds, *Lemna minor* has been reported to induce positive growth response in various fish species (Mandal *et al.* 2010) in laboratory or field conditions, it is essential to evaluate growth response and its best utilization as fish feed ingredient in region specific conditions. Hence, the study was taken up for developing *Lemna* based nutritionally balanced diet for rearing carps (rohu, *Labeo rohita* and common carp, *Cyprinus carpio*) in a semi-intensive culture system.

Materials and Methods

The experimental study was carried out for 180 days in 20 m^3 outdoor cemented tanks in triplicate. Fry of rohu, *L. rohita* and common carp, *C. carpio* stocked at the rate of 10,000 ha^{-1}were fed with *Lemna* incorporated (10-50%) diets (D_2-D_6) prepared by replacing basal diet (D_1 - rice bran and mustard meal in ratio of 1: 1 along with 1.5% vitamin -mineral mixture and 0.5% salt). Feeding was done at the rate of 5% fish body weight (FBW) and 2% FBW for the first two and following four months. The effect of different diets was determined in terms of water quality parameters, fish growth and flesh composition. The data was statistically analyzed by applying one way ANOVA for determining significant differences among treatments at 5% significant level ($p<0.05$).

Results and Discussion

Water quality parameters did not vary significantly among the treatments and were well within the recommended range in all the treatments for supporting optimum growth in carps throughout the culture period. Diet D_2 and D_1 (control) supported highest growth in *L. rohita* and *C. carpio* as compared to other experimental diets. At the end of the experiment, maximum per cent net weight gain (3248.67), specific growth rate (1.95) and protein efficiency ration (1.96) was recorded in rohu fed with diet D_2 and the differences among treatments were significant ($D_2=D_1>D_3>D_4\geq D_5=D_6$). In common carp also, maximum growth in term of percent net weight gain (3605.88), SGR (2.01) and PER (2.09) was recorded in diet D_2 and the differences were significant ($D_2=D_1\geq D_4=D_6=D_5=D_3$). Incorporation of *L. minor* at 10% in basal diet also resulted in efficient utilization of feed in the form of minimum FCR (1.87, 1.75) in rohu and common carp respectively. At the termination of the experiment, maximum total protein (TP) 15.53, total lipid (TL) 2.69, total carbohydrates (TC) -3.80 and ash contents (1.78) were recorded in D_2, D_3, D_5 and D_3 respectively in rohu and the differences among the diets were significant. In common carp, maximum TP (14.45), TL (3.43), TC (2.57) and Ash contents (2.61) were recorded in D_3, D_2, D_1 and D_4 respectively and the differences among the diets were significant. Collectively, results of the present study revealed that dried *Lemna* powder can be incorporated in carp diet @ 10% by replacing conventional feed ingredients without compromising fish growth and with improved flesh quality.

Reference

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Table 1: Changes in growth parameters and flesh composition (g/100g on wet weight basis) of *L. rohita* and *C. carpio* fed on experimental diets

Parameters	Diets						Diets					
	L. rohita						*C. carpio*					
	D_1	D_2	D_3	D_4	D_5	D_6	D_1	D_2	D_3	D_4	D_5	D_6
Av. Initial length (cm)	$4.3^{a}\pm$ 0.072	$4.25^{a}\pm$ 0.088	$4.21^{a}\pm$ 0.091	$4.29^{a}\pm$ 0.065	4.25^{a} ±0.064	$4.28^{a}\pm$ 0.065	$4.71^{a}\pm$ 0.079	$4.67^{a}\pm$ 0.106	$4.61^{a}\pm$ 0.225	$4.61^{a}\pm$ 0.116	$4.62^{a}\pm$ 0.109	$4.67^{a}\pm$ 0.095
Av. Final length (cm)	14.00^{a} ±0.105	14.22^{a} ±0.478	13.43^{b} ±0.487	13.47^{b} ±0.481	14.17^{a} ±0.472	13.94^{a} ±0.372	15.00^{b} ±0.247	$15.8^{a}\pm$ 0.451	13.22^{d} ±0.239	13.97^{cd} ±0.218	14.17^{c} ±0.183	14.25^{bc} ±0.239
Av. Initial weight (g)	$1.12^{a}\pm$ 0.045	1.087^{a} ±0.046	1.127^{a} ±0.069	1.107^{a} ±0.06	1.113^{a} ±0.068	1.133^{a} ±0.062	$1.54^{a}\pm$ 0.084	$1.53^{a}\pm$ 0.068	$1.48^{a}\pm$ 0.110	$1.41^{a}\pm^{a}$ 0.118	$1.51^{a}\pm^{a}$ 0.094	$1.51^{a}\pm^{a}$ 0.082
Av. Final weight (g)	35.70^{a} ±1.086	36.40^{a} ±0.718	30.70^{ab} ±0.857	29.00^{c} ±0.650	26.75^{cd} ±0.891	26.20^{d} ±0.879	55.00^{a} ±3.187	56.70^{a} ±3.246	38.90^{b} ±1.853	38.80^{b} ±2.275	40.60^{b} ±1.634	41.30^{b} ±1.967
% NWG	3087.5	3248.67	2273.56	2266.76	2658.31	2459.57	3471.43	3605.88	2528.37	2651.77	2588.74	2635.10
SGR	1.92	1.95	1.84	1.81	1.77	1.74	1.98	2.01	1.81	1.84	1.82	1.83
PER	1.87	1.96	1.72	1.80	1.80	1.81	1.91	2.09	1.72	1.78	1.82	1.77
FCR	1.93	1.87	2.15	2.08	2.11	2.12	1.89	1.75	2.15	2.11	2.09	2.17
Flesh Composition												
Total Protein	14.07^{a} ±0.43	15.53^{a} ±0.55	15.37^{a} ±0.48	15.43 ^{a}±0.54	14.93^{a} ±0.26	14.47^{a} ±0.26	13.87^{a} ±0.35	14.45^{a} ±0.34	14.45^{a} ±0.36	14.12^{a} ±0.31	14.11^{a} ±0.28	13.89^{a} ±0.45
Total lipid	2.10^{ab} ± 0.24	2.41 ^{a}±0.13	$2.69^{a}\pm$ 0.06	$2.69^{a}\pm$ 0.03	2.32 ^{ab}±0.02	2.25 ^{ab}±0.11	$2.78^{ab}\pm$ 0.21	$3.43^{a}\pm$ 0.23	$3.10^{a}\pm$ 0.16	$3.12^{a}\pm$ 0.13	$3.23^{a}\pm$ 0.12	$3.15^{a}\pm$ 0.21
Total carbo-hydrates	2.97^{ab} ±0.06	$2.10^{b}\pm$ 0.21	$2.19^{b}\pm$ 0.05	$2.14^{b}\pm$ 0.37	$3.80^{a}\pm$ 0.04	$3.37^{a}\pm$ 0.46	$2.57^{a}\pm$ 0.16	$2.43^{a}\pm$ 0.18	$2.12^{b}\pm$ 0.15	$2.17^{b}\pm$ 0.27	$2.56^{a}\pm$ 0.14	$2.18^{b}\pm$ 0.26
Ash	1.35^{ab} ±0.23	$1.06^{b}\pm$ 0.17	$1.78^{a}\pm$ 0.25	$1.57^{a}\pm$ 0.18	$1.57^{a}\pm$ 0.17	$1.09^{b}\pm$ 0.21	$1.29^{b}\pm$ 0.26	$1.06^{b}\pm$ 0.21	$2.01^{ab}\pm$ 0.35	$2.61^{a}\pm$ 0.28	$2.60^{a}\pm$ 0.27	$2.52^{a}\pm$ 0.15
Moisture	79.51^{a} ±0.62	78.90 ^{a}±0.53	77.97 ^{a}±0.28	78.17^{a} ±0.08	77.38 ^{a}±0.13	78.82 ^{a}±0.46	79.25^{a} ±0.34	78.63^{a} ±0.25	78.32^{a} ±0.31	77.98^{a} ±0.17	77.50^{a} ±0.28	77.98 ^{a}±0.51

Values are mean±S.E; Values with same superscript in row do not differ significantly ($P \leq 0.05$)
D_1- control diet, without *Lemna*; D_2-D_6 - Experimental diets having *Lemna minor* from 10-50%.

25.

Effect of Synbiotics on Growth, Immune Response of *Labeo rohita* and Disease Resistance against *Aeromonas hydrophila*

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Keywords: Synbiotics, probiotics, *Labeo rohita*, enzyme activity, immune response

Introduction

Although application of pro- and pre- biotics as environment-friendly alternatives in fish nutrition seems to be relatively recent, the interest in such dietary supplements is increasing rapidly not only in fish, but also in Shrimp aquaculture. Currently, many pro- and pre-biotics are successfully use for growth and health management in the sustainable aquaculture industry. The present study investigate the synbiotic effect of probiotic *Paenibacillus polymyxa* and a short-chain fructooligosaccharide (FOS) prebiotic (Inulin) on growth performance, digestive enzyme activity, immune responses of *Labeo rohita* and disease resistance against *Aeromonas hydrophila*.

Materials and Methods

In the present study, symbiotic effect of probiotic *Paenibacillus polymyxa* (@10^6cfu/ml) and a short-chain fructooligosaccharide (FOS) prebiotic (Inulin) was evaluated in *Labeo rohita*. The experiment was conducted in triplicates for ten weeks and treatments includes: F0=Basal diet (control); F1= Basal diet +*P. polymyxa* (10^6 cfu/g) as +ve control; F2= Basal diet + Inulin (0.05%) +*P. polymyxa*(10^6 cfu/g) (0.125 g/250 g feed); F3= Basal diet + Inulin (0.1%) +*P. polymyxa* (10^6 cfu/g) (0.250 g/250 g feed); F4= Basal diet + Inulin (0.2%) +*P. polymyxa* (10^6 cfu/g) (0.500 g/250g feed); and F5= Basal diet + Inulin (0.4%) +*P. polymyxa* (10^6 cfu/g) (1.0 g/250 g feed). For prebiotic treatments, Inulin was dissolved in 10 ml of distilled water and sprayed and mixed uniformly on the diet (250g). Water quality analysis was performed as per standard methods. Biometry analysis, digestive enzyme activity and innate immune responses were performed as per standard procedures as mentioned in Gupta *et al.* (2014). After termination of experiment trial, an experimental infection was induced in fish with the pathogenic bacterium, *A. hydrophila*.

Results and Discussion

The results of the present study indicated that use of Inulin (@ 0.2%) and *P. polymyxa* (@10^6cfu/ml) as synbiotic resulted in improved growth performance, digestive enzyme activities and enhanced immune responses of *L. rohita*. Also, these feed additives reduces the prevalence of *Aeromonas hydrophila* related disease problems. However, further research is needed on the effect of prebiotics against bacterial infections and commercially available oligosaccharides. Since, Inulin and *P. polymyxa* improved immunity in fish, further research is needed on the mode of action of synbiotic in both fish and shellfish. Table 1 shows the effect of symbiotic on growth performance of *L. rohita.*

Table 1: Effect of dietary supplementation of synbiotic on growth and survival of *Labeo rohita*.

Treatment	F0	F1	F2	F3	F4
In BW (g)	52.74	52.74	52.74	52.74	52.74
F BW (g)	153.4	162.5	163.5	185.0	163.0
Weight gain(g)	100.8	109.8	110.8	132.2	110.3
Survival (%)	53.3	53.3	66.67	90.00	86.67

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26.

Effect of Biofouling in Cage Culture System of Chhirpani Reservoir, Chhattisgarh

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Keywords: Biofouling, cage culture, bryozoan, Chhattisgarh

Introduction

Recently, cage aquaculture in reservoirs is gaining lot of momentum in India for intensive fish culture. Chhattisgarh has taken keen interest and lead in implementation of cage farming. The state is bestowed with 1, 53, 873 ha water spread area for fish production with a total fish production of 2.7 lakh tonnes. About 83, 873 ha (54.51%) of water spread area is in the form of reservoirs contributing 0.6710 lakh tones. Presently, at six different locations cage farming is practiced in Chhattisgarh. Biofouling is a very common and recurring problem in cage aquaculture for both in freshwater and marine environment (Jones, 2009). There are two fouling organisms: micro fouling and macro fouling which consists of flora and fauna that attach and grow on net of the cages (Fitridge *et al.*, 2012). Hence, the present study was conducted to analyze the composition and intensity of biofouling agents and their relationship with existing physico-chemical parameters of cages at Chhirpani Reservoir, Kawardha, Kabirdham District, Chhattisgarh, India.

Materials and Methods

The study was carried out for one year period (June, 2013 to July, 2014) in cage farm located at Chhirpani reservoir (450 FRL) in Kabirdham district (latitude: 2°12'08.91"N and longitude: 81°11'47.47"E). Fingerlings (Avg. length: 80-90 mm, Avg. body weight 40.3 g) of striped catfish (*Pangasianodon hypophthalmus)* were stocked at the rate of 52 / m^3 with a total cage volume of 4608m^3 on 15th June, 2013. The samples of biofouling communities accumulated on the cage net were collected using scalpel for quantitative and qualitative analysis of flora and fauna associated with bio fouling. Water samples were collected at fortnight interval for analysis of physico-chemical parameters (APHA, 1998). The data were analyzed for fluctuations during study period and descriptive statistics was used for obtaining mean and standard deviation in Paleontological statistics (PAST).

Results and Discussion

Five major groups were identified on 240 net panels, which included bryozoans, crustaceans, green algae and blue green algae. Bryozoans were the dominant (60%) among all the groups followed by crustaceans (20%), green algae (12%) and blue green algae (8%) (Table 1, Fig. 1). The highest temperature was recorded in May (31.5°C) and the lowest in December (20.3°C). High alkalinity was in January (147.5 mg/l) while the lowest in August (84 mg/l). Unionised ammonia is more toxic than ionized ammonia. Fish continuously exposed to more than 0.02 mg/l of the un-ionized form may exhibit reduced growth and increased susceptibility to disease. Mean ammonia level was 0.06 mg/l throughout the study period. The lowest dissolved oxygen was recorded in January (3.5mg/l) due to higher growth of biofouler communities and restricted water exchange that has led to mortality of fish in large quantity. The highest dissolved oxygen was noted in November (6.2 mg/l). BOD varied throughout the year ranging between 38 to 52 mg/l. The main impact of cage aquaculture is the increase in the load of N, P and organic matter that enrich water leading to growth of biofoulers (LonggenGuo and Zhongjie Li, 2003).

Fig. 1: Colony of biofouling on cage net

Table 1: Composition of biofouling organisms

Major Groups		Species	Composition (%)
Green Algae	*Chlorophyceae*	Chlorella, Spirogyra	12
Blue Green Algae	Cyanophyceae	*Anabaena, Nostoc sp.*	8
Crustaceans	Rotifera	Keratella sp.	20
	Ostracoda,	Cypris	
	Cladoceran	Daphnia	
	Copepod	Cyclops, Diaptoma	
Bryozoans	Hydroids	*Cordylophora*	60

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27.

Effect of Broodstock Sex Ratio on Reproductive Performance of Common Carp, *Cyprinuscarpio* (Linnaeus, 1758) Reared in Hapas

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Keywords: Common carp, sex ratio, fecundity, fertilization

Introduction

The common carp (*Cyprinuscarpio*) omnivorous fish is one among the earliest species to be cultured in the world. Alikunhi (1966) and Guha& Mukherjee (1991) published information on reproductive aspects of common carp (*C. carpio*) from India. As common carp breeding is still very traditional in India, therefore, the quantity of common carp seed which is available is needed to be most economic and technique should be such that the resources are utilized most efficiently to meet the demand of the fish farmers and entrepreneurs for developing culture techniques.

Materials and Methods

Two treatments of male: female, were selected namely 2: 1, 3: 1, while 1: 1 ratio, acted as a control. The three experimental sex ratios were subjected to be studied in one way analysis of variance with three replicates/ treatment giving total number of nine (2 m^3) spawning hapas. The experiment lasted for a total 60 days.Average weight of female and male fish, gonadosomatic index of Female fish and malefish, absolute fecundity and relative fecundity of female fish, water quality parameters running fecundity, fertilization, hatching, survival rates and total number of fry produced were calculated.

Results and Discussion

Best result was observed in the 2: 1 set of the experiment, in which, maximum number of spawn/fry production was recorded, followed by 1: 1, and 3: 1. During the breeding experiments, all the factors such as temperature, pH and Dissolved oxygen remained within the optimal range. 32420 fry of common carp (*Cyprinuscarpio*) were produced in experimental set with male: female of 2: 1, which was found to be best among all the treatments, followed by 24,746 in 1: 1, followed by 24502 fry in 3: 1 (Table 1).Highest running fecundity of 94 936 eggs was observed with male to female ratio of 2: 1. Highest fertilization rate of 78.66% was found in male to female ratio of 3: 1. Hatching rate of 92% was found to be highest in male to female ratio of 3: 1. Survival rate of 54% was highest in 1: 1 male to female ratio.

Table 1: Effect of variable sex ratio of male: female on fecundity, fertilization, hatching and survival rate

Male: Female	Running Fecundity	Fertilization (%)	Hatching (%)	Survival (%)	No. of fry produced
1: 1	75300.33±1798.00	70.45±0.97	85.33±1.20	54.67±0.88	24746
2: 1	94936.67±930.80	74.89±1.94	90.00±1.53	50.67±3.38	32420
3: 1	69567.33±1336.02	78.66±1.76	92.00±1.73	48.67±2.03	24502
CD	6866.56	6.043	3.104	NS*	

NS*- Non Significant ($p<0.05$) and treatment group values are expressed as mean±SE (n= 3)

Higher male to female ratio of brood fish has a significant effect on running fecundity, fertilization rate, hatching rate, and total number of fry produced. Survivability of hatchlings is not much affected by male to female ratio of brood fishes.

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28.

Effect of Dietary Supplementation of Organic Acid Blend on Antioxidant Defence Enzyme Activity and Disease Resistance of *Cirrhinus mrigala (Ham.)* Fingerlings

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Keywords: Organic acid blend, defence enzyme activity, cumulative mortality.

Introduction

In any aquaculture system, water quality refers to the quality of water that enables successful propagation of the desired organisms. Growth and survival, which together determine the ultimate yield, are influenced by a number of ecological parameters and managerial practices. Furthermore, organic acids have been used for decades in commercial compound feeds, mostly for feed preservation, for which formic and propionic acids are particularly effective. Organic acids and their salts can also contribute in nutritional ways, because their salts can improve the digestibility of the diet. In rainbow trout (*Oncorhynchus mykiss*), dietary supplementation with 1% sodium diformate was found to increase the digestibility of some nutrients, such as proteins, lipids, and amino acids, as well as improve diet stability (Morken *et al.*, 2011).

Materials and Methods

Fingerlings of Indian Major Carp, *Cirrhinus mrigala* were procured from Palghar fish farm, Panvel, Maharashtra, India. The experiment was conducted for 60 days in the wet laboratory of the Aquaculture Division, Central Institute of Fisheries Education, Maharastra, India. Total experiment was conducted on 12 plastic rectangular tubs (80 × 57 × 42 cm, 150 l capacity) and completely randomized design is followed throughout the experiment. Water quality parameters namely temperature, pH, dissolved oxygen, free carbon dioxide, total hardness, ammonia, nitrite and nitrate were recorded. Diet formulation are given in Table 1Six fish per treatment were sampled and anaesthetized with clove oil at 50µl l^{-1} water. The gill and liver of the fishes were removed carefully and were weighed. It was homogenized with chilled sucrose solution (0.25 M). Catalase activity was assayed according to the method described by Takahara *et al.* (1960). Superoxide dismutase activity was assayed according to the method described by Mishra and Fridovich (1972)

After 60 days of feeding trial, 12 fish per group were challenged with virulent *A. hydrophila* (obtained from Aquatic Animal Health & Management Division, CIFE, Mumbai). The fish in each experimental group were intra-peritoneally injected with 0.2 ml of bacterial suspension. Mortality was observed for 15 days.

The cumulative mortality in different treatment groups were calculated as follows:

$$\text{Cumulative mortality \%} = \frac{\text{Total mortality in each treatment after challenge}}{\text{Total no. of fish challenged for same treatment}} \times 100$$

Results and Discussion

Dissolved oxygen (DO) and pH ranged from 6.46 to 7.12 mgL^{-1} and 7.4 to 8.5, respectively. The total ammonia and nitrite levels varied between 0.22-0.49 mgL^{-1} and 0.03-0.15 mgL^{-1}, respectively. Water temperature varied from 27.4 to 29.2°C and CO_2 was not detected in any of the tubs. The values were within tolerable limits for carp (Jhingran, 1991). Catalase and SOD enzyme activity in gill and liver tissue of *C. mrigala* fingerlings are shown in the Table II. Both enzyme activities were decreased in gill and liver tissue with increasing inclusion of OAB in the diets during pre challenge as well as post challenge period administered with *Aeromonas hydrophilla* infection. In the present study, higher CAT and SOD activities were recorded in the organic acid fed groups, apparently to counteract the after effects of ROS accumulation in the liver and gill (Cajaraville *et al.,* 2000). The cumulative mortality % of fish of the different experimental groups during post-challenge period is illustrated in Fig. 1. Fingerlings fed on the control diet showed the highest mortality rate (80%) compared with the organic acid fed groups, which showed a reduction in the mortality rate from 60% to 25% in the groups treated with 0.5%, 1% and 1.5% OAB supplemented in the diet. Hence, this study corroborates the functionality of acidifier at the level of 1.5% in the diet of *Cirrhinus mrigala* fingerlings which positively affects antioxidant defence enzyme activity and disease resistance

Table I: Composition of the experimental diets (% Dry matter basis)

Ingredients	Control	0.5% OA*	1% OA	1.5% OA
Fish meal	18	18	18	18
GNOC	21	21	21	21
Soybean meal	30	30	30	30
Corn flour	9	9	9	9
Wheat bran	8	8	8	8
Rice flour	8	8	8	8
Oil mix	4	4	4	4
Vit & Min.	2	2	2	2
BHT	0.2	0.2	0.2	0.2
Organic acid	-	0.5	1	1.5

Composition of vitamin mineral mix (PREEMIX PLUS) (quantity/2.5kg)
Vitamin A, 55,00,000 IU; Vitamin D_3, 11,00,000 IU; Vitamin B_2, 2,000 mg; Vitamin E, 750 mg; Vitamin K, 1,000 mg; Vitamin B_6, 1,000 mg; Vitamin B_{12}, 6 mcg; Calcium Pantothenate, 2,500 mg; Nicotinamide, 10 g; Choline Chloride, 150 g; Mn, 27,000 mg; I, 1,000 mg; Fe, 7,500 mg; Zn, 5,000 mg; Cu, 2,000 mg; Co, 450 L- lysine, 10 g; DL- Methionine, 10 g; Selenium, 50 ppm; Satwari, 2500 mg;
OA*- Organic Acid

29.

Effect of Stocking Density on Survival and Growth Performance of Fry of Stinging Catfish, *Heteropneustes fossilis* (Bloch.)

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Keywords: Stocking density, growth, survival, *Heteropneustes fossilis,* fry rearing.

Introduction

Heteropneustes fossilis (Bloch.) commonly known as 'Singhi' or 'Stinging catfish' is one of the highly demanded species in the Indian subcontinent and Southeast Asian region. It is one of the hardiest and highly priced fish due to its high digestibility, palatability and medicinal qualities, besides having lesser spines. Optimizing stocking density (SD) is a pre-requisite for developing package of practice for rearing any species under controlled conditions, since it has direct effect on growth, survival and productivity of fish. Considering the importance of SD for optimum growth performance of fish (Kohinoor *et al* 2012), the present investigation was undertaken to study the survival and growth of *H. fossilis* under different stocking densities with same feeding regime.

Materials and Methods

The study was conducted at College of Fisheries, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana for a period of 90 days in fiber reinforced plastic (FRP) pools. Healthy fry of *H. fossilis* were reared at four (T_1, T_2, T_3 and T_4) SD i.e. 5, 7, 9 and 11 fry / m^2 (in triplicate) respectively. The fry were fed with formulated pellet dry diet [groundnut meal (30%), rice bran (29%), boiled egg yolk (40%) and vitamin-mineral mix (1%)], containing 35.23 and 14.75 crude protein and ether extract (% DM basis); respectively at the rate of 10% of fish body weight in two split doses daily. Water quality parameters, fish survival and growth were studied at regular intervals. Data was analyzed using SPSS-16 software by applying one way Analysis of variance for determining significant differences among the treatments at 5% significance level ($P < 0.05$).

Results and Discussion

Differences for all the water quality parameters among different treatments were insignificant and the values were within the optimum range for freshwater aquaculture. Maximum fish survival of 100% was recorded in T_1 and T_2 followed by T_3 (91.6%) and T_4 (86.3%), respectively (Table 1). Fish growth in terms of av. final total body length (cm), total body length gain (%), av. final body weight (g) and net weight gain (%) was found to be significantly higher ($p \leq 0.05$) in T_1 (8.60, 45.76, 4.2, 220.61) followed by T_4, T_2 and T_3, respectively. Average daily gain and performance index was also found to be significantly higher in T_1 (0.032, 3.2) as compared to all other treatments, which was in accordance with respective weight gain and survival of fish (Monir and Rahman, 2015). The specific growth rate (SGR) of *H. fossilis* fry at different stocking densities ranges between 1.01 to 1.28 with highest SGR at stocking density of 5/m^2 (T_1). The feed conversion ratio (FCR) in T_1 was significantly lower (1.86) followed by T_2 (2.70), T_4 (2.82) and T_3 (2.93) respectively. Significantly ($p \leq 0.05$) highest individual fish growth was observed at SD of 5/m^3, however, highest fish biomass per unit area (kg/m^3) was obtained in T_4 (0.029 kg/m^3/90 day) followed by T_3, T_2 and T_1, indicating positive relationship with number of fish stocked. Hence, the present study reveal that for rearing fry of *H. fossilis*, the optimum stocking density, in terms of survival, growth and profitability from sale of fingerlings is 5/m^2/ i.e. 50000 fry / ha.

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Table 1: Growth parameters of fry of *H. fossilis* reared at different stocking densities

Parameters	T_1	T_2	T_3	T_4
Average initial total BL (cm)	5.9^{a}±0.07	5.9^{a}±0.56	6.0^{a}±0.56	5.9^{a}±0.21
Average final total BL (cm)	8.6^{a}±0.71	8.0^{b}±0.64	7.9^{b}±0.56	8.04^{b}±0.60
Total BL gain(%)	45.76^{a}±0.65	35.59^{b}±0.60	31.67^{c}±0.55	36.27^{b}±0.58
Average initial BW (g)	1.31^{a}±0.15	1.26^{a}±0.23	1.24^{a}±0.26	1.25^{a}±0.31
Average final BW (g)	4.2^{a}±1.05	3.26^{b}±0.96	3.08^{b}±0.63	3.14^{b}±0.83
Net weight gain (g)	2.89^{a}±1.08	2.00^{b}±0.96	1.84^{bc}±0.75	1.91^{b}±0.74
Average daily weight gain (ADG)	0.032^{a}±1.02	0.022^{b}±0.97	0.020^{b}±0.85	0.021^{b}±0.87
Performance index (PI)	3.2^{a}±1.02	2.02^{b}±0.96	2.0^{b}±1.01	1.81^{c}±0.93
Net weight gain(%)	220.61^{a}±1.03	158.73^{b}±1.05	148.38^{c}±0.98	151.20^{bc}±0.85
Specific growth rate	1.28^{a}±0.96	1.05^{b}±0.87	1.01^{b}±0.96	1.04^{b}±0.94
Protein efficiency ratio	1.53^{a}±1.02	1.06^{bc}±0.97	0.98^{c}±0.87	1.02^{bc}±0.92
Feed conversion ratio	1.86^{c}±0.98	2.70^{b}±0.89	2.93^{a}±1.02	2.82^{a}±0.98
Survival (%)	100^{a}±1.03	100^{a}±1.03	91.6^{b}±0.98	86.3^{c}±1.01
Production (kg/m^3/90 days)	0.021^{b}±0.98	0.022^{b}±1.04	0.028^{a}±0.96	0.029^{a}±0.98

Values are mean±S.E. BL= body weight
$^{a, b, c}$ Values bearing different superscripts in a row differ significantly ($P \leq 0.05$)

30.

Evaluation of Protein Isolate from Leather Flushing as Fish Meal Replacer by Rat Bioassay

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Keywords: Fish meal, leather flushing, casein, soya, protein quality, growth profile.

Introduction

Fish has been in demand from decades due to low fat high quality protein. Hence fish is cultured in large quantity, many of the fish farmed are carnivorous. Manufactured feeds are an important part of fish culture in which fish meal is major source of protein. The price of fish feed is increasing thus price of fish meal continues to rise. Demand for fish meal has remained strong but currently not entering the supply chain thus there is need of alternate source. Proteinaceous animal flushing from tannery is available abundantly can be used as feed protein source for fish culture.

Materials and Methods

Protein isolated from leather flushing was evaluated and compared to one vegetable protein (Isolated soya protein) and one animal protein (casein). Protein isolate contained about 85 to 88% of protein. Growth profile study was made by using 28 days weaning Wistar/IND/CFT rats. Food intake (daily) and body weight (weakly) were measured, recorded and protein efficiency ratio was calculated. Vital organ weight of rats fed with protein isolate were recorded and compared to casein and soya fed rats. Urine were analyzed for pH, specific gravity, protein, glucose, leucocytes, ketones, bilirubin, nitrite and blood using automated urine analyzer (Uro-dipcheck^{TM}300).

Results and Discussion

The body weight and feed intake of rats fed with protein isolate had reduced compared to rats fed with casein, whey and soya protein. Though the amount of protein in protein isolate is approximately equal to the protein in casein and soya, rats showed poor acceptance to the protein isolate. Protein efficiency ratio of protein isolate had been reduced compared to other groups. This may be due to less absorption of collagen into body. Organ weight (except brain) of the rats fed with protein isolate had also reduced compared to rats fed with casein and soya protein.Urine analysis showed no difference between groups. Hence further hydrolyzation with enzyme may improve absorption of protein isolate and can replace fish meal. Thus it is best approach to solve solid waste disposal problem and also beneficial as an economic feed in fish culture.

Table 1: Growth profile of rats fed with different protein source

	Feed intake	Protein Intake	Body weight gain	Protein efficiency ratio
Casein	391.29±16.32	78.258±3.26	119.33±14.89	1.524828±0.22
Whey	366.31±30.49	73.262±6.09	110.1±17.25	1.502825±0.28
Soya	367.07±31.05	73.414±6.21	85.65±15.56	1.166671±0.41
Protein isolate from leather flushing	201.56±20.62	40.312±4.12	10.08±3.42	0.25005±0.07
Nitrogen free diet	204.89±24.02	40.978±4.80	9.77±3.26	0.238421±0.88

Values are in mean±SD (n=10)

31.

Fatty Acid Composition of Fish Processing Waste Generated in Fish Markets of Ludhiana, India

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Keywords: Fatty acid composition, fish waste

Introduction

Fish lipid contains long-chain n-3 Polyunsaturated fatty acids (omega-3 PUFAs), particularly eicosapentaenoic acid (EPA; C20: 5 n-3) and docosahexaenoic acid (DHA; C22: 6 n-3). Consumption of these PUFAs has been linked to the development of brain and nervous tissue in infants and reduction in incidence of coronary heart disease. With growing public awareness of the clinical benefits of EPA and DHA and population growth, there is a dramatic need to locate a compatible source. Keeping this in mind; an analytical study on fatty acid composition of the fish processing waste being generated in different fish markets of Ludhiana, Punjab was carried out.

Materials and Methods

Fresh samples of composite fish waste from three different fish markets of Ludhiana city namely; Railway Station fish market (M1), Field Ganj fish market (M2) and Sherpur Chowk fish market (M3) were collected every month from December, 2014 to May, 2015. The lipids from the samples of three fish markets were extracted by soxhlet extraction method and dissolved in petroleum ether for fatty acid analysis. Fatty acid composition analysis was carried out using a gas chromatograph. The data were analyzed by applying one-way and multifactor analysis of variance followed by Duncan's Multiple Range Test (MRT) using SPSS version 20.0.

Results and Discussion

The present study revealed that the fish processing waste includes liver, kidney, intestine, blood, testis, vertebral column and viscera (excluding ovary and head). The total n-3 polyunsaturated fatty acids (PUFAs) were higher in the total lipids obtained from the fish waste of Railway Station fish market (M1; 12.21±0.31%) which mainly comprised of *Channa striatus* than the n-3 PUFAs obtained from fish waste of Field Ganj fish market (M2; 10.38±0.18%) and Sherpur Chowk fish market (M3; 10.40±0.51%), where *Labeo rohita* and *Wallag oattu*, respectively were the predominant fishes (Table 1). Likewise, the total n-6 PUFAs were higher in M1 (8.13±0.31%) fish market as compared to M2 (5.14±0.40%) and M3 (4.59±0.31%) fish market. Consequently, the n6/n3 ratio for the M1 fish market (0.65) was relatively higher than M2 (0.47) and M3 (0.46) fish market. The United Kingdom Department of Health recommended that n6/n3 ratios lower than 4.0 are beneficial for human health. Total PUFAs (20.34±1.68%) were highest in fish waste of M1 fish market, whereas, the total monounsaturated fatty acids (MUFAs) were recorded to be maximal in M3 fish market (9.21±0.55%). Furthermore, the total saturated fatty acids (SFAs) were exorbitant in fish waste of M2 fish market (40.32±0.16%). The UFAs/SFAs ratio recorded for M3 (0.96) and M1 (0.89) fish market was in close proximity to the saturation level (1: 1) as compared to the M2 fish market (0.49). Fish waste has found its value in human diet around the world. It is, therefore, suggested that initiatives for proper utilization of fish waste may be undertaken.

Table 1: Comparison of major groups of fatty acids in the fish waste from different fish markets of Ludhiana city

Fatty Acid (% age of total lipids)	Fish Market		
	Railway Station fish market (M1)	Field Ganj fish market (M2)	Sherpur Chowk fish market (M3)
Total n-3 Polyunsaturated fatty acids	12.21±0.31	10.38±0.18	10.40±0.51
Total n-6 Polyunsaturated fatty acids	8.13±0.31	5.14±0.40	4.59±0.31
n-6/n-3 Ratio	0.65	0.47	0.46
Total Polyunsaturated fatty acids	20.34±1.68	15.52±0.51	14.99±0.40
Total Monounsaturated fatty acids	5.36±0.22	4.72±0.35	9.21±0.55
Total Saturated fatty acids	28.93±0.24	40.32±0.16	25.32±0.40
Unsaturated fatty acids/Saturated fatty acids Ratio	0.89	0.49	0.96

32.

Rose Petal Meal as a Potential Natural Carotenoid Source for Pigmentation and Growth of Freshwater Ornamental Fish, Koi Carp, *Cyprinus carpio* (Linnaeus)

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Keywords: Rose petal meal, pigmentation, carotenoids, koi carp, colour enhancement

Introduction

Commercial value of ornamental fishes depends upon the intensity and pattern of pigmentation owing to the carotenoids found in plants, algae, photosynthetic, some non-photosynthetic bacteria and animals. Like other animals, *de novo* synthesis of carotenoids does not occur in fish. Hence, natural and synthetic pigments incorporated supplementary feed are the only sources of these pigments in fish. Rose in the form of petal meal had been tried as a natural carotenoid source for various ornamental fish species. In view of importance of rose, the present study was designed to assess the efficacy of rose petal meal (*Rosa indica*) on colouration, survival and growth of ornamental Koi, *Cyprinus carpio* (Linn.).

Materials and Methods

Experimental fish, koi carp, *C. carpio* L. were stocked in glass aquaria and fed with five diets including one control (RPM0) without carotenoid source and four formulated pelleted diets with 1 (RPM1), 3(RPM3), 5(RPM5) and 7 percent (RPM 7) of powdered rose petals in control diet for 120 days. Total carotenoid content (mg/100g) of experimental diets increased from 0.041 to 0.272 in RPM1 to RPM7. Fish were fed with pelleted feed at the rate of 5% fish body weight twice a day. Water quality parameters, fish survival, growth and colouration parameters were studied at regular intervals. The results were analyzed using SPSS-16 by applying one way ANOVA for determining significant differences among treatments at 5% significant level ($p<0.05$).

Results and Discussion

Water quality parameters did not vary significantly among the treatments and were within the recommended range for ornamental fish culture (Rinna *et al.,* 2013). The results revealed carotenoid supplementation with rose petal meal improved fish survival, growth and colouration significantly. Hundred percent survival of fish was recorded with diets supplemented with RPM1 and RPM3, while it was 90% in RPM5 and RPM7 and 80% in RPM0. Significantly higher ($p\leq0.05$) fish growth in terms of % TLG, NWG (g) and % NWG was observed in RPM1 (24.77, 2.65 and 119.36) followed by RPM3, RPM5, RPM7 and RPM0. Likewise, PER and SGR was also maximum in RPM1 (0.79, 0.66) and minimum in RPM0 (0.37, 0.45), whereas CF was maximum in RPM3 (1.62) and minimum in RPM 1 (1.38). The FCR was minimum in RPM1 (1.98) and maximum in RPM0 (4.17) (Table 1). Unlike growth, significantly highest carotenoid (3.04 µg g^{-1}) content of fish muscle and skin and digital colouration parameters (RGB and L*a*b*) were observed in RPM3. Results indicate effectiveness of rose petal meal in colour enhancement as well as growth, but at different level in accordance to previous studies (Lee *et al.,* 2010). It can be concluded from the study that the rose petal meal has a positive effect on growth as well as colour enhancement of koi carp, *C. carpio* L. and hence, can be supplemented in koi carp diet up to 3% level both as colour enhancer and growth promoter.

Table 1: Growth and colouration parameters of koi carp, *Cyprinus carpio* L. in different treatments

Parameters	Diets				
	RPM0	RPM1	RPM3	RPM5	RPM7
Av. final total body length (cm)	6.24^{cd}	7.05^{a}	6.56^{b}	6.53^{b}	6.25^{cd}
TLG (%)	12.63	24.77	14.68	13.76	9.26
Average final body weight (g)	3.83^{de}	4.87^{a}	4.60^{bc}	4.37^{cd}	3.90^{de}
Net weight gain (NWG)	1.60	2.65 (+65.63%)	2.40 (+50%)	2.19 (+36.87%)	1.66 (+3.75)
NWG (%)	71.74	119.36	109.09	100.45	76.14
Food conversion ratio (FCR)	4.17	1.98	2.18	2.84	3.45
Protein efficiency ratio (PER)	0.37	0.79	0.65	0.56	0.45
Specific growth rate (SGR)	0.45	0.66	0.61	0.58	0.47
Condition factor (CF)	1.57	1.38	1.62	1.56	1.57
Total carotenoid (µg g^{-1})	0.77^{a}	1.24^{d}	1.96^{c} (58.06)	3.04^{a} (145.16)	2.74^{b} (120.96)
R (Red)	59^{a}	75.66^{c}	168.66^{ab}	174.66^{a}	160.00^{b}
B (Blue)	51^{a}	66.66^{e}	153.33^{b}	165.00^{a}	134.00^{cd}
G (Green)	28^{a}	51.66^{de}	143.00^{ab}	159.66^{a}	137.66^{cd}
L* (luminosity)	22^{a}	31.00^{de}	65.66^{c}	62.00^{c}	67.66^{a}
a* (balance between red / green)	1^{a}	1.89^{de}	5.66^{a}	4.66^{bc}	3.66^{c}
b* (balance between yellow / blue)	16^{a}	15.00^{ab}	14.00^{ab}	17.00^{a}	9.33^{cd}

Values with same superscript in row do not differ significantly ($P\leq 0.05$); Figures in parenthesis represent % change over control

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33.

Species Selection for Enhancing Productivity of Freshwater Carps in Inland Saline Water of Punjab, India- A Field Study

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Keywords: Inland saline water, freshwater carps, survival, growth, productivity

Introduction

South-west districts of Punjab (Mukatsar, Ferozepur, Faridkot, Fazilka, Bathinda and Mansa) are affected with dual problems of underground salinity and water logging. It has devastated agriculture productivity in the affected areas. However, water although saline, is abundantly available in these degraded lands and offers substantial potential for aquaculture. Although, freshwater carps can be reared in inland saline water, but salinity tolerance and growth of freshwater carps varies with species and their growth declines with increase in salinity of water. Hence, the present study was taken up to work out the possibility of enhancing productivity of freshwater carps in inland saline water, through species selection.

Materials and Methods

Freshwater carps were stocked 15,000 fingerlings ha^{-1}) in three combinations (in duplicate) namely 5 species [*Catla catla* Ham. (catla), *Labeo rohita* Ham. (rohu), *Cirrhinus mrigala* Ham. (mrigal), *Cyprinus carpio* Linn. (common carp) and *Ctenopharyngodon idella* Val. (grass carp)], 4 species (catla, rohu, common carp and grass carp) and 3 species (catla, rohu, and common carp), in inland saline water ponds in village Shajrana of district Fazilka and reared for 6 months following standard semi-intensive aquaculture practices. After 6 months, fish was harvested to record comparative individual/overall survival and productivity of fish in 5, 4 and 3 species rearing ponds.

Results and Discussion

The salinity of water in 5, 4 and 3 species rearing ponds varied between 3.5-8 parts $thousand^{-1}$(ppt) during the culture period of 6 months. Species selection was not found to have any undesirable effect on overall survival of fish and among all the species, rohu registered highest percent (%) survival (87.03 to 95.42%), followed by mrigal, catla, common carp and grass carp (Table 1), indicating better adaptability of rohu to inland saline water as compared to other species. In 5 species rearing pond, rohu attained maximum average body weight (BW), while in case of 4 and 3 species rearing ponds, common carp (bottom feeder) registered maximum average BW, which can be attributed to absence of mrigal (another bottom feeder) in the rearing system and hence reduced competition pressure on common carp for food and space. On an average, 207, 218 and 238 g fish was harvested m^{-2} from 5, 4 and 3 species rearing ponds after 6 months, with an apparent feed conversion ratio of 2.24, 2.19 and 2.11 (with respect to supplementary feed only) and an anticipated productivity of 2.07, 2.18 and 2.38 t ha^{-1}, respectively. As compared to 5 species rearing, 15% higher productivity of freshwater carps was achieved in inland saline water (salinity 4-8 ppt), through 3 species rearing at a stocking density of 15,000 fingerlings ha^{-1}. However, there is need to conduct more trials for identifying more ideal combinations of species to develop a high yielding package of practice for rearing freshwater craps in inland saline water.

Table 1: Survival and growth of freshwater carps in 5, 4 and 3 species rearing ponds

Parameter	Catla	Rohu	Mrigal	Common carp	Grass carp
5 species combination (catla, rohu, mrigal, common carp and grass carp)					
Survival rate (%)	80.40	95.42	87.33	78.20	74.13
Initial BW (g)	19.50^{a}±0.62	15.33^{a}±0.84	10.50±0.43	23.83^{a}±0.87	9.50^{a}±0.42
Final BW (g)	136.67^{a}±4.28	186.67^{a}±4.33	176.83±4.42	150^{b}.50±5.04	84.67^{a}±2.46
NWG (g)	117.17	171.34	166.33	126.67	75.17
Overall fish survival= 85.88%; Fish biomass harvested m^{-2}= 207 g (Anticipated productivity= 2.07 t ha^{-1} 6-$months^{-1}$)					
4 species combination (catla, rohu, common carp and grass carp)					
Survival rate (%)	85.00	89.43	-	84.33	80.77
Initial BW (g)	19.17^{a}±0.83	16.33^{a}±0.80	-	23.84^{a}±0.87	9.00^{a}±0.57
Final BW (g)	137.17^{a}±3.77	174.17^{b}±3.95	-	210.67^{a}±5.80	81.00^{a}±1.32
NWG (g)	118.00	157.84	-	186.83	72.00
Overall fish survival= 86.13%; Fish biomass harvested m^{-2}= 218 g (Anticipated productivity= 2.18 t ha^{-1} 6-$months^{-1}$)					
3 species combination (catla, rohu and common carp)					
Survival rate (%)	86.40	87.03	-	83.50	-
Initial BW (g)	19.33^{a}±0.84	15.17^{a}±0.87	-	23.50^{a}±1.09	-
Final BW (g)	142.17^{a}±3.01	195.67^{a}±2.74	-	219.00^{a}±5.29	-
NWG (g)	122.84	180.50	-	195.50	-
Overall fish survival= 85.67%; Fish biomass harvested m^{-2}= 238 g (Anticipated productivity= 2.38 t ha^{-1} 6-$months^{-1}$)					

Values for initial and final BW are mean±S.E. (n=10) and the respective values for different species with different superscript in a column differ significantly (P≤ 0.5)

34.

Study of Biometric Characteristics of Pacific White Shrimp, *Litopenaeus vannamei* (Boone, 1931) Cultured in the Salt Affected Area of District Fazilka (Punjab), India

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Introduction

In recent past, culture of Pacific white shrimp, *Litopenaeus vannamei* (Boone, 1931) has expanded very fast, due to its wide range of salinity tolerance, disease resistance, growth and market demand. Morphometric characteristic expresses the wellbeing of an animal under culture conditions. Length-weight morphometric relationship has been widely applied for wild and captive penaeids at different life stages and environmental conditions (Chu *et al.*, 1995). Evaluation of morphometric characteristics also indicates the suitability of environmental conditions for the growth and productivity of an animal. The present study was conducted to compare the morphometric characteristics of *L. vannamei* reared in inland saline water to assess its suitability for culture in salt affected areas of Punjab.

Materials and Methods

Post larvae of *L. vannamei* were reared under extensive culture conditions in manmade ponds in salt affected water logged area in district Fazilka, (Punjab) for 105 days. Water quality parameters like temperature, pH, dissolved oxygen (DO), salinity, total alkalinity and total hardness of the pond water were measured as per standard methods given in APHA (2005). The shrimp were harvested and brought at College of Fisheries, Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana, Punjab under iced condition and their morphometric and gravimetric traits were measured. Data collected for morphometric and gravimetric traits were statistically analysed using Bray's Curtis matrix for the regression value and Linear relationship using one way ANOVA by SPSS 16.00 software.

Results and Discussion

Water quality is an important criterion for the culture of any aquatic animal. No abrupt change in the water quality parameters were reported during culture period. After 105 days of rearing period, *L. vannamei* attained an average length and body weight of 134 mm and 14.29g, respectively with corresponding r^2 value of 0.881 for total length and weight. Average cephalothorax length was 47.8 mm, carapace width was 14.18 mm and carapace weight with integrated muscle and shell was 4.68g, while abdominal length was recorded 66.5 mm and abdominal weight with shell was 8.67g. The major chelate leg length, minor chelate leg length and telson length were measured 40.0, 23.4, 24.0 mm, respectively; while telson weight was 0.45g. Details of the morphometric and gravimetric traits are given in Table 1. The Bray- Curtis matrix was prepared to find out biometric relationship with single body segment with body segments. Through Bray- Curtis matrix highest relationship was observed in between telson weight and carapace weight with integrated muscle and shell (0.991), while least relationship was recorded in between abdominal weight without shell and telson weight (0.917). Biometric data reveals the wellbeing of shrimp the present environmental conditions hence can be concluded that there is substantial scope of rearing brackish water shrimp, *L. vannamei*, in salt affected areas of Punjab.

Table 1: Study of morphometric and gravimetric traits of cultured *L. vannamei* (mean±SD).

Morphometric traits	Average values (mm)
Total length	1340.0±7.04
Cephalothorax length	478.1±2.96
Abdominal length	665.4±3.20
Telson length	240.9±2.02
Carapace width	141.8±1.07
Major chelate leg length	400.0±1.67
Minor chelate Leg Length	234.5±3.83
Gravimetric traits	Average values (g)
Average body weight	14.29±2.13
Carapace weight with integrated muscle and shell	4.68±0.79
Carapace shell weight without integrated muscle	0.30±0.05
Abdominal weight with shell	8.67±1.32
Abdominal weight without shell	7.53±1.11
Telson weight	0.45±0.07

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35.

Study of Primary Productivity and Fisheries Potential of Daya Reservoir, Udaipur, Rajasthan

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Keywords: Primary productivity, fisheries potential, reservoir

Introduction

The state of Rajasthan offers vast potential for the development of fisheries due to the occurrence of 3131 water bodies of different sizes The primary productivity of different water bodies has been widely investigated to assess the fish production potentialities of a water body and to formulate fishery management policies. Natarajan and Pathak (1983) have also advocated the significance of physico-chemical and primary productivity studies in the management of inland waters. In view of the above, the present study on primary productivity and fisheries potential of Daya reservoir has been designed and conducted.

Materials and Methods

The Daya reservoir, under investigation is situated 35 km away from Udaipur (Rajasthan) near the village Palodhara. In the present investigation, three sampling stations were selected in the reservoir. Out of these three sampling stations, two sampling stations were selected only for surface water analysis and one sampling station was selected for surface and bottom water analysis. Water quality parameters such as temperature, pH, alkalinity, dissolved oxygen, free CO_2, electrical conductivity (EC) and primary productivity were determined in the field itself, while for the analysis of nitrate-nitrogen and orthophosphate the samples were brought to the laboratory in plastic bottles of one litre capacity and analysed as soon as possible using standard methods of APHA (1989) Primary productivity was measured at all the stations following light and dark bottles method.

Results and Discussion

The results pertaining to gross and net primary productivities of Daya reservoir during the study period are presented in Table. The mean value of Gross Primary Productivity (GPP) in surface water was 0.45 g C m^{-3} h^{-1} (Table). The average value of Net Primary Productivity (NPP) in surface water was found 0.31 g C m^{-3} h^{-1} (Table). Gupta (1991) recorded the average GPP of 0.19 g C m^{-3} h^{-1} in the Daya reservoir and reported the moderate primary productivity at that time. This gap may be due to the fact that the water body has not received adequate influx of water for the last six years due to erratic and scanty monsoon rains. Odum (1971) considered 1.2 per cent of the primary production as ideal fish harvest in freshwater bodies. Taking this into account, in Daya reservoir, the possible fish production would be 1, 68,500.79 kg fish per year which represent 545.31 kg per hectare per year. To attain this production from Daya reservoir, is a remote possibility. The present production of 36616.50 kg per year is just 21.73 per cent of the total fisheries potential of Daya reservoir.

Table: Statistical standard deviation, minimum-maximum range and mean value of different parameters of Daya reservoir, Udaipur

Parameter(s)	Water Temp.	pH	Depth of visibility	Dissolved oxygen	Free CO2	Nitrate	Orthophos-phate	GPP	NPP
Mean	23.8	8.32	140.84	7.57	2.8	0.19	0.55	0.45	0.31
SD	3.74	0.22	16.64	0.75	0.27	0.1	0.17	0.12	0.09
Min.	18.67	7.94	167.33	6.13	2.42	0.03	0.21	0.23	0.18
Max.	29.67	8.7	114	8.67	3.3	0.47	0.78	0.67	0.5

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36.

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. Water quality analysis tested as perstandardprocedures.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 byGupta *et al.* (2014). Enzyme activities were measured as the change in absorbance using spectrophotometer and expressed as specific activity (U mg^{-1} protein). 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.

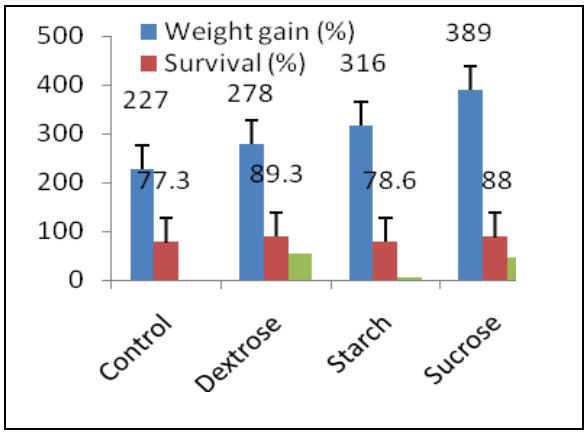

Fig. 1: Effect of BFT on growth and survival of freshwater prawn.

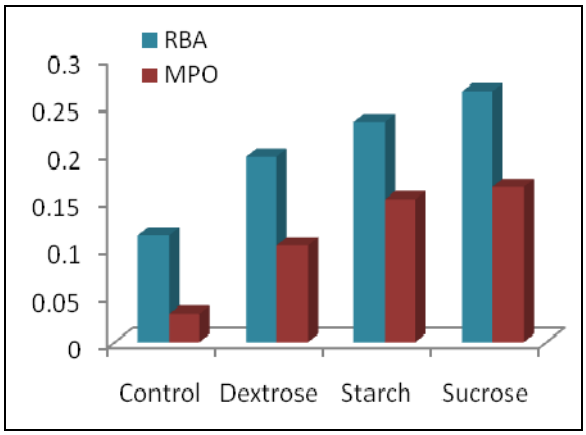

Fig. 2: Effect of BFT on innate immune parameters such as RBA and MPO.

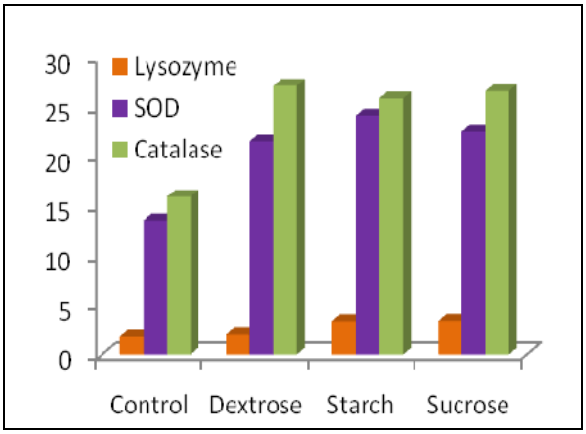

Fig. 3: Effect of BFT on innate immune parameters.

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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37.

Larval Rearing of *Anabas testudineus* with HUFA and Vitamin C Enriched *Moina micrura*

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Keywords: *Anabas testudineus, Moina micrura*, HUFA and vitamin C.

Introduction

One of the major limitations for large scale farming of climbing perch, *Anabas testudineus* (Bloch, 1792) has always been the lack of seed. The transition from an endogenous to an exogenous food supply during first feeding is one of the most critical phases of the life cycle and is the period when high mortality occurs. Though *Moina micrura,* is an important live food for the fish larvae, it lacks some nutrients, particularly in essential n-3 Highly Unsaturated Fatty Acids (HUFA). Thus, the present study was conducted to assess the effect of enriched *Moina micrura* live food attempting to enhance growth and survival of *Anabas testudineus* larvae.

Materials and Methods

The study was conducted with twelve hundred larvae of *Anabas testudineus* which were randomly distributed in 4 distinct experimental groups in 12 glass aquariums (15 L capacity) (100 fish larvae per aquarium), in triplicate for a period of 30 days, following completely randomised design (CRD). The fishes were fed with T1 (un-enriched *Moina micrura*), T2 (Highly Unsaturated Fatty Acid enriched), T3 (Vitamin C enriched) and T4 (Highly Unsaturated Fatty Acid + vitamin C enriched). The data were statistically analysed by one way analysis of variance (ANOVA) and significant difference between treatment means was determined by Duncun's Multiple Range Test (DMRT) using SPSS (version 17.0).

Results and Discussion

HUFA enriched *Moina* resulted highest level of both EPA and DHA content in *A. testudineus* larvae followed by HUFA+ vitamin C enriched *Moina* than other experimental groups. The level of EPA and DHA content of larvae fed with HUFA enriched *Moina* was 2.7 and 7.9 times higher than the larvae fed with un-enriched *Moina* respectively. The highest DHA/EPA ratio was found in the larvae fed with HUFA enriched *Moina* (1.26) than the larvae fed with HUFA+vitamin C enriched *Moina* (1.02). The highest weight gain was observed in the group HUFA + Vitamin C and the lowest in the control group. However, there was no significant difference (P=0.066) among other treatment groups at the end of the experimental period. The mean SGR of HUFA + Vitamin C enriched *Moina* fed larval group (25.778±0.413) was significantly higher (P=0.047) than the control group, but not differ from the HUFA fed larval group (25.248±0.339). The lowest SGR value was found in control (24.210±0.128). The highest survival % (24±1.53) was observed in larval group fed with HUFA enriched *Moina* and the lowest in the un-enriched (control) group at the end of 30th day (9.3±0.88). From the present study, it can be concluded that enrichment of *Moina micrura* with HUFA alone could enhance the survival and growth rate significantly.

Table 1: Body weight gain (mg), Specific Growth Rate (SGR) and survival (%) of *A. testudineus* larvae of different experimental groups fed with enriched *Moina micrura* for 30 days

Treatments	Initial weight* (mg)	Final weight** (mg)	Body Weight gain (mg)	Specific Growth Rate	Survival (%)		
					Day 3-15	Day 16-30	Day 3-30
Control	0.105±0.007	150.000±5.8	149.895^{a}±5.8	24.210^{a}±0.13	12.00^{a}±0.58	77.43^{a}±3.64	9.3^{a}±0.88
HUFA	0.105±0.007	206.667±21.9	206.562^{ab}±21.9	25.248^{ab}±0.34	28.67^{c}±1.45	83.70^{ab}±3.00	24^{d}±1.53
Vitamin C	0.105±0.007	180.000±20.0	179.895^{ab}±20.0	24.784^{ab}±0.35	21.00^{b}±0.58	76.23^{a}±2.47	16^{b}±0.58
HUFA + Vitamin C	0.105±0.007	243.333±29.1	243.228^{b}±29.1	25.778^{b}±0.41	22.67^{b}±1.20	88.03^{b}±1.99	20^{c}±1.53

Data expressed as Mean±SE n=3;
Mean values in the same column with different superscript differ significantly (P<0.05);
*Cumulative weight of five larvae (3 days old) expressed as Mean±SE n=8;
**Cumulative weight of five larvae (30 days old) expressed as Mean±SE n=3;

38.

Growth Performance of Rohu Fingerlings under Recirculatory Aquaculture System at Various Media Thickness

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Keywords: RAS, Rohu, BWG (%), SGR, FCE, FCR; trickling bio filter.

Introduction

Filter system is consider the heart of recirculatory aquaculture system**,** as they are helpful to treat the water and maintained optimum water parameter for cultured fish. The challenge to the designer is to produce a bio filter that removes ammonia and nitrite at required rate, requires little maintenance; cost effective and efficient, and integrated into the operating system. The current studies based on the comparison of two different media namely molluscan shell and charcoal treated group with different media thickness for growth performance of rohu fingerlings under re-circulatory System at various media thickness.

Materials and Methods

Experiment was conducted in wet lab of Aquaculture Division of Central Institute of Fisheries Education, Mumbai. In 180 days, three experiments (I, II, III) were carried out for 60 days each. In trickling bio-filter, two filter media (charcoal and molluscan shell) used, for experiment I, II & III bed thickness were kept 10, 15, & 20 cm respectively. Average weight of fishes was 2.8±0.04gm, feeding rate kept 5% & 2 times/day respectively. Rohu fingerlings were stocked 75 no/tank after proper acclimatization.

Results and Discussion

All the physio-chemical parameters of water such as temperature, pH, dissolved oxygen, ammonia, nitrite-N and nitrate-N were observed well within the optimum range. Body weight gain (%) was found higher throughout the experiment in shell treated media. At the end of the experimental period average body weight gain (7.3±0.73 gm) by *Labeo rohita* was highest for molluscan shell treated group at 20 cm media thickness compare to charcoal and control. The trend of SGR was found to be same as that of body weight gain percentage, significant difference ($p<0.05$) was found among treatments throughout the experiments. Best specific growth rate (SGR) was observed in mollusacan shell (1.08±0.66) followed by charcoal (0.86±0.01) at 20 cm media thickness. In the present study, the feed conversion ratio in different filter groups followed almost the same trend as that of body weight gain and SGR. FCR was found significantly higher ($p>0.05$) in control compare to mollusk shell & charcoal treated group throughout the experiment,(FCR) found highest in control (5.64±0.45) throughout the experiment, least FCR obtained in molluscan shell treated group (2.66±0.03) at 15 cm media thickness. FCE found significantly higher ($p<0.05$) mollusk shell compare to control and charcoal. Best feed conversion efficiency (FCE) (0.28±0.01) was found in molluscan shell treated group at 20cm media thickness.

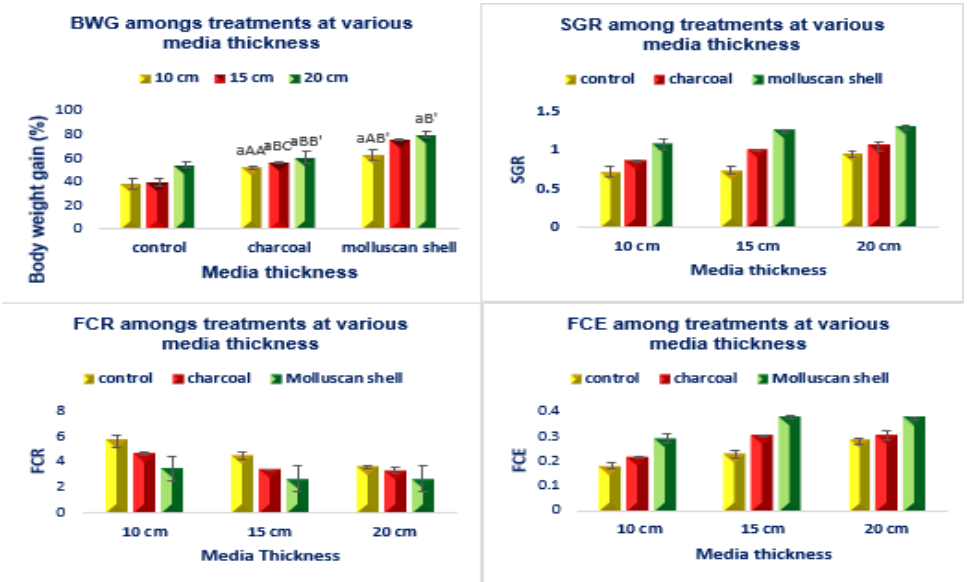

Fig. 1: Growth parameters like BWG (%), SGR, FCE, FCR and survival percentage were observed at different media thickness (10, 15, 20 cm) for growth performance of rohu fingerlings. *NS*- Non Significant ($p<0.05$) and treatment group values are expressed as mean±SE (n= 3), Superscript a- shows significance difference at 15th days of experiment, A and B- shows significance difference at 30th day of experiment, A', B' and C'- shows significance difference at 45th day of experiment.*

3

Integrated Nutrient Management

39.

Impact of Integrated Nutrient Management on Soil Fertility and Cotton Productivity in Vertisols under Semiarid Agro-ecosystem of Maharashtra

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Keywords: Integrated nutrient management, soil fertility, Vertisols.

Introduction

The long-term use of conjunctive nutrient management results in improvement of soil quality (Sharma *et al.*, 2008). The information on relationship between soil quality changes and cotton productivity in Vertisols for rainfed regions are limited (Hullugalle *et al.*, 2007). Use of organic manures along with biofertilizers help in reducing the dose of inorganic fertilizer, reduce the cost of cultivation and help in improving the soil health. With this consideration, an experiment was conducted from 2009 to 2014 to study the impact of integrated nutrient management on soil fertility and productivity of rain-fed cotton in Vertisols under semi-arid conditions of Maharashtra.

Materials and Methods

A field experiment to evaluate the effect of integrated nutrient management on soil fertility and productivity of cotton in Vertisols was conducted from 2009 to 2014 at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The soil of the experimental site was moderately alkaline in reaction, low in available nitrogen, medium in available phosphorus and high in available potassium. The nine treatments comprised of control, 100% recommended dose of fertilizers (RDF, 50: 25: 00 NPK kg ha^{-1}) through chemical fertilizers and the combinations of 50% N through gliricidia green leaf manure and 50% N through inorganics, 25 kg K ha^{-1} and seed treatment with bio-fertilizers in randomised block design with three replications.

Results and Discussion

The six years pooled data (2009 to 2014) in respect of seed cotton yield indicate that the highest seed cotton yield (842.1 kg ha^{-1}) was recorded with the application of 100% RDF + 25kg K ha^{-1} + biofertilizers and was on par with application of 50% N through gliricidia+50% N through inorganics+ biofertilizers + 100% P + 25kg K ha^{-1}. The higher gross monetary returns(GMR) and net monetary returns(NMR) was recorded with the application of 50% N through *glyricidia* +50% N through inorganics+ biofertilizers+ 100% P + 25kg K ha^{-1} (T_9) and was on par with application of 100% RDF+25kg K ha^{-1} +biofertilizers (T_6). The residual soil fertility indicated that the highest available N (215.34kg ha^{-1}),P (16.88kg ha^{-1}) and K (350.9kg ha^{-1}) was also recorded with the application of 50% N through *gliricidia* + 50% N through inorganics + biofertilizers + 100% P + 25 kg K ha^{-1} (T_9). The effect of integrated nutrient management (INM) on sustainable yield index(SYI) of cotton indicate that the higher SYI (0.50) was observed with the application of 50% N through *glyricidia* +50% N through inorganics+ biofertilizers+ 100% P + 25kg K ha^{-1}. Thus, indicating a significant role of conjunctive use of organic maures/green manure and chemical fertilizers in sustaining the cotton productivity. Hence, it is recommended that integrated application of 50% N through *gliricidia* + 50% N through inorganics + biofertilizers+ 100% P + 25 kg K ha^{-1} resulted in improvement in soil fertility, higher cotton yield with higher monetary returns from cotton grown in Vertisols under semi arid conditions of Maharashtra.

Table 1: Effect of INM on soil fertility, cotton productivity, sustainable yield index and economics of cotton production

Treatments	Seed cotton (kg ha^{-1})	SYI	NMR (Rs ha^{-1})	Avail. Nutrients (kg ha^{-1})		
				N	P	K
T_1-Control	582.1	0.31	10311.2	189.0	10.32	307.4
T_2-100% RDF (50: 25: 00 NPK kg ha^{-1})	679.7	0.35	11642.3	196.5	13.43	316.1
T_3-100% RDF + biofertilizers	725.9	0.37	13297.9	197.8	14.11	317.6
T_4-100% N FYM + biofertilizers	621.3	0.32	3270.6	192.8	13.32	314.8
T_5-100% RDF + 25kg K ha^{-1}	772.5	0.41	15123.4	197.4	14.20	336.4
T_6-100% RDF + 25kg K ha^{-1} + biofertilizers	842.1	0.49	17577.4	211.6	16.71	347.4
T_7-50% N *glyricidia* + 50% N inorganics	699.8	0.39	12426.3	202.4	13.74	332.6
T_8-50% N *glyricidia* + 50% N inorganics + biofertilizers	726.4	0.39	13509.6	206.6	15.91	336.6
T_9-50% N *glyricidia*+50% N inorganics+biofertilizers+25kg K ha^{-1}	840.9	0.50	17783.0	215.3	16.88	350.9
SE (m)±	20.8	-	925.5	2.1	0.79	2.28
CD at 5%	58.6	-	2602.1	6.4	2.38	6.83

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40.

Effect of Integrated Nutrient Management on Seed Yield Parameters of Fenugreek (*Trigonella foenum-graecum* L.)

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Keywords: Evaluation of fenugreek INM, biofertilizer use, organic and inorganic manure use.

Introduction

Several INM schemes have been designed by Govt. of India with the aim of promoting the use of organic manures and bio-fertilizers. The focus of INM is on rationalizing the use of organic manures & biofertilizers for sustainable agriculture. The cost of inorganic fertilizers has been enormously increasing to an extent that they are out of reach of the small and marginal farmers. It has become impractical to apply such costly inputs for a crop of marginal returns. The use of INM in such a situation is therefore a practically paying proposal. The use of biofertilizers and organic and inorganic manure combinations are known to improve growth, yield as well as productivity of crops.

Materials and Methods

The study was conducted in the field research area of department of vegetable science CCS HAU, Hisar. The variety "Hisar Suvarna" of fenugreek was grown in the field research area in a Randomized Block Design (RBD) with three replications and seventeen treatments. The sowing was done in Rabi, 2013. The biofertilizers Rhizobium and PSB were used as seed treatment while FYM and Vermicompost were used @ 20t/ha and 5t/ha respectively. Recommended dose of fertilizer was taken @ 25kg N/ha and 40kg P/ha. The observations were recorded on 5 plants selected randomly from each plot at appropriate stages. The data was analyzed statistically according to the method described by Panse and Sukhatme (1985)

Results and Discussion

The data revealed that the Inoculation of biofertilizers, FYM, Vermicompost and RDF alone or in combination significantly influenced the yield & yield parameters viz, Days to 50% flowering, Plant Height (cm), Number of branches/plant, No. of pods/plant, Pod length (cm), Seeds per pod and Seed yield q/ha (Table 1). Maximum increases were noticed under the application of nitrogen and Rhizobium+PSB. The nutrient combination of Rhizobium+PSB+75% nitrogen was significantly higher over the rest of treatments (Table 1) and control followed by Rhizobium+100% Nitrogen and PSB+100% Nitrogen.

The number of Days to 50% flowering were less (71.67) in T_{15} (Rhizobium+PSB+75% Nitrogen) followed by T_5 (Rhizobium+100%Nitrogen) (73) and T_{11} (PSB+100%Nitrogen) (73.33) over T_0 (control) (91.00). The maximum seed yield (15.93) was also recorded in T_{15} (Rhizobium+PSB+75% nitrogen) followed by T_5 (Rhizobium+100%Nitrogen) (15.83) and T_{11} (PSB+100%Nitrogen) (15.66) over T_0 (control) (10.67). Similarly other yield parameters viz, Plant Height (cm), Number of branches/plant, No. of pods/plant, Pod length (cm), Seeds per pod were higher in T_{15} (Rhizobium+PSB+75% nitrogen) followed by T_5 (Rhizobium+100% Nitrogen) and T_{11} (PSB+100% Nitrogen) as compared to T_0 (control) (Table 1). The INM in fenugreek revealed that the slightly reduced dose of inorganic nitrogen was best when applied in combination with bio-fertilizer (Rhizobium+PSB) for improving yield and yield attributing characters as compared to the rest of INM treatment combinations.

Table 1: Effect of INM on seed yield parameters of fenugreek (*Trigonella foenum-graecum* L.)

Treatments	Days to 50% Flowering	Plant Height (cm)	Number of Branches/Plant	No. of Pods/Plant	Pod Length (cm)	Seeds per pod	Seed Yield q/ha
T0 Control	91.00	83.33	4.87	81.06	7.43	14.97	10.67
T1 Rhizobium + FYM (100%)	77.67	95.40	7.33	102.93	8.67	18.47	14.50
T2 Rhizobium + FYM (75%)	79.67	91.20	5.53	98.47	8.20	18.07	13.88
T3 Rhizobium + Vermicompost (100%)	81.33	93.33	8.13	97.52	8.10	17.87	12.70
T4 Rhizobium + Vermicompost (75%)	82.67	91.47	5.93	93.47	7.90	17.63	12.35
T5 Rhizobium + Nitrogen (100%)	73.00	102.67	8.53	108.23	9.33	19.20	15.83
T6 Rhizobium + Nitrogen (75%)	74.67	99.73	6.93	102.27	9.03	18.72	15.44
T7 PSB + FYM (100%)	75.33	96.47	8.80	101.87	8.20	16.97	14.44
T8 PSB + FYM (75%)	77.00	93.47	8.27	98.93	7.97	16.67	13.77
T9 PSB + Vermicompost (100%)	84.33	93.93	5.93	92.07	8.07	16.70	12.60
T10 PSB + Vermicompost (75%)	83.00	88.33	5.33	89.92	7.87	16.63	12.30
T11 PSB + Nitrogen (100%)	73.33	102.00	8.67	104.07	9.20	18.93	15.66
T12 PSB + Nitrogen (75%)	75.00	100.87	7.67	100.20	8.90	18.43	14.90
T13 Rhizobium + PSB + 75% FYM	74.67	97.33	7.07	99.67	8.93	18.97	15.10
T14 Rhizobium + PSB + 75% Vermicompost	83.33	94.07	6.47	98.00	8.40	17.67	13.05
T15 Rhizobium + PSB + 75% Nitrogen	71.67	105.80	9.70	111.30	9.93	19.77	15.93
T16 N: P: K	75.67	98.00	8.53	104.73	8.73	18.63	14.81
Grand Mean	78.43	95.73	7.28	99.10	8.52	17.90	14.00
S.E(m)	0.79	1.32	0.47	1.50	0.14	0.35	0.11
C.D (P=0.05)	2.27	3.81	1.35	4.33	0.40	1.01	0.32

41.

Impact of Long-term Integrated Nutrient Management on Groundnut Yield, Soil Properties and Organic Carbon Stocks in Scarce Rainfall Zone of Andhra Pradesh, India

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Keywords: Integrated nutrient management, soil properties, organic carbon stock, groundnut

Introduction

Groundnut (*Arachis hypogaea*), the most prevalent mono-cropping system in red sandy loam soils of Anantapur district of Andhra Pradesh. The productivity in this region has reached the lowest plateau. Low soil fertility is one of the reasons for low productivity besides frequent occurrence of dry spells. The nutrient use efficiency in rainfed ecosystem may be improved through integrated nutrient supply system and also through the recycling of farm waste and organic manures. Application of animal, crop residues, bio fertilizers etc., helps in natural soil biological activity and protect the soil from further degradation and enhancing the soil fertility and there by productivity.

Materials and Methods

Studies on long-term integrated nutrient management for groundnut were initiated during rainy (*kharif*) season 1985 at Agricultural Research Station, Anantapur, Andhra Pradesh, comprising of treatments including inorganics and organic manures. with and without recyclable farm wastes *namely* FYM and groundnut shells replicated thrice in RBD to study the long-term effects of recycling of farm wastes along with or without chemical fertilizers on soil properties and crop yield. The soil samples analyzed for different physical, physico-chemical and chemical properties following the standard procedures.

Results and Discussion

In long-term application of manure and fertilizers, slightly increase in soil pH towards neutral was observed in treatments applied with organics alone or in combination of organics along with inorganics after 30 years of experimentation. Significantly higher soil organic carbon (%) was recorded in treatments applied with organics alone or organics along with inorganics. The initial available phosphorous content (44 kg ha^{-1}) increased with only inorganics (106 kg ha^{-1}) applied plots. In the control plot, initial available phosphorous (P_2O_5) levels of 44 kg $ha^{-1}$was reduced to 23 kg ha^{-1}over 30 years. Mean differential groundnut pod yield of half recommended fertilizer dose (HRFD) + FYM at the rate of 4t/ha (937 kg ha^{-1}) was at par with recommended fertilizer dose (RFD) applied through inorganics alone (920 kg/ha). However, control (713 kg ha^{-1}) recorded lowest mean pod yield. Significantly higher organic carbon stocks of 12.31 Mg ha^{-1} recorded in the treatment with 50% recommended fertilizers along with Farm Yard Manure applied at the rate of 4t ha^{-1} and least was in control (4.81Mg ha^{-1}). From the similar study by Subehia *et al.* (2005) revealed that application FYM and lime along with chemical fertilizers maintained better nutrient availability (N, P and K) over the soils where only chemical fertilizers were applied. So keeping in view of soil inherent nutrient status, the treatment with half recommended dose (10-20-20 N, P_2O_5, K_2O kg ha^{-1}) along with FYM at the rate of 4 t ha^{-1} will be the best option, which not only giving sustainable yields but also enhancing the soil health.

Reference

Subehia S K, Verma S and Sharma S P 2005. Effect of long-term use of chemical fertilizers with and without organics on forms of soil acidity, phosphorus adsorption and crop yields in an acid soil. *Journal of the Indian Society of Soil Science*, **53**: 308-314.

Table 1: Effect of long term integrated nutrient management on soil properties, organic carbon stocks and mean groundnut pod yield

Treatment		pH	Organic carbon (%)	Avail.P_2O_5 (kg ha^{-1})	Avail.K_2O (kg ha^{-1})	Organic carbon stock (Mg ha^{-1})	Groundnut pod yield (mean of 30 years)
T1	Control	5.67	0.21	23	210	4.81	713
T2	RFD	5.03	0.39	103	382	9.20	920
T3	Half RFD	5.37	0.36	80	345	8.54	855
T4	GNS @ 4 t/ha	5.67	0.39	46	355	9.20	819
T5	FYM @ 4 t/ha	6.43	0.42	48	409	9.51	879
T6	$T_3 + T_4$	5.30	0.32	83	494	7.30	850
T7	$T_3 + T_5$	6.50	0.55	85	393	12.31	937
T8	$T_2 + ZnSO_4$ @50 kg/ha	5.63	0.39	107	388	8.33	896
T9	FYM @ 5 t/ha	6.07	0.51	47	433	11.57	874
	CD (0.05)	0.89	0.20	17.2	66.08	1.66	
	SEm±	0.29	0.02	3.54	22.24	0.56	
	Initial values	6.6	0.3	44	155		

42.

Effect of Integrated Nutrient Management on Growth, Yield and Quality of Summer Groundnut (*Arachis hypogaea* L)

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Keywords: INM, organic manures, groundnut, growth, yield and quality.

Introduction

Groundnut (*Arachis hypogaea* L.) is an important oilseed cum legume crop of India. India occupied an area of 55.27 lakh ha with production of 96.72 lakh tonnes and productivity was 1750 kg ha^{-1} during 2013-2014 (Anonymous 2014). Groundnut is one of the most important oilseed crops of Maharashtra state. The area under groundnut in Maharashtra in 2013-14 is 3.2 lakh ha with annual production of 4.17 lakh tonnes with productivity of 1373 $kgha^{-1}$ (Anonymous 2014). Use of chemical fertilizers is increasing to boost up crop production to meet the need for ever increasing population of the nation. The physico-chemical and biological properties of the soil were found to be influenced by the application of farm yard manure, compost and waste. Considering the above important aspects, the present investigation was carried to study the effect of integrated nutrient management on growth and yield of summer groundnut.

Materials and Methods

A field experiment was conducted during the summer season of 2014 at the AICRP on Summer Groundnut, Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri, district Ahmednagar, Maharashtra (India). The soil of experimental site was sandy clay loam in texture, moderately alkaline in reaction (pH 8.2), low in available nitrogen (198kg ha^{-1}), medium phosphorus (23 kg ha^{-1}) and high in potassium (341 kg ha^{-1}). The field experiment was laid out in random block design with three replications. Ten treatment combinations were: T_1 - absolute control, T_2 - general recommended dose of fertilizer (GRDF) (25: 50: 00 N,P_2O_5,K_2O kg ha^{-1} +5 t farm yard manure (FYM) ha^{-1}), T_3 -100% RDF (25: 50: 00 N,P_2O_5, K_2O kg ha^{-1}), T_4- 50% RDF + 50% N through FYM, T_5 - 50% RDF + 50% N through Vermicompost, T_6 - 50% RDF + 50% N through Neem cake, T_7 -75% RDF + 25% N through FYM, T8 - 75% RDF + 25% N through Vermicompost, T_9 - 75% RDF + 25% N through Neem cake, T_{10} - 1/3 N through FYM + 1/3 N through Vermicompost + 1/3 N through Neem cake. The organic manure through farmyard manure, vermicompost and neem cake was incorporated in soil 15 days before dibbling of seed except in control treatment. The recommended dose of fertilizer i.e. 25 kg N through urea and 50 kg P_2O_5 ha^{-1} through single super phosphate was applied as a basal dose.

Results and Discussion

Mean plant height (25.5 cm), plant spread (40.23 cm), number of branches $plant^{-1}$ (9.0), leaf area $plant^{-1}$ (4.01 dm^2) and dry matter $plant^{-1}$ (42.25 g) were significantly influenced by the GRDF (25: 50: 00 N,P_2O_5,K_2O kg ha^{-1} + 5 t FYM ha^{-1}). The yield contributing characters were number of pods $plant^{-1}$ (26.7), hundred kernel weight (55.67 g), weight of dry pods $plant^{-1}$(14.01 g), highest in GRDF. However, it was at par with the application of 100% RDF, 75% RDF + 25% N through FYM and 75% RDF + 25% N through vermicompost. The dry pod yield of groundnut was significantly higher in GRDF treatment (4420 kg ha^{-1}) followed by RDF (3574 kg ha^{-1}). This might be because of addition of chemical fertilizers to groundnut provides the nutrient in readily available forms, which was easily taken by groundnut and utilized for pod formation and development and ultimately reflected in higher dry pod yield. The application of nitrogen dose through chemical fertilizers and organic manures to groundnut crop recorded the less dry pod yields than the GRDF and RDF treatments. However, addition of nitrogen to groundnut as 75% RDF + 25% N through FYM and 75% RDF + 25% N through vermicompost were found at par with each other for dry pod yield (3140 and 3196 kg ha^{-1}) and significantly superior over other treatments except GRDF and RDF (4420 and 3574 kg ha^{-1}). This might be because of soil quality is improved only by organic manures and sustained for longer period for soil health and crop yields and hence it is always advocated to fertilize the crops with an INM application. The oil and protein percentage in groundnut kernel was not significantly influenced by different treatments of integrated nutrient management. However, application of GRDF (25 kg N + 50 kg P_2O_5 ha^{-1} + 5 t FYM ha^{-1}) registered numerically higher oil (48.42%) and protein (24.52%) content than rest of the treatments. Similar findings were reported by Karmakar *et al.* (2005) and Rajanikanth *et al.* (2008).

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Table 1: Effect of various integrated nutrient management on growth, yield and quality of summer groundnut.

Treatment	Plant height (cm)	Plant spread (cm)	No. of branches plant^{-1}	Leaf area plant^{-1} (dm^2)	Dry matter plant^{-1} (g)	No. of pods plant^{-1}	100-kernel wt. (g)	Shelling (%)	Wt. of pods plant^{-1} (g)	Dry pod yield (kg ha^{-1})	Dry haulm yield (kg ha^{-1})	Oil content (%)	Protein (%)
Absolute Control	19.7	31.17	6.3	2.58	30.37	20.7	42.00	62.5	9.68	1992	2835	47.82	22.92
GRDF (25: 50: 00 N,P_2O_5,K_2O kg ha^{-1} +5 t FYM ha^{-1})	25.5	40.23	9.0	4.01	42.45	26.7	55.67	65.7	14.10	4420	4876	48.42	24.52
100% RDF (25: 50: 00 $N,P_2O_5,$ K_2O kg ha^{-1})	24.4	39.13	8.7	3.24	39.73	24.3	54.67	65.1	13.02	3574	4371	48.31	24.32
50% RDF + 50% N through FYM	22.3	34.53	7.0	2.79	32.55	22.3	46.67	64.5	11.69	2471	3589	47.95	24.36
50% RDF + 50% N through Vermicompost	21.6	35.13	7.7	2.92	36.22	23.3	46.33	64.2	10.99	2310	3381	47.88	23.51
50% RDF + 50% N through Neem cake	22.9	34.17	6.7	2.74	35.11	22.7	49.33	64.1	12.51	2093	3511	47.83	24.47
75% RDF + 25% N through FYM	23.3	32.23	6.3	3.07	38.36	24.0	52.67	64.0	12.07	3140	4190	48.22	23.25
75% RDF + 25% N through Vermicompost	23.8	37.67	8.3	3.76	41.54	26.0	50.00	64.3	12.21	3196	4350	48.16	24.38
75% RDF + 25% N through Neem cake	21.1	37.43	8.0	3.50	38.52	25.0	49.33	64.7	11.74	2721	4187	48.27	24.44
1/3 N through FYM + 1/3 N through Vermicompost + 1/3 N through Neem cake.	20.6	33.33	6.7	2.60	31.24	21.7	45.67	64.0	10.38	2612	3526	48.12	24.50
S.E.m±	1.14	0.58	0.35	0.20	0.87	0.62	1.40	0.54	0.80	75	61	0.22	0.55
CD at 5%	3.37	1.72	1.04	0.60	2.59	1.85	4.16	1.72	2.40	223	183	NS	NS
General Mean	22.5	35.5	7.5	3.12	36.61	23.7	49.23	64.3	11.84	2853	3882	48.10	24.07

43.

Integrated Nutrient Management Practices Influencing the Productivity of Potato under the Subtropical Plains of Jammu, India

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Keywords: Integrated nutrient management, phosphate solubilizing bacteria, leaf area index.

Introduction

Potato being a nutrient exhaustive crop needs nutrition heavily to meet the physiological and metabolic needs. However, with ever increasing cost of chemical fertilizers and widening of the gap between demand and supply, utilization of biofertilizers has emerged as a substitute of the chemical fertilizers. The biofertilizers and organic manures like poultry manure, vermicompost and bone meal have great potential in providing plant nutrients and are an important component of Integrated Plant Nutrient System (IPNS). In view of above mentioned facts the present experiment was conducted to study the impact of combined application of organic manures and inorganic fertilizers on the growth, yield and quality of potato crop in the plains of the Jammu region.

Materials and Methods

The field investigation on the effect of integrated nutrient management on the growth, yield and quality of potato (*Solanum tuberosum* L.) var. Kufri Badshah was carried out in 2010-11 and 2011-12 at Vegetable Research Farm, Division of Vegetable Science and Floriculture, Chatha. The experiment was laid out in Randomized Block Design with three replications. The data was analyzed statistically using analysis of variance (ANOVA) as per Gomez and Gomez (1984).

Results and Discussion

From the present study, it became evident that the nutrient application did not influence the emergence count and leaf area index of potato whereas; it was quite effective in influencing other growth and yield parameters (Table 1). A treatment combination of vermicompost in association with phosphorus solubilizing bacteria (PSB) along with 50% recommended dose of nitrogen resulted in highest plant height, weight of tubers (by grade) and ultimately total tuber yield. So far as the quality of tubers was concerned, same treatment combination i.e. vermicompost in association with PSB and 50% nitrogen resulted in tubers having low sugar content thus influencing the overall acceptability of ware tubers.

The specific gravity and starch content being interrelated were significantly influenced by the farm yard manure application. Thus on the basis of individual effects of inorganic, organic and biofertilizers, it could be concluded that vermicompost application and tuber treatment with PSB can reduce the nitrogen dose by 50% and producing tubers having good quality and potential yields.

Table 1: Effect of integrated nutrient management practices on the growth and yield parameters of potato

Treatment	Emergence count (%)	Plant height (cm)	Leaf area index	weight of tuber by grade (g)	Tuber yield (q/ha)
T1 Control (RDF: 120: 60: 120kg/ha)	60.47	36.93	0.67	30.50	158.40
T2 FYM + PSB + Azotobacter	64.28	40.09	0.90	34.50	170.60
T3 FYM + PSB + 50%N	61.42	44.10	0.81	39.20	189.99
T4 FYM + PSB + 75%N	62.85	44.38	0.71	38.80	196.46
T5 FYM +Bonemeal + Azotobacter	56.66	44.40	0.79	39.80	204.74
T6 FYM + Bonemeal + 50%N	59.04	40.09	0.71	51.70	185.48
T7 FYM +Bonemeal + 75%N	62.37	47.78	0.71	48.60	181.96
T8 Vermicompost + PSB + Azotobacter	52.37	42.90	0.73	36.30	193.50
T9 Vermicompost + PSB + 50%N	62.37	51.73	1.01	57.10	219.39
T10 Vermicompost + PSB + 75%N	49.52	51.35	0.90	41.80	201.81
T11Vermicompost + Bonemeal Azotobacter	47.61	51.34	0.74	40.00	205.68
T12 Vermicompost + Bonemeal+ 50%N	51.42	51.71	0.71	41.90	202.60
T13 Vermicompost+Bonemeal+75%N	52.38	51.35	0.75	50.09	209.70
S.E(m)±	4.36	2.94	0.07	3.49	11.71
C.D (P<0.05)	N.S	8.64	N.S	7.20	24.61

Reference

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44.

Effect of Organic and Integrated Nutrient Management on Productivity, Economics and Soil Health in Soybean (*Glycine max*)- Onion (*Allium cepa)* Cropping Sequence for Central Plateau Zone of Maharashtra

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Keywords: Evaluation of organic farming, INM, Soybean, Onion, Soil fertility, Economics,

Introduction

Soybean is basically a pulse crop but it gaining importance as an oilseed crop. The soybean has established itself as a rich source of protein (40-42%), oil (20%).Besides this it can very well fit in different cropping systems under rain fed and irrigated farming. Inclusion of legumes and other crops (Vegetables) using intensification approach help in improvement in productivity and profitability as well as soil fertility. Health consciousness is major issue among the people with their daily diet. Organically produced crops having less or no chemical preferred over conventionally produced food by the end users. Food material produced organically has got it place in market due to nutritious and quality food.

The continuous and imbalanced fertilization also deteriorate the soil health. The use organic sources of nutrients as well as integrated nutrient practices which helps for maintaining soil health and sustaining the productivity of the cropping system. Use of organic nutrient sources like FYM, Vermicompost, neem cake, bio fertilizers provide nutrients for the improvement of soil health. In view of this, an investigation was planned to study the effect of organic, inorganic, integrated nutrient management on productivity,economics and soil health in soybean- onion cropping sequence for central plateau zone of Maharashtra.

Materials and Methods

A field experiment was conducted during 2007 to 2012 at AICRP on Integrated Farming Systems, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. The soil of experimental field was clayey in texture, low in nitrogen (258 Kg ha^{-1}), medium in phosphorus (11.5 Kg ha^{-1}),), rich in potash (455 Kg ha^{-1}), low in organic carbon content 0.52% and the soil pH 7.6. The experiment was laid out in Randomized Block Design with seven treatments and three replications on same site and same randomization. The soybean crop was sown at a spacing of 45 cm x 5 cm during *kharif* season and onion was planted at a spacing of 15 cm x 10 cm during *rabi* season. The treatment details are given in Table 1. The recommended dose for soybean was 30: 60: 30 NPK kg ha^{-1} and for onion was 100: 50: 50 NPK kg ha-1was applied. The nutrient contains in farm yard manure, vermicompost and neem cake on dry weight basis were 0.50, 0.30, 0.48, 1.20, 1.6, 1.35 and 5.40, 1.10 and 1.52, NPK, respectively. The soybean seed were inoculated with *Rhizobium* + PSB and onion seedlings inoculated with *Azotobactor* + PSB before sowing.

Results and Discussion

Productivity of soybean and onion

The soybean grain yield and onion bulb yield was significantly influenced due to different organic, inorganic and INM treatments up to six year of experimentation (Table 1). The highest soybean grain yield (2.66 t ha^{-1}) and onion bulb yield (23.5 t ha^{-1}) was recorded by 100% RDF with $ZnSo_4$ 10 kg + S 25 kg ha^{-1} was significantly superior over all the treatments and at par with 50% RDF combined with 50% N applied through FYM and with $ZnSo_4$ 10 kg + S 25 kg ha^{-1}. The organic treatment with 1/3 N supplied through each from FYM, Vermicompost and neem cake recorded soybean grain yield (2.14 t ha^{-1}) and onion bulb yield (17.5 t ha^{-1}) which was significantly superior over rest of the organic treatments. This might be due to due to greater availability of nutrient in soil which improved the soil environment

Soybean equivalent yield

The soybean grain equivalent yield (7.66 t ha^{-1}) was recorded by organic treatment with the application of recommended 1/3 N each through FYM, Vermicompost and neem cake which was significantly superior over rest of the organic treatments except treatment T_4. In organic sources the soybean equivalent yield decrease by 13.44% over the integrated nutrient management treatment and 23.40% over the inorganic sources of application of nutrients.

Economics

The mean net monetary returns (Rs. 144.4 x 10^3 ha^{-1}) and B: C ratio (3.06) were maximum in 100% RDF with $ZnSO_4$ 10 kg + S 25 kg ha^{-1}) followed by integrated nutrient management. The Soybean based cropping sequence was found with high monetary benefit, as reported Tumbare (2002). In organic treatment application of 1/3 N through each FYM, Vermicompost, neem cake with bio fertilizer N and P carriers recorded the mean net monetary returns of Rs. 86.6 x 10^3 ha^{-1} and B: C ratio of 1.44.

Sustainability

Result on sustainability revealed that soybean -onion cropping system was examined over a period of six year indicating that the application of 100% RDF with secondary and micronutrients based on the soil test ($ZnSO_4$ 10 kg + S 25 kg ha^{-1}) recorded the value 0.74 of sustainable yield index, followed by 0.64 in integrated nutrient management. In organic sources recorded the sustainable value 0.54. These results are conformity with Chitale and *et al.* (2015).

Nutrient studies

The highest soil available N, P and K in soil were recorded by 100% RDF with $ZnSO_4$ 10 kg + S 25 kg ha^{-1}) followed by integrated nutrient management. Datt *et al.* (2003) reported that the beneficial effect of organic manures on yield might be due to additional supply of plant nutrients as well as improvement in physical, chemical and biological properties of soil.

Thus, it is concluded from study the application of inorganic sources of nutrient with soybean - onion cropping sequence recorded highest soybean grain equivalent yield, NMR, and B: C ratio followed by integrated nutrient management with 50% RDF +50% N through FYM +10 kg zinc and 25 kg of sulphur ha^{-1}. Lowest soybean grain equivalent yield of 7.66 t ha^{-1}, NMR (Rs. 81.1 $x10^3$ ha^{-1}) and B: C ratio (1.44) recorded under organic sources.

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Table 1: Soybean, onion bulb yield, soybean equivalent yield(SEY), total system productivity, per day productivity, Profitability, gross monetary return(GMR), net monetary return (NMR), B: C ratio, sustainable yield index (SYI), Nitrogen, Phosphorous, potassium and bulk density as influenced by soybean- onion cropping sequence (Pooled data of six years)

Treatment	Soybean grain yield (t ha^{-1})	Onion bulb yield (t ha^{-1})	SEY (ha^{-1})	Total System productivity (t ha^{-1})	Productivity (kg ha^{-1} day^{1})	Profitability (Rs. ha^{-1} day^{1})	GMR of the sequence (Rs. 10^3 ha^{-1})	NMR of the sequence (Rs. 10^3 ha-1)	B: C Ratio	SYI	N status at the end Kg/ha	P status at the end Kg/ha	K status at the end Kg/ha	Bulk density Mg/m^3
T1: 50% RDF + 50% N through FYM + ZnSO4 10 kg ha-1 and S 25 kg ha-	2.28	21.0	8.85	23.28	97.0	349.6	169.8	127.6	3.03	0.64	178.7	13.6	365.2	1.28
T2: Different organic sources each equivalent to 1/3 of recommended nitrogen through (FYM + Vermicompost + Neencake	1.81	15.4	6.65	17.21	71.70	191.2	127.1	69.8	1.23	0.45	170.8	13.0	345.3	1.22
T3: T_2 + intercropping of trap crop (*Kharif*-Maize, *Rabi*-Garlic)	1.82	16.1	6.89	17.92	74.66	197.5	132.1	72.1	1.20	0.47	150.7	12.9	350.8	1.21
T4: T_2+Agronomic practices for weed and pest control (Organic),	2.12	16.8	7.15	18.92	78.88	216.4	141.5	79.0	1.27	0.49	158.8	13.3	360.5	1.17
T5: 50% N as FYM/other organic sources+ bio fertilizer for N + Rock phosphate to substitute the P requirement of crops + PSB	1.64	14.0	6.02	15.64	65.16	181.4	115.3	66.2	1.38	0.39	165.9	12.8	360.3	1.16
T6: T_2 + bio fertilizer containing N and P carriers(PSB)	2.14	17.5	7.66	19.64	81.83	237.3	146.8	86.6	1.44	0.54	176.6	13.5	362.6	1.15
T7: 100% NPK+ secondary and micronutrient based on the soil test ($ZnSo_4$ 10 kg + S 25 Kg ha^{-1})	2.66	23.5	10.0	26.16	109.00	395.6	192.3	144.4	3.06	0.74	180.8	14.0	366.2	1.23
SE±	0.1	0.4	0.2	0.22		-	3.41	3.41		0.19				0.05
C.D. P=(0.05)	0.3	1.0	0.5	0.67		-	9.81	9.81		0.61				N.S.
Initial fertility											143.5	11.5	340.5	

45.

Influence of Integrated Nutrient Management on Productivity and Profitability of Speciality Maize Types in Peri-urban Indo-Gangetic Plains Region

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Keywords: Speciality maize, productivity, economics, livelihoods

Introduction

Maize (*Zea mays* L.) occupies 3rd position both in area and production after rice and wheat in India. The products from the speciality maize types like baby corn, sweet corn and pop corn have great demand in cities/towns and better employment generation avenues in peri-urban areas. In order to boost the productivity and profitability of these speciality maize types and promote crop diversification, we need to develop integrated nutrient management technology especially in Indo-Gangetic Plains Region (IGPR) where crops are suffering from numerous production vulnerabilities (Yadav *et al.,* 2015).

Materials and Methods

A field experiment was conducted at Indian Agricultural Research Institute (IARI), New Delhi during *kharif* 2013-14 to identify suitable speciality maize types based on their comparative productivity and economics under varying integrated nutrient management (INM) schedules and generating better market avenues to rural masses in peri-urban areas. For this purpose, different maize types *viz*. baby corn (HM-4), sweet corn (Madhuri), pop corn (Amber), maize for green cob purpose (HQPM-1), and maize for grain purpose (HQPM-1) were laid out in main plots while three INM schedules *viz*. 75% recommended dose (RDF)+ farm yard manure (FYM) @ 5 t/ha, 100% RDF + FYM 5 t/ha, and 125% RDF + FYM 5 t/ha were laid out in sub-plots in a split-plot design replicated thrice. 100% RDF for baby corn, sweet corn, maize for green cobs, and maize for grain purpose is 150: 60: 60 kg NPK/ha; while for pop corn the 100% RDF is 80: 60: 40 kg NPK/ha.

Results and Discussion

It was revealed that all the five maize types exhibited highest maize equivalent yield (MEY) and net returns under 125% RDF + FYM 5 t/ha (Table 1). Among different maize types, sweet corn exhibited significantly highest MEY (13.72 t/ha). The gross (Rs. 85134 - 219639/ha) and net returns (Rs. 44627 - 180412/ha) as well as B: C ratio (1.10 -4.59) in different maize types also followed the similar trend as that of MEY in these maize types. Production-efficiency and monetary-efficiency in different maize types also follwed the similar trend as that of productivty and profitability**.** Overall, sweet corn and baby corn are the best performers at 125% RDF + FYM 5 t/ha in terms of productivity and profitability for peri-urban areas of north-Indian plains. Similarly, maize for green cobs also confer great promises for generating better market avenues and farm livelihoods in Indo-Gangetic Plains Region.

Table 1: Influence of speciality maize types and INM practices on maize equivalent yield (t/ha) and gross and net returns (INR/ha).

Treatments	MEY (t/ha)	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B: C ratio
Speciality maize types					
Baby corn	12.96	44234	208632	164215	3.69
Sweet corn	13.72	39909	219639	180412	4.59
Pop corn	7.99	38505	119462	81361	2.13
Maize for green cob purpose	11.38	38449	191996	153019	3.92
Maize for grain purpose	4.73	39548	85134	44627	1.10
LSD (*P*= 0.05)	0.64	-	8985	8985	0.22
Integrated nutrient management					
75% RDF + FYM @ 5 t/ha	8.61	40661	140759	101563	2.59
100% RDF + FYM @ 5 t/ha	10.32	39693	167345	127100	3.15
125% RDF + FYM @ 5 t/ha	11.55	40034	186814	145518	3.52
LSD (*P*= 0.05)	0.29	-	4259	4259	0.11

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46.

Effect of Integrated Nutrient Management on Growth and Yield Attributes of Indian Mustard

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Keywords: Organic manure, nutrient, sustainability, fertilizer, nutrient use efficiency.

Introduction

The need for continued increase in agricultural production, INM has great significance because present level of fertilizer production in India is not enough to meet the total plant nutrients requirements, and neither the chemical fertilizer alone nor the organic sources exclusively can achieve the production. The integrated use of optimal dose of NPK and FYM ensures better and sustainable yields, while correcting some of the micro and secondary nutrients deficiencies. The integrated nutrients management, increasing nutrient-use efficiency, lower the cost of production, maintaining soil health and productivity, and increased mustard productivity. Balanced fertilization at right time by proper method increases nutrient use efficiency in mustard Saberi and Hassan (2014).

Materials and Methods

A field experiment was conducted on an inceptisol at Agronomy Research Farm of NDUAT, Kumarganj, Faizabad (U.P.) during *Rabi* season of 2006-07 and 2007-08. The experiment was laid out in RBD replicated thrice with 16 treatments. The treatments were T_1-control, T_2-100% recommended NPK (90: 60: 40) kg ha^{-1}, T_3 - 75% NPK + 5t FYM, T_4 - 50% NPK + 5t FYM, T_5 - 100% Recommended NPK + PSB, T_6 - 75% NPK + PSB, T_7 - 50% NPK + PSB, T_8 - 100% Recommended NPK + S 30 kg ha^{-1}, T_9 - 75% NPK + sulphur, T_{10} - 50% PK + sulphur, T_{11}-100% recommended NPK + PSB + sulphur, T_{12} - 75% NPK + PSB + sulphur, T_{13} - 50% NPK + PSB + sulphur, T_{14} - 75% NPK + 5t FYM + PSB + sulphur, T_{15} - 50% NPK + PSB + sulphur, T_{16} - 5t FYM + PSB + sulphur.

Results and Discussion

Result revealed that all the growth parameters Initial plant population, number of primary branches, number of secondary branches, plant height, number of leaves plant, leaf area index, etc. were found significantly superior with T_{14} 75% NPK+5t FYM + PSB + Sulphur over control. This was reported in both the years. Availability of nutrients in adequate amount resulted sufficient formation of photosynthates, which promote the metabolic activities, accelerated cell division and formation of meristematic tissues, ultimately enhanced the number of branches. This may be ascribed due to more supply of plant foods and its translocation in growing parts of plants with 75% recommended NPK. Result revealed that yield attributes and economic yield and Benefi: cost raio were recorded significantly superior with T14 over control. The grain yield increased tune of 84.3 percent with T_{14} followed 80.5 percent with T_{11} over control (10 q/ha). The maximum harvest index was recorded with T_{14} (23.27%) followed by T11 (23.03 which was significantly superior over control (19.21). Other yield attributes number of siliquae, length of siliqua, number of seeds siliqua, 1000 seed weight, grain yield, and harvest index were recorded significantly superior with T_{14} which was at par with T_{11} over control. Increased number of siliqua plant^{-1}, seeds siliqua^{-1} and test weight with these treatments could be explained on the basis of balanced nutrient supply which enhances cell division, photosynthesis and later on converted into reproductive phase resulted more number of siliqua plant^{-1}, seeds siliqua^{-1} and test weight. Similar findings were also reported by Patel *et al.* (2009).

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Table 1: Effect of integrated nutrient management on plant height, leaf area index, dry matter accumulation and flowering of Indian mustard.

Treatments	Plant height at 90 DAS (cm)		Leaf area index at 90 DAS		Dry matter accumulation at 90 DAS (g plant^{-1})		Days taken to 50% flowering	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
T_1	113.52	116.70	2.50	3.00	30.85	33.48	40.00	50.15
T_2	136.32	140.13	4.00	4.15	70.30	75.56	51.00	55.30
T_3	134.98	138.76	3.90	4.00	65.70	73.98	50.60	54.45
T_4	131.50	135.18	3.70	3.90	60.38	68.45	50.35	53.00
T_5	138.47	142.34	4.10	4.20	71.65	76.00	51.25	55.80
T_6	130.85	134.54	3.80	3.92	64.90	73.00	50.20	53.90
T_7	128.73	132.34	3.60	3.70	59.70	67.61	50.05	52.40
T_8	141.43	145.39	4.20	4.26	71.97	76.28	51.50	56.02
T_9	132.48	136.19	3.83	3.97	65.10	73.15	50.28	54.00
T_{10}	129.30	135.99	3.64	3.77	60.05	67.95	50.15	52.85
T_{11}	144.73	148.79	4.35	4.43	72.30	76.51	51.90	56.39
T_{12}	133.37	138.13	3.85	3.99	65.27	73.48	50.42	54.15
T_{13}	130.12	134.79	3.67	3.85	60.15	68.15	50.20	52.95
T_{14}	146.58	150.69	4.55	4.60	72.85	77.05	52.07	57.00
T_{15}	132.62	138.00	3.72	3.92	60.50	68.53	50.38	53.10
T_{16}	126.24	129.77	3.00	3.20	35.43	40.81	47.56	51.90
SEm±	6.06	5.26	0.17	0.15	2.90	3.40	2.28	2.06
CD at 5%	18.18	15.20	0.50	0.44	8.39	9.81	N.S.	N.S.

Table 2: Effect of integrated nutrient management on Yield attributes of mustard.

Treatments	No. of siliquae plant^{-1}		No. of seeds siliqua^{-1}		1000 seed weight (g)		Grain yield (q ha^{-1})	
	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08	2006-07	2007-08
T_1	195.00	203.00	9.00	11.00	3.40	3.66	9.35	10.65
T_2	240.00	260.00	12.00	13.00	4.30	4.68	16.12	17.35
T_3	227.00	250.00	11.50	12.50	4.00	4.02	15.57	16.85
T_4	223.00	245.00	11.23	11.75	3.80	3.83	14.89	16.03
T_5	245.00	264.00	12.50	12.95	4.38	4.45	16.45	17.61
T_6	222.00	247.00	11.40	11.80	3.85	3.89	14.95	16.40
T_7	217.00	241.00	10.35	11.00	3.70	3.74	14.56	15.60
T_8	249.00	267.00	12.70	13.15	4.50	4.56	16.80	18.03
T_9	224.00	248.00	11.42	11.83	3.83	3.91	15.14	16.49
T_{10}	219.00	243.00	10.50	11.15	3.74	3.79	14.74	15.90
T_{11}	260.00	270.00	13.00	13.50	4.68	4.70	17.50	18.60
T_{12}	225.00	249.00	11.45	11.87	3.89	3.93	15.36	16.58
T_{13}	221.00	244.00	10.60	11.20	3.77	3.80	14.82	15.98
T_{14}	290.00	280.00	14.00	14.20	5.00	5.09	17.80	19.05
T_{15}	225.00	246.00	10.95	11.90	3.90	3.97	15.05	16.20
T_{16}	210.00	215.00	11.00	11.09	3.60	3.86	12.30	13.20
SEm±	10.48	9.59	0.52	0.46	0.18	0.16	0.70	0.80
CD at 5%	30.27	27.69	1.50	1.34	0.53	0.46	2.02	2.31

47.

Leaf Colour Chart- A Simple Tool for Integrated Nitrogen Management in Rainfed Lowland Rice

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Keywords: Nitrogen management, LCC, rice

Introduction

Farmers generally use leaf colour as a visual and subjective indicator of the rice crop's need for nitrogen fertilizer. When the leaves are pale or yellowish green rather than dark green, farmers believe that plants need more nitrogen. According to research, it has been found that leaf colour intensity is directly related to leaf chlorophyll content and leaf nitrogen status. A Leaf colour chart (LCC) developed by a Japanese scientist Furuya in 1987 will help the farmers to measure the leaf colour intensity. LCC is a simple, easy to use and inexpensive tool to determine the time of N top dressing for rice crops. LCC can help in promoting need based, variable rate nitrogen application to rice (*Oryza sativa* L.) crop, based on soil N supply and crop demand. It is an ideal tool to optimize N use, irrespective of the source of N applied namely organic, inorganic fertilizers, bio-fertilizers etc. But, the LCC index needs to be standardized for a particular rice variety at particular location. Hence, the present investigation was planned to standardize the LCC index for integrated N management in rainfed lowland rice.

Materials and Methods

A field experiment was conducted at Agricultural Research Station (Paddy), Sirsi of the University of Agricultural Sciences, Dharwad, Karnataka in *kharif* seasons for three years from 2000 to 2002. The experiment was laid out in split plot design with three organic manures namely no manure, farm yard manure (FYM) at the rate of 10 t/ha and eupatorium at the rate of 10 t/ha as main plot treatments and nitrogen application treatments (as per LCC index 3.0, 4.0, 5.0 and N as per recommended practice) as sub plot treatments. The organic manures were incorporated three weeks before planting. Twenty-five days old seedlings of rice variety Abhilash were used for planting. The P and K were applied as per the recommendations. The nitrogen was applied as per the treatments. In LCC treatments, the LCC reading was taken on youngest fully expanded and healthy leaf at weekly interval. When the average LCC index showed below the desired index level, the crop was top dressed with nitrogen at the rate 20 kg/ha during early (14-28 DAT) and late (49 DAT to flowering) growth stages and at the rate of 30 kg/ha at rapid growth stage (29-48 DAT). The quantity of nitrogen applied in different LCC treatments is given in Table 1. At harvest grain and straw yields were recorded separately as per the treatments. The economics was worked out based the prevailed market prices of both inputs and output during the year of experimentation.

Results and Discussion

The grain and straw yield and economics of rainfed transplanted rice as influenced by integrated nitrogen management through leaf colour chart is given in Table 2. On an average over three years, the grain yield and net return recorded with application of N as per LCC 4.0 (5880 kg and Rs. 24945 ha^{-1}, respectively) and N as per practice (5940 kg and Rs. 25585 ha^{-1}, respectively) was found on par with each other. There was no significant difference in grain yield and net returns due to different organic manure treatments. The grain yield recorded with LCC 4.0, LCC 5.0 and N as per package when applied with either eupatorium or FYM was on par with each other. Whereas, net return realized with LCC 4.0, LCC 5.0 and N as per package was on par only when combined with eupatorium. With no manure and FYM, the net return with LCC 4.0 was found on par with that of N as per package only. The amount of N added in eupatorium + LCC 4.0 was least (36.7 kg ha^{-1}). Still, the yield levels and net returns realized with this treatment were on par with eupatorium + LCC 5.0 and eupatorium + N as per package, where the amount of N applied was more (122.2 and 75 kg N ha^{-1}, respectively). Hence, it can be concluded that N application can be done by using LCC index of 4.0 when inorganic fertilizers are combined with organic manures.

Table 1: Quantity of nitrogen applied in different treatments in LCC experiment (mean of three years)

Treatments		Nitrogen applied (kg/ha)	
		Mean of Manure x LCC	Mean of LCC
LCC 3.0	No Manure	26.7	26.7
	Eupatorium	26.7	
	FYM	26.7	
LCC 4.0	No Manure	63.3	48.9
	Eupatorium	36.7	
	FYM	46.7	
LCC 5.0	No Manure	143.3	137.4
	Eupatorium	122.2	
	FYM	146.7	
RPN	No Manure	75.0	75.0
	Eupatorium	75.0	
	FYM	75.0	

Table 2: Grain and straw yield and economics of rainfed transplanted rice as influenced by integrated nitrogen management through leaf colour chart (mean of three years).

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net returns (Rs.ha^{-1})
Organic Manures(M)			
M_1 - No Manure	5553	6977	23765
M_2 - Eupatorium (10 t/ha)	5966	7898	26056
M_3 - FYM (10 t/ha)	5906	7065	23802
S.Em±	231	250	846
C.D. at 5%	NS	815	NS
N Management through LCC (F)			
F_1 - N at LCC 3.0	5132	5770	19755
F_2 - N at LCC 4.0	5880	7051	24945
F_3 - N at LCC 5.0	6281	8758	27878
F_4 - N as per Rec. Practice(75 kg/ha)	5940	7675	25585
S.Em±	114	232	648
C.D. at 5%	339	666	1860
Interactions (MxF)			
M_1 x F_1	4855	5293	18763
M_1 x F_2	5708	6883	24741
M_1 x F_3	6031	9229	27915
M_1 x F_4	5618	6505	23642
M_2 x F_1	5399	6424	21874
M_2 x F_2	5891	7241	25301
M_2 x F_3	6374	8890	28673
M_2 x F_4	6199	9037	28373
M_3 x F_1	5141	5594	18628
M_3 x F_2	6040	7028	24795
M_3 x F_3	6438	8156	27046
M_3 x F_4	6003	7484	24741
S.Em±	197	402	1123
C.D. at 5%	NS	1154	NS

48.

Endophytic Microbes: An Aid to Integrated Nutrient Management

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Keywords: Endophytic microbes, INM

Introduction

Integrated plant nutrient management (IPNM) is the integration of soil health management and optimized plant nutrition. In other words the phenomenon ensures proper nutrition to growing plants while maintaining soil health. IPNM practices are inevitable for sustainable agriculture and human development. Microbes inhabiting endosphere, phyllosphere or rhizosphere of plants are acknowledged as plant associated microbes. They exhibit complex interactions with host plants. Endophytes harbour privileged space inside plants overcoming the competition faced by their counterparts in rhizosphere and soil. Endophytes showing properties of mineral solublisation like phosphorus, siderophore production and phytohormone production etc. can contribute to IPNM if used as bio-inoculants.

Materials and Methods

Endophytes were isolated from different medicinal plants of Jammu and Kashmir by surface sterilization method. Potato dextrose agar was used for the isolation of fungal endophytes whereas nutrient agar was used for the isolation of bacterial endophytes. Isolates were screened for phosphate solublisation, siderophore production and Indole acetic acid production. Siderophore production of isolates was determined on chrome azurol S (CAS) blue agar medium, Pikovskayas agar was used for phosphate solublisation plate assay and Salkowski's reagent method for Indole Acetic Acid production.

Results and Discussion

Endophytes promote plant growth through the production of phytohormones, phosphate solubilization and siderophore production. The use of plant growth promoting endophytes in agriculture offers an attractive way to replace chemical fertilizers thus decreasing load on soil health. In the present study, total of one hundred and one endophytes were obtained from three hundred and forty segments of surface sterilized plant tissue segments which included sixty two bacterial and thirty-nine fungal endophytes. Most of the bacterial endophytes were obtained from underground tissues whereas most of the fungal endophytes were obtained from aboveground tissue segments of medicinal plants studied.Siderophore production benefits plant to chelate iron ions. 50% of the fungal and 62% of the bacterial isolates were found to be positive for siderophore production (Fig. 1). Phosphorous is an important element required for the growth and development of the plants. Microbes due to their ability to secrete different chemicals could dissolve inorganic phosphorous and increase plant growth. 33% of fungal and 34% of bacterial isolates were found to be phosphate solublisers (Fig. 1). Plant growth regulators such as Indole 3-acetic acid (IAA) can stimulate rapid responses of cell elongation, cell division, and differentiation in plants. Estimation of IAA using pure IAA standard curve revealed that 35% of the fungal and 29% of the bacterial isolates produce IAA (Fig. 1). The amount of IAA ranged between 6.4-27µg/ml. Selected microbes with plant growth promoting as well as soil health promoting properties could be used as bio-inoculants in the fields. This would surely be a step forward towards realizing sustainable agriculture in general, and integrated nutrient management in particular.

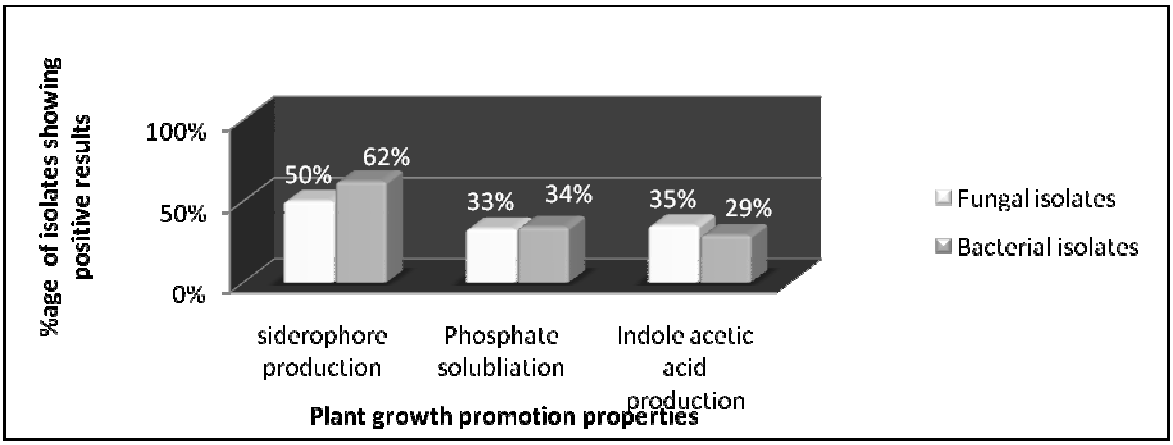

Fig. 1: Plant growth promotion potential of the endophytic isolates

49.

Integrated Nutrient Management (INM) In Peach (*Prunus persica*): Effect on Yield and Quality

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Keywords: Peach, INM, yield, quality

Introduction

The peach (*Prunus persica*) s basically a temperate fruit and grows well in temperate parts of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand. However, low chilling cultivars are performing better in sub-tropical areas of India. Rajouri is one of the main peach growing districts of Jammu division with a total area of 273.05 hectare and annual production of 548.0345 tonnes. But, productivity is low. The nutritional requirements of peaches are comparatively higher than other fruits because it bears on previous year's growth making the production of annual growth imperative for fruit production, Replenishment of the wood removed every year in pruning is also necessary. A large number of factor i.e., the type of soil, its fertility, climate, cultivar, planting density, shoot growth and irrigation facilities determine the amount of fertilizer to be applied. Therefore, it is not possible to recommend a definite amount of fertilizer for a given orchard.

Materials and Methods

With an aim to evaluate the effect of integrated nutrient management on yield and quality of peach plants, an experiment was conducted in 2013-14 by Krishi Vigyan Kendra, Rajouri at farmer's field. The trees selected for experiment were of six years of age and were healthy and were having similar growth characteristics. The experiment consisted of three treatments namely [T1: Farmers practice (Un-recommended NPK) T2: Recommended NPK {Urea- 395 g/tree, DAP- 150 g/tree, MOP- 585 g/tree}, T3: 75% NPK + Vermi compost @ 10 t/ha].

Results and Discussion

The data given in Table 1 indicates that 75% NPK along with application of 10 t/ha vermi-compost (T3) resulted in better size and quality of peach fruits {Yield: 55 kg/tree (Size: 75 g)}. However, the total yield obtained was at par with yield obtained with 100% NPK {60 kg/tree (70 g)}. Thus, it indicates that the application of vermin compost has added up to fulfilling the nutritional requirement of peach and thereby reduced the dependence on chemical fertilizers. It was also observed that vermin-compost has improved surface colour and increased the shelf life of peach fruits besides increasing the yield over farmer's practice. Application of vermin compost might have helped in better absorption and translocation of moisture as well as micronutrients that resulted in better colouration and also improved shelf life. The economic analysis indicated that net returns and returns per rupee invested were markedly influenced by treatment T2 (Recommended NPK) and T3 (75% NPK + Vermicompost @ 10 t/ha). Highest net return (Rs.1800 ₹/tree) were recorded with recommended NPK followed by recommended NPK + vermi-compost (Rs 1650 ₹/tree). Whereas, lowest returns of 1050 ₹ /tree were obtained with Farmer's practice. This shows 71.4 and 57.1% increase in net returns, respectively over the farmer practice. Maximum returns per rupee invested (₹4.38 and 3.88) were also recorded where recommended dose of NPK alone and along with vermi-compost was applied, respectively.

Table 1: Effect of INM practices on yield (kg/tree), weight of fruit (g.), net returns (₹/unit) and returns per rupee invested(₹).

Treatment	Yield (kg/tree)	Wt. of fruit (g)	Net returns (₹/unit)	Returns per rupee invested (₹)
T1- Farmer practice (un-recommended NPK)	35	45	1050	3.20
T2 - Recommended NPK {Urea-395 g/tree, DAP- 150 g/tree, MOP- 585 g/tree}	60	70	1800	4.38
T3- 75% NPK + Vermi compost @ 10 t/ha	55	75	1650	3.88

50.

Effect of Integrated Nutrient Management on Quality and Economics of Okra (*Abelmoschus esculentus* (L.) Moench)

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Keyworlds: Vermicompost, biogen, NPK, growth, yield and okra.

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench), commonly known as Bhindi or Lady's finger belongs to family Malvaceae, is a fast growing annual vegetable crop grown in tropical and sub-tropical regions of the world. Organic sources are widely accepted as low cost supplements to chemical fertilizers and have no deleterious effects either on soil health or environment. Rather organic sources should be used as partial replacement of the chemical fertilizers. Thus, a strategy for judicious combination of both organic and inorganic sources of nutrients is the most viable option for nutrient management. Hence, the present investigation was conducted to frame integrated nutrient management strategy for okra.

Materials and Methods

The present investigation was conducted at Vegetable Research Farm, Department of Horticulture, SHIATS, Allahabad during 2013-14, with ten treatments. The experiment was laid out in a randomized block design with three replications. Seeds of okra cultivar "Kashi Kranti" were dibbled manually with a recommended seed rate of 10 kg ha^{-1} on 7th October, 2013. Economics was worked out on the basis of the existing values of output and inputs used.

Results and Discussion

The maximum total soluble solids content (2.71%) of fruits was observed in T_8, while the minimum T.S.S. content (2.60%) of fruits was observed in T_{10}. The maximum fiber content (1.75 g) in pods was observed in T_8, while the minimum fiber content (1.63 g) in pods was observed in T_6. The maximum yellow vein mosaic virus affected plants (8.33) per plot were observed in T_9, while the minimum virus affected plants (5) per plot were observed in T_8. The maximum number of fruits per plant (22.04) at total harvestings were observed in T_4, while the minimum number (20.9) were observed in T_2 (Table 1). The maximum yield per plot (1866.97 g) was observed in T_8, while the minimum (1275.64 g) was observed in T_9. The maximum net return per hectare (₹ 76915.75) was in T_8, while the minimum net return (₹ 41610.25) was in T_{10}. The maximum cost benefit ratio (1: 3.00) was in T_8 and the minimum (2.01) in T_{10}. The total yield was influenced by integrated nutrient management treatment. Application of Organic manures like vermicompost showed an increased growth in terms of yield, quality and economics of the plant, it could be a better alternative to inorganic fertilizers **(**Tamilselvi and Devi, 2009).

Table 1: **Effect of integrated nutrient management on quality and economic characters of okra**

Treatments	Yellow Vein Mosaic Virus affected plants per plot	Total fruits per plant	Total yield per plot (gm)	Yield per hectare (q)	B: C ratio
T_1 [Recommended dose of fertilizers(control)*]	7.66	21.75	1447.3	35.73	1: 2.4
T_2 (25% RDF + 75% Vermicompost)	7.33	20.9	1476.31	36.45	1: 2.1
T_3 (50% RDF + 50% Vermicompost)	6.66	21.64	1550.96	38.29	1: 2.3
T_4 75% RDF + 25% Vermicompost	7.00	22.04	1576.31	38.92	1: 2.5
T_5 100% RDF + Biogen	6.33	21.1	1625.98	40.14	1: 2.7
T_6 (25% RDF + 75% Vermicompost + Biogen)	5.33	21.7	1700.97	42.00	1: 2.4
T_7 (50% RDF + 50% Vermicompost + Biogen)	5.00	21.64	1796.32	46.00	1: 2.8
T_8 (75% RDF + 25% Vermicompost + Biogen)	5.00	21.73	1866.97	46.09	1: 3.0
T_9 [100% Biogen (alone)]	8.33	21.69	1275.64	31.49	1: 2.6
T_{10} [100% Vermicompost (alone)]	8.33	21.18	1336.64	33.00	1: 2.0
F-test	Significant	Significant	Significant	Significant	
SEm±	0.40	1.20	80.53	2.02	
CD	0.85	3.58	239.23	6.01	

*Recommended dose of fertilizers- Nitrogen= 120 kilogram/hectare, Phosphorus= 80 kilogram/hectare, Potassium= 60 kilogram/hectare

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51.

Residual Effect of Integrated Nutrient Management (INM) on Performance of Buckwheat under Cold Desert Conditions of Lahaul Valley

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Keywords: Residual effect, farmyard manure, *Rhizobium*, NPK, buckwheat, cold desert

Introduction

Buckwheat (*Fagopyrum tataricum* Gaertn and *Fagopyrum esculentum* Moench) commonly known as *kathu, fafra, ogla* or *bharesh* is an herbaceous erect annual plant belonging to family *Polygonaceae.* Buckwheat, the staple food crop of higher altitudes has recently gained much attention as supplementary food in plain areas as well. Lahaul and Spiti one of the remotest tribal districts of Himachal Pradesh representing high hill temperate zone remain covered with snow for about four or five months (November to March). Buckwheat is one amongst the few crops, that fits well in double cropping sequences in such regions. Buckwheat responds well to a balanced fertilizer, but it is not considered a high nutrient user. Therefore, to conserve this underutilized crop and to find out the residual effect of organic and bio-fertilizer in conjunction with inorganic fertilizers applied in garden pea (*Pisum sativum*) crop on growth and yield of buckwheat, the field experiment was conducted.

Materials and Methods

An experiment was conducted at Highland Agricultural Research and Extension Centre, Kukumseri (Lahaul & Spiti), CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur (Himachal Pradesh) during the two consecutive *kharif* seasons. This research station is located at 32°44′55″N latitude and 76°41′23″E longitude with 2734 metres amsl in the Trans Himalayas. The experimental soil was sandy loam, slightly alkaline in nature (pH 7.66), medium in available nitrogen but high in available phosphorus and potassium with high organic carbon content (7.62 g/kg). The experiment was laid out in split-plot design with three replications, consisting of eighteen treatments combination having two crop sequences (Cpea-buckwheat and pea-mustard and three sources of organic/bio-fertilizer (FYM: 5 t/ha, *Rhizobium*: 200 g/10 kg seed and FYM: 2.5 t/ha + *Rhizobium*) as main plot treatments and three levels of chemical fertilizers (50%, 100% and 150% of recommended NPK i.e. 20: 60: 30 kg N, P_2O_5 and K_2O/ha, respectively) as sub-plot treatments.

Results and Discussion

Organic/bio-fertilizers significantly affected the grain and straw yields of buckwheat during both the crop seasons. FYM 2.5 t ha^{-1} + *Rhizobium* resulted in highest grain (21.08 and 20.46 q ha^{-1} during I^{st} and II^{nd} years, respectively) and straw yields (29.45 and 27.62 q ha^{-1} during I^{st} and II^{nd} years, respectively). Increase in chemical fertilizers level from 50% to 150% NPK also resulted in a significant and consistent increase in grain and straw yield of buckwheat during both the years. On an average recommended NPK increased grain yield by 42.6 per cent over 50% NPK. However, 150% NPK increased grain yield by 14.7 per cent over recommended NPK and 63.6 per cent over 50% NPK. Similarly, the straw yield markedly increased with the increasing level of N, P and K upto 150% of recommended NPK. Increase in yield of buckwheat with increasing levels of fertilizers was also observed by Sharma (2001). Interaction between organic/bio-fertilizer and chemical fertilizers was significant for grain and straw yield of buckwheat. Treatment combination O_3F_3 being at par with O_3F_2, gave highest grain yield of buckwheat over rest of the treatment combinations during both the crop seasons. Similarly, interaction effect different levels of organic and inorganic fertilizers on straw yield showed that combination of FYM 2.5 t ha^{-1} + *Rhizobium* with 150% of recommended NPK remaining at par with 100% of recommended NPK gave significantly higher straw yield of buckwheat during both the years. Since integration of FYM 2.5 t ha^{-1} + *Rhizobium* with 100% NPK (O_3F_2) was as good as 150% NPK (O_3F_3) in influencing grain and straw yields of buckwheat there was no need to apply NPK fertilizer beyond 100%.

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Table 1: Residual effect of organic/bio-fertilizer and chemical fertilizers on grain and straw yield (q/ha) of buckwheat

Treatment	Grain yield (q ha^{-1})		Straw yield (q ha^{-1})	
	2006	2007	2006	2007
Organic/bio-fertilizer				
O_1: FYM 5 t ha^{-1}	17.09	16.57	25.78	23.81
O_2: *Rhizobium*	15.24	14.61	25.04	23.02
O_3: FYM 2.5 t ha^{-1} + *Rhizobium*	21.08	20.46	29.45	27.62
LSD (P=0.05)	1.86	1.67	1.51	1.90
Chemical fertilizer				
F_1: 50% NPK	13.24	12.63	22.79	21.08
F_2: 100% NPK	18.78	18.10	27.65	25.54
F_3: 150% NPK	21.39	20.92	29.83	27.83
LSD (P=0.05)	1.23	1.45	1.47	1.41

Table 2: Interaction effect of residual organic/bio-fertilizer and chemical fertilizers on grain and straw yield (q/ha) of buckwheat

Treatment	Grain yield (q ha^{-1})						Straw yield (q ha^{-1})					
	2006			2007			2006			2007		
	O_1	O_2	O_3	O_1	O_2	O_3	O_1	O_2	O_3	O_1	O_2	O_3
F_1	13.42	11.35	14.95	12.95	10.77	14.16	22.76	22.12	23.49	21.00	20.40	21.84
F_2	17.62	15.37	23.36	16.90	14.42	22.98	26.14	25.32	31.49	23.98	23.06	29.60
F_3	20.24	19.00	24.94	19.87	18.63	24.25	28.43	27.67	33.38	26.45	25.61	31.42
LSD (P=0.05) Fertilizer levels at the same organic/bio-fertilizer level			2.14		2.52			2.54			2.45	
LSD (P=0.05) Organic/bio-fertilizer level at the same or different fertilizer levels			2.53		2.63			2.55			2.74	

O_1: FYM 5 t ha^{-1}; O_2: *Rhizobium;* O_3: FYM 2.5 t ha^{-1} + *Rhizobium*; F_1: 50% NPK; F_2: 100% NPK; F_3: 150% NPK

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Effect of Nitrogen, Phosphorus and Cutting Management on Yield and Quality of Oat (*Avena sativa L.*)

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Keywords: Fodder, grain, straw, yield, crude protein content, DAS per cent qha^{-1}

Introduction

Oat (*Avena sativa L.*), locally known as " jai" is an important non-legume, winter cereal crop, grown in irrigated conditions of northern and north-western regions of india because of its excellent growth characters, quick re-growth and economic source of dietary energy. It provides succulent and highly palatable fodder. Nitrogen and phosphorus are the major essential nutrients which may be able to play a major role in improving the quality and yield fodder crop like oat. Cutting management also affect crop yield. Therefore, we need to find out the nutritional and cutting requirement of oat crop taking good yield.

Materials and Methods

The field experiment was conducted at the Forage Research Farm of CCS Haryana Agricultural University, Hisar in *rabi* 2012-13 for observing the effect of cutting and fertility management on oat var. HJ 8, using factorial randomized block design. Gross plot size was 5 m x 3 m= 15 m^2 and net plot size was 4 m x 2.5 m=10 m^2. Each of 12 treatment combination was randomly allotted to individual plot in block of equal size, treatments were replicated thrice. Four fertility levels (F_0=control, F_1=N_{40}+ P_{20}, F_2=N_{80}+P_{40} and F_3=N_{120}+P_{60}) and three cuttings ($C_{50=}$ first cut 50 Days After Sowing, $C_{60=}$ second cut 60 DAS and $C_{70=}$ third cut 70 DAS) were maintained. The details of methods can be obtained by full length paper.

Results and Discussion

The data (Table 1) indicated that the significant and highest dry fodder yield of oat was recorded when oat was cut at 70 DAS (35.70 q ha^{-1}) followed by cut at 60 DAS (31.90 q ha^{-1}) and then cut at 50 DAS (28.50 q ha^{-1}). Joon *et al.* (1993) reported that green and dry fodder yield increased significantly when oat was harvested at 75 DAS. Singh (2004) reported that cutting at 70 DAS recorded maximum accumulation through leaf and stem. In case of grain yield of oat, significantly and highest grain yield was recorded when oat was cut at 60 DAS (28.06 q ha^{-1}) followed by cut at 50 DAS (25.57 q ha^{-1}). However, straw yield was recorded maximum under C_{50} treatment (65.46 qha^{-1}) followed by C_{60} (63. 68 q ha^{-1}). Similar observations were made by Patel *et al.* (2011). The data related to crude protein in fodder (%), in grain (%) and in straw (%)revealed that crude protein in fodder decreased significantly with increase in age of crop which was from 13.51% at first cut i.e 50 DAS to 11.77% at third cut i.e 70 DAS. With increase in fertility levels there was significant increase in crude protein content and highest values (13.65, 9.32 and 2.33 per % respectively) were recorded under highest fertility level (120 kg N + 60 kg P_2O_5 ha^{-1}). *In vitro* dry matter digestibility (IVDMD) in fodder was found maximum (68.48%) under C_{50}(first cut 50 days after sowing) treatment and it goes on decreasing with each delay in fodder cut and the lowest IVDMD (62.98%) was found when fodder was cut at 70 DAS. DDM (q ha^{-1}) increased significantly with each successive increase in fertility level upto the highest level *i.e* F_3 treatment and increase was from 13.85 to 27.56 q ha^{-1} over F_0, F_1 and F_2, respectively.

Table 1: Effect of cutting management and fertility levels on dry fodder, grain and straw yield (qha^{-1})

Cutting management	Fodder (Dry) yield	Grain yield	Straw yield	C.P in fodder (%)	C.P in grain (%)	C.P in straw (%)	IVDMD (%)	DDM (q/ha)
First cut	28.50	25.57	65.46	13.51	9.13	2.28	68.48	19.44
Second cut	31.90	28.06	63.68	12.64	9.12	2.23	64.99	20.73
Third cut	35.70	23.93	55.40	11.77	9.06	2.27	62.98	22.48
LSD (P= 0.05)	1.51	1.47	3.75	0.32	NS	NS	1.22	1.20
Fertility levels								
F_0	21.27	21.92	57.01	11.61	8.85	2.17	65.53	13.85
F_1	27.47	24.83	59.64	12.27	9.14	2.25	66.12	18.09
F_2	36.86	27.30	63.00	13.05	9.11	2.29	65.46	24.05
F_3	42.54	29.37	66.40	13.65	9.32	2.33	64.83	27.56
LSD (P= 0.05)	1.74	1.70	2.33	0.36	0.20	0.06	NS	1.39

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53.

Effect of Different Combinations of Organic Manures and Supplementation of Biofertilizers on Yield of Onion (*Allium cepa* L.)

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Keywords: Onion, Farmyard manure, vermicompost, neem cake, *Azospirillum* and PSB.

Introduction

In India, onion (*Allium cepa* L.) is being grown in an area of 10.51 lakh ha with production of 168.13 lakh tonnes and the productivity is 16.0 tonnes ha^{-1}. In Andhra Pradesh, onion is cultivated in an area of 86.67 thousand hectares with production of 15.60 lakh tonnes and the average productivity is 18.0 tonnes ha^{-1} (NHB, 2013). The occurrence of multi-nutrient deficiencies and overall decline in the productivity of the soil under intensive fertilizer use have been widely reported (Chhonkar, 2003). Consequently, many farmers are seeking alternative practice of organic farming to make agriculture more sustainable. Considering the adverse effects on soil health and environment, besides the residual effect, luxurious usage of inorganic fertilizers is not advisable. In India, very little work has been reported regarding the effect of different organics on growth and yield of vegetable crops and in onion particular. Hence the present investigation was taken up to study the effect of different organics on yield of onion.

Materials and Methods

The present investigation was conducted during *rabi*, 2013 to study the effect of different combinations of organic manures and supplementation of bio-fertilizers on yield of onion at Dr. Y.S.R. Horticultural University, Rajendranagar, Hyderabad, and Andhra Pradesh. The onion variety Agrifound Light Red used as experimental material and the experiment was laid out in randomized block design with three replicated 9 treatments (Table 1). The data were recorded on yield parameters like bulb dry weight (g), number of scales per bulb, bulb length (cm), bulb diameter (cm), bulb yield per plot (kg) and bulb yield per hectare (t ha^{-1}).

Table 1: Bulb dry weight, dimensions and yield affected by different organic manures and bio-fertilizers

Treatments	Bulb dry weight (g)	Bulb length (cm)	Bulb diameter (cm)	Number of scales per bulb	Bulb yield (kg plot^{-1})	Bulb yield (t ha^{-1})
T_1: FYM (50%) + vermicompost (50%)	81.20	6.21	6.60	6.66	9.12	15.20
T_2: FYM (50%) + vermicompost (50%) + BF	84.40	6.78	7.37	7.13	9.98	16.63
T_3: FYM (50%) + vermicompost (25%) + neem cake (25%)	83.47	6.69	7.20	7.26	10.11	16.85
T_4: FYM (50%) + vermicompost (25%) + neem cake (25%) + BF	89.00	7.60	8.20	8.40	11.20	18.66
T_5: Poultry manure (50%) + vermicompost (50%)	80.66	6.08	6.35	6.20	8.04	13.40
T_6: Poultry manure(50%) +vermicompost (50%) + BF	85.08	6.77	7.32	7.00	8.91	14.85
T_7: Poultry manure (50%) + vermicompost (25%)+ neem cake (25%)	83.50	6.64	6.94	6.66	10.46	17.43
T_8: Poultry manure(50%)+vermicompost (25%)+ neem cake (25%) + BF	85.15	6.79	8.00	7.40	10.93	18.21
T_9: RDF @ 150: 60: 60 NPK kg ha^{-1}	87.50	7.50	8.12	7.60	11.04	18.40
CD	2.26	0.70	0.50	0.72	0.002	0.19

BF=*Azospirillum*and PSB @ 5 kg ha^{-1} each.

Results and Discussion

The bulb dry weight, length and diameter was significantly affected by the application of farmyard manure (FYM), vermicompost, poultry manure, neem cake and bio-fertilizers at different stages of plant growth (Table 1). The maximum bulb dry weight, length, diameter and number of scales per bulb was recorded in T_4 (with farmyard manure (50%) + vermicompost (25%) + neem cake (25%) + *Azospirillum* and PSB at the rate of 5 kg ha^{-1} each) followed by T_9 (with recommended dose of fertilizers) which were at par but significantly superior to all other treatments. The growth parameter were minimum T_5(with poultry manure (50%) + vermicompost (50%). The bulb dry weight maximum in T_4(89.00 g) followed by T_9 (87.50 g). The lowest bulb dry weight was in T_5 (80.66 g). The bulb length was significantly affected by the application of FYM, vermicompost, poultry

manure, neem cake and bio-fertilizers at different stages of plant growth. Similarly bulb length was in T_4 (7.60 cm) followed by T_9. The lowest bulb length was also recorded in T_5. Similar to the bulb dry weight, bulb length the highest bulb diameter was also recorded in T_4 followed by T_9.

Similar to the growth parameters the number of scales and, bulb yield significantly affected by the application of FYM, vermicompost, poultry manure, neem cake and bio-fertilizers at different stages of plant growth being maxium in T_4 followed by T_9. The maximum number of scales per bulb was in T_4 followed T_9(7.60) which were significantly superior to all other treatments. The maximum bulb yield per plot was in T_4 (11.20 kg) followed by T_9 (11.04 kg) and was significantly higher than in other treatments. The minimum bulb yield per plot was in T_5 (8.04 kg). The bulb yield /hectare also showed the same trend.

In the present study, among the various manurial treatment combinations tried, maximum yield (18.66 t/ha) was recorded with FYM + vermicompost + neem cake + bio-fertilizers. This increased yield might be due to increased yield attributing characters like photosynthetic potential, total dry matter, number of scales, polar and equatorial diameter.

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54.

Effect of Integrated Nutrient Management on Productivity of Sorghum (*Sorghum bicolor* (L) Moench)- Wheat (*Triticum aestivum* L) Cropping System and Soil Properties under Vertisol of Marathwada Region in Maharashtra.

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Keywords: Nutrient sources, INM, productivity, sorghum, wheat and soil properties

Introduction

Sorghum (*Sorghum bicolor* (L) Moench) -wheat (*Triticum aestivum L.*) / gram *(Cicer aurountium*), soybean (*glycin max*) -wheat (*Triticum aestivum*), groundnut *(Arachis hypogea*)-wheat (*Triticum aestivum*) are the most prominent crop sequences followed under irrigated condition of Marathwada region (Central plateau region) in Vertisol. Long term fertility experiments are good indicators for maintaining soil quality and crop productivity.. The two crop sequence exhaust more nutrient from the soil and as such it become necessary to develop a sequence with efficient fertilizer management to improve the fertility of soil by adopting integration of organic and inorganic source of nutrient with chemical fertilizers. The main objective to develop suitable integrated nutrient supply systems for sorghum-wheat sequence with more efficient use of fertilizers in combination with organic manures by effective recycling techniques and maintain soil fertility and productivity at higher level. Hence, it is considered imperative to find out the ways and means for sustaining the productivity of sorghum wheat cropping sequence for Marathwada region.

Materials and Methods

The experiment was laid out in randomized block design with three replications. The experiment was conducted at same site without changing the randomization of treatments to assess the residual effect. The five irrigations were applied to the wheat crop at critical growth stages and in kharif season sorghum was irrigated as and when the stress was observed. The soil of experimental field was clayey texture with having pH ranging from 8.20 to 8.32. The initial soil- test values were organic carbon 0.55% available N 138 kg/ha, available P_2O_5 28.0 kg/ha and available K_2O 440.0 kg /ha. The experiment started with kharif sorghum crop and winter Rabi crop. The availability of nutrient was low in nitrogen, medium phosphorus and higher in potassium. The experiments consists of fourteen treatments (Table 1) which includes four treatments of different levels of recommended dose of fertilizer and eight treatments are integrated with chemical fertilizer (RDF) by using different organic sources like FYM, crop residue (wheat straw) and green manures (*glyricidia maculata*, *Leucinea leucocephala)* biomass and one unfertilized control and farmer practices of manuring was used during the experimentation in rainy and winter season. n. Farmer practice of manuring consisted of 50% recommended dose of NPK application i.e.40: 20: 20 kg/ha to sorghum and wheat 60: 30: 30 NPK kg/ha. The recommended dose of fertilizer for sorghum and wheat is 80: 40: 40 and 100: 50: 50 NPK kg/ha respectively.

Results and Discussion

The significantly highest grain and straw yield of sorghum and wheat was recorded under treatment T_6, where nitrogen requirement of both the crop met through 50% recommended dose of NPK through chemical fertilizers + 50% N through farm yard manure (FYM) applied to the both crop which was recorded as 26.44 q / ha and 26.06 q / ha, respectively (Table 1) followed by treatment 100% recommended dose of NPK through fertilizers which was 26.44 q / ha and 25.02 q / ha, respectively. The sorghum and wheat grain yield of both the crop was recorded by 50% RDF (recommended dose of fertilizer for sorghum and wheat is 100: 50: 50 and 80: 40: 40 NPK kg/ha respectively + 50% glyricidia *(glyricidia maculata*) as well as leucaenia (*Leucinea leucocephala*) lopping was found at par with 100% RDF. Similarly trend was observed in case of fodder and straw yield of both crops. These results are in close agreement with results of (Lodha *et al.* 1987). The lowest grain yield was recorded by control treatment in sorghum- wheat sequence.

The highest Sorghum grain equivalent yield was recorded significantly by application 50% RDF + 50% FYM in *kharif* (80.34 q/ha) and at par with 100% RDF. The lower sorghum grain equivalent yield was recorded significantly by 50% RDF + 50% wheat straw/ glyricidia and leucaenia lopping. In general application of organic manure showed increased in grain yield as compared to application of chemical fertilizer alone during experimental period. Similar, observation was reported by Rajput and Warsi (1992) in rice -wheat rotation. Substitution of 50% N through FYM (T_6) and 100% RDF (T_5) to *kharif* sorghum and 100% RDF to *rabi* wheat produced higher sustainable yield index of 0.21 (Table 1) followed by (T_5). Lowest SYI (-1.13) was recorded in control plot of sorghum -wheat sequence. The data on nutrient balance at the end of crops revealed that maximum net gain of 23.6 kg N, 4.10 kg P_2O_5 and 14 K_2O was observed by the application of 50% recommended through FYM (T_6). However, application of recommended dose of nutrient through inorganic

sources recorded the loss of nutrients as compared to organic sources. The inclusion of organic manures during kharif season recorded the net gain in the range of 10.3 to 23.6 kg N, 0.30 to 4 kg P_2O_5 and 8 to 14 K_2O. Similarly with the addition of *glyricidia* and *leucaenia* leaves also provide promising increase in nutrient content in soil. Nutrient application through organic manure FYM reduces loss of nutrient ultimately increased the NPK balance in soil at the end of both the crops. Similar, results are reported by Charjan and Gaikwad (2005).

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Table 1: Effect of integrated nutrient management on Sorghum and wheat grain and sorghum fodder, wheat straw, sorghum grain equivalent yield (SGEY)and nitrogen, phosphorous and potash at harvest (Mean of 1983-2012)

Treatment	Kharif	Rabi	Yield (q/ha)				SGEY (q/ha)	SYI For sorghum	SYI for Wheat	N status at the end	P status at the end	K status at the end
			Sorghum		Wheat							
			Grain	Fodder	Grain	Straw						
T - 1	Control (no fertilizer).	Control (no fertilizer).	3.14	17.89	5.90	11.98	15.22	-1.13	-0.20	94.79	18.54	324.03
T - 2	50% NPK (FF)*).	50% NPK (FF)).	18.28	58.35	17.15	29.00	54.74	0.09	0.35	106.42	21.12	342.25
T - 3	50% NPK (FF)).	100% NPK (FF)).	20.49	64.72	20.21	34.07	62.75	0.13	0.40	114.76	22.02	361.36
T - 4	75% NPK (FF)).	75% NPK (FF)).	22.10	68.64	20.76	33.66	66.49	0.15	0.36	116.75	22.91	373.44
T - 5	100% NPK (FF))+	100% NPK (FF)).	26.44	78.21	25.02	36.64	78.85	0.18	0.42	130.41	26.87	393.31
T - 6	50% NPK (FF))+50% FYM.	100% NPK (FF)).	26.44	79.00	26.06	38.61	80.34	0.21	0.45	147.86	29.04	406
T - 7	75% NPK (FF))+25% FYM.	75% NPK (FF)).	25.89	76.09	23.41	35.83	75.81	0.21	0.40	128.43	25.98	388.51
T - 8	50% NPK (FF)+50% Wheat straw	100% NPK (FF)).	22.70	69.45	23.54	36.80	70.53	0.16	0.41	127.27	26.62	383.36
T - 9	75% NPK (FF)+50% Wheat straw	75% NPK (FF)).	23.18	69.95	21.75	34.64	69.04	0.07	0.36	125.45	25.87	380.61
T -10	.50% NPK (FF))+50% Glyricidia	100% NPK (FF)).	24.68	72.66	23.26	37.42	73.16	0.18	0.43	138.64	38.71	394.14
T -11	75% NPK (FF))+25% Glyricidia.	75% NPK (FF)).	23.24	70.63	21.34	33.98	69.40	0.16	0.37	132.48	27.71	392.31
T -12	75% NPK (FF))+25% Subabul.	75% NPK (FF)).	17.86	58.76	17.08	29.18	54.86	-0.40	0.30	104.18	21.39	354.56
T -13	50% NPK (FF))+50% Subabul.	100% NPK (FF)).	23.08	61.96	21.38	32.11	66.15	0.15	0.60	123.56		485.95
T -14	Farmer's practice (40: 20: 20)	Farmers practices (60: 30: 30)	24.09	63.53	23.44	38.83	69.81	0.18	0.46	128.39		359.12
S.E.+			2.45	2.81	0.83	1.73	1.38					
C.D. at 5%			6.43	7.97	2.36	4.32	3.89					

55.

Effect of Added Phosphorus, Organic Matter and Moisture Regimes on Phosphorus Adsorption in Soils of Various Agro-Climatic Zones of Jammu Region

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Keywords: Phosphorus adsorption, desorption, adsorption maxima

Introduction

Phosphorus (P), a key element and vital component of the substances that are building blocks of genes and chromosomes, is taken up by crops from the soil. This P must be replenished or resupplied adequately for normal crop growth. The ability of the soil to re-supply this phosphorus is dependent on the adsorption/desorption behaviour of soil system, as this will govern the movement of applied as well as native phosphorus. Factually the phosphorus movement in soil is very petite even with hefty amounts of rainfall or irrigation. A study was conducted to understand the P behaviour in soils representing different agro climatic zones in foothills of the northwest Himalayas. Langumir and Freundlich isotherms were tested for adsorption/desorption studies and from these, adsorption maxima (b), bonding energy constant (K) and maximum buffering capacity (MBC) were calculated.

Materials and Methods

Four hundred soil samples (0-22.5cm depth) collected from cultivable areas representing three agro-climatic zones namely subtropical, intermediate and temperate zones of Jammu region were studied for P adorption/desportion behavior of these soils. On the basis of variable texture, organic carbon, altitude and cropping pattern, surface soil samples (0-15 cm depth) were collected The soil samples collected were dried under shade, processed, sieved through 2 mm sieve (for organic carbon through 0.5 mm sieve) and finally stored in polythene bags for analysis so that they could be used for determining various physico-chemical properties, phosphorous adsorption vis-à-vis for determination of phosphate desorption and effect of organic matter and moisture regimes on phosphate adsorption. Total phosphorus was estimated by vandomolybdophosphoric yellow colour method at 470nm.For adsorption - desorption, Langumir and Freundlich isotherms were tested for adsorption/desorption data and from these adsorption maxima(e), bonding energy constant(K) and maximum buffering capacity were calculated. Incubation studies were carried out in three soil samples representing three different zones for this study.

Results and Discussion

The mean P adsorption by the temperate soil was 523.1 mg kg^{-1} as compare to 296.6 mg kg^{-1} in the intermediate zone soils, subtropical zone soils recorded lowest P adsorption of 126.1 mg kg^{-1}(Table 1a). The adsorption isotherm indicated, although the adsorption of P increased with increasing concentration of P, yet the percentage of adsorbed P decreased from 65.3 to 57.0%, 83.1 to 21.4% and 85.2 to 39.7% for different soil in subtropical, intermediate and temperate zone soils, respectively. Langmuir adsorption maxima (b), bonding energy (K) and maximum buffering capacity (MBC) of these soils ranged from 101 to 1000 mg kg^{-1}, 12.0 to 56.01 L kg^{-1} and 2.62 to 20.0 L kg^{-1} respectively. Bonding energy was positively correlated with clay, CEC, while maximum buffering capacity had a significant negative corelationship with pH (r= -0.743) but a significant positive corelationship with clay (r=0.84). Multiple regression analysis indicated significant influence of clay and organic matter on P adsorption in these soils. The percentage of desorbed P was higher at higher level of added P, while percentage of adsorbed P decreased with the increase in the P level. Highest P desorption was noticed in subtropical zone. Lowest P desorption was in temperate zone soils (Table 1b). In all the soils the bonding energy (K) and adsorption maxima (b) decrease with the addition of farm yard manure but the decrease was more at saturation then at field capacity. The bonding energy decreased from 23.6 to 20.2 L kg^{-1} with 0 level of farm yard manure (FYM) at field capacity. At saturation point bonding energy decreased from 16.8 to 14.0 l kg^{-1} and with addition of FYM (5 t ha^{-1}) decrease was from 23.2 to 19.6 l kg^{-1} at field capacity and from 16.4 to 13.7 l kg^{-1} at saturation. Similar decreasing trend were found with the addition of 50 and 100 ppm P in all the three agro climatic zones of Jammu region. Incubation of soils at saturation and field capacity and addition of FYM at the rate of 5 tonne ha^{-1} invariably resulted in significantly higher P extraction with 0.5 M $NaHCO_3$ through out the incubation period. The increase at saturation point was from 12.5 to 20.9 kg ha^{-1} while at field capacity it was from 11.2 to 18.6 kg ha^{-1}.

Table 1: Phosphorus adsorption (a) and desorption (b) in agro-climatically dissimilar soils of northwest Himalayas

(a)

P added ($mg\ L^{-1}$)	P adsorbed ($mg\ kg^{-1}$)		
	Sub-tropical zone	Intermediate zone	Temperate zone
20	62.22	80.95	83.97
40	76.47	119.79	144.92
80	92.72	189.44	290.13
120	108.97	269.11	388.36
200	141.47	359.01	577.00
250	158.72	407.73	646.96
300	175.03	437.13	662.11
350	193.22	496.62	755.55

(b)

P added ($mg\ L^{-1}$)	P desorbed ($mg\ kg^{-1}$)		
	Sub-tropical zone	Intermediate zone	Temperate zone
20	5.76 (14.52)	8.57 (12.48)	4.85 (8.76)
40	8.46 (15.09)	10.59 (12.52)	5.92 (10.15)
80	10.99 (14.84)	12.90 (12.45)	6.98 (11.56)
120	14.33 (14.15)	15.04 (12.13)	8.16 (11.47)
200	17.28 (14.83)	17.07 (11.64)	8.90 (10.35)
250	22.04 (14.52)	19.23 (12.89)	9.86 (10.33)
300	25.49 (14.36)	21.74 (12.63)	10.80 (10.77)
350	32.04 (14.28)	23.85 (12.05)	11.90 (11.66)

Values in parentheses () are % desorption of the adsorbed

56.

Response of Organic Nutrient Sources and Sulphur Levels on Growth and Yield of Soybean (*Glycine max* L. Mirrell)

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Keywords: Farm yard manure, poultry manure, sulphur soybean and vermicompost,

Introduction

Soybean (*Glycine max* L. Merrill) is an important oilseed crop. The major constraint affecting the productivity is the adequate availability of suitable genotype and nutrients. The management of manures within a crop rotation can have large effects on yields and crop quality. Organic farming plays greater role in maintaining soil health and reducing the risk of soil erosion when compared to chemical farming. There is need to refining and standardized package of practice for important crop under organic farming system

Materials and Methods

The soil of the experimental field was shallow in depth (30 cm) having 0.34% organic carbon, 225 kg ha^{-1} available nitrogen,13.50 kg ha^{-1} available P_2O_5, 257.00 kg ha^{-1} available K_2O, pH 7.5 and EC 0.13 dS m^{-1}. The treatment combinations in the experiment comprised of 3 sources of solid organic manures namely farmyard manure (FYM), poultry manure and vermicompost and three levels of sulphur (30 kg ha^{-1}, 40kg ha^{-1} and 50 kg ha^{-1}) with control (0 kg ha^{-1} sulphur) for sulphur. Half dose of NPK was supplied by organic manure and remaining dose supplied by inorganic sources. The experiment was laid out in randomized block design and with three replications.

Results and Discussion

Among the all sources of organic manure and levels of sulphur T_3 (FYM + 40 kg ha^{-1} sulphur) was the best amongst all treatments (Table 1). The application of organic manures decrease bulk density, improve the soil environment including physico-chemical (such as enhanced nitrogenase activity), aeration biological condition, and micro climate of photosphere resulting in maximum penetration of rhizobium in root hairs.Maximum seed yield and stover yield was the highest (2112.89 kg ha^{-1}, 3776.03 kg ha^{-1} respectively) in T_3 (FYM + 40 kg ha^{-1} sulphur). Nitrogen influenced the seed yield through optimum or enhanced source-sink relationship, resulting in higher production of photosynthates and their increased translocation to reproductive parts, as nitrogen being the most important essential plant nutrient needed for growth and development of plant and known to increase the yield of soybean (Edward and Daniel, 1992). The highest gross return (₹86403.62 ha^{-1}), net return (₹56113.61 ha^{-1}) and benefit cost ratio (2.85) were registered in treatment T_3 (Farmyard manure + 40 kg ha^{-1} sulphur) followed by T_7 (Vermicompost + 40 kg ha^{-1} sulphur).

Table 1: Effect of organic nutrient sources and sulphur levels on growth and yield of soybean

Treatment		Pod plant^{-1}	Seed pod^{-1}	Seed index	Grain yield kg ha^{-1}	Stover yield kg ha^{-1}
T_1	Farmyard manure + Control (0 kg ha^{-1} sulphur)	24.77	1.66	5.51	752.27	1293.26
T_2	Farmyard manure + 30 kg ha^{-1} sulphur	24.11	1.66	5.79	771.28	1326.51
T_3	Farmyard manure + 40 kg ha^{-1} sulphur	38.66	2.66	6.16	2112.89	3776.03
T_4	Farmyard manure + 50 kg ha^{-1} sulphur	25.66	1.66	5.44	789.24	1508.40
T_5	Vermicompost + Control (0 kg ha^{-1} sulphur)	24.55	1.66	5.76	756.86	1487.06
T_6	Vermicompost + 30 kg ha^{-1} sulphur	23.11	1.55	5.89	698.52	1265.89
T_7	Vermicompost + 40 kg ha^{-1} sulphur	33.55	2.33	6.22	1629.65	2942.91
T_8	Vermicompost + 50 kg ha^{-1} sulphur	23.77	1.66	5.35	756.74	1376.77
T_9	Poultry manure + Control (0 kg ha^{-1} sulphur)	23.99	1.66	5.22	737.55	1289.91
T_{10}	Poultry manure + 30 kg ha^{-1} sulphur	24.22	1.44	5.86	733.79	1205.47
T_{11}	Poultry manure + 40 kg ha^{-1} sulphur	25.33	1.66	5.49	769.44	1314.82
T_{12}	Poultry manure + 50 kg ha^{-1} sulphur	25.88	1.55	5.64	798.68	1451.60
	SEd (±)	1.10	0.16	0.56	116.02	196.94
	CD (P= 0.05)	2.27	0.33	NS	240.61	408.44
	CV (%)	5.07	11.09	12.04	15.08	14.30

NS - Non significant

Reference

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57.

Nitrogen, Phosphorous and Potassium Contents in Broccoli as Influenced by Organic and Inorganic Nutrients

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Keywords: Curd, Nitrogen, Phosphorous and Potassium

Introduction

Broccoli (*Brassica oleracea* L.var *italica*) belonging to family Brassicaceae is a recent introduction to India and is becoming popular among the people because of its low fat content, low in calories, *high* vitamin C and good source of vitamin A, B_2 and calcium (Sanwal and Yadav, 2014). Broccoli contains a compound Glucoraphanin that can be processed into an anti cancer compound Sulphoraphane. It also contains Indole-3-carbinol, a chemical which boost DNA repair in cells and appears to block the growth of cancer cells.

Materials and Methods

The present experiment entitled "Nitrogen, Phosphorous and Potassium contents in broccoli as influenced by organic and inorganic nutrients" was carried out at the site for "Network project on Bio fertilizer" in the campus of College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar during Rabi 2008-09 and 2009-10 in Randomized block design with 10 treatments replicated thrice. General recommendation of fertilizer used for the experiment was 120: 30: 60 of NPK (kg/ha) including bio fertilizer *Azotobacter, Azospirillum*, PSB in the ratio of1: 1: 1. Besides bio fertilizer FYM 10 t/ha and vermicompost 5 t/ha were also used as per the treatments. However, the detail treatments are given below.

Notation	Treatments
T_1	Absolute control
T_2	100% NPK
T_3	100% NPK +100% FYM
T_4	100% NPK + 100% V.C
T_5	100% NPK +50%FYM +50% VC
T_6	100% NPK +50%FYM + 25% VC +25% VC
T_7	100% NPK +50% V.C +50%VC
T_8	100% NPK + 50%V.C +25%VC +25%VC
T_9	75%NP +100% K+ Bioinoculant+100% FYM
T_{10}	75% NP + 100% K +Bioinoculant+100% VC

Results

Results revealed from the above experiment, that out of ten treatments tried, the T_{10} i.e. 75% NP+ 100% K+ Bioinoculants + 100% VC proved to be the best on account of nitrogen, phosphorous and potassium content of curd and plant. The NPK content of curd was highest in T_{10} which are 60.92 kg/ha, 6.99 kg/ha and 34.36 kg/ha respectively. Whereas, NPK content of plant was 37.97 kg/ha, 6.78 kg/ha and 23.96 kg/ha respectively. Also the total NPK content of plant and curd was found highest in T_{10} i.e. 93.76 kg/ha, 11.67 kg/ha and 52.68 kg/ha respectively.

Reference

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Table: NPK content of curd, plant and total from curd and plant as influenced by integrated use of organic manures, bioinoculation and chemical fertilizers.

Treatments	N contents			P contents			K contents		
	Curd	Plant	Total	Curd	Plant	Total	Curd	Plant	Total
Absolute control	3.01	1.19	3.45	0.29	0.21	0.39	1.19	0.78	2.26
100% NPK	22.17	17.41	40.24	1.79	2.45	4.52	11.79	9.08	24.41
100% NPK +100% FYM	34.21	19.58	55.55	3.07	2.95	5.37	14.14	10.91	27.53
100% NPK + 100% V.C	44.00	22.50	68.75	3.73	3.46	6.73	19.41	13.02	32.31
100% NPK +50% FYM +50% VC	45.25	25.63	72.11	4.08	4.18	7.29	19.99	14.05	34.42
100% NPK +50% FYM + 25% VC +25% VC	47.88	27.32	73.53	4.85	4.61	7.78	23.96	15.36	38.81
100% NPK +50% V.C +50% VC	52.22	30.66	79.83	4.98	5.44	8.90	26.28	19.16	42.63
100% NPK + 50% V.C +25% VC +25% VC	56.16	33.43	85.75	5.13	5.80	9.53	31.32	19.27	46.11
75% NP +100% K+ Bioinoculant + 100% FYM	57.24	36.28	86.90	5.91	6.37	10.73	32.38	20.53	48.69
75% NP + 100% K + Bioinoculant + 100% VC	60.92	37.97	93.76	6.99	6.78	11.67	34.36	23.96	52.68
SEM±	0.19	0.44	0.36	0.18	0.20	0.16	0.26	0.46	0.17
CD(0.05)	0.54	1.21	0.99	0.53	0.56	0.45	0.73	1.29	0.52

58.

Effect of Urea and Vermicompost on Growth and Seed Yield of Bottle Gourd and their Residual Effect on Succeeding Carrot Crop

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Keywords: Bottle gourd, vermicompost, urea, seed yield, succeeding crop and carrot.

Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is an important vegetable crop of cucurbitaceous family. Good quality seed is very important factor for production purpose and nutrients directly affects the vegetative growth and yield of the crop. Application of nitrogen through organic in form of vermicompost and inorganic form of urea can help to enhance seed production of bottle gourd. Use of organic manures is not only the liable way for obtaining fairly high productivity with sustainable fertilizer economy but also a concept of ecological soundness leading to sustainable agriculture. It can also help to increase yield potential of succeeding carrot (*Daucus carota* L.) crop due to its residual effect.

Materials and Methods

A field experiment was carried out during rainy season for two years at Agriculture Research Station, Durgapura, Jaipur in 2004-05 and 2005-06. Nitrogen (80 kg/ha) was supplied through urea and vermicompost in five different treatment combinations. Experiment was replicated thrice in a randomized block design. Whole quantity of vermicompost was uniformly spread at the time of bed preparation. The required quantity of urea as per treatment was supplied in three splits. The pooled data of two years of the crop on various growth and yield attributes and nutrient contents of bottle gourd seeds were recorded. For estimating nitrogen and phosphorus content of seed spectrophotometer and vanadomolybdo_phosphate methods, respectively were used. Potash was estimated by photometric method. After harvest of bottle gourd, the beds were prepared at the original place of each plot where carrot crop was repeated as per uniform package and practices. The root length and girth were recorded and yield of carrot root were weighed. The pooled data of two years were recorded and subjected to statistical analysis.

Results and Discussion

It is evident from the data given in Table 1, that the highest vine length, number of primary branches, leaf area index, fruit length and fruit girth were recorded maximum under nitrogen supplied 50% through urea and 50% through vermicompost. It is apparent from data that there was a significant effect of treatments in increasing the number of fruits per vine (2.99), number of seeds per fruit (464.32), and seed yield per ha (1012.52 kg). The significant improvement in number of fruits and seed yield on account of application of urea along with vermicompost might have attributed to the translocation of nutrients from soil, particularly when sink was able to synthesize the enhanced amount of carbohydrate assimilated by enhanced rate of photosynthesis.

Table 1: Effect of urea and vermicompost on pooled mean growth, flowering and yield characters of bottle gourd

Characters	Treatments						
	N_1	N_2	N_3	N_4	N_5	SEM	C.D. 5%
Vine length (cm)	456.3	461.8	526.0	496.0	442.4	5.9	16.7
No. of primary branches per vine	9.22	9.48	11.29	10.56	8.9	0.15	0.42
Number of nodes per vine	18.57	18.79	18.99	20.36	19.72	0.25	0.73
Leaf area index	1.09	1.13	1.16	1.08	1.05	0.01	0.03
Days to appearance of first male flower	47.00	46.15	45.11	44.39	43.72	0.88	NS
Days to appearance of first female flower	61.97	61.27	58.88	58.50	56.89	0.85	2.41
Node at which first male flower appeared	9.47	9.14	8.89	8.70	8.43	0.11	0.33
Node at which first female flower appeared	11.76	11.40	11.15	10.89	10.65	0.17	0.48
Fruit length (cm)	37.25	38.37	41.60	40.72	39.70	0.68	1.92
Fruit girth (cm)	23.43	23.70	25.71	25.09	24.47	0.37	1.04
No. of fruits per vine	2.28	2.58	2.99	2.83	2.50	0.04	0.11
No. of seeds per fruit	429.98	444.29	464.32	451.05	442.48	5.24	14.82
Seed yield (kg/ha)	695.63	824.90	1012.52	927.83	820.88	15.37	43.47

The data revealed that nitrogen and protein content of seed, nitrogen uptake, phosphorus uptake and potash uptake by seed were observed highest also in treatment N_3 in which 50% N was given through urea and 50% through vermicompost and followed by treatment N_4 (Table 2). Nitrogen applied 100% through vermicompost to preceding bottle gourd crop had significant effect on succeeding carrot crop. The root length (16.50 cm), width (29.80 cm.) and yield of carrot (288.38 q/ha) were found highest with 100% vermicompost application.

Table 2: Effect of urea and vermicompost on pooled mean nutrient contents, uptake of bottle gourd seed, growth and yield of succeeding carrot crop

Characters	Treatments						
	N_1	N_2	N_3	N_4	N_5	SEM	C.D. 5%
Nitrogen content of seed (%)	3.03	3.06	3.12	3.08	2.99	0.01	0.04
Phosphorus content of seed (%)	0.563	0.576	0.571	0.577	0.579	0.003	0.008
Potash content of seed (%)	0.98	1.05	1.11	1.17	1.19	0.06	0.23
Protein content of seed (%)	18.94	19.10	19.50	19.26	18.70	0.09	0.26
Nitrogen uptake by seed (kg/ ha)	21.09	25.24	31.64	28.63	24.58	0.31	0.87
Phosphorus uptake by seed (kg per ha)	3.91	4.68	5.80	5.37	4.76	0.09	0.27
Potash uptake by seed (kg/ ha)	6.80	8.61	11.20	10.78	9.86	0.24	0.67
Length of roots (cm)	12.45	14.20	15.00	15.80	16.50	0.39	1.13
Width of roots (cm)	24.30	26.55	27.30	28.30	29.80	0.92	2.70
Yield of roots (q/ha)	236.25	241.16	244.81	249.52	288.38	2.80	7.91

59.

Impact of Nitrogen and FYM Doses on Performance of Japanese Pear (*Pyrus pyrifolia* Nakai) *cv.* Punjab Beauty

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Keywords: Pear, farm yard manure, shoot length, fruit set, fruit weight

Introduction

Japanese pear (*Pyrus pyrifolia* Nakai), a member of Rosaceae family, which is next only to apple in importance, acreage and production, is one of the most important temperate and subtropical fruit crops of Northern India. In India, pear is mainly grown in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Punjab and Haryana. The quality of semi-soft pears is good and fetches premium price in the market. The nutrition management in crops is a complex subject involving interplay of many factors. The physico-chemical conditions of the soil in the rhizosphere, the agro-climatic parameters and the cultural practices are important considerations for evolving the nutrient strategy. The performance of fruit crop was evaluated in terms of growth and yield.

Materials and Methods

The experiment was carried out at Experimental Orchard of the Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar during 2012-13. The study was initiated on 11 years old uniform trees of semi-soft pear *cv*. Punjab Beauty grafted on Kainth seedling (*Pyrus pashia*) rootstock. The experiment was planned in a randomized block design with three replications. The treatments consisted of five levels of nitrogen (0, 200, 400, 600 and 800 g N/plant) and three levels of FYM (30, 60 and 90 kg/plant). The data on various parameters of tree growth, fruit set and yield was recorded. Statistical analyses were carried out with the OPSTAT software using analysis of variance (ANOVA) for randomized block design.

Results and Discussion

Number of fruits per plant influenced with increased levels of nitrogen and FYM (Table 1). The maximum (308.4) number of fruits was harvested with application of 800 g nitrogen/plant followed by 600 g nitrogen per plant (290.0) and minimum (234.0) without application of nitrogen. Moreover, the number of fruits was significantly affected by different doses of FYM. The maximum number of fruits (284.3) was harvested with 90 kg FYM/plant followed by 60 kg FYM/plant (265.0) which was at par with 30 kg FYM/plant. The interaction between nitrogen and FYM was found significant. Maximum number of fruits (323.7) was harvested in plants supplied with combination of 800 g nitrogen and 90 kg FYM /plant, which was at par with 600 g nitrogen and 90 kg FYM/plant (318.0). The maximum increase in shoot length, number of leaves per shoot, initial fruit set and final fruit retention was observed with optimum dose of nitrogen (800 g/tree) and highest dose of FYM (90 kg/tree). However, the maximum fruit weight, fruit length, and fruit yield was observed with optimum economic dose of nitrogen (600 g/plant) and FYM (90 kg/plant).

Table 1: Effect of Nitrogen and FYM on number of fruits per plant of pear cv. Punjab Beauty

FYM (kg/plant)	Nitrogen (g/plant)					Mean number of fruits
	0	200	400	600	800	
30	222.0	233.7	258.0	264.3	292.3	254
60	236.7	234.7	256.7	287.7	309.3	265
90	243.3	254.3	282.0	318.0	323.7	284
Mean	234.0	240.9	265.6	290.0	308.4	
C.D. at 5% Nitrogen 11.4, FYM 11.1, Nitrogen x FYM 12.5						

Mean number of fruits has been rounded up to the nearest whole number

60.

Effect of Integrated Nutrient Module on Growth and Yield of Cauliflower under Low Hill Conditions of Himachal Pradesh

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Keywords: Integrated nutrient module, cauliflower, PGPR, yield

Introduction

Nutrient management in cauliflower (*Brassica oleracea* var. *botrytis* L.) cultivation is an important aspect and these are mainly supplied through chemical fertilizers. Repeated, heavy and unbalanced applications of chemical fertilizers lead to the deterioration or degradation of soil properties besides causing environmental pollution. Bio-fertilizers/Plant Growth Promoting Rhizobacteria PGPR have been recognized as important environmental friendly, low cost and non-bulky agricultural inputs in site specific integrated nutrient management system (INMS). So, the present investigations were undertaken to develop an INM technology consisting of effective inoculum of PGPR and optimum doses of N and P fertilizer for enhanced cauliflower yields without degradation of soil health.

Materials and Methods

The experiment was conducted at Lalsingi, Una of Himachal Pradesh. Seeds of Pusa Snowball K-1 were treated with 72h old liquid bacterial inoculums for 8h and control seeds were treated with sterilized water. One month old seedlings were transplanted in the field after giving root dip in bacterial inoculums. Treatments combinations namely: T_1 (RDF), T_2 (MK_5+75%NP), T_3 (SB_{11}+75%NP), were arranged in RBD design and replicated seven times. Various plant parameters were recorded by adopting standard methods. The total nutrient uptake by plant was worked out by formula:

$$\text{Total nutrient uptake (kg ha}^{-1}) = \frac{\text{\% Nutrient content} \times \text{Dry Matter (kg/ha)}}{100}$$

Results and Discussion

Maximum (15.44) number of non wrapper leaves was recorded in treatment T_3 (SB_{11} + 75% NP) however, it was statistically at par with treatment T_2 (MK_5 + 75% NP). Maximum curd diameter (18.56 cm) was recorded in treatment T_2 (MK_5 + 75% NP) which was statistically at par with treatment T_3 (SB_{11} + 75% NP) and minimum (11.72, 14.69 cm) was recorded with T_1 (RDF). The application of bacterial inoculum (SB_{11}) along with 75% per cent doses of NP fertilizers (T_3) recorded significant increase in gross curd weight (1891.67 g), net curd weight (940.56 g) and curd yield (262.50 q/ha), however, it was statistically at par with T_2 (MK_5 + 75% NP) and minimum was recorded with T_1 (RDF) (Table 1). N uptake in plant was significantly influenced by conjoint application of bacterial isolate (MK_5 or SB_{11}) and 75 per cent doses of NP fertilizers in comparison to uninoculated control. The highest increase in N uptake (37.1%) was recorded by treatment T_3 (SB_{11} + 75% NP). The treatment T_2 increased the P uptake by 29.8 per cent over control (RDF). The K uptake also followed the same trend as that of P concentration. Thus, the selected isolate (s) with 75% doses of N and P chemical fertilizers has good prospects to be used as integrated nutrient module not only for enhanced yield but also to sustain soil health.

Table 1: Effect of PGPR and chemical fertilizers on plant parameters under field conditions (Lalsingi, Una)

Treatments	Number of non wrapper Leaves	Curd Diameter (cm)	Gross weight of curd (g)	Net weight of curd (g)	Yield (q/ha)
T_1 (RDF)	11.72	14.69	1369.17(3.12)*	621.39(2.77)*	194.55
T_2 (MK_5+75% NP)	14.78	18.56	1847.22(3.25)	916.11(2.94)	253.07
T_3 (SB_{11}+75% NP)	15.44	17.31	1891.67(3.27)	940.56(2.95)	262.50
$CD_{0.05}$	1.68	2.02	(0.08)	(0.09)	36.7

*Figures in parentheses are log transformed values

61.

Effect of Organics on Yield Attributing Traits and Economics of Turmeric (*Curcuma longa L.*)

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Keywords: Economics, Organics, Turmeric, Yield

Introduction

Turmeric (*Curcuma longa* L.) is one the most important and ancient spice of India. The people of India use it in all prepuration for its typical color and flavor. Besides, it is used in medicine and cosmetics and as dye in textile industries. It contains about 69.49 carbohydrate 6.30 protein, 5.10 oil and 3.50% mineral and other important elements in dry turmeric. Turmeric widely used as spice as well as most important crop for medicinal use. Curcumin a pigment which constitute yellow color is very useful in food industry. Turmeric is widely used in pharmaceutical due to its anticancers, anti-inflamatory, anti-septic properties. Turmeric contains up to 5% essential oils and up to 5% curcumin. Most usage of turmeric is in the form of rhizome powder, in some regions (especially in Maharashtra, Goa and Konkan), leaves of turmeric are used to wrap and cook food.

Materials and Methods

An experiment was conducted at Department of Horticulture, JNKVV Jabalpur (MP) during 2012-13 to study the effect of biofertlizers and organic manures on growth and yield of turmeric. The two factors were chosen as a treatment. Factor A consisted of Organic manure and factor B related with biofertilizers. The treatment details are presented in Table 1. The experimental sowing was done on 26 June, harvesting was done on 22 March, 2013 when the leaves turned yellow. The net plots were marked and border rows were harvested before harvesting of net plot area. The crop was harvested plot-wise and the produce of each of the plot was, weighed with the help of electronic balance.

Results and Discussion

Effect of different treatments of bio-fertilizer and organic manure on pre harvest observation of turmeric: Among pre harvest observations, the plant height, number of leaves per plant, length of leaves, width of leaves, number of clumps per plant and length of clumps were studied in turmeric (Table 1). The treatment combination T_{12} (O_4B_2 PM 5t/ha + PSB 5kg/ha) was recorded maximum plant height, number of leaves per plant, length and width of leaves per plant followed by T_{11} (O_3B_2 VC 5t/ha + PSB 5kg/ha) at 30, 60, 90, 120 and 150 DAS. The findings are also in agreement with the findings of Velmurugan *et al.* (2009).

Effect of different treatments of bio-fertilizer and organic manure on post harvest observation of turmeric: The treatment combination T_{12} (O_4B_2 Poultry manure 5t/ha + PSB 5 kg/ha) recorded the maximum weight of primary rhizomes and secondary rhizomes per plant followed by T_{11} (O_3B_2 VC 5t/ha + PSB 5kg/ha) and which were at par with each other. While it was minimum under the treatment combination T_1 (O_0 B_0 No organic manure + No biofertilizer i.e. control). These findings are in agreement with the findings of Tiwari *et al.* (2003).

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Table 1: Interaction effect of bio-fertilizers and organic manures on growth and yield attributes of turmeric

Treat. Sym.	Code	Treatment details	Plant height at 150 DAS	Number of leaves per plant	Length of leaves (cm)	Width of leaves (cm)	Number of clumps/ plant	Length of clumps/ plant (cm)	Weight of rhizomes per plant	Fresh weight of rhizomes/ plant (g)	Dry matter recovery	Leaf area index at 150 DAS	Leaf area duration to 120-150 DAS	Rhizomes yield per hectare (q)
T_1	O_1B_0	No organic manure + No biofertilizer	82.99	4.63	30.16	7.04	3.99	28.15	29.07	316.29	30.68	0.198	-0.001	149.04
T_2	O_2B_0	FYM 15t/ha + No biofertilizer	96.54	6.32	32.44	9.48	4.83	30.20	32.56	385.77	33.63	0.207	-0.004	183.62
T_3	O_3B_0	VC 5t/ha + No biofertilizer	100.69	6.34	33.99	9.28	4.87	29.88	40.79	399.36	35.92	0.2058	-0.012	190.10
T_4	O_4B_0	PM 5t/ha + No biofertilizer	100.34	6.53	35.54	9.96	5.28	29.92	40.95	371.52	34.72	0.239	0.002	176.84
T_5	O_1B1	No organic manure +Azospirillum 5kg/ha	91.99	6.30	31.64	8.21	4.79	30.35	33.20	347.57	35.48	0.205	-0.001	167.50
T_6	O_2B_1	FYM 15t/ha + Azospirillum 5kg/ha	100.35	6.69	35.14	9.67	5.34	31.43	42.10	391.08	35.87	0.226	0.000	191.58
T_7	O_3B_1	VC 5t/ha + Azospirillum 5kg/ha	100.08	7.09	35.35	10.30	6.11	31.74	43.24	404.04	36.87	0.251	0.000	185.95
T_8	O_4B_1	PM 5t/ha + Azospirillum 5kg/ha	99.13	7.36	36.69	10.26	5.56	30.68	43.14	394.43	38.19	0.241	-0.002	184.59
T_9	O_1B_2	No organic manure +PSB 5kg/ha	93.58	6.36	33.93	8.68	4.91	31.47	34.13	351.32	35.67	0.211	-0.003	167.07
T_{10}	O_2B_2	FYM 15t/ha + PSB 5kg/ha	99.13	6.89	35.94	9.70	5.57	32.01	43.09	405.84	37.34	0.248	0.001	186.16
T_{11}	O_3B_2	VC 5t/ha + PSB 5kg/ha	101.90	7.59	36.80	10.45	5.82	32.00	44.63	408.57	37.65	0.253	0.003	193.20
T_{12}	O_4B_2	PM 5t/ha + PSB 5kg/ha	102.29	7.96	36.88	10.75	6.41	32.95	46.57	412.52	38.40	0.364	0.007	194.50
SEm±			2.96	0.37	0.40	0.35	0.25	0.51	0.87	9.92	0.93	0.004	0.003	5.72
CD at 5% levels			8.75	1.11	1.18	1.05	0.76	1.52	2.59	29.30	2.75	0.011	0.001	16.89

62.

Development and Evaluation of Subsoiler-cum-organic Manures and Soil Amendments Applicator

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Keywords: Subsoiler, vermicompost, soil amendments.

Introduction

The soils generally found in subsoil are inherently poor in nutrient status, low in organic matter content and water holding capacity due to hard impermeable layer. The subsoiling has given yield increase of over 26% in wheat and 16% in maize in comparison to conventional method of soil cultivation (Kumar, 2003). Application of fertilizers is generally accomplished, placement or mixing in upper soil layers of 20-50 mm depths which create fixation problems of phosphorous (P) and potassium (K) and volatilization of nitrogen (N). Only 40 to 50% of N fertilizers and 20 to 30% of P and K fertilizers are effectively used by the crops in broadcasting (Rowse and Stone, 1980). The aim of incorporating organic manures is an important and valuable source of plant nutrients, available NPKS and micronutrients, decreases the bulk density of soil when used either alone or in combination with inorganic fertilizers (Pawar and Patil, 2007). However, no suitable technology is presently available in the context of placement of organic manures in solid states into the subsoil zone. Therefore, a machine named as 'Subsoiler-cum-Organic Manures and Soil Amendments Applicator' have been develop and its performance was evaluated on mustard crop.

Materials and Methods

A 'Subsoiler-cum-Organic Manures and Soil Amendments Applicator' was designed and developed for placement of different materials at varying depths up to 475mm while performing subsoiling operation. The developed machine (Fig. 1) consisted of two main units namely, subsoiling unit, and a fertilizers and soil amendments metering unit. Specifications of the main components of developed machine are given in Table 1 and the developed machine is shown in Fig. 2. An experiment was conducted with seven treatments to evaluate the performance of developed machine on mustard crop. The known quantity of fertilizers and vermicompost as per treatment were applied at different depth as per treatment.

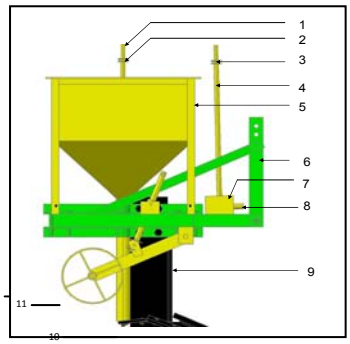

Fig. 1: Isometric view of designed machine

	Components
1	Screw conveyor shaft
2	Pulley mounted on screw conveyor shaft
3	Pulley mounted on reduction unit shaft
4	90° vertical shaft of power reduction unit
5	Hopper with supporting stand
6	Hitch system
7	Gear reduction unit
8	PTO shaft
9	Subsoiling unit
10	Screw conveyor pipe
11	Depth control wheel

Fig. 2: The developed machine

Results and Discussion

The data as presented in Table 1 pertaining to seed yield of mustard in different treatments at harvest revealed that the significantly maximum seed yield (2.108 t/ha) was obtained with the placement of 50% N (inorganic) at 200 mm + 50% N (organic) at 400 mm depths (T_7) which is at par with T_6 (1.936 t/ha) with placement of 50% N (inorganic) + 50% N (organic) at 200 mm depth followed by (T_5) i.e. 80% (inorganic) placed at 200 mm and 20% (inorganic) placed at 400 mm depths with the seed yield of 1.911 t/ha. Significantly lowest seed yield of 1.720 t/ha was obtained in T_1 (control). The applications of organic and inorganic fertilizers at different depth significantly increased the oil yield. The placement of 50% N (inorganic) at 200 mm + 50% N (organic) at 400 mm depths (T_7) recorded significantly the maximum oil yield (0.838 t/ha) which was at par with T_6 (0.766 t/ha) with the placement of 50% N (inorganic) + 50% N (organic) at 200 mm depth (Table 1). This was followed by T_5 (0.758 t/ha) with 80% (inorganic) placed at 200 mm and 20% (inorganic) placed at 400 mm depths and T_4 (0.709 t/ha) with subsoiling + 50% N (inorganic) + 50% N (organic) + mixing (100 mm), respectively. Significantly lowest oil yield was recorded in control T_1 (0.690 t/ha).

Table 1: Yield attributes of mustard crop in field experiment

Treatments	Yield attributes						
	No. of siliquae per plant	Seed yield (t/ha)	Stover yield, (t/ha)	Harvest index, (%)	Test (1000- seed) weight, (g)	Oil content, (%)	Oil yield, (t/ha)
T_1	223.9	1.720	5.638	23.494	4.13	40.12	0.690
T_2	246.7	1.751	6.105	22.402	4.22	40.35	0.707
T_3	283.9	1.738	6.346	21.630	4.09	40.23	0.699
T_4	286.1	1.783	6.598	21.297	4.28	39.75	0.709
T_5	341.7	1.911	6.780	22.002	4.21	39.64	0.758
T_6	401.0	1.936	6.923	21.850	4.39	39.59	0.766
T_7	482.5	2.108	7.693	21.498	4.45	39.75	0.838
Sem±	13.09	0.06	0.32	0.77	0.09	0.22	0.26
CD at 5%	40.36	0.19	0.99	NS	NS	NS	0.078

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63.

Influence of *Azospirillum* and Organic Manure on Growth and Yield in Broccoli under Intermediate Zone of Jammu & Kashmir

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Keywords: *Azospirillum*, broccoli, INM

Introduction

Broccoli is highly suited for cultivation under moderate intermediate agro-climates. However, it is also a nutrient exhaustive crop and requires high dose of nitrogen which can be supplied through inorganic sources depleting plant and soil health. An alternate nutrient strategy is to feed the crop through the use of organic sources of nutrients which not only maintain better quality but also sustain a higher level of soil fertility and crop productivity. Therefore, in an endeavor to standardize its production technology based on efficient nutrient management strategy, the present investigation was undertaken to find out the influence of integrated nutrient management on growth, yield and yield contributing traits.

Materials and Methods

A two year field experiment on integrated nutrient management (INM) in broccoli var. Early Green was conducted in *rabi* seasons of 2009-10 and 2010-11 at Regional Agricultural Research Station, Rajouri, Sher-e Kashmir University of Agricultural Sciences & Technology, Jammu. The experiment was laid in RBD and comprised of ten treatments with varying levels of nitrogen (50, 75 and 100%) in combination with or without farm yard manure (FYM)@ 20tonnes/ha and seedling dip with bio-fertilizer (*Azospirillum spp.)*. Each treatment is replicated thrice and data recorded in each season is pooled and subjected to analysis of variance for test of significance using standard procedure given by Gomez and Gomez (1984)

Results and Discussion

The data presented in Table 1 reveals that among all the treatment combinations, the treatment combination comprising of 50% N + FYM (20t/ha) + seedling dip with *Azospirillum* recorded significantly highest yield (158.8 q/ha) followed by treatment combination of 75% N + FYM (20t/ha) + *Azospirillum* seedling dip (156.3 q/ha) which were found to be 28.8% and 27.4% higher than control (113.1q/ha) respectively. The increased yield in these two treatments can be attributed to the better overall performance of these treatment combinations which were manifested in significantly highest values of other main yield contributing characters namely, curd weight (between 130.9g and 129.4g) and curd diameter (between 10.3cm and 10.7cm). All the other characters viz., number of leaves/plant, number of lateral shoots and weight of lateral shoots/plant also contributed in increased yields in these two treatment combinations except plant height

Table 1: Integrated nutrient management in broccoli under intermediate zone of Jammu region

Treatment	Plant height (cm)	No. of leaves/ plant	Curd weight (g)	Curd diameter (cm)	No. Of lateral shoots/ plant	Weight of lateral shoots/ plant (g)	Yield/ hectare (q)
50% N + *Azospirillium*	34.3^{b}	20.1^{b}	92.8^{a}	8.1a	7.3^{b}	321.5^{b}	129.1^{a}
75% N + *Azospirillium*	32.1^{b}	20.6^{b}	95.3^{a}	8.0^{a}	5.8^{a}	284.2^{a}	128.9^{a}
100% N + *Azospirillium*	31.2^{a}	21.5^{b}	106.9^{b}	8.4^{a}	8.8^{c}	370.5^{c}	129.2^{a}
50% N + 20t/ha FYM	31.7^{a}	18.9^{a}	102.7^{b}	9.3^{b}	7.1^{a}	356.5^{c}	141.3^{b}
75% N + 20t/ha FYM	31.0^{a}	18.6^{a}	97.6^{a}	9.1^{b}	8.7^{c}	350.3^{c}	142.9^{b}
100% N + 20t/ha FYM	32.6^{b}	17.3^{a}	113.9^{c}	9.0^{b}	8.2^{b}	370.5^{c}	146.6^{b}
50% N + 20t/ha FYM + *Azospirillum*	32.5^{b}	19.2^{b}	130.9^{f}	10.3^{c}	9.8^{c}	395.4^{d}	158.8^{c}
75% N + 20t/ha FYM+ *Azospirillum*	33.1^{b}	21.7^{c}	129.4^{f}	10.7^{c}	9.2^{c}	393.2^{d}	156.3^{c}
100% N + 20t/ha FYM+ *Azospirillum*	29.2^{a}	18.0^{a}	123.8^{e}	9.5^{b}	8.3^{b}	358.4^{c}	145.8^{b}
Control	31.7^{a}	19.1^{b}	116.6^{d}	8.7^{a}	6.6^{a}	269.3^{a}	113.1^{a}

Within column means superscripted by same letter did not differ significantly at 5% level of significance

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64.

Sweet Corn (*Zea mays* var. saccharata) Production with Different Organic Sources

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Keywords: Sweet Corn, Growth and Yield attributes, sweet corn yield

Introduction

It is well known that addition of organic manures has shown considerable increase in crop yield, quality and significant influence on physical, chemical and biological properties of soil. Use of organic manures and biofertilizers not only improve soil health but also help to sustain crop productivity. The present investigation was undertaken to find the effect of different organic inputs on growth, yield attributes and sweet corn (*Zea mays* var. saccharata) yield and its quality in sweet corn.

Materials and Methods

The experiment was conducted in kharif seasons of 2008 at the Post Graduate Institute research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, district Ahmednagar (Maharashtra) India.

The experiment was laid out in randomized block design with four replication consisting of soil organic levels and in combination with the different organic inputs. Treatments were: T_1: control, T_2: farm yard manure at the rate of 10 t/ha., T_3: vermicompost at the rate of 5 t/ha., T_4: : farm yard manure at the rate of 5 t/ha. + vermicompost at the rate of 2.5 t/ha, T_5: : farm yard manure at the rate of 5t/ha + jeevamrut 2 times [30 and 45 days after sowing (DAS)], T_6: Vermicompost at the rate of 2.5 t/ha. + jeevamrut 2 times (30 and 45 DAS), T_7: farmyard manure at the rate of 5 t/ha. + vermicompost at the rate of 2.5 t/ha and T_8: Jeevamrut 2 times (30 and 45 DAS).

The gross plot size was 5.40 X 4.80 m^2 and net plot size was 4.20 X 3.00m^2. The farmyard manure and vermicompost was applied seven days prior or dibbling of sweet corn as per the treatment. Jeevamrut was applied to sweet corn at 30 and 45 DAS with irrigation. The seeds were inoculated with Azotobacter and phosphate solubilizing bacteria (PSB). Sweet corn Cv. Sugar-75 was dibbled at 60 X 20cm^2 spacing.

Results and Discussion

The application of farmyard manure at the rate of 5 t/ha. + vermicompost at the rate of 2.5 t/ha. + Jeevamrut 2 times (30 and 45 DAS) recorded significantly higher growth and yield attributes and green cob yield of sweet corn (14.5t/ha) and green fodder yield (26.9t/ha) the results in agreement with Dalvi (2006) and Banik P and Ranjita Bejabaruah(2003).

Similarly application of farmyard manure at the rate of 5 t ha + vermicompost at the rate of 2.5 t ha + Jeevamrut 2 times (30 and 45 DAS) recorded significantly higher values for sweet corn grain quality parameters namely protein content (10.29%), sucrose content (10.11%), starch content (70.74%) and brix (15.87%) in corn grain as compared to other treatments.

Application of farmyard manure at the rate of 5t/ha + vermicompost at the rate of 2.5 t/ha + Jeevamrut 2 times (30 and 45 DAS) recorded significantly higher gross and net monetary returns while application of jeevamrut 2 times (30 and 45 DAS) recorded higher value of benefit: cost ratio but at par with application farmyard manure at the rate of 5 t/ha. + vermicompost 2.5t/ha. + Jeevamrut 2 times (30 and 45 DAS)

Application of farmyard manure at the rate of 5t/ha. + vermicompost at the rate of 2.5 t/ha. + Jeevamrut 2 times (30 and 45 DAS) found superior for sweet corn cob yield and green fodder yield with higher realization.

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Table 1: Growth and yield attributes, yield and quality of sweet corn as influenced by application of different organic inputs

Treatments	Growth attributes				Yield attributes					Sweet corn yield t/ha		Sweet corn grain quality			
	Plant height at harvest (cm)	No of functional leaves plant at 56 DAS	Leaf area plant at 56 DAS (g plants)	Total dry matter plant at harvest (g plant)	No. of cobs plant	Length of cob (cm)	Girth of cob (cm)	Weight of cob with husk (g plant)	Weight of cob without husk (g plant)	Cob yield	Green fodder yield	Protein content (%)	Starch content (%)	Sucrose content (%))	Brix (°brix)
T_1: Control	102.0	7.6	22.1	121.3	1.0	13.1	11.5	130.6	86.6	8.1	14.4	6.8	59.4	8.1	12.4
T_2: Farm yard manure @ 10 t/ha	107.4	8.3	22.3	128.9	1.5	14.4	12.7	150.6	109.6	12.0	21.5	9.3	68.6	8.7	14.2
T_3: Vermicompost @ 5 t/ha	116.5	9.6	22.8	133.4	1.6	15.8	13.6	175.1	139.5	13.0	23.5	9.8	69.4	9.6	15.2
T_4: : Farm yard manure @ 5 t/ha + vermicompost @ 2.5 t/ha	157.1	10.4	42.1	139.8	1.8	16.6	14.4	232.4	158.7	13.4	24.4	9.9	70.1	10.0	15.8
T_5: : Farm yard manure @ 5t/ha + Jeevamrut 2 times (30 and 45 DAS)	116.1	9.4	22.6	129.3	1.6	14.6	13.6	162.2	124.4	12.0	23.0	9.8	68.7	9.5	14.4
T_6: Vermi-compost @ 2.5 t/ha + Jeevamrut 2 times (30 and 45 DAS)	132.6	9.8	24.1	136.6	1.7	16.0	13.9	204.3	146.8	13.3	24.1	9.9	69.6	9.9	15.3
T_7: farmyard manure @ 5 t/ha + vermicompost @ 2.5 t/ha	162.0	10.6	44.0	149.0	2.1	17.0	14.8	238.6	170.5	14.5	26.9	10.2	70.7	10.1	15.8
T_8: Jeevamrut 2 times (30 and 45 DAS)	104.4	8.2	22.2	122.8	1.3	13.6	12.6	133.9	90.3	11.8	20.8	8.0	59.7	8.7	13.4
SEm^+	1.6	0.2	0.6	5.2	0.1	0.3	0.2	2.0	3.9	0.4	0.9	0.1	0.5	0.1	0.2
CD at 5%	4.9	0.7	1.9	15.6	0.2	0.9	0.8	6.0	11.8	1.2	2.9	0.3	1.5	0.5	[0.6
General mean	124.8	9.2	27.8	132.6	1.6	15.1	13.4	178.5	128.3	12.4	22.3	9.2	67.0	9.3	14.6

65.

Influence of Various Post-composting Organic Supplements on the Yield and Quality Characters of *Agaricus bitorquis* (Quel.) Sacc. under Kashmir Conditions

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Introduction

Agaricus bitorquis (Quel.) Sacc.a sister species of *A. bisporus* requires 4-6°C temperature more than *A. bisporus* for its growth and fructification. *A. bitorquis* like most cultivated edible fungi is Basidiomycetes and is widespread in nature. This species has specific characteristics and grows at higher temperature than strains of *Agaricus bisporus* (Hasselbach and Mutsers, 1971; Raper, 1978). It is resistant to the virus that causes the dreaded dieback (Zaayen, 1972). Another important characteristic of this species is its resistance to pressure and bruising (Vedder, 1978). It is a four spored fungus as compared to two spored *A. bisporus*. Its sexual behaviour is unifactorial heterothallic (Raper, 1976).

Materials and Methods

The present investigation was conducted in Mushroom Research & Training Centre, Division of Plant Pathology, Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, in 2014-2015. The cultivation trails were laid under natural temperate climatic conditions during May-July. The experiment was set up in a completely randomized design with 3 replications. Soyabean (*Glycine max)*, bengal gram (*Cicer arietinum)*, corn flour (*Zea mays)*, and mustard oil cake (*Brassica rapa*) cake used as supplements to the compost at the time of casing. These supplements were mixed with compost at 0.2%, 0.3% and 0.4% per 5 kg compost at the time of casing. Unsupplemented bags were kept as control.

Results and Discussion

All organic supplements added to compost at the time of casing showed early case run, pin head formation and first flush, maximum yield, fruit weight, diameter of pileus and maximum length of stipe except mustard oil cake. Maximum yield (21.62 kg/q) was obtained in soybean meal supplement at 0.4%. Minimum yield (11.26 kg/q) was also obtained in mustard oil cake supplement at 0.4%. Supplementation of compost at casing with nutrient rich organic supplements is relatively easy and low cost cultural practice that may successfully be used to enhance the yield and maximize the utilization of substrate. Early case run could be due to better nutritional status of compost at casing that might have stimulated mushroom mycelium to penetrate and ramify fast in casing soil. This is probably due to fact that extra nutrition was provided at casing which is directly utilized by mycelia. Our observations also lend support from Raina *et al.* (2013). Bahl (1991) reported inhibitory effect of mustard oil cake on *A. bisporus* as it contains traces of mustard oil cake a biocide substance allylisothiocyanate.. Similar results were observed in present study, mustard oil cake supplementation delayed spawn run, case run, pinning and later reduced the button yield. Mami *et al.* (2013) found that supplementation with ground corn and soybean seeds increased the yield and quality of *A. bisporus* more than control treatment.

Table 1: Influence of organic supplements on yield of *Agaricus bitorquis.*

Organic supplements	Concentrations (%)	Yield (kg/q)
Soybean meal	0.2	19.19
	0.3	19.90
	0.4	21.62
Bengal gram	0.2	15.80
	0.3	17.48
	0.4	17.71
Corn flour	0.2	15.50
	0.3	15.50
	0.4	15.88
Mustard oil cake	0.2	13.32
	0.3	12.08
	0.4	11.26
Control (unsupplemnted)		13.50
CD (P≤0.05)		0.75

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66.

Effect of Biofertilizers on Growth, Flowering and Corm Yield in *Gladiolus* (Tourn.) L. cv. Priscilla

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Keywords: *Gladiolus,* biofertilizers, *Azotobacter, Azospirillum, VAM, PSB*

Introduction

Gladiolus is known as "Queen of bulbous flowers". It is a popular cut flower grown almost all over the world. It is excellent plant for beds, rockeries, pots, herbaceous borders and cut flowers. Nutrition is one of the important aspects in increasing the yield and quality of flowers and corms which can be improved by adopting integrated nutrient management practices including the judicious and combined use of organic, inorganic and biofertilizers. Biofertilizers are microbial inoculants of selective micro organisms like bacteria, algae, fungi, already existing in nature. They may help in improving soil fertility by the way of accelerating biological nitrogen fixation from atmosphere, solubilization of the in soluble nutrients already present in soil, decomposing plant residues, stimulating plant growth and production. The process consumes less energy and provides cheap nutrients to agriculture without polluting the nature.

Materials and Methods

The present investigation was carried out at the Experimental Farm of the Division Floriculture and Landscape Architecture, Sher-e-Kashmir university of Agricultural Sciences and Technology of Kashmir in year 2014. The experiment was laid out in randomized complete block design with 13 treatment combinations, replicated thrice. Azotobacter + 60% N + 100% PK of recommended dose(T_1), Azotobacter + 80% N + 100% PK of recommended dose ($T_{2)}$,Azospirillum + 60% N + 100% PK of recommended dose ($T_{3)}$, Azospirillum + 80% N + 100% PK of recommended dose ($T_{4)}$, Azotobacter + Azospirillum + 60% N +100% PK of recommended dose ($T_{5)}$, Azotobacter + Azospirillum + 80% N +100% PK of recommended dose ($T_{6)}$, VAM (Vesicular Arbuscular Mycorrhyzae) 60% P +100% NK of recommended dose ($T_{7)}$, VAM+ 80% P + 100% NK of recommended dose ($T_{8)}$, PSB(Phosphorus Solublizing Bacteria) + 60% P + 100% NK of recommended dose ($T_{9)}$, PSB+ 80% P + 100% NK of recommended dose ($T_{10)}$, VAM+ PSB+ 60% P + 100% NK of recommended dose ($T_{11)}$,VAM+ PSB+ 80% P + 100% NK of recommended dose ($T_{12)}$, RDF(200: 100: 100) ($T_{13)}$.

Results and Discussion

The combination of Azotobacter + Azospirillum +80% N +100% P and K of recommended dose recorded significantly higher number of leaves plant^{-1}, leaf nitrogen (%), leaf phosphorus (%), number of florets spike^{-1}, number of spikes m^{-2}, number of corms m^{-2}, number of cormels plant^{-1}, corm nitrogen(%) and corm phosphorus(%). These findings on growth attributes are in accordance with Dubey and Misra (2006). Increase in phosphorus availability due to the application of phosphorus solubilizing biofertilizers resulted in a significant increment in weight of corms m^{-2} and weight of cormels plant^{-1}(g). This may be due to more dry matter production by the plants which exhibited superior vegetative growth in treatment combination containing VAM +PSB +80% P +100% N and K of recommended dose and thus higher rates of transport and accumulation of metabolites in storage structures. Increase in availability of phosphorus by the application of phosphorus solubilizers significantly increased the phosphorus content in leaves (0.25%) and corms (0.51%). Singh *et al.* (2002) also reported that phosphorus application at 20 g m^{-2} increased the leaf nitrogen status, however, higher levels of phosphorus application (30 g m^{-2}) decreased leaf nitrogen status.

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Table 1: Effect of biofertilizers on yield, corm production and nutrient status in *Gladiolus* (Tourn.) L. cv. Priscilla

Treat-ments	No. of leaves plant^{-1}	No. of florets spike^{-1}	No. of spikes m^{-2}	No. of corms m^{-2}	No. of cormels plant^{-1}	Weight of corms (kg m^{-2})	Weight of cormels (g plant^{-1})	Leaf N (%)	Leaf P (%)	Corm N (%)	Corm P (%)
T_1	9.22	12.60	26.00	46.83	32.60	1.40	12.9	2.55	0.18	3.80	0.28
T_2	9.06	13.53	31.00	61.13	35.50	1.90	15.5	3.75	0.27	4.35	0.60
T_3	8.90	12.85	27.50	59.13	33.25	2.44	14.3	2.80	0.20	3.95	0.29
T_4	8.54	13.80	31.50	66.66	36.45	2.76	16.4	4.40	0.28	4.55	0.73
T_5	9.53	13.05	28.50	60.66	33.85	2.17	17.5	3.35	0.21	4.15	0.41
T_6	10.63	14.20	32.00	74.70	38.10	2.35	17.6	4.63	0.30	4.80	0.75
T_7	9.96	14.13	24.00	37.86	25.80	1.40	16.8	1.30	0.10	2.70	0.17
T_8	9.16	13.13	29.00	39.83	34.20	1.71	16.7	1.99	0.22	3.20	0.46
T_9	8.93	12.93	24.50	48.23	27.10	1.79	19.1	1.93	0.13	2.85	0.20
T_{10}	9.03	13.30	29.33	68.86	34.50	3.33	19.0	2.30	0.24	3.30	0.48
T_{11}	9.38	12.03	25.50	54.30	29.05	1.81	20.6	1.74	0.16	3.05	0.26
T_{12}	9.82	13.40	30.50	71.30	34.80	3.07	22.1	2.40	0.25	3.45	0.51
T_{13}	7.96	11.20	23.50	27.26	25.20	1.26	12.5	1.27	0.08	2.15	0.11
C.D$_{(P\leq0.05)}$	**1.14**	**1.21**	**2.61**	**6.05**	**1.80**	**0.25**	**1.10**	**0.14**	**0.71E-02**	**0.26**	**0.45**

67.

On Farm Response of Organic, Chemical and Bio-fertilizers on Productivity of Garden Pea (*Pisum sativum L.)*

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Keywords: Garden pea, FYM, line sowing, bio-fertilizer, inorganic fertilizer

Introduction

Garden pea ((*Pisum sativum L.)* is one the foremost important legume crops which is highly nutritious due to its important bio-chemical attributes and is an important sources of vegetable proteins. In the North Indian hills, it is the most important off-season vegetable grown both as summer and autumn crop, thereby making the availability of green pods from March onwards till October end when these are not available in plains. India is second largest producer of pea in the world after Russia. In India, it is cultivated in an area of 80 thousand ha with the production of 488252 tonnes with an average yield of 6.12 tonnes/ha (Fageria *et al.,* 2003). It is grown primarily as winter vegetable in the plains of North India. It enriches the soil, being a leguminous crop, and do not need much nitrogen. Several factors are responsible for the low productivity of pea in India among these imbalance fertilization is an important one. Integrated use of organic, inorganic and bio-fertilizer play a major role in enhancing the productivity of pea through increased nutrient availability to plants, which in turn was reflected through the quality of produce and yield maximization.

Materials and Methods

The investigation was conducted out in village Dhara district Doda on integrated nutrient management in garden pea at farmers' field during two consecutive years i.e. 2012 and 2013 by Krishi Vigyan Kendra (KVK) Doda. The garden pea variety Arkel was sown during first week of May during both the years. Critical inputs were provided free of cost to the farmers on whose fields experimental plots were laid out. The treatments used were (Table 1).

T1: farmers' practice (Broadcasting and only Farm Yard Manure: (FYM).
T2: line sowing (45x15 cm with 100% recommended doses of fertilizers N 50, P 60, K50+20 tonnes FYM ha-^{1}) and
T3: line Sowing (45x15 Cm with 75% recommended doses of NPK fertilizers + 20 tonnes FYM ha-^{1} + seed treatment with rhizobium 5 ml per 100 ml of water).

The treatments were replicated six times. FYM at the rate of 20 tonnes ha-^{1} was applied during field preparation in all the fields. The whole quantity of phosphorus and potash were applied before sowing along with half the dose of nitrogen and remaining half dose of nitrogen was top dressed before flowering.

Results and Discussion

Findings revealed that garden pea recorded highest yield with treatment T3 with an average yield of 52.0 q/ha-^{1} followed by treatment T2 48.75 qha-^{1} in both the years. The treatment T1 recorded lowest yield 31 qha-^{1} in both the years. Length of pods (cm), number of seeds per pod (net return) and BC ratio were also recorded highest in T3 followed by T2 and T1 during both the years(Table 1). The investigation reveals that integrated use of nutrient sources was superior in application compared to chemicals fertilizers alone. The study indicates good potential of natural organic resources for sustainable vegetable production. On farm trials laid out by KVK Doda at farmers' field for two consecutive years i.e. 2012 and 2013 not only helped in demonstrating the ways and means of increasing productivity of garden pea but also helped in obtaining feedback for further refinement of production technology. It also encouraged the farmers to adopt new technology of vegetable cultivation.

Table 1: Performance of garden pea under integrated use of organic and inorganic fertilizers

Treatments	Pod length (cm)	No. of seed per pod	Yield (q ha-1)	Net returns (Rs.)	B: C ratio
T1	5.0	4.5	31.0	44000	1: 2.44
T2	6.6	6.0	48.75	73500	1: 3.06
T3	7.1	6.5	52.0	79750	1: 3.30

(Average data of two years)

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68.

Effect of Zinc Levels and Zinc Bio-Fertilizer on the Productivity, Quality and Zinc-Use Efficiency in Groundnut (*Arachis hypogaea*) and Their Residual Effect on Succeeding Wheat (*Triticum aestivum)*

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Keywords: Zinc, bio-fertilizer, zinc use efficiency, groundnut

Introduction

India ranks first in area and second in production of groundnut (*Arachis hypogaea*), but the productivity (1000 kg/ha) is quite low than world average productivity (1500 kg/ha). Zinc fertilization improves the productivity and quality of groundnut and also bio-fortifies the kernel and cake with zinc (Shukla and Behera 2011; Prasad 2012). Zinc solubilizer is a new entry in the group of bio-fertilizers and can be used to substitute zinc requirement of crops under field conditions. Groundnut-wheat (*Triticum*) is most productive and sustainable cropping system under Indian condition and being considered as substitute for rice (*Oryza sativa*)-wheat system. In view of this study was conducted to assess the effect of zinc fertilization and zinc solubilizer on yield and quality of groundnut and their residual effects on succeeding wheat.

Materials and Methods

The field experiments was conducted in two consecutive years during 2013-14 and 2014-15 at New Delhi, India, on sandy loam soil having *p*H 7.9, SOC 0.34% (low), available nitrogen 190 kg/ha, 0.5 *M* $NaHCO_3$ extractable available P 14.2 kg/ha, NH_4OAc extractable available K 270 kg/ha and DTPA-extractable Zn 0.72 mg/kg. The treatments comprised of 4 zinc levels (0, 2.5, 5.0, 7.5 kg/ha) and two bio-fertilizer levels (control and PUSA zinc solubilizer), which were tested in four times replicated split plot design. Groundnut 'GG 20' was planted at 30 cm row spacing in the first week of July and received recommended cultural practices including recommended dose of NPK. After the harvest of groundnut in the first week of November, wheat 'HD 2967' was sown in the last week of November to study the residual effect of treatments applied to groundnut. Wheat crop received recommended dose NPK and cultural practices. Crop was harvested in the 3rd week of April. Observations were recorded following standard procedure and statistically analyzed.

Results and Discussion

Based on the 2-year average, application of 2.5, 5.0 and 7.5 kg Zn/ha was found to increase kernel yield by 17.2, 21.1 and 13.6% over control (Table 1). Zinc solubilizer was also found to improve the kernel yield by 4.7%. Zinc application also induced marked improvement in oil content, protein content and 100-kernal weight. Successive increase in Zn-levels improved Zn-content in kernel, shell and haulms at harvest. This improvement in Zn-content and biomass production resulted in marked improvement in Zn-uptake, which increased by 30.2, 44.9 and 45.5% over the control at 2.5 kg, 5.0 kg and 7.5 kg/ha, respectively. Effect of Zn-bio-fertilizer was significant on Zn-content and Zn-uptake (Table 1). Response to Zn-levels was found quadratic and optimum dose of Zn was worked out to be 4.5 kg/ha (Fig. 1). Based on the interaction of Zn-levels and Zn-solubilizer, it was observed that application of 5.0 kg Zn/ha produced yield at par with 2.5 kg Zn/ha+ Zn-solubilizer. Agronomic Zn-use efficiency, crop recovery efficiency and physiological-use efficiency declined with increasing levels of Zn. Grain yield of wheat recorded marked improvement due to residual effect of 5.0 and 7.5kg Zn/ha applied to groundnut over control and 2.5 kg Zn/ha. Maximum Zn-content and uptake in grain and straw of wheat was recorded with residual effect of 7.5 kg Zn/ha. Residual effect of zinc solubilizer applied to groundnut was not observed on grain yield, Zn concentration and uptake of succeeding wheat crop. Effect of Zn-levels on system productivity, economic efficiency, Zn-uptake, net returns, B: C ratio and energy returns were perceptible up to 5.0 kg Zn/ha. Perceptible variations in these parameters were also recorded due to direct and residual effect of Zn-solubilizer over control.

Based on the study, application of 5 kg Zn/ha is recommended for groundnut in soil low in Zn. Application of Zn-bio-fertilizer found to improve the yield, but its solubilizing effect is sufficient to replace 2.5 kg Zn requirement of groundnut. Residual effect revealed that 5.0 kg Zn/ha applied to groundnut had significant effect on wheat. Zn application fortified the kernel, haulms and cake of groundnut and grain and straw of wheat. System productivity of groundnut-wheat sequence was the highest with direct and residual effect 5.0 kg Zn/ha.

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Table 1: Effect of sulphur and zinc levels and zinc solubilizer on the pod yield, oil and protein content in kernel, Zn-content and uptake in kernel and Zn-use efficiency of groundnut (Pooled data of 2 years)

Treatment	Pod yield (kg/ha)	Oil content (%)	Protein content (%)	Zn-content (ppm)	Zn-uptake in kernel (g/ha)	Agronomic Zn-use efficiency (kg yield/kg Zn)
Zinc levels (kg/ha)						
0	1,654	47.5	25.4	22.8	26.3	0
2.5	1,639	48.5	26.3	24.6	34.1	113
5.0	2,004	48.6	26.5	26.6	38.1	65
7.5	1,880	48.6	27.1	28.8	38.4	29
CD (P=0.05)	48	0.34	0.38	0.51	2.10	-
Zinc solubilizer						
0	1,823	48.2	26.3	25.4	32.8	60
Zinc solubilizer	1,908	48.4	26.5	26.1	35.3	46
CD (P=0.05)	35	NS	NS	0.36	1.46	-

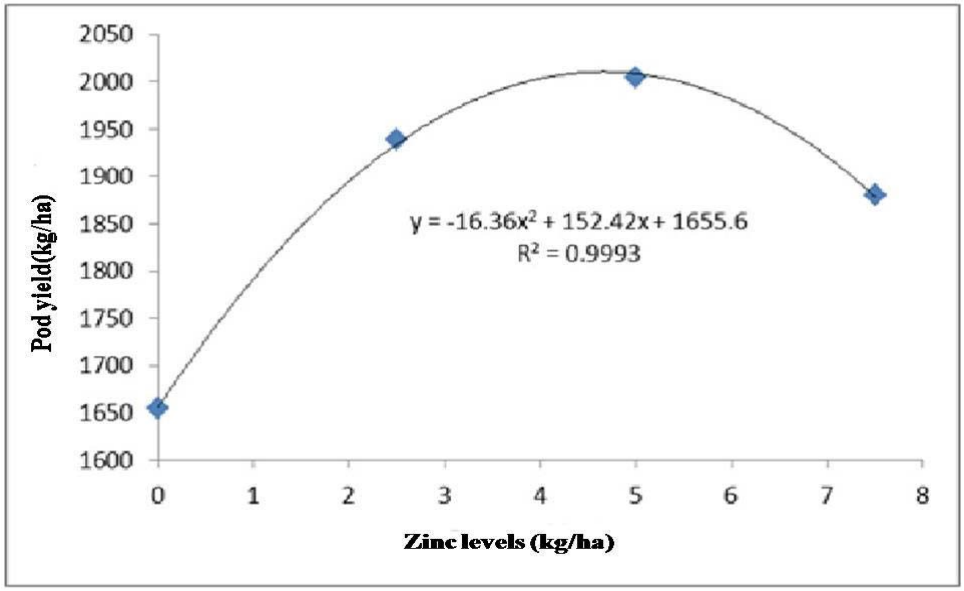

Fig. 1: Response equation/curve of optimum economic dose Zn (kg/ha) to pod yield

69.

Effect of Sulphur on Growth, Yield Attributes, Yield and Economics of Onion (*Allium cepa* L.)

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Keywords: Sulphur; Dry matter, growth, yield, onion.

Introduction

Onion belongs to the family Alliaceae is widely used as most important crop among the vegetables and spices. It is generally consumed with different dishes. For increasing the productivity and storage capacity sulphur plays an important role because onion is a sulphur loving plant and it requires much for proper growth, yield and its quality. This deficiency is becoming acute over time due to extensive use of sulphur free fertilizer, intensive crop production and poor sulphur status of soils. Super Black (zirat) is an important indigenous cultivar of onion which is grown widely throughout in Koshi region of Bihar. The present research work was undertaken to investigate the effect of sulphur on growth, yield and yield attributes of onion.

Materials and Methods

The experiment was conducted at Farmers field of Katihar district by KVK, Katihar, (BAU Sabour, Bhagalpur) to study the effect of sulphur on growth attributes, yield and economics of onion. The experiment was laid out in RBD with three treatments and ten replications. The experimental soil was prepared in early November with T_1- Farmers use imbalance fertilizer, T_2- 100 kg N + 50 kg P_2O_5 + 100 kg K_2O + 400 kg Zypsum as basal application and T_3- 100 kg N + 50 kg P_2O_5 + 100 kg K_2O + 10 kg S 80% WDG ha^{-1} respectively. 45 DAS seedlings were transplanted after application of treatments wise nutrients. The evaluated traits were fresh weight, dry weight, bulb and neck diameter and data analyzed with MSTAT package.

Results and Discussion

The data related to plant height, bulb and neck diameter, fresh and marketable yield with BC ratio have been presented in Table 1. Different dose of sulphur application had a significant variation on fresh and dry weight of individual onion. The maximum fresh weight (254.25 kg ha^{-1}) was observed with the application of 10 kg 80% WDG S ha^{-1} followed by 230.66 kg ha^{-1} with T_2 and 212.72 kg ha^{-1} with T_1 where no sulphur application. The maximum marketable yield (242.25 kg ha^{-1}) was observed where land was fertilized with 10 kg 80% WDG S ha^{-1} followed by 215.24 kg ha^{-1} and 195.80 kg ha^{-1} with same statistical rank. Control treatment showed the minimum fresh and dry weight. The highest bulb diameter (5.04 cm) was observed with application of 10 kg 80% WDG S ha^{-1}. The highest neck diameter (1.49 cm) was observed with 10 kg 80% WDG S ha^{-1} and the highest neck bulb ratio (0.30) was observed with 10 kg 80% WDG S ha^{-1}. A response curve on the effect of different doses of sulphur on yield of onion was constructed at final harvest. The sulphur dose at 10 kg 80% WDG S ha^{-1} produced significantly highest yield and subsequently yield was reduced with T_2 and T_1. The data related to benefit cost ratio varied from 2.77 to 2.33. It was found maximum with the treatment T_3 and minimum B C ratio with treatment T_1.

Table 1: Effect of different doses of sulphur on onion yield attributes and economics

Treatments	Plant Height (cm)	Bulb Diameter (cm)	Neck Diameter (cm)	Neck Bulb ratio	Fresh Weight (qt/ha)	Marketable yield (qt/ha)	Yield Damage (%)	B:C ratio
T_1	33.94	4.68	1.32	0.28	212.72	195.80	7.92	2.33
T_2	37.58	4.90	1.36	0.28	230.66	215.24	6.68	2.46
T_3	42.34	5.09	1.49	0.30	254.25	242.25	4.72	2.77
CD (p=0.05)	4.6	0.6	0.04	0.03	16.51	12.85	1.37	

70.

Effect of Ants on Soil Fertility and Yield of *Solanum lycopersicum* L.

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Introduction

Pheidole latinoda Roger is ubiquitous in terrestrial ecosystems and nests in a variety of annual and perennial agroecosystems. However, direct experimental evidence of the impact of ant colonies on soil fertility is still lacking. In an earlier study we have reported the enhanced concentration of carbon, nitrogen and Phosphorus in the debris soil of *Pheidole latinoda* Roger, an ecologically dominant ant species, with abundant, long- lived nests (Shukla *et al.*, 2013) and biological control potential (Agarwal *et al.*, 2007) in agroecosystems. Hence, in the present investigation we have focused on an experimental study of the impact of *P. latinoda* nest debris soil on the growth and yield of tomato plants.

Materials and Methods

The study sites were the Agricultural Farm and the Botanical garden, both located in the Banaras Hindu University campus. Tomato plants were grown in polybags containing garden soil (control) and debris - amended soil (experimental). The ant nest density was recorded in the cultivated fields. The study period was from July, 2013 to January, 2014.

Data on the physiological traits of tomato plants was collected after 30, 60, 90 and 120 days following tomato transplantation. For sampling, three plants were harvested randomly at regular intervals of 30 days each and all growth parameters were calculated.

Chemical analysis (including total C, N, P, NH_4-N, NO_3-N, microbial biomass carbon, nitrogen and phosphorus) of the control and debris - amended soil samples, from tomato plant polybags (n= 3 in each case) was carried out at the flowering stage.

Results and Discussion

A total of 11 ant species representing 09 genera and 05 sub-families were recorded in the cultivated fields. The nest density was found to be highest for *P. latinoda* in comparison to the co-existing ant species. A significantly higher biomass, fruit/plant, mean fruit weight, % of marketable fruits and yield of experimental plants was obtained as compared to the control plants. Total C, N, P, ammonium nitrogen, nitrate nitrogen, microbial biomass carbon, nitrogen and phosphorus was significantly higher in the debris - amended treatments as compared to the control. This study demonstrates that the ant nest debris-derived nutrients contribute towards soil fertility and enhanced growth and yield of tomato plants in a dose-dependent manner. Our results on the impact of nest debris of disturbance - tolerant colonies of *P. latinoda* on tomato plants, thus provide direct evidence of the significant positive impact of the ecosystem engineering activities of ant colonies on crop plant biomass and yield. Therefore, we must conserve and augment ant species in the fields.

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71.

Assessment of Soil Biological Health as influenced by IPNS in Rice-Wheat Cropping System

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Keywords: Integrated Nutrient Management, Rice-Wheat Cropping System

Introduction

Rice (*Oryza sativa* L.) and wheat {*Triticum aestivum* (L.) emend. Fiori & Paol.} are the main staple foods which account for about 60% of world's human food thus form backbone of food security (Lathwal *et al.,* 2010). Rice-wheat system is the most widely adopted cropping system and covers about 10.5 MHa area in India (Chauhan *et al.*, 2012). Fertilizers are kingpin in increasing crop productivity. However, integrated nutrient management, the managerial aspect of IPNS is more vital in sustaining increased productivity. Assessing soil biological health is most important in modifying agronomic practices in favour of healthy crop growth.

Materials and Methods

The study was conducted in long-term experiment on Integrated Plant Nutrition System (IPNS) in rice-wheat cropping system at the Bhadiarkhar farm of the University. Twelve (12) treatment combinations (Table 1) were evaluated in a randomized block design with four replications.

Results and Discussion

The application of organics, farm yard manure (FYM), wheat cut straw (WCS) and green manure (GM) and chemical fertilizers increased the number of heterotrophic bacteria, fungi, Actinomycetes, and nitrogen fixing bacteria significantly over the control (Table 1). A definite build up of organic carbon and thereby microbial biomass carbon over its initial value of 0.6% was observed in all the treatments. The highest increase in organic carbon content over control and initial status was observed under T_6 where 50% N was substituted through FYM during *kharif* followed by 100% NPK through fertilizers in *rabi*. The highest microbial biomass carbon was found under T_8 where 50% N was substituted through wheat cut straw during *kharif* followed by 100% NPK through fertilizers in wheat. Both dehydrogenase and phosphatase activities were stimulated by the application of organic manures and inorganic fertilizers over control. Organic fertilizers were more effective than inorganic fertilizers in increasing the microbial activity. Among the organic sources, FYM and wheat straw were superior to green manure. Microbial index of the soil increased with increase in the level of fertilization. The effect was more pronounced with organics than with inorganics. T_6 where 50% NPK through fertilizers and 50% N through FYM to rice and 100% NPK through fertilizers to wheat was applied had highest microbial index of soil. This was followed by T_8 (50% NPK through fertilizers and 50% N through wheat straw to rice and 100% NPK through fertilizers to wheat).

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Table 1: Effect of fertility treatments on microbial population (cfu* × 104 g-1 soil) microbial biomass carbon, enzymatic activities and organic carbon

Treatment			Bacterial	Fungal	Actinomycetes	N_2 fixing bacteria (Azotobacter)	Phosphate Solublising Microorganisms	Microbial biomass carbon (µg g-1)	Dehydrogenase activity (µg TPF $g^{-1}h^{-1}$)	Phosphatase activity (µg $g^{-1}h^{-1}$)	Organic carbon (%)	Microbial index (soil)
	Rice	Wheat										
T_1	Control	Control	187.5	39.0	28.8	47.7	36.5	692.7	1.22	15.80	0.63	0.752
T_2	50% NPK	50% NPK	190.9	36.0	33.5	59.7	47.5	735.8	1.43	17.73	0.69	0.842
T_3	50% NPK	100%***NPK	200.6	61.3	37.3	63.5	52.5	770.8	1.57	18.55	0.72	0.945
T_4	75% NPK	75% NPK	197.4	55.8	35.8	60.2	50.3	823.8	1.92	22.49	0.74	0.970
T_5	100%** NPK	100% NPK	231.1	67.0	56.0	66.5	59.0	844.7	1.95	23.60	0.76	1.101
T_6	50% NPK + 50% N (FYM)	100% NPK	233.8	65.5	59.0	69.4	56.9	872.3	2.32	23.88	0.89	1.154
T_7	75% NPK + 25% N (FYM)	75% NPK	231.6	57.3	54.0	57.5	51.8	821.7	2.02	22.88	0.77	1.045
T_8	50% NPK + 50% N (WCS)	100% NPK	235.8	70.3	55.5	70.0	62.3	891.6	1.98	21.92	0.81	1.129
T_9	75% NPK +25% N (WCS)	75% NPK	220.0	62.0	53.5	59.6	47.8	873.4	1.86	20.29	0.74	1.022
T_{10}	50% NPK +50% N (GM)	100% NPK	221.0	60.5	50.3	66.3	55.5	767.1	1.95	23.52	0.77	1.052
T_{11}	75% NPK+ 25% N (GM)	75% NPK	218.0	51.8	45.0	50.5	49.5	734.1	1.92	22.37	0.76	0.966
T_{12}	Farmer's**** practice	Farmer's practice	200.5	55.8	52.5	62.9	57.2	720.6	2.15	20.47	0.75	1.021
CD (P=0.05)			10.8	7.0	7.9	8.8	5.4			10.9	0.14	0.50

*cfu, colony forming units

**Recommended (100%) doses of fertilizer in rice is 90: 40: 40 kg N, P_2O_5 and K_2O/ha

***Recommended (100%) doses of fertilizer in wheat is 120: 90: 30 kg N, P_2O_5 and K_2O/ha

****Farmer's practice treatment, 40% of the recommended NPK and 5 t FYM/ha

72.

Effect of Different Levels of Rock Phosphate along With PSB and VAM on Yield, P Uptake and P Balance Sheet under Soybean-Wheat Cropping System

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Keywords: Soybean, wheat, rock phosphate, biofertilizers, P balance and soil fertility

Introduction

Phosphorus availability is much limited in soils of Uttarakhand because of quick fixation of most of the applied water soluble P to insoluble phosphate complexes by way of reaction with soil Al and Fe ions. Under such situations, use of phosphate solubilizing (PSB) and mobilizing (VAM) micro-organism may reverse the above process thereby enhancing the availability and uptake of phosphorus by field crops thus economizing the fertilizer phosphorus dose to some extent. Due to escalating price of fertilizers, it is necessary to minimize the use of chemical fertilizers and improve nutrient use efficiency by adding biofertilizers along with rock phosphate to the soil. The present investigation was undertaken to study the effect of rock phosphate alone and along with biofertilizers on yield, P uptake and P balance under soybean- wheat cropping systems.

Materials and Methods

A field experiment with soybean (*Glycine max* (L.) Merrill)-wheat (*Triticum aestivum* (L.) emend. Fiori & Paol) cropping was carried out during 2009-10 to 2011-12 at ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora- Uttarakhand. The 14 treatments were laid out in randomised block design with three replications. The recommended dose of phosphorus was (80 and 60 kg P_2O_5 ha-^{1}) for soybean and wheat applied through rock phosphate as 100, 125 and 150% of recommended dose (80 and 60 kg P_2O_5 ha-^{1} for soybean and wheat, respectively) of phosphorus. biofertilizers applied as per treatment. The recommended dose of N and K were uniformly applied through urea and muriate of potash to all the plots. The P uptake by wheat and soybean was estimated by multiplying P content with corresponding yields. Phosphorus balance in soil-plant system after 3 crop cycles was calculated.

Results and Discussion

Grain yield of soybean and wheat increased with increasing levels of rock phosphate along with biofertilizers (Table 1). Maximum grain yield of wheat was recorded with 150% RP + PSB + VAM and SSP during 2009 and 2010, 2011, respectively. Inoculations of PSB and VAM increased 3.9 -7.9% yield of soybean and 2.5 - 10.2% yield of wheat. Similarly, phosphorus application to soybean and wheat crop increased total P uptake as compared to control. In soybean highest total P uptake (18.5 kg P ha^{-1}yr^{-1}) was observed with SSP treated plot (Fig. 1). While, highest total P uptake (25.4 kg P ha^{-1}yr^{-1}) by wheat was observed with 150% RP + PSB + VAM treated plot.

Table 1: Effect of different levels of rock phosphate (RP) and biofertilizers (PSB and VAM) on grain of yield of soybean and wheat

Treatment	Soybean grain yield (q/ha)			Wheat grain yield(q/ha)		
	2009	2010	2011	2009-10	2010-11	2011-12
T_1: Control	27.6	24.3	29.7	34.0	45.9	37.8
T_2: 100% P through SSP	33.4	30.6	35.0	40.5	59.6	50.4
T_3: 100% P through RP	29.5	25.2	31.8	36.1	49.2	41.7
T_4: 100% P through RP + PSB	30.4	26.0	32.7	37.1	52.1	43.1
T_5: 100% P through RP + VAM	30.5	26.6	32.8	36.6	49.9	42.5
T_6: 100% P through RP+ PSB+VAM	31.6	27.2	33.2	38.3	54.2	43.9
T_7: 125% P through RP	31.2	27.3	32.8	36.6	52.1	42.9
T_8: 125% P through RP + PSB	31.7	28.0	33.1	38.0	54.4	45.9
T_9: 125% P through RP + VAM	31.8	28.1	32.9	38.3	53.3	43.6
T_{10}: 125% P through RP + PSB+VAM	32.4	29.3	33.6	40.0	56.3	46.9
T_{11}: 150% P through RP	32.2	29.0	33.0	38.1	53.8	45.0
T_{12}: 150% P through RP + PSB	32.7	30.2	33.4	39.4	57.74	46.4
T_{13}: 150% P through RP + VAM	32.6	29.5	33.1	40.1	56.7	45.5
T_{14}: 150% P through RP + PSB+VAM	33.7	30.8	34.3	41.4	58.7	47.4
CD at 5%	1.9	1.8	1.4	2.2	2.7	2.9

Based on cumulative P uptake by both crops and changes in (0-15 cm) soil with the time, phosphorus balance in soil-plant system after 3 crop cycles was calculated. Annual removal of phosphorus was more in wheat ((14.7 - 25.4 kg Pha^{-1}) as compared to soybean (12.4- 18.5 kg P ha^{-1}). Annual addition of phosphorus was almost double than annual removal of phosphorus by soybean and wheat (Fig. 1). Continuous fertilization of phosphorus in soybean and wheat results in build up of P level. Theoretical positive balance of available P is much higher than actual available P in soil. However, net negative balance of P was recorded in control (- 23.7 kg P/ha), which indicate that decline in available P status over its initial levels.

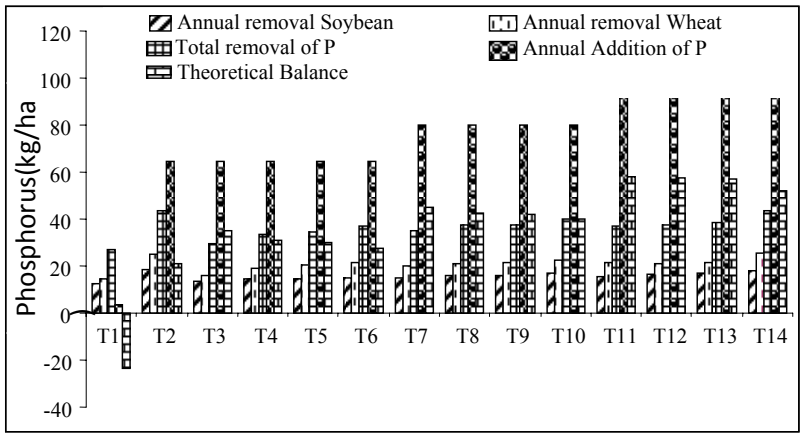

Fig. 1: Effect of rock phosphate and bio fertilizers on phosphorus Balance sheet in soybean-wheat cropping system

73.

Stastical Analysis for Optimization of Bacterial Polyhydroxybutyrate Production Using Agribyproducts

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Keywords: Response surface methodology, polyhydroxybutyrate, agribyproducts, optimization studies

Introduction

Polyhydroxyalkanoate are the polyster of hydroxyacids which is naturally synthesized by bacteria as carbon reserve under stress conditions. It is beneficial for bacteria to store surplus nutrients within their cells, especially as their general physiological health is not affected. Polyhydroxybutyrate is the first and most studied PHA to be discovered. Attempts were made to use economical strategies to reduce the production costs of PHB as well as its expeditious production from agribyproducts (Jangra and Sikka, 2015) and its applications in various fields. The aim of this study was to optimize PHB production and to study the interaction of various factors which help to enhance the PHB production through stastical media optimization for its possible applications in various scale up studies and to develop a farmer friendly protocol.

Materials and Methods

The PHB producing bacteria B3 used in this study were isolated from garden soil at Hisar, India. For screening the PHB producing bacterial isolates, Nile blueA staining method was used. Morphological and biochemical tests were performed for characterization of selected PHB producing bacterial strain B3 for its tentative generic identification. Determination of the amount of PHB was performed by chemical method. Twenty four different media were investigated to determine the suitable composition for the maximum PHB accumulation by B3 strain. The optimization of process parameters in growth associated PHB production by B3 strain was studied using central composite design (CCD) of Response Surface Methodology. Fourier transform infrared spectroscopy (FTIR) was used for confirmation of Polyhydroxybutyrate.

Results and Discussion

Microbial strains were isolated from different sample and about 300 hundreds of colonies were screened for their ability to produce PHB in minimal media. Based on the cultural, morphological features, growth rate, the intensity of fluorescence under UV-light, kinetic studies, expeditious and maximum PHB producers were screened. From a comparison of their cell growth in terms of optical density and PHB recovery, B3 with a highest PHB content for given cell dry weight was selected for further study. Response surface methodology was used for optimization of PHB production. The maximum predicted optical density (0.897) increased with increase of fructose and mustard cake up to 4.6 g/l and 1 g/l. PHB recovery also increased with increase of fructose, mustard cake and yeast extract up to 4g/l, 1.5g/l and 1.5g/l respectively. The graphs showing the interaction between carbon source fructose, nitrogen sources mustard cake and yeast extract. So, the effect of interaction of various nutrients on the PHB production (z axis) was studied by plotting three dimensional response surface curves. The accumulated PHB was extracted and subjected to FT-IR analysis. The spectroscopic analysis revealed 4 major peaks at 2920, 1722, 1461, 1250 cm^{-1}. Plastics have created a renewed interest in biologically derived polymers. To apply PHAs as product plastics, the utilized raw materials should be inexpensive and it has to be easily available. The media and PHB production process developed on the novel pseudomonad has enabled to achieve these goals to help the environment of the globe at large. Future efforts in the direction of adopting these processes may help in making PHB, the bioplastic of farmers.

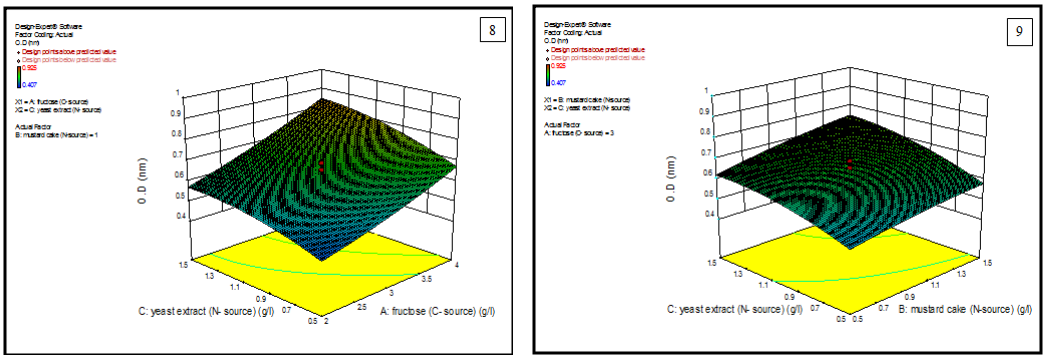

Fig. 1: 3-D plots showing the interactive effect of mustard cake, yeast extract and fructose for the responses (a) optical density and (b) PHB recovery in strain B3

Table 1: Response surface methodology yield of PHB by strain B3

Run	A: fructose (C- source) (g/l)	B: mustard cake (N-source) (g/l)	C: yeast extract (N- source) (g/l)	O.D. (nm)	PHB Recovery (mg/l)
1	4	1.5	1.5	0.925	45
2	4	0.5	0.5	0.599	19
3	3	1	1	0.625	21
4	3	1	1	0.648	23
5	3	1	1	0.656	23
6	4.6	1	1	0.897	41
7	1.3	1	1	0.427	16
8	3	1	1	0.696	29
9	3	1	1	0.689	28
10	3	0.1	1	0.487	13
11	3	1	0.1	0.407	20
12	3	1	1	0.623	21
13	3	1	1.84	0.659	25
14	2	0.5	0.5	0.495	15
15	4	0.5	1.5	0.774	34
16	2	0.5	1.5	0.559	17
17	2	1.5	0.5	0.468	12
18	4	1.5	0.5	0.752	31
19	2	1.5	1.5	0.629	21
20	3	1.84	1	0.699	29

Reference

Jangra, M. and Sikka, V.K. 2015. Expeditious and ecofriendly production of poly-β-hydroxy butyrate in bacteria grown on renewable agribyproducts. *International Journal of Recent Scientific Research*. **9**: 6400-6404.

74.

Influence of Phosphorus and Phosphate Solubilizing Bacteria to Physico-chemical Soil Characteristics of Wheat (*Triticum aestivum* L.)

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Keywords: Wheat, phosphorus, phosphate solubilizing bacteria, soil, physico-chemical.

Introduction

Phosphorus is one of the limiting elements for crop production. It is essential for energy transfer, photosynthesis and other biochemical and genetic activities of plant. They are easily retained in most soils when added, and in many cases this retention is so high that the element becomes largely unavailable to the plants. The transformation of mineral or organic phosphorus into soluble inorganic phosphorus is brought about by microbial action. Phosphate solubilizing bacteria (PSB) have potentiality to solubilize the unavailable P in rhizosphere soil and make it available to the crops. Information is scanty on efficient use of PSB strain as phosphatic biofertilizer for wheat cultivation in India. Therefore, the present study was undertaken with the objective to evaluate the effects of different PSB inoculants on physic-chemical characteristics of soils.

Materials and Methods

The present investigation entitled "Influence of phosphorus and phosphate solubilizing bacteria to physico-chemical characteristics of wheat (*Triticum aestivum* L.) " was carried at Raja Bajwant Singh Collage Research Farm, Brichpuri, Agra. There were six treatment combinations (Three phosphorus levels three namely 30, 45, 60 kg ha $^{-1}$; and two inoculations namely uninoculated seeds and seed inoculation with *Pseudomonas striata*, arranged in randomized block design with four replication. The investigation was evaluated in wheat variety HD2338 for physico-chemical properties of soil before and after crop harvest.

Results and Discussion

Persual of data in Table 1 indicates that different treatments had significant influences on physico-chemical properties of soil in wheat, except soil pH which was found to be non significant. Among the different treatments, 60 kg ha $^{-1}$ phosphorus in combination with seed inoculation of *P. striata* treatment recorded highest electrical conductivity of 0.58 dsm^{-1}, pH of 8.7, organic matter of 0.50%, available nitrogen of 255.0 kg ha $^{-1}$, available phosphorus of 17.0 kg ha^{-1} and available potassium of 182.0 kg ha $^{-1}$ and was found significantly superior than rest of the treatments, while least readings were recorded in treatment 30 kg ha $^{-1}$ phosphorus un-inoculated with *Pseudomonas striata.* Inoculation by phosphate solubilizing microorganisms with inorganic P increased the physical and chemical soil properties of wheat and other crops were reported by many workers (Chaykovskaya *et al.,* 2001; Tomar *et al.,* 1996). These findings were almost similar to those of Afzal *et al.* (2005) who found that phosphate solubilizing microorganisms (PSM) alone or along with other combinations showed profound effect on physico-chemical soil characteristics of wheat. From the results it can be concluded that among the phosphate solubilizing microorganism inoculants 60 kg/ha rate of phosphorus fertilizer showed better performance in physic-chemical characteristics in wheat soils than phosphorus fertilizer alone.

Table 1: Physico-chemical properties of soil before sowing and after crop harvest as influenced by different treatments

Treatments	EC dsm^{-1}	pH	Organic matter (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Before sowing	0.45	8.5	0.25	203.0	8.2	162.0
P_1PS_0	0.55	8.7	0.44	243.6	10.0	176.0
P_1PS_1	0.56	8.7	0.45	245.0	12.5	176.5
P_2PS_0	0.58	8.8	0.46	250.0	12.6	178.0
P_2PS_1	0.57	8.7	0.48	252.0	15.2	178.0
P_2PS_0	0.57	8.8	0.49	252.5	15.5	180.0
P_3PS_1	0.58	8.7	0.50	255.0	17.0	182.0
CD at 5%	0.02	NS	0.03	2.02	2.15	2.14

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75.

Effect of Seed Management and Foliar Nutrition on Yield Attributes of Rice-fallow Black Gram (*Phaseolus mungo* (L.) Hepper)

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Keywords: Seed rate, Seed treatments, foliar spray and cycocel

Introduction

India is the world's largest producer as well as consumer of black gram (*Vigna mungo* (L.) Hepper). The output accounts for about 10% of India's total pulse production, but the productivity is low in general due to poor management and low soil fertility. The average productivity of pulses in Tamil Nadu is about 432 kg ha^{-1} which is very low, when compared to Indian average of 610 kg ha^{-1}. Astudy was conducted with the objectives to determine, optimum seed rate, seed treatment with foliar nutrition spray in rice-fallow black gram in southern district of Tamil Nadu, where this type of cultivation is common.

Materials and Methods

The soil of the experimental field at Killikulam, was analysed for the nutrient status and the presence of organic matter. The experiments were then laid out in Factorial Randomized Block Design (FRBD) with three replications of blackgram ADT-3 and four treatments during the two years. The yield attributes like number of pod per plant, pod length, number of grain per pod and grain yield (kg ha^{-1}) was recorded at harvest. Then analysis was performed with ANOVA, F (variance ratio) and critical difference (CD) at 5% level of significance for comparison and statistical interpretation of treatments (Gomez and Gomez,1984).

Results and Discussion

Among the seed rates, adoption of 30 kg ha^{-1} (S_2) significantly produced higher grain yields of 563 and 526 kg ha^{-1} in both the seasons respectively (Table 1). Plant densities would have enabled better translocation of photosynthates for production of sink resulting significantly influenced the yield attributes of black gram *viz.,* grain weight, number of seed per pod and pod length (Ratnam *et al.*, 1999). Pre-conditioning of seeds (T_4) recorded significantly maximum yield of 641 and 595 kg ha^{-1} during both the seasons respectively and seed soaking $MnSO_4$ (T_2) and water soaking (T_1) practices ranked second in order for both the crops respectively. Foliar spraying with ammonium molybdate (F_2) recorded maximum yield of 565 and 519 kg ha^{-1} respectively during first and second season and it was significantly superior over the foliar application of KCl + cycocel (F_1) (526 and 483 kg ha^{-1}). It is well recognized as application of ammonium molybdate through Foliar increase nutrient uptake, DMP, yield attributes and subsequent yield in horsegram (Duraisamy and Mani, 2001). The interaction effect between seed rate and seed treatment was found significant. Seed rate at the rate of 30 kg ha^{-1} with pre-conditioning seed treatment (S_2T_4) registered maximum grain yield of 686 and 636 kg ha^{-1} in first and second crop respectively. It was on par with 40 kg ha^{-1} with pre-conditioning (S_3T_4) in first season, whereas identical performance with S_3T_4 and S_2T_1 were observed in second season. The endeavor of the study is to improve the productivity of black gram under rice fallow condition, in sustain manner.

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Table 1: Effect of seed rate, seed treatment and foliar nutrition on grain yield (kg ha^{-1}) of rice fallow blackgram

Treatment	I crop (Feb. - April)			II crop (July - Sep.)		
Seed rate (S)						
S_1 - 20 kg ha^{-1}	511			465		
S_2 - 30 kg ha^{-1}	563			526		
S_3 - 40 kg ha^{-1}	561			512		
SEd	18			19		
CD	35			37		
Seed Treatment (T)						
T_1 - Water soaking	501			519		
T_2 - 8% $MnSO_4$	553			452		
T_3 - Seed pellet SSP	486			437		
T_4 - Pre-conditioning	641			595		
SEd	20			21		
CD	41			43		
Foliar nutrition (F)						
F_1 - KCl + CCC	526			486		
F_2 - Ammonium molybdate	565			519		
SEd	14			15		
CD	29			30		
	S_1	S_2	S_3	S_1	S_2	S_3
T_1	388	363	358	308	403	333
T_2	357	433	393	305	320	300
T_3	336	333	381	279	276	323
T_4	408	494	484	354	426	416

	SEd	CD	SEd	CD
S x T	26.28	52.90	24.81	49.95
T x F	18.58	NS	20.26	NS
S x F	21.45	NS	17.54	NS
S x T x F	37.16	NS	35.10	NS

76.

Response of Summer Groundnut (*Arachis hypogaea* L.) to Water Soluble Foliar Fertilizers

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Keywords: Water soluble fertilizers, foliar spray, growth, yield, Economics

Introduction

Groundnut (*Arachis hypogaea* L.) is an annual legume. It is the source of edible oil and vegetable protein. India occupied an area of 55.27 lakh ha with production of 96.72 lakh tonnes and productivity was 1750 kg ha^{-1} in 2013-2014 (Anonymous 2014). Groundnut is one of the most important oilseed crops of Maharashtra state. The area in Maharashtra in 2013-14 is 3.2 lakh ha with annual production of 4.17 lakh tonnes with productivity of 1373 $kgha^{-1}$ (Anonymous, 2014). The groundnut productivity in Maharashtra is low due imbalanced nutrition of crop. The nutrient requirement of groundnut is high especially at pegging and pod development stages which can be supplemented through foliar application. Foliar spray enables plants to absorb the applied nutrients from the solution through their leaf surface and thus, may result in the economic use of fertilizer. Keeping this in view, the present investigation was planned to study the impact of water soluble fertilizers on growth and yield of groundnut during summer.

Materials and Methods

A field experiment was conducted at All India Co-ordinated Project (AICRP) on Groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri during summer seasons in 2012, 2013 and 2014 in randomized complete block design with twelve treatments in three replications. The groundnut cultivar TPG-41 was used for the experiment. Treatments include combination of various levels of recommended dose of NPK and farm yard manure (FYM) through soil application at the time of sowing and foliar sprays of water soluble fertilizers at 30, 45 and 60 days after sowing (DAS). Foliar application includes starter dose of water soluble grade fertilizer (11: 36: 24 + trace elements) at the rate of 2% at 30 days after sowing + Foliar application of booster dose of water soluble grade fertilizer (8: 16: 39 + trace elements) at the rate of 2% at 45 and 60 DAS. Treatments include T_1= absolute control (no FYM, no RDNPK and no foliar application of water soluble grade fertilizers, only water spray), T_2= 100% recommended dose of fertilizers (RDF) (25 kg N and 50 kg P_2O_5 ha^{-1}), T_3= Foliar application of water soluble grade fertilizers at the rate of 2%, T_4= 100% RDF + foliar application of water soluble grade fertilizer at the rate of 2%, T_5= 100% RDF + FYM at the rate of 7.5 t/ha, T_6= 100% RDF + FYM at 7.5 t/ha + Foliar application of water soluble grade fertilizer at the rate of 2%, T_7= 85% RDF + FYM at 7.5 t/ha, T_8= 85% RDF + FYM at 7.5 t/ha + Foliar application of water soluble grade fertilizer at the rate of 2%, T_9= 60% RDF + FYM at 7.5 t/ha, T_{10}= 60% RDF + FYM at .5 t/ha + Foliar application of water soluble grade fertilizer at 2%, T_{11}= 35% RDF + FYM at 7.5 t/ha, T_{12}= 35% RDF + FYM at 7.5 t/ha + Foliar application of water soluble grade fertilizer at the rate of 2%. The growth and yield observations were recorded at the time of harvest.

Results and Discussion

The growth of groundnut is intense from 30 to 70 DAS. Therefore, synchronizing the nutrient supply at these stages through foliar application resulted in growth and consequently higher yields. Further, this period coincides with the pegging and pod development stages wherein the crop requires higher amount of nutrients. The pooled data presented in Table 1 reveals that treatment (T6) application of FYM at 7.5 t ha^{-1} + 100% RDF + foliar spray of fertilizers at 30, 45 and 60 DAS recorded significantly higher growth and yield contributing characters namely plant height (25.50 cm), number of branches (6.13), dry matter (58.21 g), number of pods $plant^{-1}$(19.33), weight of pods $plant^{-1}$(15.47 g), dry pod yield (3172 kg ha^{-1}), dry haulm yield (7438 kg ha^{-1}) and kernel yield (1738 kg ha^{-1}). Amongst the foliar applications the treatment T-8 (85% RDF + FYM at 7.5 t ha^{-1} + foliar spray of fertilizers at 30, 45 and 60 DAS) recorded the yields at par with that of T-6. It is well established fact that adequate fertilization improved various physiological and metabolic processes in the plant system. Profound influence of water soluble fertilizer grade sprays at pegging and pod development stages might have provided balanced amounts of major and micronutrients at the peak requirement resulting into higher crop growth and yield attributes and finally the dry pod and haulm yield. The results are in conformity with Manasa *et al.* (2015) and Jain and Meena (2015).

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Table 1: Pooled data on growth and yield attributes as influenced by various treatments in summer groundnut at MPKV, Rahuri

Trt. No.	Treatment	Plant height (cm)	No of branches plant^{-1}	Dry matter plant^{-1} (g)	No of pods plant^{-1}	Weight of pods plant^{-1} (g)	Shelling (%)	SMK (%)	Dry pod yield (kg ha^{-1})	Dry haulm yield (kg ha^{-1})	Kernel yield (kg ha^{-1})
T1	Absolute control	22.46	5.21	35.95	10.30	9.73	61.77	88.44	1517	2711	787
T2	100% RDF (25: 50: 00 NPK kg ha^{-1})	23.85	5.87	48.63	14.59	13.27	62.06	89.22	2516	5121	1504
T3	Foliar application of starter dose of WSF 11: 36: 24 @ 2% at 30 DAS + Foliar application of Booster dose of WSF 8: 16: 39 @ 2% at 45 and 60 DAS.	24.28	5.67	47.97	14.55	14.53	58.62	89.89	1667	3364	944
T4	100% RDF + T3	24.10	5.80	51.66	17.95	14.80	58.07	87.89	2857	6301	1604
T5	100% RDF + FYM @ 7.5 t ha^{-1}	25.48	5.53	50.57	13.88	14.67	57.72	87.33	2933	6561	1639
T6	100% RDF + FYM @ 7.5 t ha^{-1} + T3	25.50	6.13	58.21	19.33	15.47	57.46	88.67	3172	7438	1738
T7	85% RDF + FYM @ 7.5 t ha^{-1}	24.57	5.47	53.25	17.28	14.27	61.49	89.22	2551	5153	1497
T8	85% RDF + FYM @ 7.5 t ha^{-1} + T3	25.09	6.00	56.89	18.30	15.40	59.56	90.44	2840	5719	1560
T9	60% RDF + FYM @ 7.5 t ha^{-1}	24.50	5.13	47.27	16.44	12.27	63.56	91.11	2117	4049	1210
T10	60% RDF + FYM @ 7.5 t ha^{-1} + T3	24.72	5.80	47.55	13.40	12.40	64.43	88.78	2234	4593	1362
T11	35% RDF + FYM @ 7.5 t ha^{-1}	24.59	5.20	44.63	12.09	11.87	61.42	89.11	1900	3677	1043
T12	35% RDF + FYM @ 7.5 t ha^{-1} + T3	23.57	5.53	40.32	12.34	11.40	64.90	89.00	1984	3968	1144
	Mean	24.39	5.61	48.58	15.04	13.34	60.92	89.09	2348.21	4888	1336
	S.Em±	0.25	0.14	2.26	0.91	0.53	1.68	1.42	165.89	164.36	56.78
	LSD (P=0.05)	0.72	0.40	6.41	2.58	1.49	4.96	NS	914.5	485.17	167.61

DAS= Days after sowing, RDF= Recommended dose of fertilizers

77.

Impact of Organic and Inorganic Sources of fertilizers on Growth and Yield of Okra (*Abelmoschus esculentus* (L.) Moench) Under Sub-tropical Conditions

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Keywords: FYM, vermicompost, biofertilizer, *Azospirillum,* yield, okra

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench), 2n= 2x= 130) belongs to family Malvaceae. It is a fast growing annual vegetable crop grown in tropical and sub-tropical regions of the world. It is primarily valued for its tender, immature green pods in fresh form; however its curry, soups, stews and edible young leaves are also popular. To a limited extent it finds use in canned, dehydrated or frozen forms for off-season consumption by the army at high altitudes and export. Biofertilizer increases soil fertility and crop yield by rendering unavailable sources of elemental nitrogen bound phosphate and decomposed plant reside into available form in order to facilitate the plant to absorb the nutrients of these bio fertilizers.

Materials and Methods

A study was carried out at the Division of Vegetable Science and Floriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Chatha in 2008 and 2009. The experiment was laid out in split plot design with four levels of organic fertilizers (control and *Azospirillum*, farmyard manure (FYM) and vermicompost) and five levels of inorganic fertilizers (0, 25, 50, 75 and 100% of Recommended Dose of Fertilizer (RDF), 60: 30: 30: : N: P: K) having three replications with spacing 45 x 30 cm, plot size 4.05 x 2.70 m. The source of N, P and K were urea, diammonium phosphate and muriate of potash respectively. The soil was inoculated with *Azospirillum* at the rate of 2 kg ha-1 mixing with 40 kg FYM ha-1. To maintain uniformity in the quantity of FYM the control plots were also supplied with 40 kg FYM per plot The observations on plant height, stem diameter, internodal length, branches per plant, fruit weight, marketable yield and seed yield were recorded at maturity.

Results and Discussion

A significant linear increase in plant height, stem diameter, branches per plant, fruit weight, marketable yield and seed yield was noticed with the increase in inorganic fertilizers and 100% RDF while the minimum in control. The economics point of view, 75% NPK resulted in higher cost: benefit ratio (2.26) and minimum in control. Among organics soil application of *Azospirillum* gave higher cost: benefit ratio (2.25). Thus it may be concluded that the 100% RDF significantly influenced the growth and yield of okra. The results clearly show that the inoculation with *Azospirillum* performed better with respect to growth attributes and seed yield of okra.

Table 1: Effect of organic and inorganic fertilizers on yield and benefit cost ration of okra (Pooled data for 2 years)

Treatments	Seed yield (q/ha)	B: C ratio
NPK Fertilizers		
Control	10.15	1.69
25% RD	11.44	1.94
50% RD	11.90	2.02
75% RD	12.48	2.26
100% RD	12.78	2.07
C.D.(p=0.05)	0.68	
Organic fertilizers		
Control	10.87	1.92
Azospirillum	12.46	2.25
FYM	11.91	1.88
Vermicompost	11.62	1.76
C.D.(p=0.05)	0.70	

78.

Effect of Organic and Inorganic Sources of Fertilizers on Plant and Soil in Pomegranate Orchard

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Keywords: Inorganic fertilizers, laterite soil, organic fertilizers, pomegranate, quality, yield

Introduction

It has been established that pomegranate (*Punica granatum* L.), a high value fruit crop of waste lands, requires proper nutrition for higher yield and quality fruits. In India, most of the fertilizer recommendations in pomegranate are on the basis of higher quantity of inorganic fertilizers which may have deleterious effect on the soil environment. Integrated plant nutrient supply (IPNS) is the modern approach of soil health management and sustainable fruit production. An investigation was undertaken to assess the effect organic and inorganic fertilizers singly and combined on plant and soil of pomegranate orchard.

Materials and Methods

The investigation was carried out in a private orchard, Jhargram, Paschim Midnapore district of West Bengal during the period 2009 to 2012 on nine years old plants of pomegranate cultivar 'Ruby', planted at a spacing of 3 m ×3 m. The soil of the orchard was laterite and acidic in nature (pH 5.0-5.5). There were eleven treatments (detail in Table 1) which were replicated three times in randomized block design with four plants in each replication. Various organic manures and inorganic fertilizers were applied singly and in combination during different times of fruit growth. Observations on plant growth, fruit yield, physico-chemical characteristics of fruits, soil organic carbon, pH N, P and K and foliar N, P and K status were made following standards procedures.

Results and Discussion

The data of three consecutive years of investigation indicated that 241.6 g N + 711.6 g P + 592.42 g K/ plant/ year (T_4) through organic manures (farm yard manure(FYM) and neem cake) and inorganic fertilizers (DAP, SSP and MOP) showed highest fruit yield (24.1 kg plant^{-1}), maximum fruit size (7.8 x 8.0 cm), fruit weight (189.5 g), juice content (74.6%) with highest TSS/acid ratio and leaf N,P content. The treatment (T_4) also improved soil pH(6.997) and increased organic carbon (24,917.2 kg/ha), available nitrogen (710.7 kg/ha) and phosphorus (278.5 kg/ha) content in the soil. Lowest fruit yield and size was recorded from the plants with organic fertilizers only (FYM and poultry manure). The results clearly indicated that pomegranate plants grown in laterite soils require higher amount of P and K than N from organic and inorganic sources instead of organic sources only. It is concluded that application of 241.6 g N + 711.6 g P + 592.42 g K/plant/year through three split doses (November, January and February) was found as a good approach for production of high yield and good quality pomegranate fruits before monsoon starts in laterite zone of West Bengal.

Table 1: Effect of various treatments on fruit yield, date of harvest and chemical composition of pomegranate fruits cv. Ruby

Treatments (per plant/year)	Fruit yield (kg/ plant) before monsoon	Total fruit yield/ Plant/year (kg)*	TSS/acid ratio*	Soil pH*	Organic Carbon(kgha^{-1})*
T_1	9.8	19.3	43.1	6.687	18,134.80
T_2	6.8	13.1	41.0	6.937	22,658.95
T_3	7.1	14.8	40.4	6.917	22,865.00
T_4	12.8	24.1	46.4	6.997	24,917.24
T_5	9.7	19.0	42.2	6.773	18,757.10
T_6	8.0	14.4	37.0	6.523	16,209.17
T_7	8.5	16.5	38.3	6.443	19,917.90
T_8	4.9	9.7	34.4	6.89	21,198.40
T_9	8.5	19.1	43.0	6.783	12,658.73
T_{10}	8.2	14.8	34.4	6.377	17,778.40
T_{11}	9.6	15.1	35.6	6.303	21,569.10
C.D.	0.91	0.92	2.198	0.378	1,146.34
SE(m)	0.31	0.44	0.740	0.127	385.873
SE(d)	0.43	0.31	1.046	0.180	545.707
C.V.	6.22	3.30	3.235	3.291	3.393

**Average of three years from 2010 to 2012.*

T_1- DAP 600 g+ SSP 500g,+MOP500g=108 g N + 356 g P_2O_5+ 300 g K_2O; T_2- FYM 40 Kg + neem cake 2kg+ DAP: 600 g+SSP 1000g+MOP 500g+10: 26: 26 (N: P: K) 1000g=265.6 g N + 725.6 g P + 622.4 g K; T_3 -FYM 20 kg + poultry manure 4 kg=29.6 g + 20.4 g P + 32.8 g K; T_4- FYM 20 Kg + neem cake 2kg+ DAP: 600 g+SSP 1000g+MOP 500g+10: 26: 26 (N: P: K) 1000g=241.6 g N + 711.6 g P + 592.42 g K; T_5- FYM 20 kg + poultry manure 2 kg+ wood ash 2kg=27.2 g N + 24.8 g P + 79.4 g K; T_6-- FYM 20 kg + DAP: 1000 g+ SSP 500g+10: 26: 26 (N: P: K) 1000g=304 g N + 814 g P + 290 g K; T_7- FYM 40 Kg +DAP: 1000 g+ SSP 500g+MOP 500g+10: 26: 26 (N: P: K) 1000g=328 g N + 828 g P + 620 g K; T_8- FYM 20 Kg+ poultry manure 4 kg=29.6 g N + 20.4 g P + 32.8 g K; T_9- Vermicompost 5 Kg=12.5 g N + 3.0 g P + 5.5 g K; T_{10}- FYM 20 Kg, DAP 1000 g + SSP: 1000 g +10: 26: 26 (N: P: K) 1000g=304 g N + 734 g P + 450 g K; T_{11}- FYM 20 Kg + neem cake 1kg+ DAP: 300 g+SSP 500g+MOP 300g+10: 26: 26 (N: P: K) 500g=132.8 g N + 362.8 g P + 341.2 g K

DAP-di-ammonium phosphate, SSP- single super phosphate, MOP-muriate of potash, 10: 26: 26 (N: P: K)-mixed fertilizers

79.

Effect of Foliar Application of Boron and Zinc on Seed Yield and Relative Economics of Tomato Seed (*Solanum lycopersicon L.*) cv. Shalimar 1.

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Keywords: Boron, zinc, foliar application, tomato

Introduction

Tomato (*Solanum lycopersicon* L; 2n=2x=24), is one of the most important annual vegetable crop. With the rapid increase in population, the demand of tomato has significantly increased, but the production and productivity has remained low due to depletion of micronutrients in the soil. Nutrients can be applied both by conventional or foliar application methods. Foliar application become promptly available to crop plants. Boron (B) and zinc (Zn) are essentially required by the plants for normal growth and development, hence application of proper doses of boron and zinc can lead to the improvement in quality and production of this crop.

Materials and Methods

An experiment was conducted at Experimental Field of Division of Vegetable Science, Sher-i- Kashmir University of Agricultural Sciences and Technology, Shalimar (J&K) during the year 2014 with nine treatments viz., T_1 (Zinc at the rate of 50 ppm),T_2 (Zinc at the rate of 100 ppm), T_3(Boron at the rate of 100 ppm), T_4 (Boron at the rate of 50 ppm + Zinc at the rate of 50ppm), T_5 (Boron at the rate of 50 ppm + Zinc at the rate of 100ppm) T_6(Boron at the rate of 100 ppm), T_7(Boron at the rate of 100 ppm + Zinc at the rate of 50 ppm), T_8(Boron at the rate of 100 ppm + Zinc at the rate of 100 ppm), T_9(Control) and three replications in randomised complete block design.

Results and Discussion

Adequate supply of nutrients can increase the yield, fruit quality, fruit size, keeping quality, colour and taste of tomato. Micronutrients in general play an important role in tomato production. The results inferred that among different treatments, T_8 (Boron at the rate of 100 ppm + Zinc at the rate of 100 ppm) recorded maximum seed yield plant^{-1} and seed yield hectare^{-1} viz., 6.00g plant^{-1} and 445.54 kg ha^{-1} respectively. This can be attributed due to role of boron in better utilisation of minerals accompanied with enhanced photosynthesis, metabolic activity and greater diversion of food material to fruits. Zinc plays an important role in activation of certain plant growth hormones (auxin). These plant hormones increases the mobilisation of assimilates to the developing fruits and also stimulate the transport of nutrients through phloem. The treatment wise cost of cultivation and returns revealed that maximum net returns of Rs.6,68,691in seed yield/ ha with a benefit cost ratio of 3.00 was observed with the application of treatment, T_8 (Boron at the rate of 100 ppm +Zinc at the rate of 100 ppm). This result is in conformity with the findings of Patil *et al.* (2008). This is due to the reason that boron nutrition enhanced vegetative growth and nutrient uptake in tomato that resulted in increased assimilation. The beneficial effect of zinc on relative economics may be due to the reason that zinc is an important component of several enzymes which are involved in carbohydrate and nitrogen metabolism.

Table 1: Relative economics (hectare basis) of tomato seed as affected by foliar application of boron and zinc

Treatment symbol	Treatment	Total Cost of cultivation (Rs./ha)	Yield (q ha^{-1})	Gross returns (Rs./ha)	Net profit (Rs./ha)	Returns/ rupee invested
T_1	Zinc @50ppm	222281	317.82	635640	413359	1.85
T_2	Zinc @100ppm	222300	379.45	758900	536600	2.41
T_3	Boron @50ppm	222285	320.04	640080	417795	1.87
T_4	Boron @50ppm+ Zinc @50ppm	222345	388.36	776720	554375	2.49
T_5	Boron @50ppm+ Zinc @100ppm	222362	437.37	874740	652378	2.93
T_6	Boron @100ppm	222310	351.98	703960	481650	2.16
T_7	Boron @100ppm+ Zinc @50ppm	222360	414.35	828700	606340	2.72
T_8	Boron @100ppm+ Zinc @100ppm	222389	445.54	891080	668691	3.00
T_9	Control	222275	300.74	601480	379210	1.70

Reference

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80.

Response of Foliar Application of Urea on Fodder Yield of Oats Crop under Rain-fed Conditions of Rajouri

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Keywords: Oats, urea spray, green fodder yield, rainfed

Introduction

Animals in hilly areas are generally underfed, which results in unsatisfactory production of livestock. Oats (*Avena sativa* L.) locally known as javi, jai, or jodar is the most important cereal (graminaceous) forage crop grown during winter season. However, its productivity is low in the hills. One of several reasons for low yield is low fertility status. Nitrogenous fertilizers play a vital role in modern farm technology, however only 20- 50% of the soil applied nitrogen is recovered by the annual crops (Bajwa, 1992). Thus efforts are needed to minimize its losses and to enhance its economic use. Keeping in view the scanty information available on these aspects of multi-cut oats, the study was undertaken to investigate the efficiency of foliar application of urea for yield and when applied after first cut.

Materials and Methods

The study was based on on-farm trials carried out at three locations in Rajouri District during the *rabi* 2014-15 using cv. Kent to evaluate the application of 2% urea spray on second cut of oats crop under rainfed conditions. The experiment was laid out in randomized complete block design having three replications, consisting of three treatments having T1: (Farmer practice- injudicious use of fertilizer), T2: (Recommended dose of fertilizer 80: 40: 20 N: P: K) and T3: (T2 + 2% urea spray). Foliar spray of urea at concentration 2% was prepared by the addition of urea fertilizer in water (20 gm/1 litre). The required quantity of foliar spray of urea in formulated concentrations was applied to crop after first cut i.e. 60-70 DAS. The data were recorded for yield at maturity. All the standard agronomic practices were practiced.

Results and Discussion

The results on the preliminary study based on the pooled data indicates that foliar application of 2% urea after the first cut significantly increased the green fodder yield of oats crop. Treatment T3 (Recommended dose of fertilizer + urea spray 2%) resulted in highest green fodder yield (245 q/ha) followed by 225 q/ha observed in treatment T_2 (Recommended dose of fertilizers 80: 40: 20 N: P: K) and least in T_1 (Farmer practice- i.e injudicious use of fertilizer). This might be due to increase in growth attributes of oat crop due to timely availability of nitrogen and resulted in better re-growth. Nitrogen plays a vital role in forage production besides increasing the quantity of forage; it improves the quality of herbage also. Oat responds well to nitrogen application, among the various nutrients which produces more tonnage in per unit area per unit time under favourable environmental conditions (Purushotham *et al.*, 1995). The economic analysis indicated that net returns and returns per rupee invested were markedly influenced by treatment T_2 (Recommended dose of fertilizers 80: 40: 20 N: P: K) and T_3 (Recommended dose of fertilizer + urea spray 2%). Highest net return (₹9256) were recorded with recommended dose of fertilizer + urea spray 2% followed by recommended NPK (₹7566). Whereas, lowest returns of ₹4048 were obtained with Farmer's practice. Maximum returns per rupee invested (₹1.63 and 1.72) were also recorded where recommended dose of NPK alone and along with 2% urea spray was applied, respectively. Since the foliar application of 2% urea after first cut of oats i.e. 60-70 DAS resulted in enhancement of green fodder yield. Hence, it is easily concluded from the present study that foliar application of urea at 2% helps in boosting the second cut green fodder yield of oats.

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Effect of 2% urea spray on green fodder yield (q/ha), net returns (₹/ha) and returns per rupee invested (₹) in oats crop

Treatment	Grain yield (q ha^{-1})				Net Returns (₹/ha)				Returns per rupee invested (₹)			
	Location 1	Location 2	Location 3	Mean	Location 1	Location 2	Location 3	Mean	Location 1	Location 2	Location 3	Mean
T_1: (Farmer practice- injudicious use of fertilizer)	190	180	200	190	3946	3240	4957	4048	1.30	1.25	1.38	1,31
T_2: (Recommended dose of fertilizer 80: 40: 20 N: P: K)	220	225	230	225	7425	6750	8524	7566	1.60	1.60	1.70	1.63
T_3: (T2 + 2% urea spray)	240	235	260	245	8894	8332	10543	9256	1.70	1.65	1.82	1.72

81.

Effect of Foliar Application of Mineral Nutrients on Anatomical Changes and Activities of Hydrolytic Enzymes in Pedicel of Pigeonpea (*Cajanus cajan* L.)

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Keywords: Pigeonpea, flower abscission, mineral nutrients, pedicel anatomy and hydrolytic enzymes.

Introduction

Legumes are considered the most important source of food after cereals in the world, as they are main sources of protein and energy for humans. Among the legumes, pigeonpea (*Cajanus cajan* L.) is grown extensively but its yield remains low due to high level of flower/fruit abscission (70-96%) leading to a much-reduced realization of sink potential. So, it is very necessary to compensate the high degree of flower abscission and increase the pod yield. Nutrients play a pivotal role in increasing the seed yield in pulses. The low availability of mineral elements leads to the abscission of flower buds, flowers and pods. During the phase of abscission, the synthesis of hydrolytic enzymes dissolving polysaccharides of the cell wall mainly cellulases and polygalacturonase are activated. These enzymes dissolve the middle lamella and also the cell walls and the cohesion of cells is weakened. Pedicel is responsible for the translocation of substances from source tissues to the developing fruits through vascular tissues (xylem and phloem). So if various mineral nutrients are supplied exogenously they may help in flower retention. The present investigation was, thus planned to study the effect of nutrients on the activity of hydrolytic enzymes and anatomical changes in vascular tissues of flower pedicel in pigeonpea.

Materials and Methods

This experiment was conducted in Punjab Agricultural University, Ludhiana during *kharif* season of 2012-13 and 2013-14. The experiment consisting of two pigeonpea varieties (PAU 881 and AL 201) having one control and eight treatments, was laid out in a randomized block design with three replications. The treatments were, Control (water), T_1 (0.01% $CaCl_2$), T_2 (0.02% $CaCl_2$), T_3 (0.5% KNO_3), T_4 (1% KNO_3), T_5 (0.1% $MgCl_2$), T_6 (0.2% $MgCl_2$), T_7 (1% urea) and T_8 (2% urea) and these were applied as foliar spray at green floral bud stage of inflorescence followed by another spray after two days. Anatomical changes and enzyme activities in pedicel were observed after ten days of foliar treatments.

Results and Discussion

Mineral nutrients application increased the diameter of pedicel and the area of vascular tissues (phloem and xylem) thereby improving translocation of assimilates and providing mechanical support (Table 1). Maximum amount of phloem tissue was observed in 1% KNO_3 treated plants *i.e.* 0.97 cm followed by 0.5% KNO_3 (0.88 cm) and 2% urea (0.88 cm) in PAU881 and 0.5% KNO_3 (1.91 cm) followed by 1% KNO_3 (1.84 cm) and 2% urea (1.72 cm) in AL201. Minimum amount of phloem tissue was recorded in control which was 0.71 cm and 1.24 cm in PAU881 and AL201, respectively. In PAU881, maximum amount of xylem tissue was observed in 0.2% $MgCl_2$ (1.32 cm) treated plants followed by 0.5% KNO_3 (1.28 cm), 0.1% $MgCl_2$ (1.27 cm) and 1% urea (1.20 cm) treated plants while, in AL201, it was maximum with 1% KNO_3 (2.18 cm) application followed by 0.5% KNO_3 (2.13 cm), 0.1% $MgCl_2$ (1.77 cm), 0.2% $MgCl_2$ (1.64 cm) and 2% urea (1.63 cm) application. Cellulase and PG are the main enzymes engaged in the abscission and our study revealed a decline in activities of these enzymes in the pedicel following various mineral nutrient treatments. Foliar application of mineral nutrients increased the area of translocatory tissues and enhance the translocation of assimilates from source to developing sink through pedicel thereby reducing flower drop. This reduction can also be attributed to diminishing activities of hydrolytic enzymes in the pedicel which led to enhanced flower retention and ultimately, improved the yield of pigeonpea crop with 2% urea being the most effective treatment.

Table 1: Effect of foliar application of various mineral nutrients on anatomy and activities of enzymes in flower pedicel of pigeonpea varieties

Treatments		Diameter (cm)		Phloem (cm)		Xylem (cm)		Cellulase activity (µg D-glucose released g^{-1} FW min^{-1})		Polygalaturonase activity (µg D-galacturonic acid released g^{-1}FW min^{-1})	
Nutrient	**Concentrations**	**PAU 881**	**AL 201**	**PAU 881**	**AL 201**	**PAU 881**	**AL 201**	**PAU 881**	**AL 201**	**PAU 881**	**AL 201**
Control		23.69±0.68	29.35±2.04	0.71±0.05	1.24±0.12	0.99±0.05	1.13±0.18	16.60±1.81	14.13±2.15	17.30±2.15	16.93±2.86
$CaCl_2$	0.01%	23.69±0.63	29.54±2.02	0.77±0.05	1.44±0.10	1.11±0.04	1.39±0.15	10.17±1.67	10.00±0.88	17.23±2.19	16.63±0.43
	0.02%	24.25±0.85	30.87±1.97	0.71±0.10	1.46±0.10	1.14±0.04	1.58±0.14	10.50±1.72	10.67±0.66	16.63±2.24	15.77±0.39
KNO_3	0.5%	26.42±0.94	38.20±1.98	0.88±0.14	1.91±0.09	1.28±0.05	2.13±0.14	13.17±1.78	11.90±0.68	16.93±2.30	15.63±0.37
	1%	26.51±1.21	39.00±1.87	0.97±0.17	1.84±0.08	1.17±0.08	2.18±0.13	12.53±1.79	9.93±0.74	16.50±2.35	15.13±0.40
$MgCl_2$	0.1%	25.54±2.41	30.09±1.02	0.85±0.24	1.48±0.05	1.27±0.18	1.77±0.04	11.40±1.82	10.67±0.77	16.37±2.43	16.80±0.44
	0.2%	26.38±2.98	33.87±0.79	0.72±0.26	1.52±0.04	1.32±0.23	1.64±0.01	11.03±1.89	13.17±0.82	15.87±2.51	16.27±0.47
Urea	1%	24.81±2.83	31.20±0.89	0.73±0.23	1.68±0.02	1.20±0.23	1.62±0.01	10.77±1.96	10.53±0.96	15.47±2.61	15.27±0.36
	2%	26.50±2.48	33.86±0.04	0.88±0.18	1.72±0.01	1.17±0.22	1.63±0.01	9.63±2.04	9.57±0.32	15.30±2.72	14.90±0.12

82.

Effect of Foliar Application of Boron and Zinc on Growth Parameters of Tomato (*Solanum lycopersicon* L.) Cv. Shalimar 1 under Temperate Conditions in Kashmir Valley

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Introduction

Tomato (*Solanum lycopersicon* L; 2n=2x=24), is one of the most important vegetable crops grown throughout the world. Under deficiency of micronutrients, the growth of plant is hampered; the plants are subjected to attack by diseases and the yield of crop decreases accordingly (Das, 2008). Generally, nutrients can be applied both by conventional or foliar application methods. Foliar application of micronutrients makes promptly available to crop plants (Naz *et al.*, 2012). In Kashmir, the soils are deficient in boron and zinc (Shaista 2015). Hence application of proper doses of boron and zinc can lead to the improvement in quality and production of this crop.

Materials and Methods

An experiment was conducted at Experimental Field of Division of Vegetable Science, Shalimar, Srinagar in 2014 under temperate conditions with nine treatments viz., T_1 (zinc at the rate of 50 ppm), T_2 (zinc at the rate of 100 ppm), T_3 (boron at the rate of 50 ppm), T_4 (boron at the rate of 50 ppm + zinc at the rate of 50 ppm), T_5(boron at the rate of 50 ppm + zinc at the rate of 100 ppm), T_6 (boron at the rate of 100 ppm), T_7(boron at the rate of 100 ppm + zinc at the rate of 50 ppm), T_8(boron at the rate of 100 ppm + zinc at the rate of 100 ppm), T_9(control) and three replications in randomised complete block design. Foliar applications of micronutrients (boron and zinc) were applied 15 days after transplanting of seedlings and repeated at 15 days interval. A total of three foliar sprays were carried out during the cropping season

Results and Discussion

The results obtained from present investigation revealed that maximum plant height of 55.06cm was recorded with T_8 (boron at the rate of 100ppm + zinc at the rate of 100 ppm) which was significantly superior to rest of the treatments. The increase in plant height was due to role of zinc in the synthesis of auxin (IAA). Auxin plays an important role in apical dominance and inhibits the growth of lateral buds thus increases the plant height. Also boron is associated with the cell differentiation and development of cell wall that helps in shoot growth resulting in increased plant height.

Table 1: Effect of foliar application of boron and zinc on plant growth and fruit quality of tomato cv. Shalimar 1 under temperate conditions in Kashmir valley.

Treatment symbol	Treatment	Plant height (cm)	Plant spread (cm)
T_1	Zinc @50ppm	48.09	24.18
T_2	Zinc@100ppm	51.21	23.90
T_3	Boron@50ppm	46.18	24.96
T_4	Boron @50ppm+ Zinc @50ppm	53.16	24.00
T_5	Boron @50ppm+ Zinc @100ppm	54.29	23.18
T_6	Boron @100ppm	49.90	27.62
T_7	Boron @100ppm+ Zinc @50ppm	53.98	26.15
T_8	Boron @100ppm+ Zinc @100ppm	55.06	26.10
T_9	Control	45.12	23.06
	C.D($p \leq 0.05$)	4.21	2.86

Plant spread was recorded maximum (27.62cm) in treatment T_6 (Boron at the rate of 100ppm). This is because boron nutrition enhances nutrient absorption and also enhancing Ca metabolism in cell wall which may have resulted in increasing plant spread. Decrease in plant spread by treatment, T_8 (boron at the rate of 100ppm + zinc at the rate of 100ppm) may be attributed to the fact that zinc leads to apical dominance as a result lateral growth is suppressed. These results are in agreement with findings of Sathya *et al.* (2010).

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83.

Effect of Spacings and Application of FYM on Production of *Oenothera biennis* L.

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Keywords: Evening primrose, farm yard manure, gamma linolenic acid, spacing

Introduction

Oenothera biennis L. commonly known as evening primrose, is a native North American species belonging to the family Onagraceae. It is commercially cultivated for its seed oil, known as Evening Primrose Oil (EPO) and is of special interest because oil characterized by its content of gamma linolenic acid (7-10%) (GLA), the precursor of prostaglandin E1 and its derivatives. Crop is a subject of agricultural interest because of the potential market for GLA, which is useful in medicine and nutrition. The present study was carried out to determine the effects different FYM and spacings applications on production parameters of the crop.

Materials and Methods

The present study was conducted in the Department of Forest Products, University of Horticulture & Forestry, Nauni, Solan (Himachal Pradesh). The seedlings were transplanted in May and FYM at the rate of 15, 30, and 45 t/ha were applied. There were 4 treatments of FYM and 4 spacing (30 × 30, 30 × 45, 45 × 45, 45 × 60 cm). Capsules were harvested before opening. Before harvest, the plant height (cm), plant spread (cm), number of flowers/plant, number of fruits/plant were recorded. After harvesting number of seed/fruit, seed yield/plant (g) was also recorded along with oil content (%). The data recorded was subjected to Randomized Block Design (factorial).

Results and Discussion

With the increase in spacing, the values for growth parameter increased. Application of FYM gave significantly higher growth and yield as compared to the control. The highest number of branches was obtained from the wider row spacing applications and the higher FYM doses. Numbers of branches per plant were significantly affected by the plant spacing. Plant spread (cm) and number of flowers per plant increased significantly with the increase in spacing. The increase in these parameters with increase in spacing can be attributed to the less competition for water, minerals etc. and more space to grow. Seed yield (g) per plant increased significantly with the increase in FYM doses from control to 45 t/ha. The beneficial effect of wider row spacing has been due to better light penetration and higher photosynthetic efficiency resulting in better development of plant canopy with more number of capsules per plant and seed yield (g) per plant. The treatment of 45 t/ha and 45 × 60 cm spacing gave maximum number of branches/plant, plant spread, number of flowers/ plant, number of capsules/plant, seed yield/plant. Therefore, it can be concluded from the present investigations that maximum value for plant height and seed yield/ha were recorded with 30 × 30 cm spacing and also with 45 t/ha. The plant height and seed yield/ha decreased with the further increase in spacing. FYM and spacing both showed non-significant results on number of seeds/capsule (Table 1) and oil (%).

Table 1: Effect of FYM and spacing on number of seeds/capsule

Treatments	30 × 30 cm	30 × 45 cm	45 × 45 cm	45 × 60 cm	Mean
Control	321.9	230.7	331.5	333.3	304.3
15 t/ha FYM	316.2	334.1	330.9	325.9	326.8
30 t/ha FYM	323.0	331.5	314.0	338.9	326.9
45 t/ha FYM	338.1	329.5	334.8	334.8	334.3
Mean	324.8	306.5	327.8	333.2	

$CD_{(0.05)}$

Treatment (T)	NS
Spacing (S)	NS
T × S	NS

84.

Isolation of Phosphate Solubilizing Microorganisms from Fennel *(Foeniculum vulgare* Mill*.)* Rhizospheric Soils

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Keywords: Fennel (*Foeniculum vulgare* Mill**.**), phosphate solubilizing bacteria, PSB, rhizosphere.

Introduction

Fennel (*Foeniculum vulgare* Mill.) belongs to family Apiaceae with chromosome number 2N=22 (Masoud *et al.*, 12) and is cultivated as an annual crop in the winter months. Fennel is a native of the Southern Europe and Mediterranean region and one of popular major seed spice in India mainly grown in *rabi* season. Gujarat and Rajasthan are major fennel producing states of India. The ability of a few soil microorganisms to convert insoluble forms of phosphorus to an accessible form is an important trait in plant growth-promoting bacteria for increasing plant yields. The use of phosphate solubilizing bacteria as inoculants increases the P uptake by plants. Keeping these information's under consideration, the present investigation was conducted for isolation and evaluation of phosphate solubilizing microorganisms from fennel rhizosphere soils.

Materials and Methods

Fennel plant and soil samples were collected from Ajmer, Pali, Jhalawar, and Kota districts of Rajasthan for isolation of rhizospheric bacteria. All the fennel field soil samples were analyzed for electrical conductance (EC) and pH. The serially diluted soil samples were inoculated by pour plating technique on standard agar medium (pH 6.8-7.0) containing 5 g of tricalcium phosphate (TCP) as sole phosphorus source for selectively screening the bacteria which have the ability to release inorganic phosphate from tricalcium Phosphate (Nautiyal, 1999). Sixteen phosphate solubilizing bacterial strains thus isolated were selected for further analysis. These fennel crop rhizospheric and soil isolates were designated as FEN-1to FEN-16.

For the quantitative evaluation of P-solubilization potential these phosphate solubilizing bacteria were inoculated into 100 ml National Botanical Research Institute Phosphate (NBRIP) broth containing tricalcium phosphate. Dissolved phosphate concentration in the culture filtrate was determined by vanado-molybdate method as described by Kaushik *et al.*, (2004). Based on diameter of radial growth of bacterial isolates and zone of clearance on Pikovskaya medium ager plates phosphate solubilization index [= the ratio of the total diameter (colony + halo zone) to the colony diameter] was calculated.

Results and Discussion

In the present investigation of fennel soil samples the EC ranged between 1.02 and 0.15 dS/m whereas pH of ranged from 8.8 to 7.6. Maximum EC (10.2 dS/m) was recorded for fennel soil samples collected from Khanpura locality in district Jhalawar while minimum EC (0.15 dS/m) was observed with samples of Krishi Vigyan Kendra Pali-A. Maximum pH was observed with fennel field soil samples from Sarwara in district Ajmer whereas minimum pH was recorded with sample of Sanchore in district Jalore of Rajasthan. In the present investigation, high pH did not always correspond with high EC (Table 1).

Table 1: List of fennel soil samples from Rajasthan

District	Village / locality	EC (dS/m)	pH
Ajmer	Kekari	0.34	8.6
Ajmer	Nayakedh,	0.43	8.3
Ajmer	NRCSS,Tabiji-A	0.38	8.4
Ajmer	NRCSS,Tabiji-B	0.38	8.5
Ajmer	NRCSS,Tabiji-C	0.37	8.5
Ajmer	NRCSS,Tabiji-D	0.38	8.4
Ajmer	NRCSS,Tabiji-E	0.36	8.6
Ajmer	Sarwara	0.46	8.8
Jhalawar	Khanpura	1.02	8.3
Kota	Ummedganj farm	0.32	8.0
Pali	KVK, Pali-A	0.15	8.1
Pali	KVK, Pali-B	0.22	8.1
Pali	KVK, Pali-C	0.23	8.0
Jalore	Sanchor	0.69	7.6

Table 2: Screening of selected bacterial isolates for tricalcium phosphate solubilization

Bacterial isolates	Phosphate solubilization Index	Tricalcium Phosphate solubilization (µg/ml)
FEN-1	2.2	51.30
FEN-2	2.2	34.82
FEN-3	2.1	18.86
FEN-4	1.6	23.92
FEN-5	1.9	50.68
FEN-6	2.4	22.77
FEN-7	1.6	38.04
FEN-8	2.0	30.62
FEN-9	1.9	31.67
FEN-10	1.4	27.92
FEN-11	1.3	47.26
FEN-12	1.8	25.94
FEN-13	1.4	38.21
FEN-14	1.7	51.66
FEN-15	1.2	41.13
FEN-16	1.3	15.83
SEm	0.08	1.07
CD 0.05	0.20	2.90

Phosphate solubilization index as calculated on the basis of bacterial colony diameter and zone of clearance on Pikovskaya agar medium revealed the difference among various PSB strains isolated from fennel rhizosphere and soil samples. The maximum P-solubilization index (2.4) was recorded for FEN-6 which was at par with FEN-1 and FEN-2. The minimum P-solubilization index was recorded for FEN-15 which was at par with FEN-16 (Table 2). Quantitative screening for phosphate solubilization was assayed with NBRIP broth containing tricalcium phosphate in liquid growth medium and released soluble phosphate was estimated. The highest P-solubilization was recorded for PSB isolate FEN-14 which was at par with FEN-1 and FEN-5 although these isolates were not showing highest P-solubilization index. However, the minimum P-solubilization was recorded for PSB isolate FEN-16 which was showing least P-solubilization index (Table 2).

Phosphate solubilizing bacteria as Biofertilizers may be considered among the most effectual plant assistants to supply phosphorous and to enhance plant growth by giving those nutrients in a readily useable form. The results obtained in present investigation may be valuable for formulation of native PSB biofertilizers for seed spices crops especially grown in semi-arid regions of India.

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85.

Identification of Nitrogen Use Efficient Potato Genotypes

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Keywords: Nitrogen use efficiency, potato genotypes and tuber yield

Introduction

Potato is considered as a future food crop because it produces maximum edible energy and edible portion per unit area per unit time among all the major food crops of the world. Application of excessive amount of fertilizers led to environmental hazards, natural resources depletion, yield stagnation and raised cost of cultivation. Moreover, use of nitrogenous fertilizers and their unscientific application results in emission of NO_2, a major greenhouse gas. Production potential of any crop is proportional to the genetic and environmental interactions. Nitrogen management practices and increasing the efficacy of nitrogen utilization of potato crop can be an alternate approach. Development of nitrogen use efficient cultivars can reduce input cost of the farmers and can help in preventing the environmental hazards.

Materials and Methods

Twenty germplasm lines were tested at ICAR-CPRS, Jalandhar under nitrogen deficient and sufficient conditions in a single row, 2.4m long without replication in first year 2012-13. The recommended dose of P (100kg/ha) and K (150 kg/ha) was applied as basal application, whereas, N was applied in four graded levels i.e. N_0= 0 kg/ha; N_{80}= 80 kg/ha; N_{160}= 160 kg/ha and $N_{240=}$ 240 kg/ha. In 2013-14, seven germplasm selected were tested under nitrogen deficient and sufficient conditions under plot wise trial with control varieties K Gaurav, K Pukhraj and K Jyoti. During the year 2014-15, the two germplasm accessions found promising in the previous year were evaluated in replicated trial under different N - doses in the plot size 14.4m^2.

Results and Discussion

In the first year, tuber yields of different germplasm lines varied between 21 and 80 q/ha under N stress, whereas, mean tuber yields over different rates of N varied between 55 and 244 q/ha. In the year 2012-13, the 7 germplasm having mean yield more than 150 q/ha were selected for plot wise trial. In 2013-14, the 2 germplasm lines (CP 1987 and CP 2013) having mean tuber yield more than 16 t/ha have been selected for further testing under replicated trials next year.In the replicated trial 2014-15, these two germplasm accessions were evaluated for N use efficiency. The accession CP2013 was found superior than best nitrogen efficient variety Kufri Gauravparticularly at low doses of nitrogen (Table 1). This accession can be a useful parent in breeding programme for N-use efficient.

Table 1: Response of different potato genotypes to nitrogen application in 2014-15.

N-Rate / Variety	N_0 Tuber Yield (q/ha)	N_{80} Tuber Yield (q/ha)	N_{160} Tuber Yield (q/ha)	N_{240} Tuber Yield (q/ha)	Mean Tuber Yield (q/ha)
Kufri Pukhraj	120.44	218.09	298.81	327.45	241.58
CP-1987	98.95	200.51	233.71	255.84	197.25
CP-2013	163.40	268.86	281.23	322.25	258.93
Kufri Gaurav	98.30	203.11	274.07	283.84	214.83
Kufri Jyoti	82.03	182.28	193.35	253.24	177.72

86.

Understanding the Influence of Nitrogen Application on Rice (*Oryza sativa* L.) Genotypes under Direct Seeded Conditions for Assessing Nitrogen Use Efficiency

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Keywords: Genotypes, nitrogen, nitrogen use efficiency, panicle, grain yield.

Introduction

An experiment was conducted at the Punjab Agricultural University (PAU), Ludhiana to study the influence of nitrogen on rice (*Oryza sativa* L.) genotypes under direct seeded conditions. Direct seeded rice (DSR) helps to overcome the constraints of water and labour availability. Under DSR conditions, the crop is established from the seeds sown directly in the field rather than transplanting seedlings from nursery. Our research aimed to identify nitrogen use efficient genotypes under DSR.

Materials and Methods

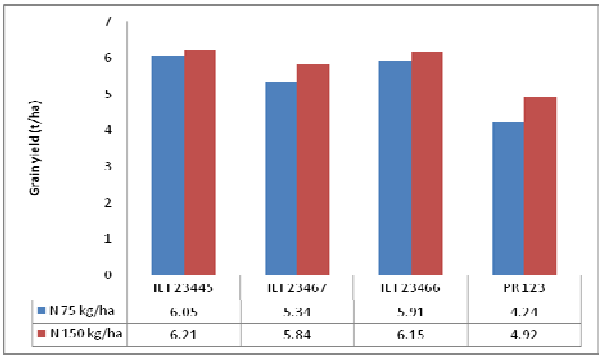
The study was carried out at the research farm of PAU, Ludhiana during the months of June to October, 2014 on four rice genotypes namely IET 23445, IET 23467, IET 23466 and PR 123 to study the influence of different doses of applied nitrogen (75 and 150 kg/ha). The experiment, replicated three times, was laid out in a split-plot design with two N levels as main plots and four genotypes as sub-plots. At harvest maturity, panicle weight, panicle/m^2 and grain yield were recorded.

Results and Discussion

Averaged over genotypes, at recommended level of N (150 kg/ha), there was an increase in plant height (5.61%), panicle/m^2 (17.35%), panicle weight (28%) and grain yield (7.43%). The interaction between nitrogen level and genotypes was found to be significant for panicle/m^2, panicle weight and plant height at 5% level of probability (Table 1). In the genotypes IET 23445 and IET 23466, maximum grain yield was recorded at both low and recommended dose of applied nitrogen (Table 1, Fig. 1). Analysis of yield components indicated that the higher grain yield in IET 23445 and IET 23466 was attributed to a larger panicle size (spikelets per panicle) and number of panicle/m^2. Nitrogen being constituent of enzymes and proteins, enhanced cell expansion and various metabolic processes and consequently yield attributes. It was concluded that the genotypes IET 23445 and IET 23466 showed higher grain yield at both low and recommended dose of applied nitrogen. Hence they have better nitrogen use efficiency than the genotypes IET 23467 and PR 115.

Table 1: Mean performance of four genotypes and least significant differences (LSD) for 4 traits at two N treatments

Applied nitrogen dose	Parameters observed			
	Plant height(cm)	Number of panicle/ m^2	Panicle weight (g)	Grain yield (t/ha)
N 75 Kg/ha	102.55	287.33	2.54	5.38
N 150 Kg/ha	108.30	337.17	3.25	5.78
LSD (0.05)	4.64	30.56	0.35	NS
Genotypes				
IET 23445	116.23	334.67	3.16	6.13
IET 23467	108.67	312.00	2.85	5.59
IET 23466	111.37	327.33	2.97	6.03
PR 123	85.43	275.00	2.59	4.58
CD (0.05)	0.62	43.21	NS	0.72



(N75 kg/ha: Nitrogen dose of 75 kg/ha; N 150 kg/ha: Nitrogen dose of 150 kg/ha)

Fig. 1: Effect of different doses of applied nitrogen (N 75 kg/ha and N 150 kg/ha) on grain yield.

87.

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 design with 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 Capsaicin & 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.

Reference

Sadasivam, S. and Manickam, A. 1996. *Biochemical Methods* (2nd edn.) New Age International Publisher, New Delhi, pp. 187-188.

Table: Effect of different sources of N

	Plant height (cm)	Days required for first flowering	No. of fruits per plant	Fruit yield (t/ha)
T1: 25% N(CM) +75% N(IN)	64.34	48.25	85.86	6.05
T2: 50% N(CM) + 50%N(IN)	65.21	45.00	93.33	6.22
T3: 75% N(CM) +25% N(IN)	62.72	44.36	90.75	6.15
T4: 25% N(NC) + 75%N(IN)	63.16	47.37	110.75	7.27
T5: 50% N(NC)+ 50%N(IN)	65.23	46.18	117.45	7.56
T6: 75% N(NC) + 25%N(IN)	66.32	44.97	112.12	7.35
T7: 25% N(PM) + 75%N(IN)	62.10	48.21	85.36	6.08
T8: 50% N(PM) + 50%N(IN)	67.38	45.33	108.26	7.25
T9: 75% N(PM) + 25%N(IN)	68.19	44.37	98.28	6.93
T10: 25% N(VC)+75%N(IN)	66.47	46.28	129.75	8.27
T11: 50% N(VC)+ 50%N(IN)	69.56	44.52	136.37	8.65
T12: 75% N(VC +25% N(IN)	68.42	42.75	131.85	8.46
T13: 25% N(PC) + 75%N(IN)	66.34	47.56	88.16	6.00
T14: 50% N(PC) + 50%N(IN)	64.31	46.37	106.17	6.95
T15: 75% N(PC) + 25%N(IN)	65.54	43.25	102.24	6.72
T16: 25% N(MC)+75% N(IN)	66.72	46.18	105.27	6.88
T17: 50% N(MC)+50% N(IN)	65.59	45.42	125.25	8.06
T18: 75% N(MC)+25% N(IN)	63.32	45.05	109.75	7.15
T19: Control	61.24	44.32	76.38	5.32
S.E.m	0.356	0.677	2.002	0.626
CD at 5%	1.060	2.010	5.945	1.060

88.

Studies on Effect of Surface Fertigation on Nutrient Uptake, FUE and Economics of Inter-specific Hybrid *Bt* Cotton

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Keywords: Surface fertigation, Fertilizer use efficiency, Nutrient uptake, RDF

Introduction

Cotton (*Gossypium* spp.) popularly known as "white gold", is an important commercial fibre crop grown under diverse agro-climatic conditions around the world. Fertigation has been found to increase the efficiency in the application of fertilizer besides reducing the quantity of fertilizes applied. The fertigation technique is presently restricted to drip method of irrigation. The major limitation of drip irrigation is its higher initial investment. Applicability of fertigation technique in surface irrigation is more useful, as more irrigated area (>99 per cent) is under surface methods. We analyzed the efficiency of fertigation by surface irrigation method.

Materials and Methods

A field experiment was conducted at ZARS, GKVK, Bengaluru during *kharif* season of 2012. The experiment was laid out in a randomized complete block design with three replications involving 7 treatments namely,T_1: Recommended dose of fertilizers- soil application in (1+2) splits (50%+25%+25%), T_2: Fertigation in 3 splits(33% each) - 100% dose of NPK, T_3: Fertigation in 3 splits - 75% dose of NPK, T_4: Fertigation in 4 splits (25% each) - 100% dose of NPK, T_5: Fertigation in 4 splits - 75% dose of NPK, T_6: Fertigation in 5 splits (20% each) - 100% dose of NPK, T_7: Fertigation in 5 splits - 75% dose of NPK.

Results and Discussion

Total nitrogen uptake at harvest was significantly higher with fertigation which received 100 per cent RDF with fertigation in 5 splits (161.00 kg ha^{-1}) over RDF-soil application and other fertigation treatments. Similar trend in the uptake of phosphorus (28.57 kg ha^{-1}) and potassium (134.87 kg ha^{-1}) was noticed (Table 1). This increase in uptake was due to better availability of nutrients at root zone as a result of frequent application of nutrients at different intervals to ultimately reduce losses. Fertilizer use efficiency was also significantly superior in fertigation treatments which received 75 per cent and 100 per cent of NPK at 5 splits (4.06 and 3.69, respectively) over other fertigation treatments and RDF-soil application. Higher fertilizer use efficiency was due to better availability of moisture and nutrients in sufficient quantity throughout the growth stages in more splits with fertigation was also reported. Higher gross returns (Rs.112101 ha^{-1}), net returns (Rs.79231 ha^{-1}) and B: C ratio (3.41) was recorded with 100 per cent RDF with fertigation in 5 splits as compared to all other treatments (Table 1). This was mainly attributed to significantly higher seed cotton yield as compared to all the other treatments.

Table 1: Nutrient uptake (NPK) at harvest (kg ha^{-1}), fertilizer use efficiency and economics of hybrid *Bt* cotton production as influenced by surface fertigation with different splits and dosage of fertilizer

Treatments	(Uptake kg ha^{-1})			Fertilizer use efficiency (Kg-kg^{-1})	Economics		
	Nitrogen	Phosphorus	Potassium		Gross returns (Rs.ha^{-1})	Net returns (Rs.ha^{-1})	B: C Ratio
T_1: RDF-Soil application	99.70	18.54	80.96	2.02	61347	31703	2.06
T_2: Fertigation in 3 splits-100% dose	131.82	25.12	110.44	2.97	90156	58912	2.88
T_3: Fertigation in 3 splits-75% dose	110.79	21.19	93.00	3.19	72534	43256	2.47
T_4: Fertigation in 4 splits- 100% dose	139.00	26.44	116.66	3.11	94281	62244	2.94
T_5: Fertigation in 4 splits- 75% dose	115.01	21.95	96.11	3.35	76197	46126	2.53
T_6: Fertigation in 5 splits- 100% dose	160.99	28.57	134.87	3.69	112101	79231	3.41
T_7: Fertigation in 5 splits- 75% dose	134.87	25.75	112.80	4.06	92466	61562	2.99
S.Em±	5.53	1.06	4.66	-	-	-	-
C.D. at 5%	17.05	3.27	14.37	-	-	-	-

89.

Prospects of Long-term FYM Application on Physical Properties of Sandy Loam Soil under Pearl Millet-wheat Rotation

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Key Words: Farmyard manure, Soil productivity, Physical properties and Pearl millet-Wheat rotation

Introduction

Pearl millet (*Pennisetum glaucum* L.)-wheat (*Triticum aestivum* L.) is an important cropping system in arid and semi-arid of India. Maintaining soil productivity is essential for sustainable agricultural productivity to meet the food demands of growing population. Green revolution technologies involving enhanced use of fertilizers, pesticides etc. coupled with high yielding varieties resulted in a significant boost in productivity of all major crops. Increase in production has slowed down or there has been a declined. To arrest fall in soil productivity, use of FYM or other manures is best alternative to maintain soil productivity by supplement essential plant nutrients, including micronutrients.

Results and Discussion

Among the different modes of FYM application, SOC was higher when FYM was applied in *rabi* than that applied in *kharif* season and it was increased by 11.3, 6.9 and 9.2%, respectively with 10, 15 and 30 t FYM ha^{-1} application in *rabi* as compared to similar its rate in *kharif* season. Bulk density decreased by 8.4 and 6.9 per cent in *rabi* and *kharif* season, respectively over control. The influence of FYM on decreasing the bulk density was more pronounced in upper soil layers (0-10 cm) than the lower layer (10-15 cm). Further, application of FYM significantly increased the saturated hydraulic conductivity of soil over control. Application of FYM in *rabi* increased the saturated hydraulic conductivity significantly (15.7, 26 and 31% with 10, 15 and 30 t FYM ha^{-1}) as compared to *kharif* season (12, 26 and 31% with 10, 15 and 30 t FYM ha^{-1}) over control. Moreover, long-term application of FYM increased the infiltration rate by 23.6 and 19% in *rabi* and *kharif* season, respectively over control. Among seasons, the effect of FYM applied in *rabi* was more pronounced in terms of increased mean weight diameter both dry as well as wet (27.7 and 24.8%) than in *kharif* season (27.4 and 26.8%) over control.

Materials and Methods

Present study was carried out with selection of seven treatments as given below:

L_0 Control: An absolute control; L_1 FYM ha^{-1} (5 t FYM ha^{-1} from 2008-09 onward in *rabi* season); L_2 FYM ha^{-1} (10 t FYM ha^{-1} from 2008-09 onward in *rabi* season); L_3 FYM ha^{-1} (15 t FYM ha^{-1} from 2008-09 onward *rabi* season); L_4 FYM ha^{-1} (5 t FYM ha^{-1} from 2008-09 onward in *kharif* season); L_5 FYM ha^{-1} (10 t FYM ha^{-1} from 2008-09 onward in *kharif* season); L_6 FYM ha^{-1} (15 t FYM ha^{-1} from 2008-09 onward *kharif* season).

Table 1: Long-term effect of FYM application in *rabi* and *kharif* season on soil organic carbon

Treatment	Soil organic carbon (%)
Control (No fertilizer no FYM)	0.30
L_1 15 t FYM ha^{-1} in (*rabi*) + N	0.49
L_2 30 t FYM ha^{-1} in (*rabi*) + N	0.62
L_3 45 t FYM ha^{-1} in (*rabi*) + N	0.65
L_4 15 t FYM ha^{-1} in (*kharif*) + N	0.44
L_5 30 t FYM ha^{-1} in (*kharif*) + N	0.58
L_6 45 t FYM ha^{-1} in (*kharif*) + N	0.59
CD (at 5%)	0.03

* N applied @ 120 kg ha^{-1}

Table 2: Long-term effect of FYM application in *rabi* and *kharif* season on soil bulk density of different layers

Treatment	Soil bulk density (Mg m^{-3})		
	0-5 cm	5-10 cm	10-15 cm
Control (No fertilizer no FYM)	1.31	1.38	1.50
L_1 15 t FYM ha^{-1} in (*rabi*) + N	1.23	1.21	1.34
L_2 30 t FYM ha^{-1} in (*rabi*) + N	1.21	1.24	1.34
L_3 45 t FYM ha^{-1} in (*rabi*) + N	1.17	1.27	1.35
L_4 15 t FYM ha^{-1} in (*kharif*) + N	1.24	1.19	1.35
L_5 30 t FYM ha^{-1} in (*kharif*) + N	1.19	1.22	1.34
L_6 45 t FYM ha^{-1} in (*kharif*) + N	1.22	1.23	1.34
CD (at 5%)	0.02	0.02	0.02

* N applied @ 120 kg ha^{-1}

90.

Nutrient Status of Mothbean [*Vigna aconitifolia* (Jacq.) Marechel] Growing Soils of District Poonch (J&K)

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Keywords: Available nutrients, status, mothbean and soil

Introduction

Mothbean [*Vigna aconitifolia* (Jacq.) Marechal] popularly known as "MOTH" in urdu/ hindi/ dogri is widely grown in arid and semi arid part of the country, mostly as a dryland crop either sole or in mixture for grain or fodder. The lower productivity of this crop is attributed to several factors namely growing the crop under moisture stress conditions, late sowing and absence of or inadequate use of fertilizers. Moreover, the yield of local cultivars of mothbean is much less as compared to other pulse crops. Considering the constraints in the production potential of mothbean and also very little information available on the content of different nutrients in mothbean growing soils of Poonch in Jammu and Kashmir (J&K), this study was conducted.

Materials and Methods

The present investigation was undertaken in Poonch district of J&K State in 2014. The soil samples were collected from surface layer (0-0.20 m) from each mothbean growing villages of district Poonch (Jammu province). A total of twenty seven villages growing mothbean were selected for random soil sampling. Collected soil samples were air dried, ground with wooden mortar and pestle and passed through 2 mm stainless steel sieve. These soil properties and available nutrients were analyzed by standard methods (Jackson, 1973).

Results and Discussion

The soil reaction was acidic in nature (pH=4.78 to 6.87). The electrical conductivity ranged between 0.11 and 0.33 dS m^{-1} with the safe form soluble salt content. The organic carbon (OC) content of the soils in mothbean growing areas of Poonch district ranged from medium to high values (5.2 - 8.4g kg^{-1}). The available nitrogen was low to medium range (243.98 kg ha^{-1} to 395.27 kg ha^{-1}). The available phosphorus content in the soils ranged from (8.19 to 15.46 kg $ha^{-1)}$. Overall, the soils were in low to medium range with respect to available phosphorus. The available potassium content was medium to high in the soils ranged from (127.00 to 318.16 kg ha^{-1}). Available sulphur was found in a narrow range of medium to low (6.99 mg kg^{-1} to 13.75 mg kg^{-1}) in soil of mothbean growing areas. Soil pH of the surface layer had a significant and negative correlation with available Phosphorus (r=--0.278**). Soil organic carbon showed a significant positive relationship with the available nitrogen and available sulphur (r= 0.451** and 0.259*). Thus it may concluded that the Phosphorus management is very crucial aspect, there is a further need to assess the various fertility status of mothbean growing soils in district Poonch, which will give insight for a better fertilizer scheduling in general and phosphorus fertilizers in particular to get the better productivity of mothbean as well as sustainable soil health.

Table 1: Soil fertility status of mothbean growing areas of Poonch district

Soil quality	Overall ranges	Mean
pH	4.78 - 6.87	5.84
EC (dS m^{-1})	0.11 - 0.33	0.21
Organic carbon (g kg^{-1})	5.2 - 8.4	6.34
Available Nitrogen (kg ha^{-1})	243.98- 395.27	311.61
Available Phosphorus (kg ha^{-1})	8.19 - 15.46	12.59
Available potassium (kg ha^{-1})	127.00 -318.16	234.63
Available Sulphur mg kg^{-1}	6.99 - 13.75	10.62

Reference

Jackson, M. L. 1973. *Soil chemical analysis: Advanced course*. The Author. Madison, Wisconsin, USA.

91.

Determination of Critical Limits of Available Phosphorus for Indian Mustard (*Brassica juncea* L.) in Chatha Soil by Linear Response Plateau Model

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Keywords: Indian mustard, dry matter yield, available phosphorus and critical limits.

Introduction

Phosphorus (P) is among the principle elements required for crop growth. It plays a key role in photosynthesis, metabolism of sugars, energy storage and transfer, cell division, cell enlargement and transfer of genetic information. Application of P not only affect its own absorption and assimilation in plants but also influence a number of other essential as well as non essential elements present in the soil. Increase in yield brought by P application is significant and economically viable owing to its wide spread deficiency in soils of India in general and particularly in Jammu and Kashmir (J&K) Hasan (1996). Several soil test methods have been developed to evaluate the available phosphorus status of soils for predicting the response of applied phosphorus and to establish its critical limits for various crops.

Materials and Methods

Bulk surface soil samples (0 to 15 cm depth), extremely deficit in available phosphorus, were collected from selected mustard growing location. The soil sample were air dried and grounded to pass through 2 mm stainless steel sieve to remove gravels and crop residues. The processed soils were thoroughly mixed and stored in polyethylene lined gunny bags for conducting pot culture experiment. Sample of the processed soil was brought to the laboratory for analysis. Ten levels of phosphorus at the rate of 0, 10, 20, 30, 40, 50, 60, 70, 80 and 100 mg P kg^{-1} soil. The phosphorus treated soils were incubated in pots at field capacity for 28 days. A representative sample of soil was drawn from each treatment for the analysis of available phosphorus by Olsen (Olsen *et al.*, 1954) soil test method. Indian mustard (*Brassica juncea* L.) (cv. RSPR-03) was raised as a test crop. The critical limits of available P were established by using linear response plateau (LRP) model as described by Waugh *et al.* (1973).

Results and Discussion

In order to demarcate the soils on the basis of their responsiveness and non-responsiveness or relatively less responsiveness, the critical limits of available P was determined. The (LRP) model proposed by was employed to establish the critical limit of available P for predicting the response of applied P fertilizer to Indian mustard crop raised in Chatha, soil. The response to each nutrient interpreted separately by using the threshold and plateau yield levels in this model. The application of nutrient results in yield response having a starting point i.e. threshold yield and ending point i.e. plateau yield. There were significant relationship between dry matter yield and available P determined by different soil tests as well as between P uptake and available P. Out of the five methods tested. Olsen's method gave the highest correlation coefficients values with dry matter and P uptake by Indian mustard crop in Chatha The linear response and plateau lines were established and the point of intersection was used to determine the critical limits of available P. Hence, the critical limits of available P for Indian mustard (Cv.RSPR-03) were established as by Olsen soil test for Chatha with the help of these critical limits (Fig. 1). One can determine the area of probable deficiency for available P in soils. The present investigation indicated that below 10 kg P ha^{-1} by Olsen soil test method, farmer may get definite response to application of P in Chatha soil, and above these critical limits, farmer may get very little response or may not get response at all. Therefore, the farmers will have to apply higher P fertilizer doses in these soils for obtaining the optimum yield of Indian mustard crop.

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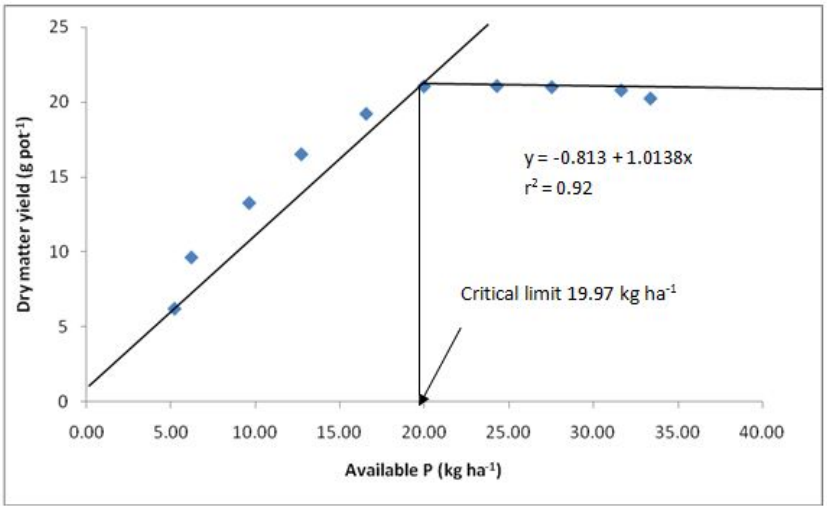

Fig. 1: Determination of critical limit of available Phosphorus (Olsen method) for Indian mustard (Cv. RSPR-03) in Chatha soil by Linear Response Plateau (LRP) model.

92.

Quality and Seed Production of Single Cross HQPM Hybrid as Influenced by Different Row Ratio of Male and Female Parents and Fertility Levels

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Keywords: HQPM, single cross hybrid, male: female ratio, fertility level, hybrid seed production, tryptophan, lysine.

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops in the world. Quality protein maize (QPM) contains nearly twice amount of lysine and tryptophan, the two amino acids essential for protein synthesis in humans. Research suggests that QPM can help in reducing protein deficiencies, particularly in young children where maize dominates in the diets. Keeping this in view we undertake the study to find out the suitable row ratio of male and female parents and effect of fertility levels on production of quality seed/grain single cross maize hybrid i.e. HQPM.

Materials and Methods

A field experiment was conducted in *kharif* 2012 at Shivalik Agricultural Research and Extension Centre, Kangra of Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The treatments consisting of 4 fertility levels (80-40-25, 120-60-40, 160-80-55 and 200-100-70 kg N-P_2O_5-K_2O ha^{-1}) in main plots and 3 row ratios (3: 1, 4: 1 and 5: 1 of female: male) in sub plots which were laid out in split plot design with three replications. Seeds of 'Male (HKI 163) and female (HKI 193-1) parent' were used for sowing with recommended seed rate of 20 kg ha^{-1}. Protein content in grains by Kjeldahl's method, tryptophan and lysine content by spectrophotometric method were determined.

Results and Discussion

The data in Table 1 revealed that in general, all the quality parameters i.e. protein content, lysine content and tryptophan content were increased with increase in the fertility level in male and female parents. Application of 200-100-70 kg N-P_2O_5-K_2O ha^{-1} recorded significantly higher values for all quality parameters as compared to lower fertility levels. The reasons for higher protein content under 200-100-70 kg N-P_2O_5-K_2O ha^{-1} may be attributed to higher N availability which is the major constituent for protein synthesis. Row ratios did not have any significant effect on quality parameters in male/female parents. Application of 120-60-40 kg N-P_2O_5-K_2O ha^{-1} being at par with 160-80-55 kg N-P_2O_5-K_2O ha^{-1} recorded significantly higher seed/grain yield as compared to 200-100-70 kg N-P_2O_5-K_2O ha^{-1} and 80-40-25 kg N-P_2O_5-K_2O ha^{-1} fertility level for both the parents. Significantly lower yield was recorded with 200-100-70 kg N-P_2O_5-K_2O ha^{-1} which might be due to the adverse effect of higher fertility level leading to less plant population, lodging of the plants and more disease incidence. Among row ratios, 3: 1 (Female: Male) produced significantly highest seed/grain yield and was followed by 4: 1 (Female: Male) row ratio for both parents. The highest seed/grain yield at 3: 1 (F: M) may be attributed mainly due to availability of sufficient viable pollens during flowering period which ensured increased pollination and fertilization to obtain higher hybrid seed set and yield. Application of 120-60-40 kg N-P_2O_5-K_2O ha^{-1} and 3: 1 (F: M) row ratio found to be optimum for hybrid seed production.

Table 1: Effect of different treatments on quality parameters and yield (q ha^{-1}) of maize seed/grain

Treatments	Protein content (%)		Lysine content (%)		Tryptophan content (%)		Seed/Grain yield (q ha^{-1})	
	F	M	F	M	F	M	F	M
Fertility levels (kg N-P_2O_5-K_2O ha^{-1})								
80-40-25	8.2	9.2	1.9	1.8	0.6	0.5	16.0	4.21
120-60-40	8.5	9.3	2.6	2.3	0.7	0.6	19.2	5.77
160-80-55	8.9	9.4	3.1	2.7	0.8	0.8	17.1	5.37
200-100-70	9.3	9.5	3.3	3.2	0.9	0.9	9.4	2.97
CD (P=0.05)	0.5	0.21	0.23	0.3	0.12	0.12	2.6	0.60
Row ratio (F: M)								
3: 1	8.9	9.5	2.8	2.6	0.8	0.7	17.6	5.40
4: 1	8.5	9.3	2.7	2.5	0.7	0.6	15.3	4.71
5: 1	8.7	9.3	2.6	2.5	0.7	0.7	13.3	3.63
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.5	0.43

F- Female, M- Male

93.

Phosphorus Uptake and Allocation in Pigeonpea Genotypes

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Keywords: Pigeonpea genotypes, P-uptake, phosphorus content

Introduction

Phosphorus (P) never found as a free state in soil, it forms complexes with several cations such as Fe, Ca, Mg and Al. P does not move freely in rhizosphere due to complex formation. Some crops like pigeonpea may increase P uptake by modifying their root system. Pigeonpea genotypes secrete some organic acids and enzymes which solubilize the unavailable P of soil and make it available to plant. Wide variations occurs in pulse crops for nutrient requirement; thereby these crops possess differential capability to utilize plant nutrient from different soil layers, resulting in better use efficiency of the applied nutrient and residual fertility (Singh *et al* 2005).

Materials and Methods

The study was carried out at Punjab Agricultural University, Ludhiana. Forty three genotypes were screened in pots with eight replications. Design of experiment was factorial complete randomized design (FCRD) and treatments were two (No added P and recommended dose of P). Phosphorus was applied to the soil in the form of Di Ammonium Phosphate (DAP). The pots were filled with 12 kg soil. The P content in roots, shoots and leaves was estimated by vanado-molybdate method (Jackson 1973).

Results and Discussion

Large genetic variations seem to exist within pigeonpea genotypes for uptake and allocation of P. The P content in stem at P sufficient conditions was high in genotype Manak and ICPL 20340 while AL 1836 and AL1933 had low P content. Under P deficient condition, ICPL 88039, MN5 had high P in root and AL1847 and AL1778 accumulated low P content in roots. Genotypes like ICPL 20329, MN5 and ICPL 88039 accumulated more P in leaves under P deficient condition. P accumulation in leaves at P sufficient condition was higher in AL1747 and IC245506. Among 43 genotypes some genotypes like ICPL 20330 MN5 and ICPL 88039 had higher P content in their leaves, whereas these genotypes showed low concentration of P in roots (Fig. 1). More P accumulation in roots showed low P uptake and low P concentration in roots showed high P uptake. Some genotypes had more P acquisition AL1873, AL1941 and AL1839 but P utilization low in these genotypes under P deficient condition. The phosphorus content of the leaves of some genotypes was appreciably higher than stem at 60 days. Genotypic variation to acquire and utilize P from soil was observed in this study under both P deficient and sufficient conditions. Genotype with higher external P uptake efficiency showed higher relative root growth because the additional P taken up by roots, allow further biomass accumulation including root growth.

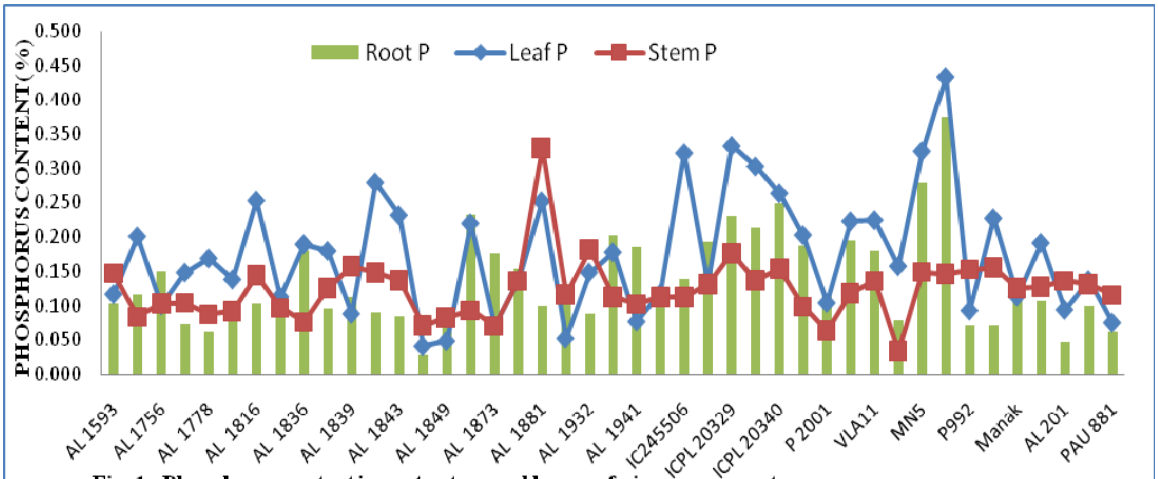

Fig. 1.- Phosphorus content in roots, stem and leaves of pigeonpea genotypes

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94.

Evaluation of Different Levels of Zinc Application on Grain Yield and Important Agronomic Characteristics of Basmati Rice

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Keywords: Zinc application, grain yield

Introduction

Basmati rice (*Oryza sativa)* occupies a prime position in national and international markets due to its quality and heavy foreign demand. Zinc deficiency is a serious nutritional problem throughout the rice-growing world. Under severe Zn deficiencies, tillering decreased or could stop completely, and time to crop maturity increased. Zinc concentration lower than the required range resulted in restricted diffusion of zinc to the root surface thereby limiting zinc supply to crops (Chand *et al.,* 1981). Zn deficiency can be corrected by applying zinc fertilizers. Therefore, present study was undertaken to evaluate different doses of zinc on grain yield and yield attributes of basmati rice.

Materials and Methods

The experiment was conducted at regional research station, Gurdaspur on clay loam soil for two consecutive years. Pusa Basmati 1121, a promising variety of basmati in Punjab, was used for the study. The concentration of DTPA-extractable Zn was 0.49 and 0.53 mg kg^{-1} in 2013 and 2014, respectively. The experiment was conducted in randomized complete block design with 3 replications and five zinc treatments namely, control, 6.25kg $ZnSO_4$/acre, 12.5kg $ZnSO_4$/acre, 25kg $ZnSO_4$/acre and 50kg ZnSO4/acre along with basal dose of recommended NPK. Data on plant height, number of tillers per hill and panicle length was recorded at maturity along with yield at harvest.

Results and Discussion

A considerable increase was observed in grain yield with zinc application and a significant difference between the highest and lowest yield was observed with the highest crop yield in T_5 (37.76 q/ha). The grain yield increased with Zn application. On an average, the yield increase ranged from 9.3% to 21.5%. The highest increase in yield was obtained in treatment T_5 but was at par with T_4 treatment(Table 1). Although, a little increase or decrease occurred for the number of plant height, panicle length and no. of productive tillers per hill with zinc application. Similar results were observed for the maturity time and tiller number and for tillering, time to crop maturity and spikelet sterility (IRRI, 2000). The findings from this study revealed that zinc fertilization increased basmati rice yield in zinc deficient soils.

Table 1: Grain yield and agronomic parameters as influenced by different levels of zinc application (pooled data of two years)

Treatment	Average yield q/ha		Plant height	Panicle length	No.of productive tillers per hill
		Increase %			
T_1 - control	31.07		123	27.5	19
T_2 - 6.25kg $ZnSO_4$/acre	33.95	9.3	126	27.5	18
T_3 - 12.5 kg$ZnSO_4$/acre	36.12	16.2	129	27.0	21
T_4 - 25 kg$ZnSO_4$/acre	37.09	19.4	127	28.0	20
T_5 - 50 kg$ZnSO_4$/acre	37.76	21.5	129	28.0	20
CD (5%)	1.1		1.70	1.24	NS

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95.

Growth Performance and Biochemical Responses of Tomato (*Lycopersicon esculentum* Mill.) and Brinjal (*Solanum melongena* L) Grown in Coal Ash Amended Soil

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Keywords: Coal ash, tomato, brinjal, germination, growth, nutrient acquisition.

Introduction

Coal ash is an important industrial waste generated by thermal power stations that can be used as a soil amendment to crops. It also acts as a feasible alternative to lime for amelioration and amendment of acid soils and micronutrient carrier. The effect of coal ash on solanaceous vegetables such as tomato and brinjal in Odisha has not been studied. As such, the study intends to find out the effect of levels of coal ash on the growth and development of these solanaceous vegetables and to evaluate the tolerance level of tomato and brinjal to coal ash.

Materials and Methods

A pot culture experiment was carried out in the Regional Research and Technology Transfer Station, Orissa University of Agriculture and Technology, Semiliguda, Koraput, Odisha during 2009 and 2010. The experiment comprised of five treatments such as T_1: 100% soil mixture +0% coal ash, T_2: 75% soil mixture +25% coal ash, T_3: 50% soil mixture +50% coal ash, T_4: 25% soil mixture +75% coal ash, T_5: 0% soil mixture+100% coal ash was laid out in completely randomized block design with 5 replications to assess the effect of varying levels of coal ash on growth performance and bio-chemical parameters of tomato and brinjal.

Results and Discussion

The results revealed that the combination of 50: 50 soil and coal ash mixture increased the seed germination, seedling height, collar girth, number of leaves, leaf area, number of flowers, number of fruits, fruit weight (gm/plant) and other yield attributing characteristics of tomato and brinjal. The increase in growth traits was attributed to increase in nutrient acquisition of plants grown under above combination (50: 50) in both tomato and brinjal. However, 100% coal ash in the growing medium reduced seed germination, seedling vigour, growth, yield and yield attributing characters. In tomato, the chlorophyll content, leaf nutrient status of N, P, Ca, Mg, S and the micro nutrients Zn, Mn, B, Mo, Fe and Cu status were found to be higher in the treatments having higher proportion of coal ash than other treatments and the lowest was recorded in control (no coal ash). Similarly, in brinjal the leaf nutrient status of Ca, Mg, S and the micro nutrients Zn, Fe and Cu status were found to be higher in the treatments having higher proportion of coal ash in the growing medium. The present investigation suggests that application of coal ash in certain proportion along with soil mixture is beneficial in terms of plant growth parameters and nutrient acquisition in tomato and brinjal plant.

Table 1: Effect of coal ash on micronutrients status (mg/kg) of tomato and brinjal (Pooled data of 2009 and 2010)

Treatment	Tomato						Brinjal					
	Mn	B	Mo	Fe	Cu	Zn	Mn	B	Mo	Fe	Cu	Zn
Coal Ash: Soil (0: 100)	27.50	55.5	40.5	162.8	18.2	21.35	0.78	0.46	2.51	0.76	0.45	0.35
Coal Ash: Soil (25: 75)	28.25	58.2	42.2	170.2	20.5	22.16	1.08	0.42	2.82	0.76	0.48	0.37
Coal Ash: Soil (50: 50)	29.30	58.5	42.5	172.8	21.2	23.4	1.70	0.38	3.75	0.78	0.50	0.40
Coal Ash: Soil (75: 25)	30.20	58.8	42.8	175.6	21.8	24.2	1.55	0.42	3.43	0.82	0.55	0.42
Coal Ash: Soil (100: 0)	30.50	58.9	43.5	178.8	22.0	24.3	1.37	0.50	3.40	0.85	0.62	0.50
SE (m)±	0.92	1.55	1.22	1.73	0.52	0.02	0.02	0.01	0.18	0.03	0.19	0.17
LS.D. (0.05)	2.82	4.75	3.74	5.31	1.59	0.614	0.06	0.04	0.49	0.32	0.58	0.52

96.

Study on Comparison of Precision Seeding with Traditional Seeding in Wheat

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Keywords: *INM, Resource conservation technologies, Rice-wheat system*

Introduction

Amount of seeds in rows in an important factor in crop production, which can affect growth and yield and this to a great extent, depends on the performance of the metering mechanism of the precision seed drill. Therefore, proper design of a metering device is an essential element for satisfactory performance of a precision seed drill. Irregularity of placement of seeds in an index of estimation of seeding quality sown by precision seed drill. Determination of irregularity of seed deposition in the field is very difficult. For a seed drill, the operator has no chance to see the workability of the metering mechanisms. In the present investigation, an effort has been made to compare the efficiency of various seeding techniques as mediated by manual sowing (broadcasting), ordinary seed drill, zero seed drill and precision seed drill. Data on crop growth yield and soil fertility at periodic intervals was recorded.

Materials and Methods

A field experiment was conducted at the research farm, PDFSR Modipuram, Meerut during the *rabi 2007-08* and *2008-09*. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction, low in organic carbon (0.38%) and available nitrogen (240 kg/ha) and was medium in available phosphorus (13.9 kg/ha) and potassium (262.2 kg/ha). Wheat variety PBW 226 was sown with recommended N, P, K and agronomical practices and harvested during the mid April both the years of experimentation using 120 kg seed ha^{-1}. The experiment of 12 treatments of broadcasting manually, seeding with ordinary seed drill, Zero seed drill and CIAE precision seed drill using 120 kg seed ha^{-1}.

Results and Discussion

The performance of precision seed drill resulted Grain yield of wheat (4.84 t ha^{-1}) was increased significantly compared to all other methods of seeding. The lowest yield (3.86 t ha^{-1}) was recorded under broadcasting technique (Table 1). In comparison to broadcasting technique of seeding, the yield performance under precision plot drill was highest (25.4%) followed by zero till drill (11.9%) and ordinary seed drill (6.2%). The significant yield advantage under precision seeding was attributed mainly due to proper seed placement. Water and nitrogen use efficiencies under this treatment were also highest being 1.13 g grain /lit of water and 40.33 kg grain per kg of nitrogen. The efficiency of zero till drill was second best followed by ordinary drill, which provides same spacing as those of precision plot drill.

There are numerous reports that the soil fertility status monitored at various phonological stages of the crop revealed that, organic carbon of soil did not varied significantly under all the seeding techniques, but available N, P and K status at later growth stages was improved under precision seeding which was on par with zero-till seeding.

The results show similar or slightly higher yields with precision seed drill. The developed precision could sense the number of grains dropped, i.e., the grain seed flow for wheat. The maximum difference between the number of grain seeds dropped on the greased belt and that indicated in the display unit was within 18% for wheat seeds.

Table 1: Effect of improved agricultural implements on growth and yield of wheat

Treatment	Plant height (cm)	No. of tillers m^{-2}	Ear length (cm)	No. of grains per spike	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T1	88.9	335.3	8.2	37.2	3.86	6.86	10.72	36.01
T2	91.9	370.0	9.2	39.1	4.10	7.05	11.15	36.77
T3	104.1	421.7	9.9	50.3	4.84	7.91	12.75	37.96
T4	89.7	390.3	9.4	47.9	4.32	6.98	11.30	38.23
SEm±	2.1	6.8	0.2	2.1	0.12	0.23	0.57	0.58
CD (P=0.05)	7.1	23.3	0.8	7.2	0.42	0.79	1.97	1.99

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97.

Effect of Micro Nutrients Mixture Ratio on Growth of Chilli Seedlings

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Keywords: Chilli, micronutrients, seed, germination

Introduction

Chilli (*Capsicum annuum* L.) (Solanaceae) commonly known as hot pepper or hot chilli is an important commercial high value crop. According to Ministry of Agriculture in 2014-15, chilli was cultivated in 0.78 million hectare and produced 1492 million tonnes with a productivity of 1925 kg/ha. Andhra Pradesh, Madhya Pradesh and Telungana and Karnataka are the major chilli growing states. Providing optimum micronutrients as starter for enhance and give uniform seedling vigour of chilli seedlings, facilitating uniform seedling emergence and good establishment.

Materials and Methods

The experiment was conducted at department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore in a completely randomized design with five treatments in four replications. Perforated semi-bleached and poster paper was used as bottom and top paper of seed tapes (Fig. 1). The synthetic adhesive poly vinyl acetate 80 per cent and micronutrient mixture was used. Therefore an experiment was conducted with the following treatments using various concentration of six micronutrient mixture used were: Zinc sulphate ($ZnSo_4$), Borax (Bo), Iron sulphate ($FeSo_4$), Molybdenum (Mo), Manganese sulphate ($MnSo_4$) and Copper Sulphate ($CuSo_4$) were included in the adhesive mixture in three dosages namely 0.17 g, 0.20 g and 0. 35 g. The treatments consisted of T1: seed tapes with 8 ml of adhesive + 2 ml of water with mixture (0.35 g), T2: seed tapes with 8 ml of adhesive + 2 ml of water with mixture (0.2 g), T3: seed tapes with 8 ml of adhesive + 2 ml of water with mixture (0.17 g), T4: control seed tapes (with 80% adhesive alone), T5: control (Untaped seeds).

Fig. 1: Tapped chilli seeds

Results and Discussion

The result in this study indicated that $ZnSO_4$, Bo, $FeSO_4$, Mo, $MnSO_4$ and $CuSO_4$ were included in the adhesive mixture in three dosages namely 0.17 g, 0.20 g and 0. 35 g. Among the three concentrations, 0.20 g recorded the highest values of germination percentage (88.7), seedling root length (13.8), seedling shoot length (17.8), dry matter production (g seedling^{-10}) and vigour index (2803) (Table 1).

Table 1: Effect of micronutrient treatment on seed germination and seedling vigour of taped chilli seeds

Treatments	Speed of germination	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (g seedling^{-10})	Vigour index
Control	19.7	85.5 (67.7)	10.4	15.1	1.308	2175
Control tape	19.4	85.2 (67.2)	10.6	15.0	1.332	2182
0.17 g	20.9	87.0 (68.9)	13.0	16.6	1.634	2574
0.20 g	20.4	88.7 (70.4)	13.8	17.8	1.783	2803
0.35 g	20.0	85.7 (67.5)	11.8	16.9	1.480	2461
Mean	20.0	86.4 (67.9)	11.9	16.3	1.507	2439
S.Ed	0.424	0.703	0.403	0.800	0.026	68.813
CD(P=0.05)	0.905	1.499	0.860	1.706	0.056	146.674

Note:
Micronutrient mixture 0.17 g= $ZnSo_4$ (0.05g), Bo (0.025g), $FeSO_4$ (0.025g), Mo (0.025g), $MnSO_4$ (0.025g) and $CuSO_4$ (0.025g).
Micronutrient mixture 0.20 g= $ZnSo_4$ (0.075g), Bo (0.025g), $FeSO_4$ (0.025g), Mo (0.025g), $MnSO_4$ (0.025g) and $CuSO_4$ (0.025g).
Micronutrient mixture 0.35 g= $ZnSo_4$ (0.1g), Bo (0.05g), $FeSO_4$ (0.05g), Mo (0.05g), $MnSO_4$ (0.05g) and $CuSO_4$ (0.05g).

It is well documented that most of the macro and micronutrients like K, Fe, Mn and Zn are the cofactors of many enzymes which are involved in the metabolic activities of seeds and plants by regulating the enzyme activities. Probably, this might be the reason for the increase in germination and seedling vigour in this study. The results of the present investigation are in agreement with the findings of Grzywnowicz-Gazda (1982) in spring barley, Fasui *et al.* (1996) in sunflower, who recorded enhanced germination and vigour due to seed treatment with micronutrient mixtures**.**

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98.

Distribution of Different Forms of Nitrogen and Sulphur and their Relationship with Some Soil Properties under Vertisols, Inceptisols and Entisols

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Keywords: Entisols, inceptisols, nitrogen, sulphur, vertisols

Introduction

Nitrogen and sulphur have been assumed critically in management of soil fertility in Indian soils. Nitrogen is the major nutrient in crop production required for chlorophyll and protein synthesis and recognized as a universally deficient plant nutrient. In most of the soils, nitrogen content found to be low to medium in range. Sulphur as a nutrient gained lot of importance in crop production and found deficient in low organic matter light textured intensively cultivated soils (Malewar and Ismail, 1997). Distribution of different forms of sulphur determines the sulphur supplying power of soil by influencing its release and dynamics in soil particularly where sulphur is added as a carrier**.** Annual rainfall of study areas was799 mm with temperature ranged 19.1°C and 39.7°C.

Materials and Methods

An investigation was carried out to study the different forms of nitrogen and sulphur along with some soil properties in soils of Lohara tahsil of Osmanabad district. The 180 soil samples were collected from all the selected 30 villages by grid survey from Lohara tahsil of Osmanabad district of Maharashtra state and analyzed for different forms of N and S along with some soil properties by following standard procedures as out lined by Jockson (1973). The relationship between different forms of nitrogen and sulphur with soil properties under various orders namely Vertisols, Inceptisols and Entisols were worked out.

Results and Discussion

The pH, EC, O.C. and $CaCO_3$ of Vertisols, Inceptisols and Entisols varied from 7.1 to 8.9, 7.2 to 8.9, and 6.9 to 8.7 with mean of 8.25, 8.17 and 8.13, 0.10 to 0.60, 0.10 to 0.90 and 0.10 to 1.00 dSm-1 with average of 0.26, 0.26 and 0.60,0.37 to 7.65, 0.69 to 7.80 and 0.75 to 7.87 g kg-1 with a mean value of 4.31, 3.95 and 3.85 g kg-1 and 10 to 164, 10 to 175 and 10 to 180 g kg-1 with a mean values of 82.97, 94.94 and 94.59 g kg-1, respectively. These soils were categorized as neutral to alkaline in reaction, safe in salinity, low to medium in organic carbon and calcareous to highly calcareous in nature. The total N and available N in Vertisols, Inceptisols and Entisols ranged from 0.056 to 0.096, 0.036 to 0.096 and 0.042 to 0.073 with an average of 0.076, 0.067 and 0.058 per cent and 103 to 439.04, 141.12 to 442.18 and 166.20 to 385.73 kg ha^{-1} with mean values of 223.34, 259.81 and 260.82 kg ha^{-1}, respectively. The total S and available S in Vertisols, Inceptisols and Entisols varied from 544.00 to 3489.00, 430.00 to 2225.00 and 318.00 to 1920.00 mg kg^{-1} with a mean values of 1862.14, 1448.34 and 906.17 mg kg^{-1} and 1.75 to 51.25, 1.25 to 57.75 and 1.75 to 49.00 mg kg^{-1} with an average of 9.97, 11.15 and 10.35 mg kg^{-1}, respectively. It is concluded that Vertisols were low in available N and S as per their critical limits of less than 280 kg^{-1} and10 mg kg^{-1} followed by Inceptisols and Entisols while, total N, total S and other remaining forms of N and S were recorded as low to medium in soils of all the orders of Lohara tehsil. All the forms of nitrogen and sulphur were showed negative but significant correlation with pH, EC and $CaCO_3$ while, organic carbon was positively and significantly correlated with all forms of nitrogen and sulphur.

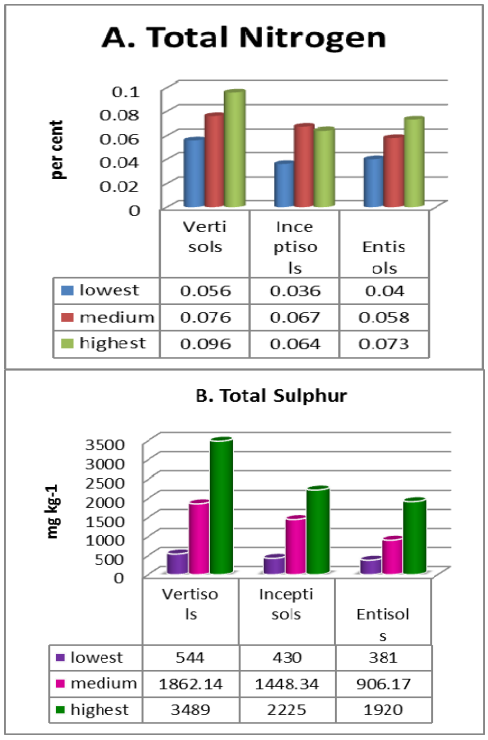

Fig.: Status of Total Nitrogen and Total Sulphur (1 and 2).

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99.

Interactive Effect of Brassinosteroid and Cadmium on Antioxidative Metabolism in Wheat (*Triticum aestivum*) Seedlings

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Keywords: Cadmium, wheat, brassinosteroids, ROS scavenging enzymes

Introduction

Wheat (*Triticum aestivum)* is the world's most widely grown cereal crop. Elevated concentrations of both essential and nonessential heavy metals in the soil can lead to toxicity symptoms and growth inhibition in most plants. Cadmium (Cd) is one of the most highly toxic environmental pollutant in the atmosphere, soil and water. Cd induces oxidative stress in plants by generating reactive ooxgen species (ROS) like superoxide, hydroxyl radical, hydrogen peroxide, alkoxy radical. Brassinosteroids (BRs) are plant natural polyhydroxysteroids with pleiotropic effects and also responsible for plant stress tolerance. Therefore,we analyzed the interactive effect of brassinosteroids & cadmium on antioxidative metabolism in germinating wheat seedlings.

Materials and Methods

The seeds of the wheat cultivar were germinated aseptically in petri plates having sterilized wet filter paper. Different concentrations of cadmium chloride ($CdCl_{2)}$ were prepared using distilled water (DW) which were: $CdCl_2$ (5ppm, 20ppm, 50ppm & 100ppm). Three petri plates were kept for each concentration. To each petri plate, 20 ml of $CdCl_2$ was added. Combinations of BR with $CdCl_2$ were also prepared in DW i.e 10 ml of BR and 10 ml of $CdCl_2$. The 5 day old germinated wheat seedlings were analysed for the activities of antioxidative enzymes like catalase (CAT), ascorbate peroxidase (APX), guaiacol peroxidase (GPX), polyphenol oxidase (PPX) and soluble proteins.

Results and Discussion

In the present investigation, activities of antioxidative enzymes were monitored in $CdCl_2$-treated wheat seedlings and the interaction of BR and $CdCl_2$ was also studied with regard to their effect on antioxidative enzymes. It was observed that under the effect of $CdCl_2$, wheat seeds showed retarted germination and growth. But when BR is added with $CdCl_2$ stimulation in the germination and growth of seedlings were noticed. At the varying concentration of $CdCl_2$, wheat seedlings showed the decreasing activity of CAT and APX but BR treatment enhances the activities of these enzymes (Fig. 1). Under the effect of $CdCl_2$, increased activities of GPX and PPX (Fig. 1) were studied with an increase in the concentration of $CdCl_2$ and BR in combination with $CdCl_2$ but the activity was substantially higher than in the presence of $CdCl_2$ alone, suggesting a protective role of BR against heavy metal stress. The content of soluble protein increased gradually under the influence of BR in combination of $CdCl_2$ while it decreased with increased concentration of $CdCl_2$ alone. This suggested that the application of both BR and $CdCl_2$ relieved the seedling from the $CdCl_2$ stress by affecting the antioxidative metabolism.

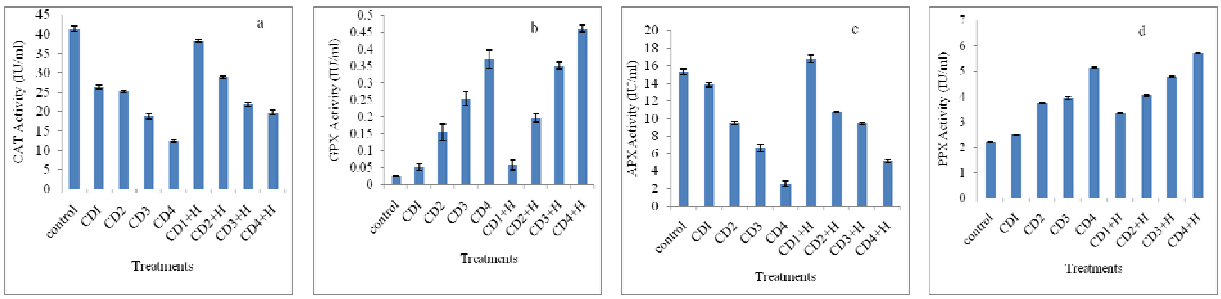

Fig. 1: CAT, GPX, APX and PPX activity (IU/ml) in the 5 day germinated wheat seedling, treated with different concentration of Cd with single concentration of BR. The metal treatments (in ppm) are: control, CDI (Cd 5), CD2 (Cd 20), CD3 (Cd 50), CD4 (Cd 100), CD1+H (Cd 5+BR(10µl/20ml)), CD2+H (Cd20+BR(10µl/20ml)), CD3+H(Cd50+BR(10µl/20ml)), CD4+H (Cd 100+BR(10µl/20ml)).

From this study it can be concluded that cadmium adversely effect the antioxidative metabolism while brassinosteroids by inducing the activity of ROS scavenging enzymes, alleviate the negative effect of cadmium chloride in germinating wheat seedlings.

100.

Effect of Nitrogen and Potassium on Quality of Turf of Bermuda Grass (*C. dactylon* L.)

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Keywords: Turf, nitrogen, potassium, appearance, quality

Introduction

The experiment was conducted at orchard of Department of Horticulture, CCS HAU, Hisar (Haryana). Nitrogen and potassium plays very important role in growth and development of turf grass. Nitrogen is perhaps the most important nutrient as it helps the grass to produce green, healthy leaves. Potassium plays important role in photosynthesis and carbohydrate production. Johnson (1973) reported that N fertilizer improve the appearance of turf. High rates of nitrogen are needed to ensure top quality turf, and nitrate is usually the principal source of nitrogen in fertilizers (Epstein and Bloom, 2005).

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 RBD design with four levels of nitrogen *viz.* (0, 10, 20, 30 g/sq.m) and three levels of potassium *viz.* (0, 10, 20 g/sq. m) in thirty six plots with three replications. The variety used in turfing is Selection No.1 of *Cynodon dactylon* L. (Bermuda grass).

Results and Discussion

The observations were recorded on appearance and quality of turf. Highest appearance of turf was observed in N_3 (30g N/m^2) and minimum in N_0 (Control). A good appearance of turf was observed in K_2 (20g K/m^2) and poor in K_0 (Control) at 15, 30 and 45 days after transplanting. After 60, 75 and 90 days of transplanting appearance of turf were found non-significant with respect to potassium. Very good appearance was observed in N_3K_2 which was at par with N_3K_1 showed in Table 1. Highest quality of turf was observed in N_3 (30g N/m^2) and minimum in N_0 (Control). Similarly, turf quality was found to be highest in K_2 (20g K/m^2) and minimum in K_0 (Control). The interaction between nitrogen and potassium was found non-significant. Turf quality was also found maximum in N_3K_2. Hence based on above parameters, N_3K_2 was best for good turfing depicted in Table 2.

Table 1: Effect of different level of nitrogen and potassium on appearance of turf

Treatments	Appearance					
	Days after transplanting					
	15	30	45	60	75	90
N_0K_0	2.77	4.17	5.23	6.17	4.57	2.23
N_0K_1	3.30	4.20	5.33	6.33	4.37	2.33
N_0K_2	3.63	4.53	5.23	6.10	4.10	2.37
N_1K_0	4.13	5.23	6.20	7.37	5.17	3.43
N_1K_1	4.23	5.20	6.13	7.30	5.20	3.13
N_1K_2	4.53	5.30	6.47	7.40	5.27	3.47
N_2K_0	5.23	6.10	7.33	8.20	6.17	4.70
N_2K_1	5.30	6.27	7.30	8.17	6.27	4.20
N_2K_2	5.60	6.80	7.23	8.17	6.17	4.30
N_3K_0	6.10	7.20	8.20	8.53	7.30	5.13
N_3K_1	6.27	7.67	8.17	8.60	7.33	5.30
N_3K_2	6.23	7.73	8.90	9.10	7.50	5.20
CD at 5% Nitrogen (N)	0.25	0.27	0.20	0.17	0.22	0.22
Potassium (K)	0.22	0.23	0.17	NS	NS	NS
N x K	NS	NS	0.35	0.30	NS	NS

Table 2: Effect of different level of nitrogen and potassium on quality of turf

Treatments	Quality of turf
	60 days after transplanting
N_0K_0	6.17
N_0K_1	6.27
N_0K_2	6.37
N_1K_0	6.63
N_1K_1	6.76
N_1K_2	6.87
N_2K_0	7.27
N_2K_1	7.43
N_2K_2	7.50
N_3K_0	8.10
N_3K_1	8.33
N_3K_2	8.57
CD at 5% Nitrogen (N)	0.07
Potassium (K)	0.06
N x K	NS

101.

Influence of Zinc and Iron Application on Morpho-physiological, Seed Yield and Yield Attributing Characters of Wheat (*Triticum aestivum* L.)

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Keywords: Zinc, Iron, physiological parameters, yield, wheat.

Introduction

Wheat (*Triticum aestivum* L.) is a staple food which ranks second after rice to contribute total food grains basket of the country. To provide food security to the increasing populations, India will have to produce 109 million tonnes of wheat by 2020. Zinc and iron have been found to play an important role in physiological activities of plants which influence yield. Zinc acts as an activator of various enzymes in the plant and plays an important role in protein synthesis and participates in chlorophyll formation which helps in vegetative plant growth and enhancing seed quality and yield. The extent of iron (Fe) deficiency in India is next to that of Zn. Iron is a component of many enzymes associated with nitrogen reduction, fixation, and lignin formation. It plays a role in energy transfer within the plant. Iron is momentous for photosynthesis and chlorophyll formation (Li *et al.*, 2012).

Materials and Methods

The present investigation was carried out in 2010-11 and 2011-12 at Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. Soil texture of experimental site was analyzed before experimentation. The zinc and iron was found to be deficient. The experiment was conducted on wheat var. K-9162 (Gangotri). Four doses of zinc (0, 5, 10, 15 Kg ha^{-1}) and iron (0, 2.5, 5.0, 7.5 Kg ha^{-1}) in form of zinc sulphate monohydrate 33% and ferrous sulphate 19%, respectively were applied as basal dose and experiment was laid out in Factorial RBD with three replications. The feeder dose of NPK at the rate of 150: 75: 60 Kg ha^{-1} was also applied. Standard procedure for experimentation was followed. Observations were recorded on morpho-physiological characters, seed yield and yield attributing parameters. Data were statistically analyzed following the standard methodology.

Results and Discussion

Results from pooled data of two year study (Table 1) revealed that levels of Zn and Fe application were statistically significant to each other except the dose Zn_2 and Zn_3 and Fe_2 and Fe_3 which showed either at par performance or non-significant difference for almost all the morpho-physiological parameters under investigation. The values for the parameters were increased with increasing level of zinc and iron. Minimum values for all the parameter was observed under control while maximum was reported either in Zn_2 and Fe_2 or Zn_3 and Fe_3.

Table 1: Effect of Zinc and Iron on morpho-physiological, seed yield and yield attributing parameter of wheat variety Gangotri (pooled data of two years).

Treatment	Leaf area index 30 DAS	Leaf area index 60 DAS	Leaf area index 90 DAS	Specific leaf weight (mg cm^{-2})	Chlorophyll intensity (%)	Canopy temperature tepression (°C)	Chlorophyll fluorescence (Fv/Fm)	Number of tillers (m^{-2})	Test weight of Seed (g)	Seed yield (q ha^{-1})
0.0 (Zn_0)	1.48	2.90	3.70	6.31	42.68	4.91	0.79	293.29	44.77	33.79
5.0 (Zn_1)	1.62	3.06	3.81	6.43	47.45	5.10	0.82	301.71	45.41	35.58
10.0 (Zn_2)	1.79	3.21	3.94	6.63	51.75	5.27	0.83	314.08	47.06	38.90
15.0 (Zn_3)	1.81	3.23	3.93	6.58	50.63	5.27	0.82	311.96	47.01	38.23
SE (d)	0.01	0.02	0.02	0.02	0.22	0.03	0.02	1.24	0.32	0.35
CD(p=0.05)	0.02	0.04	0.04	0.04	0.43	0.05	NS	2.48	0.65	0.71
0.0 (Fe_0)	1.59	3.02	3.77	6.38	45.21	5.01	0.80	298.00	45.54	35.78
2.5 (Fe_1)	1.66	3.08	3.83	6.46	47.49	5.11	0.82	303.79	45.95	36.40
5.0 (Fe_2)	1.72	3.14	3.88	6.55	49.46	5.21	0.82	308.96	46.30	37.17
7.5 (Fe_3)	1.73	3.17	3.89	6.57	50.36	5.22	0.82	310.29	46.46	37.18
SE (d)	0.01	0.02	0.02	0.02	0.22	0.03	0.02	1.24	0.32	0.35
CD(p=0.05)	0.02	0.04	0.04	0.04	0.43	0.05	NS	2.48	0.65	0.71

NS- non-significant, DAS- days after sowing

The application of different levels of zinc significantly influenced the number of tillers m^{-2}. Among treatments, application of Zn_2 produced the maximum number of tillers m^{-2} (314.08). The iron levels showed significant effect on number of tillers m^{-2}. Statistical analysis revealed that Fe_3 (310.29) showed maximum number of tillers m^{-2} which expressed non-significant difference to Fe_2 (Table 1). Various levels of zinc influenced significantly to test weight of seed also. However, treatment Zn_2 exhibited significant difference from

rest of the treatment except Zn_3 (47.01 g). Application of Fe_3 produced highest test weight of seed (46.46 g) which did not show significant difference with Fe_2 (46.30 g).

The application of zinc had influenced significantly the seed yield. Treatment Zn_2 produced the highest seed yield (38.90 q ha^{-1}) while lowest was observed in control (33.79 q ha^{-1}). Treatment Zn_3 and Zn_2 did not show significant difference (Table 1). Application of Fe_3 showed maximum (37.18 q ha^{-1}) seed yield however, treatment Fe_3 did not express significant difference with treatment Fe_2. Enhancement in seed yield may be attributed to the increased value of morpho-physiological and yield attributing characters due to application of Zn and Fe which in turn helped in terms of achieving greater seed weight, more number of tillers m^{-2} and formation of chlorophyll resulting in higher photosynthesis, thus converting greater photosynthates toward increased seed yield (Nautiyal *et al.,* 2011).

Thus, it is concluded that application of 10 kg zinc and 5.0 kg iron ha^{-1} either singly or in combination of both have been found most appropriate and economical for achieving the maximum morpho-physiological, seed yield and yield attributing characters of wheat cv. K-9162 (Gangotri).

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102.

Influence of Biomass Ashes on Phosphorous Fractions and Enzyme Activity

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Keywords: Phosphorous fractions, baggase ash, rice husk ash, rice straw ash, enzyme activity

Introduction

Recycling of by-product wastes of agro-industrial origin with appropriate techniques can produce energy and supply nutrients (Bougnom and Insam, 2009). Biomass is one of the most important resources for achieving our renewable energy targets. Ashes from agricultural biomass have most of the plant nutrients except nitrogen and sulphur (Patterson *et al.*, 2004), thus, can be used as alternative fertilizer sources. Application of organic wastes is often recommended to maintain soil fertility and improve the microbial growth. Therefore, there is a great need to evaluate the potential of biomass ashes as a source of phosphorous (P) and its effect on enzymatic activity.

Materials and Methods

The pot experiment was conducted using wheat crop at glass house of the department of Soil Science, Punjab Agricultural University, Ludhiana, India. The experiment consisted of treatment combinations of four different phosphorus sources [baggase ash (BA), rice husk ash (RHA), rice straw ash (RSA), fertilizer P (Fert-P)] and three P levels (10, 20 and 30 µg g^{-1}). The screen house experiment was laid out in a completely randomized design with three replications. Olsen-P and P fractionation in soil samples were determined using 0.5N $NaHCO_3$ extractable P method (Olsen *et al.* 1954) and P fraction scheme given by Chang and Jackson (1958), respectively. For enzymatic activity soil samples were stored at 4°C for subsequent analysis (dehydrogenase, alkaline phosphatase and phytase).

Results and Discussion

From the study it is evident that the mean effect of all the treatments caused significantly higher Olsen-P than control in all the soils (Table 1). The interaction between P sources and levels of P on Olsen-P was not significant. The mean effect of different sources on Olsen-P was significant only in S_2. The Olsen-P with application of RSA was significantly higher than all other P sources. The application of fertilizer-P caused significantly higher Olsen-P than BA. The application of P at different levels increased Olsen-P significantly with increase in P level from P_{10} to P_{20} to P_{30} in both soils. The application of P from different sources failed to cause significant affect on Al-P content. Different P sources, irrespective of P levels, showed no significant effect on Fe-P content in all the soils. The different P levels increased significantly Fe-P content with increase in P level from P_{10} to P_{20} only in S_2. In S_1, the application of Fert-P and RSA caused significantly higher Ca-P content than BA and RHA. Fert-P showed 14 per cent and 8 per cent higher Ca-P than RHA and BA, respectively. But, in S_2, the application of Fert-P caused significantly higher Ca-P content than all other P sources. The Ca-P content with the application of P from RHA was significantly higher than BA. Different P levels, irrespective of P sources, increased Ca-P content significantly with increase in P level from P_{10} to P_{20} to P_{30} in both soils. The application of P from different sources, irrespective of P levels, failed to cause significant affect on Org-P content. Moreover, enzyme activities (dehydrogenase, alkaline phosphatase and phytase) were at par with different sources of P when applied in same amount in both the soils. This showed the potential of biomass ashes (BA, RHA and RSA) to increase the activities of enzymes was comparable to Fert-P.

Table 1: Olsen-P (Kg ha^{-1}) and P fractions (µg g^{-1}) as influenced by various levels of phosphorus applied through different sources in both soils

Treatments		Soils		Soils		Soils		Soils		Soils	
		S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2	S_1	S_2
		Olsen-P		Al-P		Fe-P		Ca-P		Org-P	
P sources	BA	9.61	9.72	14.2	14.1	45.2	47.2	561	510	78.8	79
	RHA	9.52	9.84	13.5	14.1	43.3	44.8	534	553	79.4	79.6
	RSA	9.89	10.31	14.3	14.1	46.3	47.6	600	529	81.2	82.4
	Fert-P	9.74	10.0	14.3	14.3	44.2	46.0	607	589	80.9	81.6
	LSD (0.05)	NS	0.235	NS	NS	NS	NS	38.3	33.2	NS	NS
P Levels (µg g^{-1})	10	9.16	9.31	13.3	13.1	42.7	43.5	499	494	76	76.8
	20	9.67	9.98	14.1	14.3	45.1	46.8	582	542	80.4	81.2
	30	10.25	10.61	14.8	15	46.4	48.9	645	600	83.8	83.9
	LSD (0.05)	0.285	0.204	NS	NS	NS	2.58	33.2	28.8	4.62	NS
Interaction (Sources x levels)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control vs Treatments											
Treatments		9.69	9.97	14.1	14.2	44.7	46.4	575	545	80.1	80.6
Control		7.58	7.68	12.3	12.4	38.4	38.8	395	418	69.8	69.3
LSD (0.05)		0.42	0.3	NS	NS	4.99	3.79	48.9	42.4	6.8	8.48

103.

Integrated Effect of Inorganic and Organic Fertilizers with Fly Ash on Heavy Metal Accumulation on Acid Soil of Northern Hills Zone (Chhattisgarh)

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Keywords: Rice, fly ash, FYM, GRD, grain and straw yield, available heavy metals

Introduction

Fly ash is a product of "thermal power plant", which is produced during burning of coal for energy purpose, is a major concern. Recently, more than 175 metric tonnes (mt) of fly ash was generated in India from several thermal power plants and it is expected about 300 mt of fly ash will be generated in the year of 2016-17 (Das *et al.*, 2011). There is a need to evaluate the effect of fly ash on soil environment, growth and yield of agriculture crops. Fly ash (FA) a coal combustion residue of thermal power plants has been regarded as a problematic solid waste all over the world. Metal content in soil increased with increase application of ash.

Materials and Methods

A field study in acid soil was carried out during *kharif* season of 2014-15 at farmer field, Ajirma village, Surajpur district, Chhattisgarh. The treatments comprised of without fly ash (control), 100% general recommended dose (GRD) (100: 60: 40), 75% GRD + 20 t fly ash ha^{-1}, 75% GRD + 40 t fly ash ha^{-1}, 75% GRD + 60 t fly ash ha^{-1}, 75% GRD + 20 t fly ash ha^{-1} + 5 t farm yard manure FYM ha^{-1}, 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1} and 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1} were laid out in randomized block design (RBD) with three replications. Fly ash and FYM applied as per the treatments before transplanting the rice. The rice cultivar MTU-1010 was selected as test crop and twenty five days old rice seedlings were transplanted in 20 x 10 cm spacing. Available heavy metals (DTPA extractable) Co, Cr, Ni and Pb were analyzed by DTPA method using atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

Results and Discussion

The soil belongs to sandy clay loam in texture. The application of different fly ash combinations with and without FYM significantly increased the grain yield compared to general recommended dose (GRD). The highest grain (37.27 q ha^{-1}) and straw yield (59.48 q ha^{-1}) was recorded by application of 75% GRD + 60 t FA ha^{-1} + 5 t FYM ha^{-1}, which was at par with 75% GRD + 40 t FA ha^{-1} + 5 t FYM ha^{-1} and 75% GRD + 20 t FAha-1 + 5 t FYM ha^{-1} and control showed the lowest yield. The increased doses of fly ash combination with and without FYM increased grain and straw yield. The DTPA extractable available heavy metal contents were significantly increased in different fly ash treatments as compared control. Fly ash applied at 20, 40 and 60 t FA ha^{-1} integrated with inorganic fertilizer and FYM significantly increased in heavy metals as compared to GRD. The highest available Co, Cr, Ni and Pb content were recorded in application of 75% GRD + 60t FA ha^{-1} + 5t FYM ha^{-1} while, control showed lowest. It is concluded from the present study that integrated use of fly ash, FYM and chemical fertilizer in acid soil was effective in increasing yield of rice crop as compared to use of chemical fertilizers only. Heavy metal content in soil increased with increase application of ash.

Table 1: Integrated effect of inorganic and organic fertilizers with fly ash on available heavy metal status of soil after harvest of rice crop

Treatments	Available heavy metal status of soil (mg kg^{-1})				Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})
	Cr	Co	Ni	Pb		
T_1 Control	0.17	0.43	0.33	1.20	26.07	31.08
T_2 100% GRD (100: 60: 40)	0.17	0.45	0.34	1.40	33.94	53.09
T_3 75% GRD + 20 t fly ash ha^{-1}	0.19	0.44	0.37	1.42	30.49	42.09
T_4 75% GRD + 40 t fly ash ha^{-1}	0.23	0.47	0.39	1.52	31.60	45.00
T_5 75% GRD + 60 t fly ash ha^{-1}	0.26	0.48	0.41	1.52	32.10	51.85
T_6 75% GRD + 20 t fly ash ha^{-1} + 5 t FYM ha^{-1}	0.21	0.45	0.38	1.48	35.80	57.18
T_7 75% GRD + 40 t fly ash ha^{-1} + 5 t FYM ha^{-1}	0.24	0.49	0.42	1.56	36.07	57.33
T_8 75% GRD + 60 t fly ash ha^{-1} + 5 t FYM ha^{-1}	0.27	0.50	0.43	1.76	37.27	59.48
SEm±	0.01	0.01	0.006	0.08	0.56	0.76
CD (P= 0.05)	0.03	0.03	0.018	0.25	1.69	2.30

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104.

Rock Phosphate Enriched Compost: A Complimentary Source of Phosphorus in Soybean-Wheat Rotation in Indian Himalayas

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Keywords: Soybean, wheat, rock phosphate enriched compost, yield, P balance and soil fertility

Introduction

Phosphorus is being considered second major element whose deficiency has become widespread in Indian soils (Hasan, 1996). It involves in root development, nodulation and nitrogen fixation, metabolic activity in synthesis of protein. But recent hikes in prices of phosphatic fertilizers like Di Ammonium Phosphate and Single Super Phosphate, restricted to use of this important element by the poor farmers. Therefore, it may become necessary to look for alternative source of water soluble phosphorus. In India, about 160 million tonnes of rock phosphate deposits are available (FAI, 2011), mostly of low-grade containing less than 20% P_2O_5 that are considered unsuitable for manufacturing commercial phosphatic fertilizers. In this context, rock phosphate enriched composting would be reducing dependence on costly inorganic P fertilizers and save precious foreign exchange, besides providing an environmentally sound and economically feasible solution to problems of waste management. Keeping above facts, the present investigation was undertaken to study the effect of different P sources on yield of soybean and wheat, P balance and soil fertility status.

Materials and Methods

A field experiment was carried out during 2008-09 to 2011-12 at ICAR- Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand. The experiment consisting of 5 treatments T1- Control,T2- rock phosphate, T3- single super phosphate, T4- P enriched compost, T5- P enriched compost + SSP(50% P through each), and laid out in randomized block design with four replications. Recommended dose of phosphorus (80 and 60 kg P_2O_5 ha^{-1}) were applied in soybean (*Glycine max* (L.) Merrill) and wheat (*Triticum aestivum* (L.) emend. Fiori & Paol) crop every year. Nutrient content in soil and plant were determined as per standard procedure. The P uptake by wheat and soybean was estimated by multiplying P content with corresponding yields. Phosphorus balance was estimated.

Results and Discussion

Application of phosphorus through SSP gave highest yield (32.76 q/ha) of soybean, which was comparable with P enriched compost and P enriched compost + SSP (Fig. 1). Response of phosphorus varied from 7.9-25.2% over the control and highest with SSP. Similarly, in wheat highest yield (53.73 q/ha) was recorded with SSP, which was comparable with P enriched compost and P enriched compost + SSP. Response of applied phosphorus to wheat crop varied from 6.7-21.7% over control and highest response observed with SSP. In soybean - wheat cropping system response of applied phosphorus was more in soybean as compared to wheat.

Annual P removal by soybean- wheat rotation is comparatively less than annual addition of P. Highest P removal by soybean and wheat was observed with SSP followed by P enriched compost + SSP and P enriched compost. Continuous fertilization of phosphorus resulted in buildup of P levels (Fig. 2) and net changes in available P varies from -0.3 to 4.7 kg P ha^{-1} over its initial P status. Highest P build-up under SSP treated plot. Theoretical positive balance of available P is much higher as compared to actual available P in soil. However, net negative balance of P was recorded in control plot (-19.8 kg P/ha).

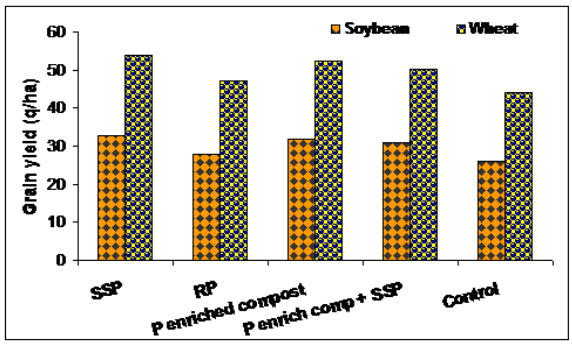

Fig. 1: Effect of different P sources on pooled grain yield of soybean and wheat (4 years)

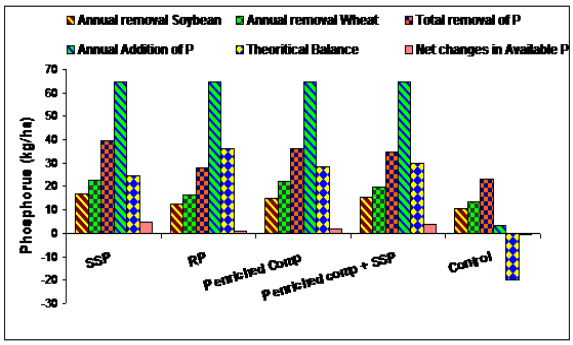

Fig. 2: Effect of different P sources on phosphorus balance sheet in soybean- wheat cropping system

Application of phosphorus through different sources to soybean and wheat improved soil pH, soil organic carbon, available NPK as compared to control (Table 1). Organic carbon, available NPK was significantly improved with all treatments over control. Highest soil organic carbon content was recorded with P enriched compost (0.82%) and highest available N&P with SSP treated plots. However, maximum available K content was recorded with rock phosphate (175 kg / ha) followed by SSP (174 kg/ha).

Table 1: Effect of different P sources on phosphorus on soil fertility status under in soybean- wheat cropping system

Treatment	Soil pH	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Control	5.4	0.58	368.7	12.6	169
Rock phosphate(RP)	5.5	0.60	424.6	14.0	175
RP enriched compost	5.5	0.82	399	14.7	167
SSP + RP enriched Compost	5.5	0.71	359.3	16.8	169
SSP	5.4	0.66	431.7	17.6	174
CD at 5%	NS	0.02	22.60	0.57	4.46

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105.

Extraction of High Value Compounds from Horticultural Waste

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Keywords: Citrus waste, pectin extraction

Introduction

India is the world's second largest producer of fruits (75 million tonnes) with first three positions being occupied by banana (*Musa acuminata*) (32.6%), mango (*Mangifera indica*) (22.1%) and citrus (*Citrus sp.*) (12.4%). Meager level of processing (6-8%) and a sizeable post-harvest loss (to the tune of 15-30%) are responsible for lowering gross domestic productivity, remunerative losses and diminishing interest towards horticultural production and processing. This accounts for a monetary loss of Rs 40,000/- crores annually. The fruit, whether used for table purpose or for processing, yields a considerable amount of waste (30-50%) in the form of peel, seed, stone, pomace and fruit pulp. The waste generated through fruit and vegetable processing contains compounds like flavonoids, limonoids, terpenes, pectins, carotenoids, biocolor etc.

Materials and Methods

Kinnow mandarin (*Citrus reticulata*) peel/waste was used to extract pectin using aqueous extraction method. Hundred gram of dried peel powder was soaked in water, given various treatments, and boiled for 20 to 80 min at 20 min intervals. The broth was cooled and pectin was precipitated using organic solvents. The extracted pectin was dried, purified and stored for further studies. The experiments were replicated thrice using CRD.

Results and Discussion

The boiled extract contained pectin and other soluble and insoluble ingredients released due to breakage of bonds because of heat and various treatments' effect. The pectin obtained was strained of excess water and dried in tray dryer at low temperatures. The pectin so obtained was crude pectin containing soluble and unwanted materials. The crude pectin was further purified, dehydrated and quantified. The maximum yield of extracted pectin was 12.0±1% for citric acid+degradative enzyme combination followed by only citric acid treatment (Fig. 1). The control treatment (using sulfuric acid) had 4.0±1% pectin with inferior quality. This paper will present the possibility of extracting high value compounds originated of fruits and vegetables using various methods of extraction. This can lead to further value addition to the processing residue and complete utilization of horticultural waste. Utilization of nearly 50% photo-synthetically fixed biomass (termed as waste) can pave a better way towards sustainability of horticulture.

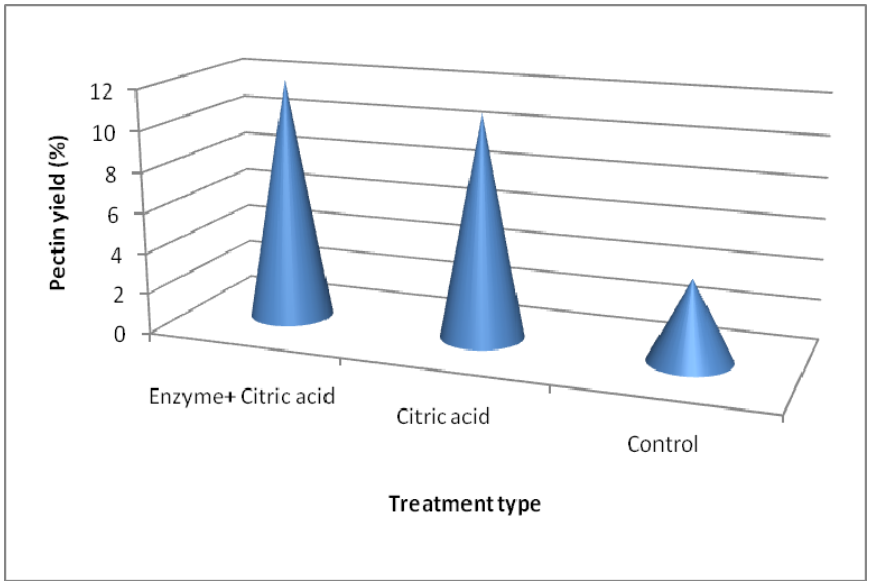

Fig. 1: Yield of pectin with respect to treatment type

106.

Chemical Properties of Soils in Relation to Different Forest Vegetation Covers of Achanakmar Chhattisgarh, India

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Keywords: Soil organic matter, soil organic carbon, soil total nitrogen, C: N ratio, forest vegetation covers, Achanakmar.

Introduction

The soil and vegetation have a complex interrelation because they develop together over a long period of time. The adequate theoretical and practical knowledge of various forest soils and the complex relationship between the life of various trees and other plants of the forest is therefore necessary to study. The present study was thus carried out to assess the various chemical properties of soils with respect to different vegetation covers to know the ecological relationship of different vegetation covers on nutrient storage and fertility status of soils.

Materials and Methods

The present study was carried out in Achanakmar Chhattisgarh, lies between east longitudes 81°51' 76'' E and north latitudes 22°24' 56'' N**.** Soil sampling was carried out randomly in under different vegetation covers namely *Shorea robusta, Tectona grandis*, *Bambusa arundinaceae*, mixed, open and scrub vegetation covers. Walkley and Black's rapid titration method as modified by Walkley (1947) was adopted for organic carbon estimation. The factor of 1.724 was used to convert the values of organic carbon into soil organic matter. Total nitrogen was estimated by the Kjeldhal method.

Results and Discussion

The average values of organic carbon varied between 0.54 percent to 1.40 percent was higher under soils of mixed forest followed by*, Tectona grandis*, *Bambusa arundinaceae*, *Shorea robusta*, open and scrub vegetation covers. Organic carbon percent was also comparatively higher in the upper horizons followed by middle horizons and least was observed in lower horizons among all the five vegetation covers. The average values of soil organic matter varied from 0.93 percent to 2.41 percent under different vegetation covers. The decrease in soil organic matter percent with increasing depth was observed among all the vegetation covers. The average values of total nitrogen varied between 0.084 percent to 0.217 percent being maximum in soils of mixed vegetation cover and lower in open and scrub. The trend of decreasing total nitrogen percent was observed with increasing soil depth among all vegetation covers. The average values of C: N ratio in the study area varied between 4.66 to 6.46. The *Tectona grandis*, *Bambusa arundinaceae*, *Shorea robusta* had a lower C: N ratio compared to the mixed and open and scrub vegetation covers. The results are given in Table 1.

Table 1: Soil chemical properties of different vegetation covers.

Vegetation cover	Average values of soil chemical properties			
	Soil organic carbon (%)	Soil organic matter (%)	Soil total nitrogen (%)	C: N ratio
Shorea robusta	0.82±0.03	1.42±0.05	0.144±0.07	5.77±0.01
Tectona grandis	0.94±0.08	1.62±0.13	0.202±0.06	4.66±0.03
Bambusa arundinaceae	0.83±0.07	1.43±0.12	0.166±0.06	5.00±0.05
Mixed vegetation	1.40±0.08	2.41±0.13	0.217±0.07	6.46±0.02
Open and Scrub	0.54±0.09	0.93±0.15	0.084±0.07	6.43±0.01

The present study lead to the conclusion that among different vegetation covers the mixed forest vegetation cover was comparatively rich in nutrient and fertility status which is the indication of higher nutrient release due to input of varying litter, humus quality and decomposition rate in mixed vegetation compared to mono-cropping system.

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107.

Effects of Earthworm Casts on Soil Physicochemical Properties in Different Regions of Punjab

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Keywords: Earthworm casts, soil properties.

Introduction

Earthworms are one of the most important groups of soil engineers. They play significant and prominent roles in generating heterogeneous patterns in ecosystems, mostly by displacing soil organic and mineral compounds from one site to another, and by producing biogenic structures, i.e. organo-mineral aggregates (casts), with specific physical, chemical and biological properties. Indeed, the presence of earthworms is usually associated with formation of biogenic aggregates, i.e. casts. Earthworm casts contain more extractable nutrients than surrounding soil. Therefore, present research was carried out to examine, physicochemical properties of surface casts produced by earthworms and compared with the properties of surrounding soil.

Materials and Methods

The study was conducted in three sugarcane-wheat (*Saccharum officinarum* - *Triticum spp*) growing districts of Punjab [Amritsar, Shaheed Bhagat Singh Nagar (SBS Nagar) and Moga]. Casts sampling was carried out every month in sugarcane-wheat crop fields from June 2014 to June 2015. Earthworm casts was collected, air-dried and weighed. The surrounding soil was also sampled without casthills. 100g of surrounding soil and cast samples was collected from the study area and air-dried for analysis. The physicochemical parameters (pH, electrical conductivity (EC), organic carbon (OC), available nitrogen, phosphorous and potassium) of the earthworm casts and surrounding soil was analysed by using standard methods.

Results and Discussion

The average values of the physico-chemical analysis of the casts and surrounding soil are shown in Table 1. Earthworm casts and surrounding soil resulted in significant differences in physico-chemical properties. In casts, the pH value decreased from slightly basic to neutral in Amritsar and SBS Nagar, but from slightly acidic to neutral in Moga. In earthworm casts EC was also reduced in all the three districts as compared to surrounding soil. In earthworm casts available nitrogen, phosphorous, potassium and organic carbon was also significantly more as compared to surrounding soil. Available nitrogen was significantly more in earthworm casts in SBS Nagar (177±6.55 kg/acre) as compared to Amritsar (154.38±5.20 kg/acre) and Moga (145.76±5.09 kg/acre). Available phosphorous (46.50±2.30 kg/acre) and potassium (160.91±3.53 kg/acre) was also significantly more in earthworm casts in SBS Nagar as compared to surrounding soil and other two districts. In soil organic carbon was ranged from 0.50±0.01% to 0.59±0.02% and in earthworm casts it ranges from 1.55±0.23% to 1.98±0.29%. Organic carbon in earthworm casts was more in SBS Nagar i.e. 1.98±0.29%. The maximum significant results was obtained in earthworm casts collected from SBS Nagar as compared to surrounding soil and other two districts of Punjab. Therefore, it is concluded that, the earthworms can specifically affect soil fertility that may be of great importance to increase sustainable land use in sugarcane-wheat agro-ecosystems.

Table 1: Characteristics of soil physical and chemical properties of earthworm casts and surrounding soil from different regions of Punjab.

Districts	pH	EC (ds m^{-1})	Nitrogen (kg/acre)	Phosphorous (kg/acre)	Potassium (kg/acre)	OC (%)
Amritsar						
Soil	7.67±0.11	0.72±0.01	135.84±5.67	29.48±1.46	138.20±2.18	0.59±0.02
Casts	7.26±0.09	0.63±0.02	154.38±5.20	44.92±2.20	157.67±3.58	1.64±0.22
SBS Nagar						
Soil	8.06±0.12	0.66±0.02	145.53±4.60	28.76±1.26	139.57±2.53	0.59±0.02
Casts	7.35±0.07	0.56±0.02	177±6.55	46.50±2.30	160.91±3.53	1.98±0.29
Moga						
Soil	6.71±0.06	0.65±0.01	131.92±4.64	26.60±1.24	133.84±2.13	0.50±0.01
Casts	7.33±0.07	0.56±0.01	145.76±5.09	39.77±1.69	149.96±3.61	1.55±0.23

Values: Mean±SE, All the values are significant at ($p \leq 0.05$) as compared to surrounding soil.

108.

Performance of Winter Maize as Affected by Integrated Use of Inorganic and Organic Source of Nutrients in Inceptisols

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Keywords: Integrated nutrient management**,** maize, farmyard manure, poultry manure and goat manure.

Introduction

Maize (*Triticum aestivum)* is called queen of cereals. In maize, Nitrogen, Phosphorus and Potassium is important for all crops. The nitrogen utilization pattern is found to be increased from seedling of knee height and reaches to the peak at tasseling stage. Increasing levels of nitrogen significantly increases the grain and stover yield Phosphorus helps in development of maize at all phases of growth and shows deficiency mainly at seedling stage and delayed maturity with an imperfect ear formation. In maize, yield is increased with increasing levels of phosphrous. Potassium is essential for translocation of water and photosynathates within the plant body. Maize plants need more than half of their potash requirement upto or before flowering stage. Organic manure increases the crop productivity as well as improves soil fertility NPK with farmyard manure increases the productivity of crop. Integrated nutrient management is the best approach for better utilization of resources and to produce crop with loosing the soil fertility.

Materials and Methods

A field experiments was conducted at soil research farm, Allahabad during the Rabi seasons of 2005-2006 and 2006-07. The soil was typical was sandy loam.. The available nitrogen, phosphorus and potash was 241.00 kgha^{-1}, 22.18 kgha^{-1}, 240.00 kgha^{-1} in the year 2005-06 and 242.11 kgha^{-1}, 22.67 kgha^{-1} and 241.34 kgha^{-1} in the year 2006-07. The variety "Arjun" was planted at a spacing of 60*30cm in both the years under study through urea, SSP and MOP respectively. The experiment was laid in randomized block design with four levels of organic manure 25%, 50%, 75% and 100% and four levels of Nitrogen 25%,50%,75% and 100% with three replication and thirteen treatment.

Results and Discussion

The length was influenced by both organic manure and inorganic fertilizers. It was observed that ear length was proportionate to plant height. As plant height increase, so did the ear length. Decrease in percentage of inorganic fertilizers influenced the length of the uppermost ear, with maximum length of the ear is 24.02cm in the T_8 treatment and the minimum is 19.22cm in the control. The pooled data of the two years was statistically at par with $T_{12}$and T_4 treatment. It shows significant effect in the pooled data of the two years However, significant differences was obtained in the pooled data of two years in the treatments (T_8,T_0) (T_8,T_1) (T_8,T_2) (T_8,T_5) and (T_8,T_9). Combined effect of inorganic and organic levels was found to increase the ear. Number of kernels in a row and Number of rows in a ear were found to be favourably influenced by organic and inorganic (nitrogen) fertilizers, rather than alone and without fertilizers. Kernel rows found to increase with increasing the percentage of inorganic (nitrogen) with organic fertilizers. In the pooled data of two years, the maximum number of kernel in a row was 35.83 was observed in T_8 and the minimum was in control it was statistically at par with T_{12} and T_4. However, significant differences was obtained between (T_8,T_0), (T_8,T_1), (T_8,T_2), (T_8,T_5), (T_8,T_9) and (T_8,T_{10}). Number of rows in a ear was found to increases with increase in the percentage of inorganic (nitrogen) with organic fertilizers. It shows non-significant effect during both the years. In the pooled data of two years, the maximum number of rows in a ear was 15.72 was observed in T_8 and the minimum was in the control. It was statistically at par with T_{12} and T_4. However significantly differences was obtained between (T_8,T_0),(T_8,T_1),(T_8, T_2) and(T_8,T_5).Seed index was found to be favourably affected by organic and inorganic (nitrogen) fertilizers). Seed index was positively influenced by days from silking to maturity. In maize, increase in nitrogen levels also brought about considerable increase in the kernel yield during both the years. In the pooled data of the two years in the grain and stover yield. Pooled data of the two yeas shows that grain yield increased significantly which was 54.80qha^{-1} in T_8 treatment that was statistical at par with T_{12} and T_4. However, significant differences was obtained between (T_8, T_0), (T_8, T_1) and (T_8, T_9) and the grain yield increased over the control respectively. The increase in grain yield in maize due to active role of nitrogen in plant metabolism which perhaps accelerates the photosynthetic activities and improves the growth of yield attributes, finally leading to enhanced grain yield. Pooled data of the two years shows that increasing level of inorganic (nitrogen) with organic significantly increased the stover yield of maize at harvest stage it was 63.89 to 165.93qha^{-1}.

Table 1: Effect of different treatments of Length of the cob(cm), Number of Kernel in a row, Number of rows in a cob, Seed index, Grain yield (qha^{-1}),Stover yield(qha^{-1}) maize at different intervals (2005-06 and 2006-07).

Treatments	Length of the cob (cm)	Number of Kernel in a row	Number of rows in a cob	Seed index	Grain yield ($qha^{1)}$	Stover yield(qha^{-1})
T_O Control	19.2	27.5	13.5	11.0	31.3	63.8
T_1 100% Farmyard Manure(FYM)	20.1	28.7	13.8	11.5	35.7	75.2
T_2 75% FYM + 25% N	21.6	30.3	14.5	12.3	43.9	96.3
T_3 50% FYM + 50% N	22.1	32.5	14.8	15.0	48.3	113.4
T_4 25% FYM + 75% N	23.4	34.8	15.2	17.7	52.4	138.2
T_5 100% Poultry Manure(PM)	21.1	29.7	14.3	12.2	42.0	85.8
T_6 75% PM + 25% N	22.0	32.1	14.7	14.5	47.9	105.6
T_7 50% PM + 50% N	22.7	33.6	15.1	17.3	52.0	128.3
T_8 25% PM + 75% N	24.0	35.8	15.7	20.6	54.8	165.9
T_9 100% Goat Manure(GM)	21.1	29.5	14.1	11.9	37.4	79.5
T_{10} 75% GM + 25% N	21.9	31.1	14.6	14.0	46.0	102.6
T_{11} 50% GM + 50% N	22.4	32.8	15.0	16.2	48.6	119.8
T_{12} 25% GM + 75% N	23.6	35.2	15.5	20.2	54.4	147.0
F-test	S	S	S	S	S	S
S.Ed.	1.02	2.16	0.61	1.80	6.75	18.85
C.D. at 5%	2.11	4.4	1.26	3.71	13.94	38.90

109.

Extent of Adoption of Recommended Doses of Fertilizers in Soybean

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Keywords: Constraints, adoption, recommended, fertilizers, soybean

Introduction

Madhya Pradesh ranks first in India with 55.64% (6.13 million ha) of total area and 53.18% (7.80 million tonnes) of total production of soybean. The state has rich potential to grow soybean in central and western zone in medium and deep black soil having high K_2O and medium N and medium P_2O_5. The application of recommended dose of fertilizers (RDF) i.e. 20: 60: 20: 20 NPKS kg/ha with 5 tonne farm yard manure (FYM) per hectare is very essential for excellent yield of soybean.

Materials and Methods

To find out the extent of RDF adopted by the soybean grower and identify the constraints in adoption of RDF, this study has been carried out in Ujjain and Shajapur districts covers 120 farmers who had got their soil tested and 60 control households comprising of 180 sample soybean growers of Madhya Pradesh. The primary data were collected on different aspects of the study namely application of fertilizer, actual quantity of fertilizer applied, constraints in applying recommended dose of fertilizer etc. with the help of interview schedule.

Results and Discussion

There was significant gap between recommended dose of fertilizers and actual quantity of fertilizers applied by the farmers. Only 50% of respondents applied recommended doses of the fertilizer, out of which 40% were willing to continue with the recommended doses of the fertilizer in future. The majority of the marginal farmers had applied recommended doses of the fertilizer more efficiently as compare to rest of the farmers. The most important constraints in adoption of recommended doses of the fertilizer in soybean as reported by the majority of soil test respondents were: soil testing report not available in time, difficult to understand and follow the recommended dose, no technical advice on method and time of fertilizer application, high price of fertilizers and recommended fertilizers not available in local market. Hence, it is suggested that supply of recommended fertilizers should be ensured by the state government in the market, and is the new nutrient-based subsidy policy should be a component of agricultural extension services with environmental education and awareness for the farmers.

Table 1: Constraints in applying RDF (% of farmers) Soil Test Farmers in Soybean

Constraints	Most Important	Important	Least Important	Total
Adequate quantity of fertilizers not available	7.5	14.2	43.3	65.0
High prices of fertilizers	21.7	14.2	36.7	72.5
Lack of capital to purchase fertilizers	7.5	24.2	31.7	63.3
No technical advice on method and time of fertilizers application	25.0	38.3	8.3	71.7
Difficult to understand and follow the recommended doses	29.2	26.7	10.0	65.8
Soil testing report not available in time	64.2	27.5	6.7	98.3

110.

Effect of Polluted Water on Secondary Metabolites of Hyperaccumulator

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Keywords: Phytoremediation, *Brassica juncea*, soil pollution, heavy metals

Introduction

Hyperaccumulator plants may be used to clean areas contaminated with industrial wastes such as sewage sludge and industrial chemicals through phytoremediation. They metabolize or sequester heavy metals in root and/or shoot parts, thus changing their morphological and chemical characteristics. During their growth, these plants constantly interact with other organisms, and may in turn affect them. Therefore, knowledge of changes occurring in metabolites of hyperaccumulators is essential from environmental perspective. Indian/Brown mustard (*Brassica juncea*) is a known hyperaccumulator, with high rate of heavy metal uptake from soil, accelerated root-to-shoot translocation rate and potential to sequester them. Therefore, we studied the effect of industrial waste water on the growth parameters of *B. juncea.*

Materials and Methods

B. juncea was grown at Sri Venkateswara College, University of Delhi, Delhi, and polluted water was obtained from the common industrial effluent of Bhiwadi industrial area. Plants were watered with industrial effluent water or tap water and grown upto stage 12 according to BBCH scale (Lancashire *et al.* 1991). Primary metabolites (chlorophyll a and b, carotenoids), secondary metabolites (phenols, tannins) and morphological parameters (length and weight of roots and shoots) were measured. Two plants were pooled for each chemical analysis. Total twenty biological replicates were analysed for each chemical parameter. Root and shoot length as well as weight of forty plants were measured.

Results and Discussion

Our study was planned to assess the effect of polluted water from the industrial areas of Bhiwadi, India, on the known hyperaccumulator. Chlorophyll b was found to be 18.761% of the total chlorophyll in the control samples, it was increased to 25.718% in the treated samples. Taking this in conjunction with the knowledge that chlorophyll b is converted to chlorophyll a under oxidative stress, we can infer that the uptake of heavy metals reduces the oxidative stress experienced by the plant. An increase was also observed in the amount of carotenoids from 771.638 mg/g in the control samples to 855.819 mg/g in the treated samples, indicating an enhanced protection from photo oxidative damage. Secondary metabolites such as phenols and tannins, which the plant uses for protection against pathogens and herbivores, also showed a slight increase of 11.030% and 13.092% respectively, in the treated samples. However, the increased root length in the treated plants also indicates that the heavy metals force the plant to venture further into the soil to seek out nutrients.

Thus, *B. juncea*, uses the increased incidence of these metals to eke out a competitive advantage by developing better resistance to other organisms and experiencing a lesser oxidative stress while also cleaning up the environment in the process.

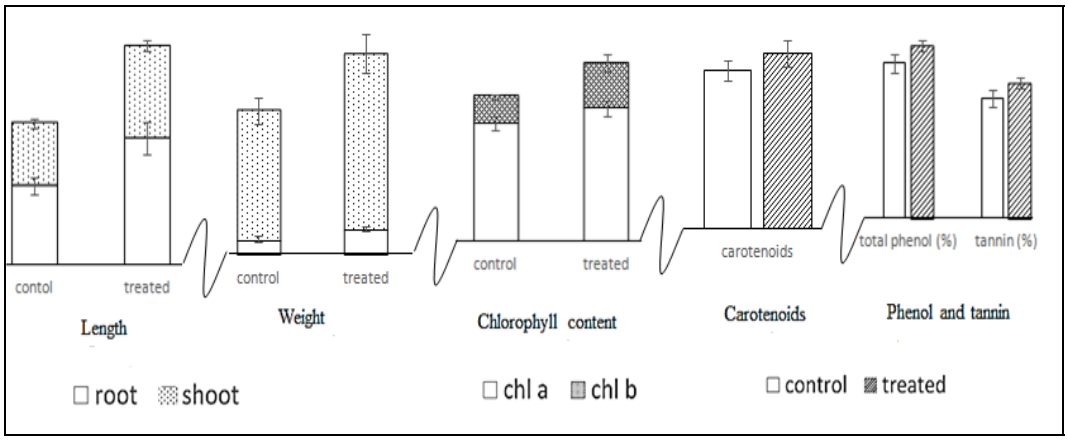

Fig. 1: Comparison of growth parameters of Brassica juncea

Reference

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4

Integrated Pest Management

111.

Biomanagement of *Trichoderma* Species against Soil Borne Plant Pathogens of Solanaceous Vegetables

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Keywords: Biocontrol, *Fusarium*, *Phytopthora*, vegetables

Introduction

Soil borne plant pathogens are important pathogens of solanaceous vegetables and causes a yield loss of 43-54% in Jammu and Kashmir (Shali, 2000)). Since chemicals are hazardous and causes environmental pollution, biological control is the best alternative for the management of soil borne pathogens. *Trichoderma* species have been found effective in suppressing the soil borne plant pathogens. Keeping in view the importance of bio-control of plant pathogens, the aim of the present study was to manage soil borne plant pathogens of solanaceous vegetables with *Trichoderma* species.

Materials and Methods

The root and shoot samples (100g) of plants showing disease symptoms were collected to isolate soil borne pathogens. The pathogens were isolated by tissue segment method on potato dextrose agar. In order to isolate *Trichoderma* isolates about 250-300g of soil around roots (rhizosphere) were collected in a sterile polythene bag and carried to laboratory in a cold container. Isolation of *Trichoderma* species was carried out by dilution plate method using TSM (*Trichoderma* selective media) as selective media. The isolated *Trichoderma* species were evaluated against *Fusarium* and *Phytopthora* wilt and root rot causing pathogens of solanaceous vegetables by Dual culture technique. Production of volatile metabolites by *Trichoderma* sp. was studied by Inverted plate technique.

Results and Discussion

The pathogens and bio-control agents isolated and identified morphologically as *Phytophthora* sp. from tomato, causing buck eye rot; *Fusarium* sp. from chilli and brinjal, causing wilt and *Trichoderma harzianum* (Table 1). In dual culture experiments a variable response of isolates was observed with respect to pigmentation, colony growth inhibition and overlapping. Maximum inhibition of *Fusarium* (brinjal) was shown by J4 (80%) followed by J3 (66.7%). However in *Fusarium* (chilli) and *Phytophthora* (tomato), J3 and J6 showed maximum inhibition 74 and 62%, respectively. The *Trichoderma* isolates viz., K2, J3 and J4 at the point of contact with *Fusarium* sp. produce yellow pigmentation. But K3 and K5 shows yellow pigmentation with all the pathogens used in the study. It has also been observed that J4 overlapped all pathogenic colonies whereas J5 and K2 overlapped only *Phytopthora* colony. Volatile compounds produced by 48 hour old isolates of *Trichoderma* sp. significantly reduced radial auxinic growth. Maximum inhibition of the auxinic growth of the pathogens *Fusarium solani* was recorded by J3 isolate followed by J5. K2 and K3 isolates caused the highest inhibition of *Fusarium oxysporum* as compared to other isolates. The suppressive effects on the growth of the pathogen, however, decreased with the age of cultures being lowest with 10 days old cultures. The study indicated that the fungus viz., *Fusarium solani*, *Fusarium oxysporum* and *Phytophthora* sp. are important soil borne pathogens of surveyed areas of Jammu and Kashmir and responsible for major yield losses of solanaceous vegetables and can be successfully managed by the use of *Trichoderma harzainum*.

Table 1: Detailed list of biocontrol agents and pathogens isolated from the rhizosphere of solanaceous vegetables.

Isolate No.	Name of the isolate	Source
J1	*Trichoderma harzianum*	Madh, Jammu (Potato)
J2	*Trichoderma harzianum*	Madh, Jammu (Potato)
J3	*Trichoderma harzianum*	Madh, Jammu (Brinjal)
J4	*Trichoderma harzianum*	Assar, Udhampur (Brinjal)
J5	*Trichoderma harzianum*	Assar, Udhampur (Tomato)
J6	*Trichoderma harzianum*	Assar, Udhampur (Tomato)
K2	*Trichoderma harzianum*	Shalimar, SKUAST-K (Chilli)
K3	*Trichoderma harzianum*	Shalimar, SKUAST-K (Brinjal)
K4	*Trichoderma harzianum*	Shalimar, SKUAST-K (Chilli)
K5	*Trichoderma harzianum*	Budgam, Kashmir (Tomato)
KP1	*Phytopthora* species	Shalimar, SKUAST-K (Tomato)
KP2	*Fusarium oxysporum*	Shalimar, SKUAST-K (Brinjal)
KP3	*Fusarium solani*	Shalimar, SKUAST-K (Chilli)

Reference

Shali, S.K. 2000. Studies on chilli (*Capsicum annum* L.) wilt in Jammu. M.Sc. Thesis. Division of Plant Pathology, SKUAST, Jammu.

112.

Do Microbial Fertilizers Increase Immunity in Indian Mustard (*Brassica juncea*) Against Insects?

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Keywords: Induced responses, natural plant resistance, insect damage, phosphate solubilizing bacteria, PSB, vesicular-arbuscular mycorrhiza, VAM.

Introduction

Plants induce various morphological and chemical changes due to insect herbivory. These induced responses may divert a substantial share of resources from plant growth towards increasing plant immunity. Microbial fertilizers are rapidly gaining popularity among farmers all over the world to increase plant growth and yield in a sustainable manner (Adesemoye and Kloepper, 2009). However, whether these biofertilizers boost immunity of plants as efficiently as their growth and development or whether bio fertilizer-facilitated development is a result of immunity tradeoff is still unknown. We therefore determine the effect of microbial fertilizers on immunity of Indian mustard (*Brassica juncea*) after damage by the generalist insect *Spodoptera litura* (Fabricius, 1775).

Materials and Methods

B. juncea was grown in soil supplemented with phosphate solubilizing bacteria (PSB) and vesicular-arbuscular mycorrhiza (VAM), separately and in combination. 4- week old plants were damaged by *S. litura* and plant's morphological and chemical changes were analyzed. Changes in antioxidants were taken as quick responses (3 to 72 hours of damage) and changes in leaf thickness and trichome density were measured as delayed responses (4^{th} and 9^{th} day of damage). Larval behavioral changes in terms of first choice, orientation and leaf area eaten were determined using leaf from undamaged and damaged plants from different treatments.

Results and Discussion

Trichome density increased significantly on both adaxial and abaxial surfaces of the leaves adjacent to the damaged leaves as well as in newly emerged leaves of induced plants supplemented with VAM as compared to the other treatments. Activities of antioxidants, namely, peroxidase (POD) and superoxide dismutase (SOD), remained highest at 3 hours (hrs) and were subsequently decreased by 72hrs. Plants showed an overall increase in POD activity after 3hrs of damage, irrespective of the treatment. However, after 72hrs, only plants without any microbial fertilizer treatment continued to show an increase in POD activity. SOD activity remained high at 3h and decreased at subsequent hours. However with VAM supplementation, the SOD activity remained high even at 9hrs after damage. PSB-VAM supplemented plants showed reduced SOD activity at all the hours.Insect behavioral bioassays revealed that the larvae moved to both PSB and VAM supplemented plants as their first choice. However, larval orientation was highest in PSB-VAM combination supplemented plants. Highest leaf area consumption by the larvae was from PSB-VAM supplemented plants when the plants were intact. However, following damage, this feeding preference was decreased to similar amount of leaf area consumed as that of other treatment plants. Our study suggests that bio fertilizers definitely boost plant induced responses along with plant growth but this doesn't necessarily translate to increase in induced resistance.

Table 1: Induced responses of *Brassica juncea* to damage by *Spodoptera litura* treated by phosphate solubilizing bacteria (PSB), vesicular-arbuscular mycorrhiza (VAM) or their combination. + and ++ indicate elevation of the response at different intensities; - indicates no change after damage by *S. litura*.

Parameters		Phosphate solubilizing bacteria (PSB)		Vesicular-arbuscular mycorrhiza (VAM)		PSB-VAM	
		Undamaged	Damaged	Undamaged	Damaged	Undamaged	Damaged
POD	3hrs	-	+	-	++	-	-
	9hrs	+	+	+	-	+	-
	72hrs	+	+	+	-	+	-
SOD	3hrs	-	-	-	+	-	-
	9hrs	+	-	+	++	+	+
	72hrs	+	-	+	-	+	-
Trichomes	Day 4	+	-	-	++	+	-
	Day 9	+	+	+	++	-	+
Leaf thickness	Day 9	-	-	-	-	+	+
Larval first choice		15%	21%	19%	15%	21%	9%
Larval orientation		9%	19%	15%	14%	23%	19%
Leaf area eaten		+	-	+	-	++	-

POD= Peroxidase, SOD= Superoxide dismutase

Reference

Adesemoye AO and Kloepper JW 2009. Plant-microbes interactions in enhanced fertilizer-use efficiency. *Applied microbiology and biotechnology* **85**: 1-12.

113.

Localization of Different Bacterial Endosymbionts in Different Stages of Whitefly *Bemisia tabaci*

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Keywords: *Bemisia tabaci*, bacteria, endosymbiont, FISH

Introduction

Bacterial ensosymbionts are present in majority of the agricultural pests and provide different physiological and ecological traits to its host. In this study, we have shown the localization of different bacterial endosymbiont both primary (*Portiera*) and secondary (*Wolbachia*, *Rickettsia* and *Arsenophonus*) in different stages of whitefly *Bemisia tabaci* by using a sensitive technique of Fluorescence *in situ* hybridization (FISH). The localization of bacterial endosymbionts was prominent in specialized cells called bacteriocytes in all the stages of whitefly nymphs and in adults.

Materials and Methods

The insect species were reared on cotton plants in insect proof climate control chambers in Indian Agricultural Research Institute (IARI), Delhi. The samples were collected in acetone for FISH analysis. They were fixed in Carnoy's solution and processed in accordance to Raina *et al.*, (2015). The samples were decolourized in H_2O_2 and incubated with hybridization buffer containing bacteria specific probe. The Locked nucleic acid (LNA) probes for different bacterial endosymbionts were used for their detection. Different nymphal stages and adults of *B. tabaci* were checked for the bacterial presence.

Results and Discussion

The results of this study showed the presence of primary bacterial endosymbiont *Portiera* and secondary endosymbionts, *Wolbachia, Rickettsia and Arsenophonus* in different nymphal stages and adult stage of whitefly, *B. tabaci*. The bacterial endosymbiont was localized in both the nymphs and in adult whiteflies in specialized cells called bacteriocytes present in the abdomen. These bacteriocytes are localized in clusters with signals for different endosymbionts at particular intensity of the laser on confocal microscope. The probes were used in combination of two with *Portiera* being the control for presence of secondary symbionts. In whitefly nymphs endosymbionts in bacteriocytes are seen in two bunches at the lower abdominal region, while in adults as a single bunch (Fig. 1). The bacterial endosymbionts have shown a co-localization pattern as shown by the merged image under confocal microscope. The results show that endosymbionts are present in bacteriocytes in the whitefly vector and points towards the close association between the vector and endosymbionts. Such detection of endosymbionts is important for understanding the role of these bacteria in insect pests, which is important for integrated pest management.

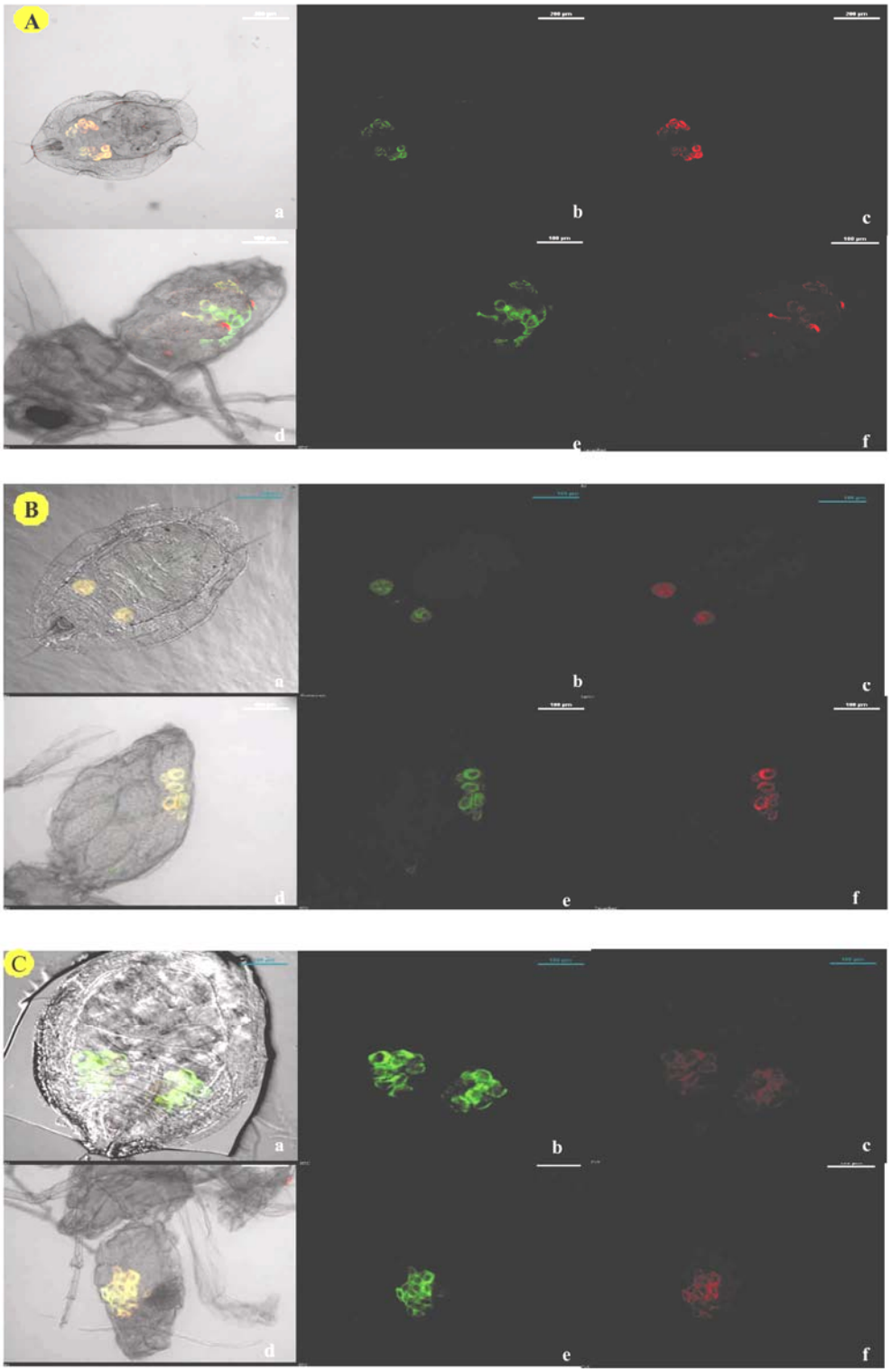

Fig. 1: Showing different bacterial endosymbionts in nymphal and adult stages of whitefly Bemisia tabaci.
(A)- Portiera and Wolbachia in nymph and adult whitefly. (B)- Portiera and Rickettsia in nymph and adult whitefly. (C)- Portiera and Arsenophonus in nymph and adult whitefly. a, d- merged image showing Portiera and respective secondary symbionts in nymph and adult B. tabaci respectively; b, e- primary endosymbiont Portiera in nymph and adult; c, f- secondary endosymbiont in nymph and adult.

114.

Biological Control of Brinjal Mealybug *Coccidohystrix insolita* Green

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Keywords: *Coccidohystrix insolita*, biological control, coccinellids

Introduction

The brinjal mealybug, *Coccidohystrix insolita* (Green) a polyphagous pest is broadly distributed in the tropics and subtropics (Williams 2004). Adult female is light yellowish-green in colour, with many long, glassy filaments. This mealybug is small, oval, soft bodied measuring 3-4mm in length, with very little dorsal wax. It secretes a white, waxy ovisac up to 6 times as long as the body of the female. Individual female has the reproductive potential of laying 200- 300 eggs, which are female biased resulting in explosive outbreaks. Both nymphs and adults suck the sap from leaves and tender shoots. Heavy clustering of mealy bugs is usually seen on the under the surface of leaves as a thick mat. They also excrete copious amounts of honeydew on which the sooty mould fungus grows. Affected plants appear sick and black, resulting in reduced fruiting capacity. The present study involved mainly in the evaluation of different predators and white halo fungus for the sustainable management of brinjal mealybug.

Materials and Methods

This study was conducted in two seasons during 2013-2015 on the evaluation of different biocontrol agents namely *Cryptolaemus, Brumus suturoides, Scymnus, Chrysoperla, Lecanicillium lecanii* for the management of *C. insolita* along with chemical check Profenophos 50EC and untreated control. There were seven treatments including untreated check with three replications. The treatments were imposed twice at 15 days interval. Observations were recorded on number of mealybugs / three leaves / plant and number of predators / plant after each release of natural enemies.

Results and Discussion

The results (Table 1) revealed that among the predators released *Cryptolaemus* @ 1500/ha *Brumus suturoides* @ 1500/ha and *Scymnus*@ 1500/ha were significantly superior with lesser population of mealybug over the control. The fruit yield in plots released with coccinellid and *Chrysoperla* predators ranged from 61.7 to 68.1 t/ha and 62.3 to 67.8 t/ha in 2013 and 2014 respectively. This was also confirmed by Mani *et al* (2011) who reported that single larva of *C. montrouzieri* is known to consume about 1100 nymphs. The mealybug, *C. insolita*, attacking brinjal crop was controlled effectively by the predator *C. montrouzieri* within 20 days of release. Profenophos 2ml/l treated plot recorded significantly lowest population of mealy bugs with maximum yield of 76.3 t/ha and 70.3 t/ha respectively in two seasons. The entomopathogen *Lecanicillium lecanii* sprayed plot was found less effective with fruit yield on par with control. Hence, it can be concluded that the use of biocontrol agents like coccinellids and chrysoperla shall be a good option for the management of mealybug for realising pesticide free produce as compared to chemical insecticide, Profenophos.

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Table 1: Performance of biological control agents on population reduction of brinjal mealybug

Treatments	I season (2013-2014)						II season (2014-2015)					
	Pre Treatment	One week after I release/spray		One week after II release/spray		Yield t/ha	Pre Treatment	One week after I release/spray		One week after II release/spray		Yield t/ha
	Mealybug/ Plant	Mealybug/ Plant	Predator/ 10 Plants	Mealybug/ Plant	Predator/ 10 Plants		Mealybug/ Plant	Mealybug/ Plant	Predator/10 Plants	Mealybug/ Plant	Predator/ 10 Plants	
Release of *Cryptolaemus* @ 1500/ha	17.8[a]	13.6[b]	1.3	11.6[bc]	1.7	65.5[b]	74.6[a]	53.6[b]	3.8	14.6[b]	7.8	67.8[b]
Release of *Scymnus*@ 1500/ha	15.4[a]	10.6[b]	3.3	9.8[b]	4.0	66.9[b]	62.8[a]	56.6[b]	2.3	24.8[bc]	4.3	64.9[b]
Release of *Brumus suturoides* @ 1500/ha	18.2[a]	9.4[b]	2.0	7.6[b]	2.7	68.1[b]	69.5[a]	59.4[b]	2.0	17.6[b]	4.7	66.2[b]
Lecanicillium lecanii 10^8 cfu /ml	16.4[a]	15.8[c]	0.8	16.8[a]	1.4	60.6[c]	82.4[a]	78.8[d]	0.8	56.4[d]	3.4	61.2[c]
Chrysopa 50,000 first instar grubs/ha	15.6[a]	13.6[b]	1.0	14.2[c]	1.8	61.7[c]	78.3[a]	70.4[c]	1.4	38.2[c]	2.8	62.3[c]
Profenophos 2 ml/l	17.0[a]	4.2[a]	0.0	1.8[a]	0.0	76.3[a]	86.2[a]	15.4[a]	0.0	1.2[a]	0.0	70.3[a]
Control	17.4[a]	17.2[c]	0.8	18.6[d]	1.2	57.1[c]	71.7[a]	76.6[d]	0.8	58.6[d]	2.4	58.7[d]

Means followed by common letter(s) are not significantly different by DMRT P=0.05)

115.

Biointensive Pest Management of Spiralling Whitefly in Tapioca

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Keywords: *Aleurodicus disperses,* BIPM, Predators

Introduction

The spiralling whitefly (SWF) *Aleurodicus disperses* (Russel) is a polyphagous pest with a characteristic spiralling pattern of oviposition on the under surface of leaves. This pest is native to Central America and the Carribean region. It was reported from India in 1993 from Kerala (Palaniswami *et al.*, 1995) and later from other parts of peninsular India. In India, it has been reported on over 253 plant species belonging to 176 genera and 60 families (Ramani *et al.*, 2002). Heavy incidence of the whitefly caused yield reduction to an extent of 53.10% in tapioca (Geetha, 2000).

Materials and Methods

Evaluation of Bio Intensive Pest Management (BIPM) against *A. disperses* on cassava was carried out using the following treatments viz., Yellow sticky traps at the rate of 12 per ha for monitoring, release of *Chrysoperla zastrowi* @ 1.0 lakh first instar grub per ha, release of *Cryptolaemus montrouzieuri* @10,000/ha, application of entomopathogen *L. lecanii* @ 2 x 10^9 conidia per ml, application of NSKE 5% and application of triazophos 40% EC @ 2.5 ml per litre and acephate 75 SP @ 1.5 g per litre (as a last resort) which was compared with the farmer's practice comprising the insecticide sprays of Imidacloprid 17.8% SL @0.4 ml/l on three months old crop and triazophos 40% EC @ 2.5 ml per litre on 5 months old crop. Observations on *A. disperses* population per 3 leaves in 5 plants were recorded at 15 days interval and also the population of natural enemies in 10 randomly selected plants were observed.

Results and Discussion

The implementation of BIPM module effectively reduced the spiralling whitefly population which showed 86.34 whiteflies per plant as compared to insecticide sprays 335.41 whiteflies per plant. The untreated check harboured 450.61 whiteflies per plant. The population reduction of spiralling whitefly achieved by BIPM was 77.03% as compared to 25.89% in farmer's practice with two rounds of insecticide sprays. The plots imposed with BIPM was free from sooty mould whereas the plots with insecticide sprays and untreated had severe incidence sooty mould indicating the presence of spiralling whitefly population. The superior performance of BIPM module comprising the predators *Cryptolaemus montrouzieri* and *Chrysoperla* was in line with the findings of Mani and Krishnamoorthy (1997) who observed that the presence of *Cryptolaemus montrouzieri* throughout the year preying on the whitefly effectively. The yield of tubers in BIPM plot was 33.25t/ha which was superior to the tuber yield of 29.62 t/ha recorded in farmer's practice. The untreated plot showed a tuber yield of 25.30 t/ha. Hence it can be concluded that the adoption of BIPM is beneficial in containing the whitefly population realising a BCR ratio of 1: 3.26 in as compared to farmer's practice which showed a BCR ratio of 1: 2.34 (Table 1).

Table 1: Effect of BIPM module on *A. disperses* population and yield of cassava

Treatments	Pre treatment count No./ 5 plants	No./ 5 plants*	Per cent reduction over control	Yield (t / ha)	BCR
BIPM module	398.5[a]	86.34[c] (9.10)	77.03	33.25	1: 3.26
Farmer's practice	472.45[a]	335.41[b] (18.40)	25.89	29.62	1: 2.34
Control	431.72[a]	450.61[a] (21.03)	0.00	25.30	-
CD (P= 0.05)	NS	34.0426			

*Mean of eight replications; significant at 1%; figures in parentheses are square root transformed values;
In a column, means followed by a common letter(s) are not significantly different by DMRT (P= 0.05)

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116.

Parasitoid of *Euproctis lunata* Walker, a Pest of Castor in South West Haryana

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Keywords: Parasitoid, *Euproctis lunata, Apanteles euproctisiphagus,* Castor

Introduction

India, being a producer of substantial quantities of oilseeds, occupies a prominent place in the oil seed map of world. The major oilseeds crops of India are mustard (*Brassica juncea*), castor (*Ricinus cummunis*), sunflower (*Helianthus annuus* L.), sesamum (*Sesamum indicum*) etc. and castor is an important crop among these oilseeds. In Haryana, particular in south-west region, farmers are growing castor as an alternative crop of mustard due to availability of limited irrigation water and losses caused by orobanche (a parasitic weed) and stem rot. The *Euproctis lunata,* caused serious damage to castor crop in south-west Haryana (Gaur, 2014). The damage caused by the voraciously feeding caterpillar is sometimes colossal and instances are not rare when the whole crop has been destroyed.

Materials and Methods

The fifty full fed larvae were collected from the infested plants in different months during August 2014 to February 2015 at Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station Bawal. The larvae were released on castor leaves and each larvae reared in separate jar in the laboratory. The number of parasitoids emerged from the pre-pupae were counted and per cent parasitization and per cent adult emergence was calculated. These parasitoids were got identified from the Indian Agricultural Research Institute, New Delhi

Results and Discussion

Investigation on natural enemy of *E. lunata* revealed that parasitization of larvae by hymenopteran parasitoid, *Apanteles euproctisiphagus* Ahmad belongs to family braconidae was the parasitoid recovered from the pre-pupa of this pest. The number of parasitoids per host (pre-pupa) ranged from 22 to 25. The larvae of parasitoids emerged from the abdomen of the host and made silken white cocoon on the host for pupation. After a period of 10 to 12 days, small hymenopterous parasitoids emerged from these cocoon which were identified as *Apanteles euproctisiphagus* Ahmad. These were gregarious parasitoids and caused 28, 42 and 20 per cent parasitisation in September, October and November, 2014, respectively (Table 1). The adult of *Apanteles euproctisiphagus* was black in colour and measured 3 to 4 mm (mean 3.52±0.27 mm) in body length and 7 to 8 mm (mean 7.42±0.22 mm) in wing expanse. The per cent adult emergence of *E. lunata* was 72, 58 and 80 per cent in September, October and November, 2014, respectively (Table 1). It is concluded that parasitoid, *Apanteles euproctisiphagus*is limiting the population of *Euproctis lunata in natural habitats*.

Table 1: Field parasitisation of larvae of *E. lunata* in different months

Months	Larvae collected (number)	Number of larvae parasitized	Per cent parasitisation	Per cent adult emergence (*E. lunata*)
September	50	14	28	72
October	50	21	42	58
November	50	10	20	80

Reference

Gaur, R.K. 2014. Diversity of insect pest of castor, *Ricinus communis* L. and their ecological interaction in South West Haryana. *International Journal of Farm Science,* 4(4),147-152.

117.

Biology and Predatory Potential of Lady Bird Beetle, *Coccinella septempunctata* (Lin.) on Mustard Aphid, *Lipaphis erysimi* (Kalt.)

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Keywords: Biology, predatory potential, *Coccinella septempunctata*, *Lipaphis erysimi*

Introduction

Rapeseed-mustard, *Brassica juncea* (Linnaeus) is one of the important oilseed crops cultivated all over India. The crop is infested by several insect pests from initiation of growth to maturity which adversely affect its yield. Out of these, the mustard aphid, *Lipaphis erysimi* Kalt is the most dreaded insect-pest infesting the crop right from seedling stage to maturity. The losses in yield caused by mustard aphid ranged from 9 to 95% at different places of India (Singh *et al.*, 2012). The bio-control agents like coccinellid and chrysopid have been reported to be effective for controlling the aphids, *L. erysimi* and can be a good replacement of highly toxic insecticides which is a common practice for its control (Bellows, 2001).

Materials and Methods

Ten pairs (Male and Female) adult of *Coccinella septempunctata* L. were collected from the experimental fields of College Farm, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. They were reared in Entomology Research Laboratory, C.P. College of Agriculture, Sardarkrushinagar at 23.22±2.47°C and 62.67±5.84 per cent relative humidity on mustard aphid in specimen jars during *rabi* season of the year 2011-2012. The mustard twigs infested with aphid were provided as food. The eggs were collected from the specimen jars and kept for hatching. The larvae hatched out were reared on aphids and observations were recorded on fecundity, different larval instars, pupal period, adult longevity, hatching percentage and oviposition period. The eggs were observed critically under research microscope to study their colour, shape and size. Length, breadth and head width of larval instar were also measured under microscope using stage and ocular micrometer. To study predatory potential of *C. septempunctata,* a definite number (thirty) of freshly hatched larvae were placed in petri dishes. Known number of mustard aphids (nymphs and adults) along with inflorescence twig of mustard plant was given to each predator larva after every 24 hour. The aphids which remained alive were counted at every 24 hour to find out the actual number of the aphids consumed by the various stages of the predators.

Results and Discussion

The incubation period and hatching percentage of eggs were an average 4.40±0.77 and 73.3±5.27 days, respectively (Table 1). The total grub period, duration of pupal stage, and pre oviposition and post oviposition are given in Table 1. The longevity of adult male on an average was 31.33±3.28 days, while in the case of female it was 37.30±3.44 days. The male: female sex ratio was 1.0: 1.39. Average length and breadth of freshly laid eggs was 1.21±0.03 and 0.52±0.05 mm, respectively. The length and breadth of 1st, 2nd, 3rd and 4th larval instars are given in Table 1. The length and breadth of pupa on an average was 5.42±0.37 and 3.12±0.33 mm, respectively. Average length and breadth of male adult was 6.05±0.39 and 4.43±0.26 mm, respectively. In case of female it was 6.95±0.44 and 5.46±0.36 mm, respectively. The mean consumption of grub was 24.57±6.50, 48.73±11.38, 110.70±20.69 and 179.06±32.71 aphids during its first, second, third and fourth instars, respectively. The total feeding potential of *C. septempunctata* grub was an average of 363.07±41.38 aphids during its whole grub period. The overall adult consumed an average of 2429.83±262.28 aphids.

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Table 1: Biology of lady bird beetle, *Coccinella septempunctata* on mustard aphid, *Lipaphis erysimi*

Particulars	Minimum	Maximum	Average±S.D
Fecundity eggs/female	405	803	582.44±93.15
Incubation period of egg (days)	3	6	4.40±0.77
Hatching percentage (%)	66.67	80.00	873.3±5.27
First instar (days)	3	5	3.73±0.7
Second instar (days)	2	4	2.80±0.76
Third instar (days)	2	5	3.50±0.78
Fourth instar (days)	2	5	3.63±0.85
Total larval period (days)	9	19	13.67±1.77
Pupal Period (days)	5	9	6.73±1.11
Adult male longevity (days)	26	39	31.33±3.28
Adult female longevity (days)	30	45	37.30±3.44
Pre- oviposition period	4	13	7.92±2.45
Oviposition period	13	26	21.60±3.39
Post- oviposition period	4	10	7.16±1.77
Sex ratio (male: female)	1.0: 1.22	1.0: 1.50	1.0: 1.39

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Efficacy of Bio-control Against Damping off in Chilli

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Keywords: Biological control, damping off, *Pythium aphanidermatum*, *Trichoderma viride*, *Pseudomonas fluorescens*

Introduction

Chilli (*Capsicum annum L.*) is one of the important crops grown for use as vegetable and condiment. Damping off caused by *Pythium aphanidermatum* is the major disease in the chillies nursery. The most common means to check the disease in nurseries is by using fungicides but frequent and indiscriminate use of fungicides often leads to atmospheric pollution and development of fungicide resistance in pathogens. In this context, biological control is coming up as an alternative strategy for disease management which is also ecology conscious and environment friendly. *Trichoderma* spp. are well documented as effective biological control agents of plant diseases caused by both soil borne fungi and leaf and fruit infecting plant pathogenic fungi. Hence, in the present study, attempts were made to assess the effect of soil application of *Trichoderma viride* and *Pseudomonas fluorescens* on damping off of chilli

Materials and Methods

The pot culture trials were conducted in completely randomized block desigh (RBD) with six treatments and four replications. The pathogen multiplied on sand maize medium was added to the pots at the rate of 250 g per pot in soil. Talc based formulations of *Trichoderma viride* and *Pseudomonas fluorescens* were incorporated into the soil prior to sowing in pots and fungicide copper Oxychloride (0.25%) was used as comparative or standard check. The observation on pre and post emergence damping off under nursery conditions in pots were recorded respectively 10 and 30 days after sowing.

Results and Discussion

Trichoderma viride (6g) + *Pseudomonas fluorescens* (6g) registered the least pre and post emergence damping off of 7.67 and 9.66% as against 28.27 and 30.32% in control, respectively (Table 1). This treatment recorded 72.86 and 68.13% reduction in pre and post emergence damping off respectively over control followed by *Trichoderma viride* (3g) + *Pseudomonas fluorescens* (6g) caused 60.73 and 57.83% reduction in pre and post emergence damping off, respectively over control. The effect of copper oxychloride in reducing pre and post emergence damping off was at par with the effect of *Trichoderma viride* (3g). Soil application of *Trichoderma viride* and *Pseudomonas fluorescens* significantly reduced the pre and post emergence damping off of chilli compared to control. Disease reduction of pre and post emergence of chilli in nursery was mostly due to the higher antagonistic potential of *Trichoderma* by different means viz. antibiosis, parasitism, production of lytic enzymes etc. and also due to the production of secondary metabolites, siderophores and induced resistance by *Pseudomonas fluorescens*.

Table 1: Effect of soil application of antagonists on damping off (Pre emergence and Post emergence) of chilli under nursery condition (in pots)

Treatments	Damping off disease (percent)			
	Pre emergence (at 10 DAS)	Reduction over control (%)	Post emergence (at 30 DAS)	Reduction over control (%)
Trichoderma viride (3g)	13.70 (21.72)	51.53	15.01 (22.79)	50.49
Pseudomonas fluorescens (6g)	12.07 (20.27)	57.30	13.92 (21.89)	54.08
Trichoderma viride (3g) + *Pseudomonas fluorescens* (6g)	11.10 (9.46)	60.73	12.77 (20.88)	57.88
Trichoderma viride (6g) + *Pseudomonas fluorescens* (6g)	7.67 (16.00)	72.86	9.66 (18.05)	68.13
Copper oxychloride (0.25%)	13.87 (21.81)	50.93	15.37 (23.03)	49.30
Control	28.27 (32.08)	-	30.32 (33.40)	-
s.e.m	0.35	-	0.39	
C.D(P=0.05)	0.76		0.83	

Figures in parentheses are arcsine transformed values

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Efficacy of Fungal Biocontrol Agents for Management of Maize Wilt Caused by *Fusarium verticillioides*

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Keywords: Biological control, *Fusarium verticillioides, Trichoderma viride* and *Trichoderma harzianum.*

Introduction

Maize is an important coarse grain cereal and fodder crop of Jammu and Kashmir. The crop is prone to several soil borne diseases and foliar diseases. Wilt caused by *Fusarium verticillioides* (Sacc.) is one of the important soil and seed borne disease. It is very difficult to control by chemical treatment alone. Hence, use of biocontrol agents may be an effective alternative for disease management instead of conventionally used chemicals. They are environment friendly and does not induced resistance in pathogen as the chemicals do. *Trichoderma* spp. are common inhabitant of the rhizosphere and well recognized as biocontrol agents of soil-borne plant pathogens.

Materials and Methods

An experiment was conducted at the research field of Advanced Centre for Rainfed Agriculture Dhiansar SKUAST-Jammu, Bari-Brahmana SKUAST-Jammu in *kharif* 2011 and 2012. The experiments were laid in the Randomized block design (RBD) with three replication and ten treatments (Table 1). The plot size was 6m x 5m.

Table 1: Treatments

Treatment No.	Treatment name	Dose
T_1	Seed treatment with *Trichoderma viride*	10g/kg seed
T_2	Seed treatment with *Trichoderma viride*	20g/kg seed
T_3	Seed treatment with *Trichoderma viride* + soil application	10g/kg seed+ 2.5kg/ha
T_4	Seed treatment with *Trichoderma viride*+ soil application	20g/kg seed + 2.5kg/ha
T_5	Seed treatment with *Trichoderma harzianum*	10g/kg seed
T_6	Seed treatment with *Trichoderma harzianum*	20g/kg seed
T_7	Seed treatment with *Trichoderma harzianum* + soil application	10g/kg seed +2.5kg/ha
T_8	Seed treatment with *Trichoderma harzianum* + soil application	20g/kg seed + 2.5kg/ha
T_9	Seed treatment with carbendazim (control)	4g/kg seed
T_{10}	Untreated control	-

Results and Discussion

The result of the present study showed that both the resident isolate of *Trichoderma* spp. namely *T. viride* and *T. harzianum* recorded less disease incidence compared to control (Table 2). In the T_8 seed and soil treatment with *T. harzianum* 20 g/kg seed +soil application 2.5kg/ha recorded the least wilt incidence (16.33%). However in this study seed treatment and soil application of *T. harzianum* found to be superior of all seed treatments. In the field trials as is evident from Table 1 all the treatment showed better growth over control (pooled data of both the years). Similarly in the T_8 seed treatment with *T. harzianum* 20g/kg seed +soil application 2.5 kg/ha recorded maximum plant height on 80 DAS (179.40cm), cob length (14.20 cm) respectively (Table 2).

Table 1: Bio efficacy of *Trichoderma viride* and *Trichoderma harzianum* against *Fusarium verticillioides* incidence in Maize under field condition (pooled data) of both the years

Treatment	Percent Disease incidence (%)	Plant height on 80DAS(cm)	Cob length in cm
T_1	38.45	162.10	11.62
T_2	29.10	169.00	12.69
T_3	20.67	174.40	13.40
T_4	19.67	176.45	13.20
T_5	38.67	164.24	12.00
T_6	28.53	168.46	12.80
T_7	19.50	177.00	13.60
T_8	16.33	179.40	14.20
T_9	21.00	172.20	12.85
T_{10}	61.67	120.50	9.65
S.E	0.32	1.033	0.083
CD 5%	0.69	2.19	0.17
CD 1%	0.95	3.01	0.24

Each value is mean of three replications

120.

Effect of Fungicide and Biocontrol Agents against Soil Borne Diseases of Tomato (*Solanum lycopersicum*)

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Keywords: Tomato, biocontrol, soil borne diseases, fungicide

Introduction

Tomato (*Solanum lycopersicum*) is the second most important vegetable crop in the world. Several diseases have been reported to cause crop losses in tomato worldwide, however, major fungal diseases affecting tomato production worldwide are late blight, early blight, fusarium wilt, damping off, root rot and verticillium wilt (Montealegre *et al.*, 2003; Panthee and Chen, 2010). In the present scenario, emphasis is being given for the integrated disease management, in which bilogical control using biocontrol agents is an essential component and the biological control of plant diseases involving the use of antagonistic microorganisms offers an excellent alternative to chemical control.

Materials and Methods

Potting soil (soil: FYM; 2: 1) was autoclave-sterilized for 1 h on two consecutive days and was placed in pots. Bacterized seeds of tomato were sown. Carbendazim as seed treatment at 2g kg^{-1}seed and after transplanting 2 g pot^{-1} as soil application was included for comparison. Untreated seeds served as control. Thirty-days-old tomato seedlings were transplanted (4 seedlings pot^{-1}) in pots filled with soil. Ten days after transplanting, soil application with 10 ml of bacterial suspension (1×10^8 cfu ml^{-1}) of the isolates was done and one day after soil application 50 ml of conidial suspension (1000 microconidiaml^{-1}) for *Fusarium oxysporum* f.sp. *lycopersici*and 8×10^5 cfu/g of Rhizoctonia *solani* was inoculated per pot. Disease incidence was recorded 30 days after transplanting using the formula:

$$\text{Per cent Disease Incidence (PDI)} = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Four pots per replication were maintained and there were three replications and each pot contained four seedlings.

Results and Discussion

The selected bacterial isolates (I-7, I-15, I-18, I-23, I-24, I-25) and carbendazim were tested against *F. oxysporum* f.sp. *lycopersici* and *Rhizoctonia solani,* the fungicide carbendazim showed maximum plant vigour index by 1501.54 which consistently reduced the disease incidence by 14.58% (Table 1) by both *F. oxysporum* f.sp. *lycopersici* and *Rhizoctonia solani,* follwed by isolate I-23 with 1453.77% vigour index and 22.91 and 16.67% disease incidence by *F. oxysporum* f.sp. *lycopersici* and *Rhizoctonia solani* respectively Ramamoorthy *et al.* (2002) found that *P. fluorescens* isolates Pf1 increased plant vigour and consistently reduced the disease incidence under green house condition and the disease protection was comparable fungicide, carbendazim.

Table 1: Effect of seed treatment formulation of *Pseudomonas fluorescens* isolates and fungicide for the management of soil borne diseases of tomato

Isolate	Vigour index (%)	Disease incidence (%)	
		Fusarium oxysporum* f.sp. *lycopersici	***Rhizoctonia solani***
I-7	1212.62	12.50	29.16
I-15	1120.54	16.67	27.08
I-18	1253.82	27.08	10.41
I-23	1453.77	22.91	16.67
I-24	1299.70	25.00	18.75
I-25	1317.27	20.83	27.08
Carbendazim	1501.54	14.58	14.58
Control	453.70	72.91	62.50
$S.E_m(\pm)$	41.97	2.21	2.90
$CD_{(P=0.05)}$	121.81	6.41	8.43

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121.

Bioefficacy of Biopesticides as Affected by Host-plant Mediated Interactions of *Phenacoccus solenopsis* Tinsley

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Introduction

Solenopsis mealy bug, *Phenacoccus solenopsis* Tinsley (Pseudococcidae: Homoptera), an invasive emerging polyphagous pest, has recently been observed in serious proportion on many solanaceous, malvaceous and cucurbitaceous vegetables and other crops including many weeds (Dhawan *et al.*, 2007; Halder *et al.*, 2013). Both nymphs and adults cause damage by sucking the sap from the growing points resulting the infested plants loose its vitality. In heavy infestation, the plants gradually dry up. Honeydew secretion also helps in developing black sooty-mould which inhibits photosynthetic activity of the plants.

Materials and Methods

This mealy bug was collected from the research farm of the institute and released on their respective hosts*viz*., eggplant (*Solanum melongena* Linn), okra (*Abelmoschus esculentus* L. Moench), tomato (*Solanaum lycopersicon* Linn.), cucumber (*Cucumis sativus* Linn.), chilli (*Capsicum annuum* Linn.), pointed gourd (*Trichosanthes dioica* Roxb.), cotton (*Gossypium hirsutum* Linn.) and white top weed *i.e.,Parthenium hysterophorus* under net-house conditions and reared for three consecutive generations. Only 6±1 day old nymphs of *P. solenopsis* were used for the toxicological studies. Microbial and plant-origin insecticides are some of the safe options available due to their target specificity, biodegradability and obvious safety to the environment. Considering these, bio-efficacy of white halo fungi, *Lecanicillium*(=*Verticillium*) *lecanii* at the rate of 5 g/l and neem oil (1%) alone and their 1: 1 mixtures were evaluated against the mealy bugs multiplied on different hosts by the direct spray method under Potter's tower (340 g/cm^2) under the laboratory conditions. Since, this exotic mealy bug is highly polyphagous and feeding on number of vegetables crops of diverse families; therefore, an attempt was made to find out the host mediated interactions of *P. solenopsis* on the bioefficacy of these duo biopesticides alone and their 1: 1 combination, if any.

Results and Discussion

Amongst the test vegetables, highest mortality (86.45%) at 4 days after treatment (DAT) was recorded when they fed on okra followed by tomato (85.26%) in case of neem oil whereas lowest mortality of 28.13% was in case of *Parthenium hysterophorus,* an associated common weed in vegetables. Almost similar trends were recorded in the case of *L. lecanii* at 5 DAT and the mortality was highest in okra (91.91%) followed by 88.28% mortality in case of pointed gourd. When the *L. lecanii* and neem oil was mixed (1: 1 ratio) and tested against the 6±1 day old nymphs of *P. solenopsis* they were found compatible and synergistic in action. Maximum mortality (90.23%) was noted when *P. solenopsis* reared on okra and pointed gourd whereas lowest in weed *P. hysterophorus* (29.91%). Median lethal time (LT50) was also calculated for these biopesticides alone and their mixture against mealy bug which again confirmed the synergistic action; however their efficacy varied with difference in host plants.

Amongst different host plants, the lowest median lethal time (LT_{50}) was registered as 30.58 hour in case of mixture of duo against mealy bug feeding on okra and the corresponding values for neem oil and *L. lecanii*, were 33.74 hour and 38.42, respectively (Table 1). In case of tomato, the LT50 values for neem oil, *L. lecanii* and their 1: 1 mixture were 45.49, 52.90 and 40.66 hours, respectively and similar trend also observed in case of pointed gourd (39.95, 44.16 and 33.20 hour), cucumber (114.32, 111.45 and 77.81) and *P. hysterophorus* (172.77, 184.27 and 149.19 hour). Since, mealy bugs infesting okra had the lowest median lethal time (LT_{50} values) in all the treatments, it was considered as base (1) for comparing with other treatments on different hosts in terms of time required for toxicity. Time required for *L. lecanii* for 50% killing of *P. solenopsis* was 1.15, 1.38, 2.20, 2.72, 2.75, 2.90 and 4.80 times higher when fed on pointed gourd, tomato, chilli, cotton, eggplant, cucumber and *Parthenium,* respectively, than okra. Our present study clearly indicates the existence of strong host mediated variations with same biopesticides against *P. solenopsis* collected from different hosts.

Host plant species directly affect the population and performance of its phytophagous insects and their susceptibility towards management practices. Cotton is a primary host of *P. solenopsis* and might be attributing developing strong endocrine system in *P.solenopsis* leading to rapid enzymatic degradation of toxicants/xenobiotics applied on it. This could be the reason for registering the higher median lethal time in cotton. In case of *P.hysterophorus*which is considered as a hardy and obnoxious weed, is grown almost all types of soils. Nutritional quality and presence of allelochemicals of this weed might be impartingtolerance to *P. solenopsis* leading to lower mortality and higher median lethal time.

Table 1: Median lethal time (LT_{50}) of *L. lecanii* alone and its combinations with neem oil (1: 1) against *P. solenopsis*

Treatments	Okra	Pointed gourd	Tomato	Chilli	Egg plant	Cucumber	Cotton	*Parthenium*
Lecanicillium lecanii	38.42	44.16	52.90	84.60	105.73	111.45	104.50	184.27
Neem oil	33.74	39.95	45.49	73.18	103.01	114.32	103.25	172.77
L. lecanii + Neem oil (1: 1)	30.58	33.20	40.66	59.51	93.91	77.81	81.70	149.19

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122.

Growth Inhibiting Effects of Some Essential Oils against *Callosobruchus Chinensis* L. (Coleoptera: Bruchidae) on Stored Chickpea

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Keywords: Botanicals, ovicidal activity, feeding deterrence, repellency**.**

Introduction

The pulse beetle, *Callosobruchus chinensis* L. is the most widespread and destructive major insect pest of stored legumes. Synthetic chemical insecticides have proved very effective in the control of the beetle. However, the problems associated with synthetic insecticides, such as health hazards, insect resistance, pest resurgence, residual toxicity, widespread environmental hazards and increasing costs of application, have prompted the need for effective, biodegradable pesticides. The use of locally available plant materials to manage insect damage in stored foodstuffs is also a common practice in developing countries. Botanicals have long been known by many farmers and used for many years traditionally to control stored insect pests.

Materials and Methods

A culture of test insect was established from infested chickpea (*Cicer arietinum*) seeds of *C. chinensis*. Five essential oils, namely neem oil (*Azadirachta indica*), eucalyptus oil (*Eucalyptus globulus*), clove oil (*Syzygium aromaticum*), camphor oil (*Cinnamum camphora*), and tulsi oil (*Ocimum sanctum*) were used for the experimental study and applied at 0.2%, 0.4%, 0.6%, 0.8% v/w concentration. Percentage of oviposition deterrence, F1 adults deterrence, feeding deterrent index and percent repellency were calculated by using suitable formulae. The data obtained from the experiments were subjected to one and two-way analysis of variance (ANOVA) and were statistically analyzed by adopting suitable transformation.

Results and Discussion

The results (Table 1) revealed that among different essential oils evaluated, the seeds treated with neem oil at the rate of 0.6%v/w and 0.8%v/w and tulsi oil at 0.8%v/w showed 100% oviposition deterrence followed by eucalyptus oil (93.64%), clove oil (90.94%) and camphor oil (79.41%) at the dose of 0.8%v/w. Significantly least oviposition deterrence was recorded in camphor oil (27.31%). Similarly, neem oil at the rate of 0.4%, 0.6% and 0.8% v/w and tulsi at 0.8%v/w showed hundred percent F_1 adult deterrence and significantly minimum F_1 adult deterrence at 0.2%v/w was recorded in camphor oil (43.02%) followed by clove oil (49.07%), eucalyptus oil (56.47%), tulsi oil (66.05%) and neem oil (78.90%). The F_1 adult deterrence increased significantly with the increase in dosage of each treatment ($p \leq 0.05$). Neem oil at the rate of 0.6% and 0.8%v/w and tulsi oil at 0.8%v/w caused 100% feeding deterrence. The next treatment at 0.8%v/w was eucalyptus oil causing feeding deterrence of 92.63%. Neem oil at 0.8%v/w caused 89.82% repellency 24 hours after application while that after 48 hours application was 88.71% and the least mean repellency of 21.60% was observed in camphor oil at 0.2%v/w. All the five botanicals tested were effective for the management of C. *chinensis*. Further research is required to explore some new indigenous organic sources of the insecticidal allelo-chemicals, which can, more efficiently, be utilized for the food-safety purposes and to overcome the dilemma of health hazards and environmental pollution.

Table 1: Effect of essential oils on oviposition, ovicidal, feeding and repellency activity of pulse beetle, *Callosobruchus chinensis* on chickpea during 2011 and 2012 (Pooled)

Treatments	Conc. (v/w)	Oviposition deterrence (%)	F_1 adult deterrence (%)	Feeding deterrent index (FDI) (%)	Percent repellency after		
					24 hr.	24 hr.	24 hr.
Azadirachta indica	0.2	71.91 (8.53)	78.90 (8.94)	74.88 (8.71)	37.80 (6.11)	36.32 (5.82)	37.06 (5.97)
	0.4	92.20 (9.65)	100.00 (10.05)	98.09 (9.95)	44.31 (6.65)	40.25 (6.27)	42.28 (6.46)
	0.6	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)	76.55 (8.80)	75.29 (8.71)	75.92 (8.76)
	0.8	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)	89.82 (9.53)	88.71 (9.47)	89.26 (9.50)
Ocimum sanctum	0.2	62.43 (7.96)	66.05 (8.18)	59.17 (7.75)	31.12 (5.29)	28.82 (4.75)	29.97 (5.02)
	0.4	81.24 (9.07)	82.64 (9.14)	80.70 (9.04)	38.17 (6.13)	37.79 (6.11)	37.98 (6.12)
	0.6	92.22 (9.66)	93.91 (9.74)	91.34 (9.61)	62.37 (7.95)	59.86 (7.77)	61.11 (7.86)
	0.8	100.00 (10.05)	100.00 (10.05)	100.00 (10.05)	81.30 (9.05)	80.60 (9.02)	80.95 (9.04)
Eucalyptus globulus	0.2	57.06 (7.60)	56.47 (7.58)	51.06 (7.21)	29.09 (5.09)	29.15 (5.33)	29.12 (5.21)
	0.4	70.73 (8.46)	75.36 (8.74)	72.48 (8.57)	32.88 (5.72)	32.04 (5.64)	32.46 (5.68)
	0.6	85.72 (9.31)	87.69 (9.42)	84.09 (9.22)	51.95 (7.16)	48.91 (6.77)	50.43 (6.97)
	0.8	93.64 (9.73)	95.18 (9.81)	92.63 (9.68)	75.32 (8.73)	73.27 (8.58)	74.29 (8.66)
Syzygium aromaticum	0.2	46.84 (6.89)	49.07 (7.06)	43.08 (6.62)	25.61 (4.79)	22.35 (4.41)	23.98 (4.60)
	0.4	70.00 (8.43)	71.08 (8.49)	69.05 (8.37)	29.08 (5.07)	28.82 (5.26)	28.95 (5.16)
	0.6	80.58 (9.03)	86.59 (9.36)	82.06 (9.11)	50.08 (7.02)	49.05 (7.04)	49.56 (7.03)
	0.8	90.94 (9.59)	92.50 (9.67)	89.80 (9.53)	68.20 (8.31)	66.17 (8.17)	67.19 (8.24)
Cinnamum camphora	0.2	27.31 (5.13)	43.02 (6.58)	33.94 (5.90)	22.65 (4.74)	20.54 (4.12)	21.60 (4.43)
	0.4	47.22 (6.94)	59.94 (7.80)	56.58 (7.59)	30.05 (5.20)	23.98 (4.89)	27.01 (5.04)
	0.6	65.11 (8.13)	74.82 (8.70)	71.52 (8.51)	43.76 (6.58)	43.03 (6.59)	43.39 (6.59)
	0.8	79.41 (8.97)	87.65 (9.41)	84.89 (9.27)	62.87 (7.92)	62.87 (7.98)	62.87 (7.95)
C.D(≤0.05)		0.56	0.38	0.25	A	B	A×B
S.E(m)		0.20	0.13	0.09	NS	0.58	NS

Figures in parentheses are square root transformed values.
A= Hr; B=Treatment; A×B= Hr × Treatment

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Evaluation of Vetiver Oil against Selected Rice Pathogens

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Keywords: Vetiver oil, rice, *Alternaria alternata*, *Dreshchlera oryzae*, *Fusarium moniliforme*

Introduction

India is the second largest producer and consumer of rice *(Oryza sativa)* in the world. There are various biotic as well as abiotic factors that reduce rice production. Among the biotic stress, fungal diseases have important role. Generally phytopathogenic fungi are controlled by synthetic fungicides but the continuous and indiscriminate use of chemical fungicides is known to cause residual toxicity, development of pathogen resistance to fungicides, environmental pollution, health hazards to humans and animals. Plant metabolites and plant based pesticides appear to be one of the better alternatives as they are known to have minimal environmental impact and danger to consumers in contrast to synthetic pesticides. Vetiver grass (*Vetiveria zizanioides* (L.) Nash is a perennial grass with thick fibrous adventitious roots belonging to the family Poaceae. The essential oil extracted from the roots of the vetiver grass possess insecticidal (Sujatha, 2010), fungicidal (Jayashree *et al.*, 2011) and herbicidal properties. Hence the aim of this study was to carry out activity-guided fractionation of antifungal agents from the oil of *V. zizanioides*.

Materials and Methods

Vetiver oil from laboratory stock was used fractioned into petroleum ether(nonpolar) and acetone (polar) fractions by column chromatography over silica gel (60-120 mesh size). Vetiver oil and its fractions were used to assess their antifungal potential against *Dreschlera oryzae*, *Fusarium moniliforme* and *Alternaria alternata* using spore germination inhibition method. The testing of compounds was done at 1000, 500, 250, 100, 50, 25 and 10µg mL^{-1} concentrations. Carbendazim (50WP) was used standard fungicide to compare the activity of the compounds. The percent spore germination inhibition was calculated using the formula:

Percent spore germination inhibition:

$$= \frac{\text{Spore germination in control} - \text{Spore germination in treated}}{\text{Spore germination in control}} \times 100$$

The antifungal activity was expressed in terms of ED_{50} and ED_{90} values (Table 1). Factorial CRD was applied to data using CPCS1 software. Significant difference between transformed values was set at 5%.

Results and Discussion

Percent spore germination inhibition at all concentrations was also calculated and statistical analysis of data showed that there was a positive correlation between concentration and antifungal activity. Vetiver oil, its non-polar and polar fraction showed 50% inhibition of spore germination (ED_{50}) at concentrations 120, 180 and 130 µg mL^{-1}, respectively. Vetiver oil is found to be more effective as compared to its fractions at all tested concentrations.

The results showed that the antifungal activity of oil was more as compared to polar and non-polar fractions for each type of tested fungi. Moreover, vetiver oil was highly effective against *F. moniliforme* as compared to *A. triticina* and *D. oryzae*. Among the fractions of essential oil, its polar fraction was more effective as compared to non-polar fraction.

The overall order of effectiveness of the all the tested components of *V. zizanioides* was as follows:

Vetiver oil > Polar Fraction > Non-polar Fraction

From the results it can be concluded that vetiver oil possessed significant antifungal activity, against three rice fungi *A. alternata, D. oryzae, F. moniliforme.* Hence, there is potential to develop new potent fungicidal compounds from essential oil of *V. zizanioides* against rice fungi.

Table 1: ED_{50} and ED_{90} values of vetiver oil, its non-polar and polar fractions against tested fungi

Fungus	Particulars	ED_{50}	ED_{90}
Alternaria alternata	Vetiver oil	220	650
	Non-polar	320	850
	Polar	290	810
	Carbendazim	08	20
Dreschlera oryzae	Vetiver oil	450	950
	Non-polar	610	1000
	Polar	550	>1000
	carbendazim	18	60
Fusarium moniliformae	Vetiver oil	120	320
	Non-polar	200	850
	Polar	180	600
	carbendazim	15	38

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Antifungal Potential of *Inula racemosa* against Selected Phytopathogenic Fungi of Rice

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Keywords: *Inula racemosa,* rice, spore germination inhibition *Dreschlera oryzae*, *Fusarium moniliforme*, *Alternaria alternata*

Introduction

Rice (*Oryza sativa*) is a staple food for large population in Asia. Its production is largely impacted by fungal diseases. To control these fungal diseases synthetic fungicides are being used which causes several adverse effects to the environment. Therefore plant pathologists have focused their attention to develop environmentally safe, long lasting and effective bio-control methods for the management of plant diseases. *Inula racemosa* is a medicinally important herb of north western Himalayas. Its roots are known to exhibit wide range of biological properties (He *et al.*, 2014). The present work deals with antifungal potential of *Inula racemosa* root extract and its fractions against rice fungi *Dreschlera oryzae*, *Fusarium moniliforme* and *Alternaria alternata.*

Materials and Methods

The chloroform root extract of *I. racemosa* and its polar (acetonitrile) and nonpolar (Petroleum ether) fractions were used to assess their antifungal potential against *Dreschlera oryzae*, *Fusarium moniliforme* and *Alternaria alternata* using spore germination inhibition method. The testing of compounds was done at 1000, 500, 250, 100, 50, 25 and 10µg mL^{-1} concentrations. Bavistin (50WP) was used standard fungicide to compare the activity of the compounds. The percent spore germination inhibition was calculated using the formula:

Percent spore germination inhibition:

$$= \frac{\text{Spore germination in control} - \text{Spore germination in treated}}{\text{Spore germination in control}} \times 100$$

The antifungal activity was expressed in terms of ED_{50} and ED_{90} values (Table 1). Factorial CRD was applied to data using CPCS1 software. Significant difference between transformed values was set at 5%.

Results and Discussion

Percent spore germination inhibition at all concentrations (1000-10 µg mL^{-1}) was calculated and statistical analysis of data showed that there was a positive correlation between concentrations and antifungal activity for all three fungi tested. The non-polar fraction showed maximum effectiveness against all the fungi tested. The ED_{50} values of root extract, nonpolar and polar fractions are 100, 60 and 110 µg mL^{-1}; 360, 120 and 240 µg mL^{-1}; 650,130 and 300 µg mL^{-1}, respectively against *Dreschlera oryzae*, *Fusarium moniliforme* and *Alternaria alternata.* ED_{50} values of all the compounds tested are not much low as compared with those of synthetic fungicide (carbendazim 50 WP) but the results are of interest since they have been obtained with the crude extract and it is widely accepted that plant extracts that are active at ED_{50} values less than 100 µg mL^{-1} could be considered to have a good potency level (Rios *et al.*, 1988). Moreover, all the compounds tested were more effective against *Dreschlera oryzae* followed by *Fusarium moniliforme* and least effective against *Alternaria alternata*. Moreover increased spore germination was observed at lower concentrations while absolute inhibitions were found at higher concentrations indicating dose dependent activities. The study revealed that non-polar compounds present in *I. racemosa* root extract may be useful in developing botanical fungicides against phytopathogenic fungi of rice.

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Table 1: ED_{50} and ED_{90} values of *I. racemosa* root extract, its non-polar and polar fractions, carbendazim against tested fungi

Fungus	Compound	ED_{50}	ED_{90}
Dreschlera oryzae	Root extract	100	450
	Non-polar	60	220
	Polar	110	330
	carbendazim	18	60
Fusarium moniliforme	Root extract	360	900
	Non-polar	120	420
	Polar	240	760
	carbendazim	15	38
Alternaria alternata	Root extract	650	1540
	Non-polar	130	400
	Polar	300	760
	carbendazim	08	20

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Antifungal Potential of Dill Seed Essential Oil and its Constituents

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Keywords: Dill seed, essential oil, limonene, antifungal activity, column chromatography, GC-MS.

Introduction

Fungi are the most important common cause of plant disease**,** since they are the most widespread and destructive parasites of plants (Mohammed, 2014)**.** However, the use of synthetic fungicides is increasingly restricted due to the harmful effects of pesticides on human health and the environment. Naturally occurring biologically active compounds, such as essential oils and several plant extracts are generally assumed to be more acceptable and less hazardous than synthetic compounds and represent a rich source of potential disease-control agents (Tripathi and Dubey, 2004). Dill (*Anethumgraveolens* L.), is the aromatic plants which produce essential oils with known biological activities. The present work deals with antifungal potential of dill seed essential oil and its chemical constituents against *Alterneria triticina* and *Bipolarissorokiniana.*

Materials and Methods

The antifungal activity of the dill seed essential oil, its fractions and isolated compounds were evaluated against plant pathogens *Alternaria triticina* and *Bipolarissorokiniana* using spore germination inhibition technique. The testing of compounds was done at 0.25, 0.5, 1.0 and 2.0 mg/mL concentrations. Carbendazim (50WP) was used standard fungicide to compare the activity of the compounds. The percent spore germination inhibition was calculated using the formula:

Percent spore germination inhibition:

$$= \frac{\text{Spore germination in control} - \text{Spore germination in treated}}{\text{Spore germination in control}} \times 100$$

The antifungal activity was expressed in terms of ED_{50} and ED_{90} values. Factorial CRD was applied to data using CPCS1 software. Significant difference between transformed values was set at 5%.

Results and Discussion

Percent spore germination inhibition at each concentration was calculated against *A. triticina*. Polar fraction of dill seed oil found to be more fungitoxic than all other components. The ED_{50} and ED_{90} (Fig. 1) values were observed in range 0.2-0.4 mg/mL and 1.6-2.5 mg/mL respectively. The order of antifungal activity obtained was:

Limonene > Non-Polar fraction > Polar fraction > Camphor > Dill seed oil.

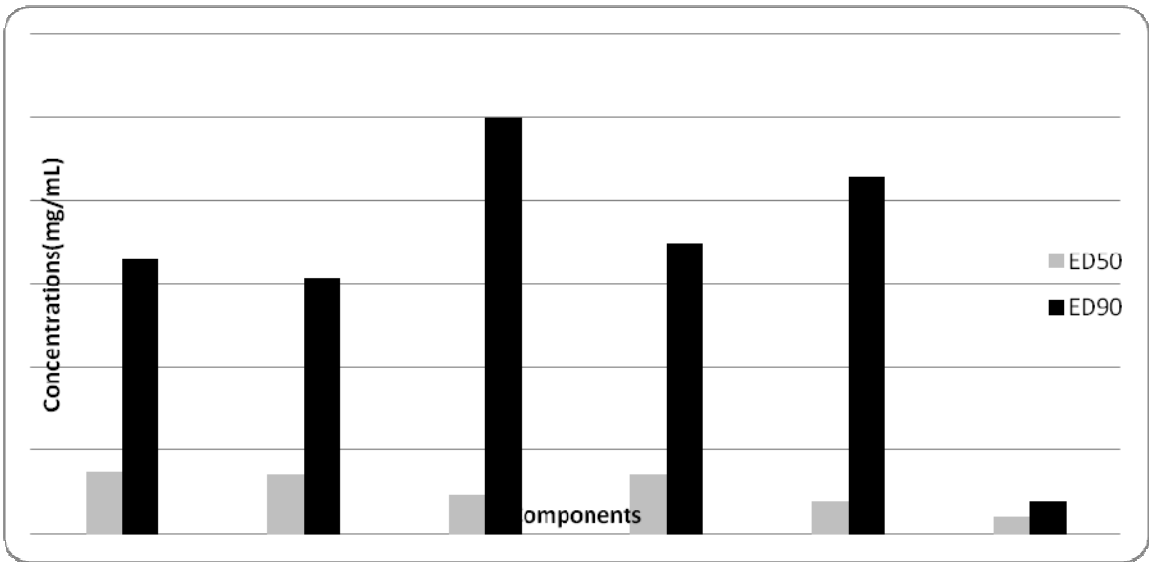

Fig. 1: ED_{50} and ED_{90} values of all components against A. triticina

Dill seed oil, its polar fraction and camphor showed significant difference (better activity) in activity at 2 mg/mL than non-polar fraction and limonene against *B. sorokiniana*. The ED_{50} and ED_{90} (Fig. 2) values were observed in range 0.1- 0.8 mg/mL and 0.7-2.1 mg/mL respectively. The order of antifungal activity obtained was:

Camphor > Polar fraction > Dill seed oil > Limonene > Non-Polar fraction.

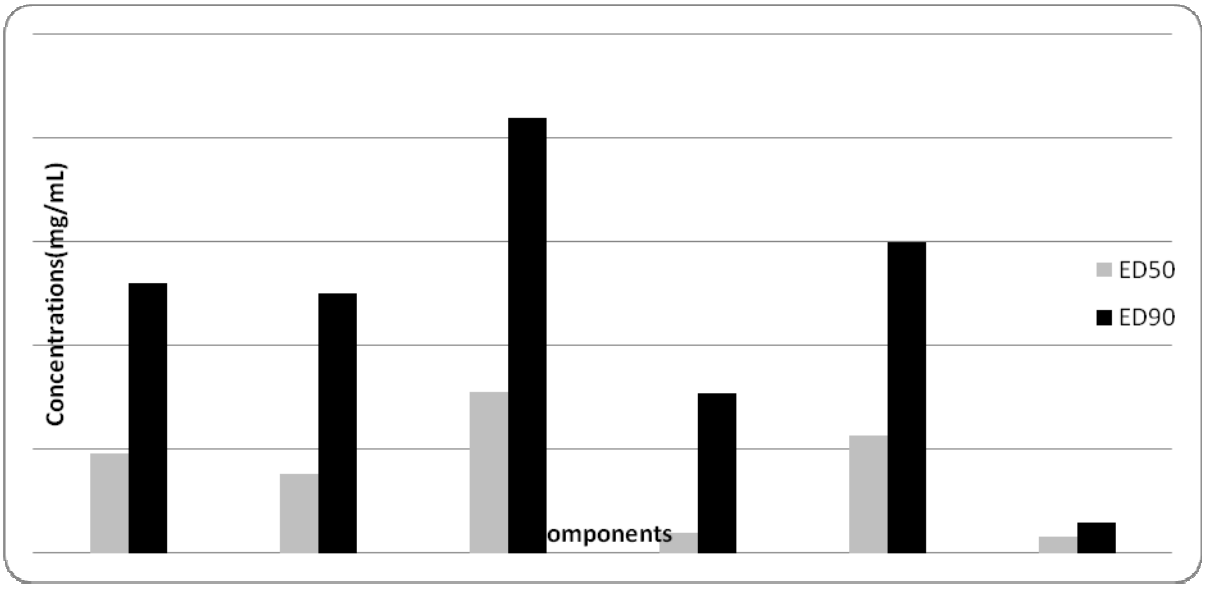

Fig. 2: ED_{50} and ED_{90} values of all components against B. sorokiniana

Statistical analysis of data showed a direct correlation between concentrations and antifungal activity. The antifungal activity increased with increase in concentration.

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126.

Effect of Hydroquinone on the Second Instar Larvae of *Spodoptera litura (*Fabricius)

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Keywords: Hydroquinone, *Spodoptera litura*, biopesticide, bioassay

Introduction

The large scale and unscrupulous use of synthetic pesticides in intensive agriculture has led to health hazards, pollution of environment, adverse effect on non-target organisms and resistance in insects. Also the buildup of pesticide residues necessitates that suitable alternate ecofriendly control strategies be identified and developed. Plant secondary metabolites that encompass several structurally diverse classes of natural products are safe and ecofriendly as they are biodegradable to non toxic products. Therefore the present study was aimed at investigating the potential of the plant compound hydroquinone in suppressing the population of tobacco caterpillar, *Spodoptera litura* (Fabricius). It is a polyphagous noctuid with high reproductive potential and ability to migrate long distances as adults.

Materials and Methods

The cultures of *S. litura,* were maintained in the laboratory at 25±2°C temperature, 65±5% relative humidity (RH) and 12: 12 dark: light (D: L) photoperiod. Bioassays against insects have been used for decades as a means of elucidating the activity of many chemical components or extracts. In the present study the antibiosis influence of hydroquinone was ascertained by feeding second instar larvae on artificial diet incorporated with different concentrations of the compound. The experimental larvae were kept in the Bio-chemical Oxygen Demand (B.O.D) incubator and observed daily for the various developmental parameters such as larval mortality, pupal mortality and adult emergence.

All the bioassays were performed in six replicates and the data were subjected to statistical analysis such as analysis of variance (ANOVA) and Tukey's test.

Results and Discussion

Hydroquinone was found to have a significant effect on all the three parameters investigated. When the second instar larvae were fed on hydroquinone incorporated artificial diet the larval mortality increased from 0% in control to a maximum of 36.67% at the highest concentration of 3125ppm (Fig. 1). The number of pupae formed from treated larvae declined with increase in concentration of hydroquinone (Fig. 2). The adult emergence was reduced significantly with maximum reduction observed at 5ppm where it decreased by 58.62% when compared to control (Fig. 3). In conclusion, the adverse effect of hydroquinone on larval mortality, pupation and adult emergence revealed that it can be considered as a promising candidate to be used as a biopesticide against the insect pest.

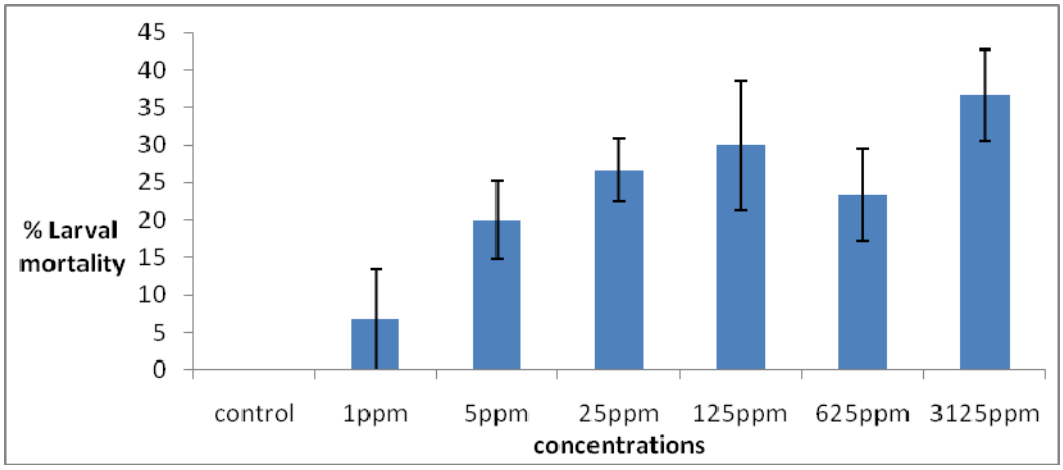

Fig. 1: Effect of different concentrations of hydroquinone on percent larval mortality of Spodoptera litura (Fabricius)

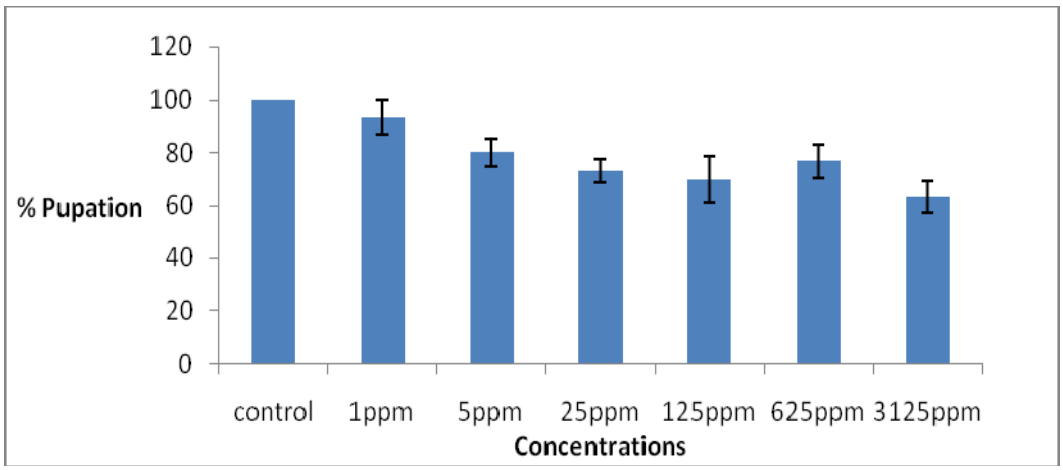

Fig. 2: Effect of different concentrations of hydroquinone on percent pupation of Spodoptera litura (Fabricius)

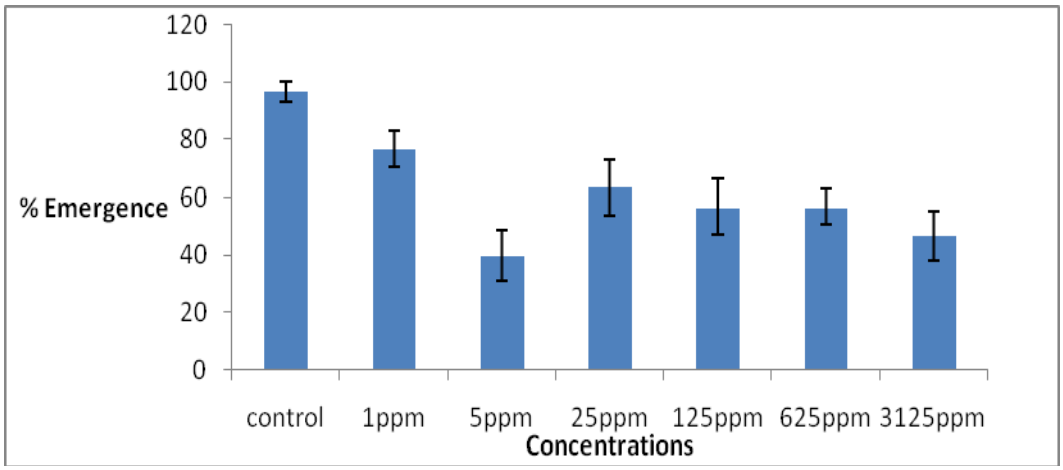

Fig. 3: Effect of different concentrations of hydroquinone on percent emergence of Spodoptera litura (Fabricius)

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Assessing Synergistic Larvicidal Potential of *Aloe vera* and *Eucalyptus* Oils against *Anopheles*

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Keywords: *Anopheles*, larvicidal effect, mortality

Introduction

Malaria, the principle mosquito borne disease is transmitted by *Anopheles* mosquito. It is one of the major public health problems throughout the world. The leaf extract of various plants has been shown to contain insecticidal properties against mosquitoes. The active phytochemical ingredients present in the *Aloe vera* and *Eucalyptus* is needed to be investigated for their potential use as new botanicals in mosquito control measures (Isman and Machial 2006).

Materials and Methods

Different treatments of the both oils mixed in dimethyl sulphoxide (DMSO) were conducted individually and in combination along with control (de-chlorinated water) and vehicle-control (DMSO + de-chlorinated water). Twenty five 4th instar *Anopheles* larvae/ plate in triplicate were exposed to various concentrations of *Eucalyptus* oil at the rate of 90, 80, 70, 60 and 50ppm and of *A. vera* oil at the rate of 550, 500, 450, 400 and 350ppm. Three concentrations of both oils, lower than their effective one were selected and 25 larvae were exposed by mixing these two oils in different combinations as calculated by Response Surface Methodology (RSM). Mortality was recorded after 3, 6, 12, 24 and 48 hours of treatment in all sets.

Results and Discussion

Out of the tested five concentrations of *Eucalyptus* oil, *Anopheles* larvae showed 100% mortality within 24hours after exposure to 90ppm. With fall in oil concentration from 90 to 50ppm the per cent mortality was found to decline from 100.00±0.00 to 51.11±3.85. In case of *A. vera* oil, after exposure to 550ppm, larvae showed 100% mortality within 24hours and thereafter reduction in oil concentration (550 to 350ppm) the per cent mortality was found to decline from 100±0.00 to 49.33±2.31% (Table 1). When three concentrations (80, 70 and 60ppm of *Eucalyptus* oil and 500, 450 and 400ppm of *A.vera* oil) less than the effective one i.e 90ppm for *Eucalyptus* and 550ppm for *A.vera* oil were put in RSM software, nine best combinations were found as given in Table 1. The combination having 71ppm of *Eucalyptus* and 450.5 ppm of *A.vera* oil was found to be the most effective as 100% mortality of *Anopheles* larvae was observed within 12hours as compared to the rest of combinations having higher concentration of these two oils.

Table 1: Larvicidal potential of *Eucalyptus* and *A.vera* oil tested individually and in combination against *Anopheles*

Experimental Set	Concentration of oil (ppm)	Mortality (%) (Mean±S.D)	Mortality (within hours)
Eucalyptus oil			
1	90	100.00±0.00	24
2	80	97.78±3.85	48
3	70	80.00±0.00	48
4	60	62.22±3.85	48
5	50	51.11±3.85	48
Aloe vera oil			
1	550	100.00±0.00	24
2	500	94.67±2.31	48
3	450	80.00±0.00	48
4	400	65.33±2.31	48
5	350	49.33±2.31	48
Eucalyptus+Aloe vera oil			
1	71+450.5	100±0.00	12
2	71+500.7	100±0.00	12
3	78+486	100±0.00	12
4	64+415	93.33±2.31	48
5	61.1+450.5	90.67±2.31	48
6	80.9+450.5	100±0.00	12
7	78+415	100±0.00	24
8	64+486	97.33±2.31	48
9	71+400.3	98.67±2.31	48

No mortality of larvae was observed in control and vehicle-control sets.

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Field Efficacy of Indigenous Plant Extracts against Diamondback Moth *Plutella xylostella* (Lepidoptera: Plutellidae)

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Keywords: Plant extract, field efficacy, *Plutella xylostella*

Introduction

Cabbage (*Brassica oleracea*), an important cruciferous vegetable, is generally cultivated for its young tender fruits. Cabbage is more prone to insect-pests and diseases primarily due to their tenderness and softness as compared to other crops. In India, about 152 species of lepidopteran, insect-pests have been found associated with vegetable crops (Sharma, 2011). Among the insect pests of cabbage *Plutella xylostella* is important pest of this crop. For the management of this pest many insecticides have been used, but it acquire resistance to almost all group of insecticides. So, there is need to manage this pest with environment friendly techniques, such as botanical pesticides

Materials and Methods

Four species of cabbage namely *Acorus calamus* L.; *Adhatoda vasica* L.; *Dioscorea deltoidea* Wall. and *Vitex negundo* L. were used to study their biological activity against *Plutella xylostella.* The leaves of two plants namely *Adhatoda vasica* and *Vitex negundo* and rhizomes of *Acorus calamus* were collected from adjoining areas of Palampur. However, the tubers of *Dioscorea deltoidea* were procured from the local market of Palampur. The oven dried plant material was crushed in grinder or blender to make a powder. The powder form extracted with different solvents and used for field experiments

Results and Discussion

Field efficacy of different plant extracts was evaluated against *Plutella xylostella* infesting cabbage under field conditions (Table 1). Data obtained on this aspect revealed that at the time of initiation of experiment, the population of diamondback moth varied from 1.0 to 2.6 larvae/ plant. Observations recorded 3,7,10 and 15 days after treatment (DAS) revealed the botanical insecticide at 5% level of concentration, methanol extract of *Acorus calamus* to be superior to all other treatments in reducing the mean population (55.51%) of diamondback moth larvae followed by methanol extract of *Vitex negundo* (49.86%). The findings of the present study revealed a maximum reduction (50.00%) in population on 3 DAS in the methanol extract of *Vitex negundo* being at par to methanol extract of *Acorus calamus* (48.15%) differing significantly to other botanicals. On 7 DAS, though methanol extract of *Acorus calamus* was significantly superior to other botanicals in reducing the population (61.11%), but also found at par to the methanol and ethyl acetate extracts of *Vitex negundo* (53.13%). Further, observations recorded on 10 DAS revealed a maximum reduction (62.50%) in population in methanol of *Vitex negundo* followed by methanol extract of *Acorus calamus* (58.52%) which in turn was at par to hexane extract of *Vitex negundo* (55.56%). On 15 DAS, methanol extract of *Acorus calamus* was found superior and significantly different to other botanicals in reducing the population (54.25%).

Reference

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Table 1: Evaluation of efficacy of different plant extracts against *Plutella xylostella* during 2013 (second round of spray)

Plant extracts	Concentration (%)	Pre count*	Per cent reduction in population over untreated				
		1DBS	3DAS	7DAS	10 DAS	15 DAS	Mean
Acorus calamus methanol	5.0	1.8	48.15 (43.92)	61.11 (51.44)	58.52 49.92()	54.25 (47.44)	55.51 (48.18)
Acorus calamus Hexane	5.0	1.6	37.50 (37.71)	41.41 (40.02)	50.00 (44.99)	33.82 (35.50)	40.68 (39.55)
Acorus calamus ethyl acetate	5.0	2.0	30.00 (33.13)	43.75 (41.37)	50.00 (44.99)	29.41 (32.70)	38.29 (38.04)
Acorus calamus Aqoueous	5.0	1.6	12.50 (20.02)	29.69 (32.87)	25.00 (29.80)	22.79 (28.28)	22.50 (27.74)
Vitex negundo methanol	5.0	1.6	50.00 (44.99)	53.13 (46.79)	62.50 (52.26)	33.82 (35.50)	49.86 (44.88)
Vitex negundo hexane	5.0	1.8	33.33 (35.20)	47.92 (43.79)	55.56 (48.19)	21.57 (27.53)	39.60 (38.68)
Vitex negundo ethyl acetate	5.0	1.2	33.33 (35.17)	53.13 (46.80)	50.00 (44.98)	26.47 (30.81)	40.73 (39.44)
Vitex negundo aqueous	5.0	2.4	25.00 (29.89)	37.50 (37.71)	41.67 (40.17)	26.47 (30.86)	32.66 (34.66)
Adhatoda vasica methanol	5.0	1.0	20.00 (26.31)	43.75 (41.37)	60.00 (50.81)	29.41 (32.71)	38.29 (37.80)
Adhatoda vasica hexane	5.0	1.8	11.11 (18.80)	27.08 (31.21)	33.33 (35.17)	31.37 (33.95)	25.72 (29.78)
Adhatoda vasica ethyl acetate	5.0	2.0	20.00 (26.74)	43.75 (41.39)	50.00 (44.98)	20.59 (26.90)	33.59 (34.94)
Adhatoda vasica aqueous	5.0	2.6	15.38 (22.96)	20.67 (26.96)	30.77 (33.64)	32.13 (34.49)	24.74 (29.51)
Dioscorea deltoidea methanol	5.0	2.4	25.00 (29.91)	29.69 (32.95)	33.33 (35.21)	26.47 (30.88)	28.62 (32.24)
Mean		2.8	27.79 (31.41)	40.97 (39.45)	46.21 (42.63)	29.89 (31.95)	
Untreated check**		3.0	3.0	3.2	3.0	3.4	

CD (P=0.05): Extract (A)= 2.77; Days after spray (B)= 1.48; AxB= 5.53
Figures in parentheses are arc sine transformed value
DBS= Day before spray; DAS= Days after spray

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Curry Leaves Possesses Antifungal Efficacy

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Keywords: Curry leaves, poisoned food technique, *A.alternata, B.specifera, C. lunata*

Introduction

Fungal diseases are major cause of morbidity and mortality worldwide. Curry leaves (*Murraya koenigii)* are used as antifungal substances to treat infectious diseases (Hema *et al.*, 2011). The plant extracts also showed significant effects in anti-inflammatory, stomachic, carminative, antioxidant and antimutagenic activities (Bonjar *et al.*, 2004). Therefore, antifungal potential of curry leaves would be helpful in treating various kinds of plant / human diseases.

Materials and Methods

The dried powered plant material was extracted in methanol and then concentrated by complete evaporation in vacuum. Different concentrations of test component (extract) were prepared in sterilized potato dextrose agar (PDA). After this 5 mm bit of test fungus was inoculated in the center of the agar plate followed by incubation of petri - plates at 26°C. The extension diameter (mm) of hyphae from the center to the dish was measured at 24 hour interval, till the growth of fungus in the plate without test component (control) reached the edge of the plates. Fungal growth diameter in each plate containing concentrations of test component was determined to calculate per cent growth inhibition (Guleria *et al.*, 2013).

Antifungal activity (%)= $(1-D_a/D_b) \times 100$

$D_{a=}$ Diameter of growth zone in the experiment dish (mm)

D_b= Diameter of growth zone in the control (mm)

Results and Discussion

In the present study, curry leaves has been investigated for antifungal potential against three test organisms *viz., Alternaria alternata, Bipolaris specifera* and *Curvuleria lunata* (test fungus) Inhibitory potential of its methanolic extract was analyzed by poisoned food technique in which different concentrations of test material were prepared in sterilized potato dextrose agar and poured in petri plates. Results of the present study revealed that curry leaves has potential activity against the test pathogens with (Inhibitory concentration) IC_{50} value of 0.97±0.02 mg/mL, 0.96±0.019 mg/mL and 1.1±0.04 mg/mL against *A. alternata, B. spicifera* and *C. lunata* respectively (Table 1).

Table 1: Growth inhibitory effect of *Murraya koenigii* against three phytopathogenic fungi

Plant part used	Extract	Conc. (mg/mL)	Phytopathogenic fungi		
			Alternaria alternata	***Curvuleria lunata***	***Bipolaris specifera***
			Growth inhibition (%)		
Leaves	Methanolic	0.5	38.5	38.75	36.5
		1	49.5	48.75	52.8
			76.5	62.5	78.5
IC_{50}			0.97	1.1	0.96

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130.

Lodging, Rodents (*Bandicota begalensis*) Damage Area and Colonies Impact on Productivity under Different Planting Methods and Cutting Management of Dual Purpose Barley (*Hordeum vulgare* L.)

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Keywords: Dual purpose barley, planting techniques, cutting practices,

Introduction

Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop of the world after wheat, rice and maize. Its grains contain 8 to 10% protein and 74% carbohydrates besides the minerals and vitamin B-complex, it thus forms a staple food, cattle feed, malt for manufacturing of beer and other liquor products (Singh *et al* 2009). The livestock sector contributes 32% for agricultural output, which is 22% of total gross domestic product (GDP) in India. The shortage in dry fodder for animals is 21.8% compared with requirement of 560 million tonnes (Kumar *et al.,* 2012). There are evidences that direction of rows influences yields of oats and wheat have also been reported to more yield when crops raised in rows planted in north-south direction than in east-west.

Materials and Methods

A field experiment was conducted during *rabi* 2014-15 at Department of Agronomy, Punjab Agricultural University, Ludhiana, India. The soil of experimental field was moderately alkaline (pH 8.3) to strongly alkaline (pH 8.8). The barley crop using variety PL 807 was on sown at 22.5 cm row spacing using 87.5 kg seed ha^{-1} on November 5, 2014. The experiment was laid out in factorial randomized block design (RBD) with 9 treatments have three planting methods namely unidirectional (UD), bidirectional (BD), broadcast (BC) and three cutting management namely uncut (UN_C), cut at 50 days after sowing (DAS) ($C_{50\ DAS}$) and cut at 60 DAS ($C_{60\ DAS}$) with four replications. The experimental field was collected soil samples before initiating the experiment and two (0-15 cm and 15-30 cm) composite sample was prepared. The field was moderately alkaline (8.3), electrical conductivity normal (0.40 & 0.30), low in organic carbon (0.30 & 0.18) and low in available nitrogen (130 kg ha^{-1}), medium in available phosphorus (21.31 & 18.2 kg ha^{-1}) and potassium (185 & 156.2 kg ha^{-1}).

Results and Discussion

Rodents (*Bandicota begalensis*) damaged area and colonies percent BD, UD and BC planting methods were non-significant, but under cutting management UN_C treatment was significantly higher in case of damaged area and colonies. C_{50DAS} and C_{60DAS} treatments of barley significantly reduced rodents damage area and colonies. Lodging was reduced significantly by cutting practices as compared to UN_C treatment. The effective tillers, grain yield were significantly higher in BD planting method compared to BC and UD planting methods and UN_C treatment were significantly higher than C_{50DAS} and C_{60DAS} treatments. The green fodder and dry fodder yield significantly higher in BD planting method compared to BC and UD planting methods and cutting management at C_{60DAS} was significantly higher than C_{50DAS}.

Table 1: Effect of different planting methods and cutting management on rodent damage area & colonies (%), lodging score, effective tillers, grain yield, green fodder yield, dry fodder yield of dual purpose barley.

Treatment	Rodent damage area & colonies (%)		Lodging score (%)	Effective tillers (no. m^{-2})	Grain yield (q ha^{-1})	Green fodder yield (q ha^{-1})	Dry fodder yield (q ha^{-1})
	90 DAS	At harvest					
Planting methods							
Unidirectional	7.34	12.22	14.82	347.73	40.10	166.90	17.29
Bidirectional	11.55	19.34	21.67	396.04	44.60	184.54	18.95
Broadcast	9.24	17.34	20.78	356.34	40.65	170.49	17.57
CD (P=0.05)	NS	NS	1.83	19.59	2.141	9.57	0.91
Cutting management							
Un-cut	27.23	47.46	57.27	396.69	44.55	-	-
Cut at 50 DAS	0.89	1.43	0	379.37	42.64	151.87	14.31
Cut at 60 DAS	0.0	0.0	0	324.05	38.16	196.08	21.56
CD (P=0.05)	4.48	7.57	1.83	19.59	2.141	7.81	0.74
Interaction	NS	NS	3.16	NS	NS	NS	NS

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131.

Morphometric Characterization of *Sclerotinia sclerotiorum* (Lib.) de Bary Causing Stem Rot on Seed Crop of Mesta and its Sensitivity towards Bioagents

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Keywords: *Hibiscus* spp., *Sclerotinia sclerotiorum,* sclerotia, morphological variation.

Introduction

Mesta *(Hibiscus Sabdariffa* and *H. canabinus*) belongs to family Malvaceae which is considered third most important bast fibre producing commercial crop with various uses of food, fodder and feed in India. Recently, during the winter season in December and January (2012-14) disease incidence of *Sclerotinia* stem rot on mesta has recorded up to 50% for the first time in the seed crop of mesta at Central Research Institute for Jute & Allied Fibers Research Farm, Barrackpore, North 24 Pargnas district of West Bengal, India. Among all the biotic stresses white/cottony rot caused by *S. sclerotiorum* act as a limiting factor for mesta seed production. The pathogen infecting and causing disease in a wide range of economically important monocotyledonous and dicotyledonous crops/plants but very little information is available with reference to mesta towards aiming for detail investigation on this disease and its management on seed crop of mesta. Therefore, present study were planned with characterization of isolates of *Sclerotinia sclerotiorum* causing white stem rot on mesta and their *in vitro* sensitivity towards bioagents.

Materials and Methods

The study was conducted at CRIJAF Research Farm, Barrackpore, North 24 Pargnas district of West Bengal, India. The infected plants of mesta were collected and the diseased stem tissue was surface sterilized for 1 minute in 1% $HgCl_2$ and plated on potato dextrose agar and incubated at 20±2°C for 10 days. Pure cultures of *S. sclerotiorum* were established and maintained on PDA for further studies viz. detection and characterization of isolates and *in vitro* bioassay. The cultural and morphological characteristics such as colony and sclerotia size of the pathogen isolates were recorded for identification. *In vitro* bioefficacy of strains of *Trichoderm aharzianum* (NBAII TH-8, NBAII TH-10, TH-1, MTCC No- 8799) and *Trichoderma viride* (TV-01, NBAII TV-10, NBAII TV-23, MTCC No- 793, MTCC No- 3144) were tested against isolates of *S. sclerotiorum* by using confrontation test. The degree of antagonisms between bioagent and test pathogen in dual culture was scored on the scale of 1-5. The per cent inhibition of growth in each treatment was calculated by using the formula of Vincent as $I= [(C-T)/C] \times 100$.

Fig. 1: Typical field symptoms of White/cottony stem rot of mesta caused by Sclerotinia sclerotiorum

Fig. 2: PDA culture plate of Sclerotinia sclerotiorum with white mycelium and black sclerotia

Results and Discussion

In CRIJAF Research farm, Barrackpore the conducive pathometerological parameters were recorded for December 2012, January 2013 and January 2014 were 76%, 72% and 82% RH respectively, with corresponding mean minimum temperatures of 18, 17 and 12°C. Mesta white stem rot symptoms were appeared in the form of water soaked lesions on stem during capsule and boll formation stage of the crop. Lesions of infected stems and bolls usually develop patches of white fluffy mycelial mat often with large irregular black coloured rat dropping like sclerotia, typical of *Sclerotinia sclerotiorum* (Fig. 1). The pathogen colonies recovered were typical of *S. sclerotiorum* and produced abundant irregular large black coloured sclerotia (0.5-1.5 cm), on PDA (Fig. 2). Myceliogenic germination produced white coloured colony with hyaline, septate, branched hyphae. The isolated pathogen was identified as *Sclerotinia sclerotiorum* (Lib.) de Barybased on morphological and cultural characteristics of mycelia and sclerotia (Bolton *et al.*, 2006) as well as pathogenicity test.On the basis of inhibition per cent of mycelial growth and production of sclerotia in tested isolates of *S. sclerotiorum* among strains of *T. viride*namely NBAII TV-23 and MTCC No-3144 were found most effective.

To our knowledge, this is the first report of occurrence of white/cottony stem rot in mesta caused by *Sclerotinia sclerotiorum* in India. Therefore, this documentation may play an important role towards aiming for detail investigation on disease free regeneration, conservation and exchange of germplasm for crop improvement programme under International Plant Protection Convention as well as management of the disease on priority under changing climatic scenario.

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132.

Occurrence of Cacao Tussock Moth, *Orgyia australis postica* Walker and Other Insect Pests on *Jhum* Maize in Arunachal Pradesh

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Keywords: *Orgyia australis postica, Chrysodeixis includens*, Jhum, maize, insect pests

Introduction

Arunachal Pradesh is the area wise largest state of North East India and maize is one of the important cereals after rice grown in over 0.57% area of the state. *Jhum* cultivation, done on hills after burning the forest, is the traditional lifestyle of the tribes. Sowing of *Jhum* maize is generally done from March to May (*Pedi*) and again in October and November (*Patan*). Being a biodiversity rich area, the crop faces slightly different insect pest complex from what we observe in plains. Here, the efforts have been put to study the level of infestation of some important insect pests of *jhum* Maize.

Materials and Methods

The study was conducted in 2014-15 in six different *Jhum* fields of West Siang District of Arunachal Pradesh situated between 93.57°-95.23°East Latitude and 27.69°-29.20° North Longitude. The observations were made on 60 numbers of randomly selected plants sown in the period of October and November. The infestation level was determined by recording the number of larvae/adults per plant/cob whereas per cent infestation was calculated as the number of infested plants out of 60 randomly selected plants in the field.

Results and Discussion

The infestation level per plant/cob and mean per cent infestation are shown in Table 1. Occurrence of *O. australis postica* on maize is an unusual case in Arunachal Pradesh. The pest was first reported in Philippines on cacao (Sanchez and Laigo, 1968). Fasih *et al* (1989) has also reported it as a pest on Mango in India. The pest was observed feeding on leaves, silks as well as on the tassels. Similar is the case of *Chrysodeixis includes,* which is generally a pest of soybean, was observed feeding on chlorophyll making the leaves transparent. In contrast to this nature of damage, Janes and Greene (1970) reported that pest make damage by removing silk and kernels from the top of the cob and make feeding holes in flag leaves. In addition to usual occurrence of *Chilo partellus*, infestation of *Spodoptera frugiperda* was higher among stem boring pests. Highest per cent infestation was observed in case of cob borer, *Stenochroia elongella* (42.56) which is prevalent in north eastern hilly region of India. *Monolepta signata*, a chrysomelid beetle, found making small holes in the leaves, the damage and intensity of infestation was not found much alarming. Also, infestation level of the red colour leaf hopper, *Bothrogonia* spp was too low to consider it as a pest.

It can be said from the result that the pest scenario is changing over time. Pests like *Orgyia australis postica* and *Chrysodeixis includens* which are not generally observed in maize, sometimes, may cause outbreak and should be treated as potential pests of the crop.

Table 1: Infestation level of insect-pest observed

Insect-pest	Infestation level per plant/cob	Per cent Infestation	Stage
Orgyia australis postica	1 to 2 larvae per plant	7.89 to 12.64	Vegetative to Silking
Spodoptera frugiperda	1 to 6 larvae/plant	17.74 to 26.34	Seedling to Vegetative
Chrysodeixis includens	1 to 4 larvae/plant	13.56 to 64.36	Seedling to Vegetative
Rhopalosiphum maidis	70 to 160 aphids/plant	1.69 to 6.39	Silking to Maturity
Monolepta signata	1 to 2 beetles/plant	3.67 to 4.26	Seedling to Maturity
Stenochroia elongella	1 hole/cob	16.33 to 42.56	Maturity
Bothrogonia spp	1 adult per 30 plants	-	Seedling to Maturity
Grasshoppers (unidentified)	1 adults per 10 plants	1.6 to 5.9%	Seedling to Maturity

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133.

Epidemiology and Management of Black Leaf Spot (*Isariopsis indica* Nair var. *ziziphi*) of Ber Under Rainfed Sub-tropics of Jammu

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Keywords: Ber, black leaf spot, epidemiology and management

Introduction

The ber (*Zizyphus mauritina* Lamk.) is an ancient and common fruit growing in wild, semi-wild and grown throughout India mostly on waste and dry land area. The plants having wide potential for high yields, excellent economic returns to the growers, cultivation of this hardy and highly nutritive fruit is expanding at a faster rate. The diseases.namely powdery mildew (*Oidium erysiphoides* f.sp. *ziziphi*), black leaf spot/ sooty mould (*Isariopsis indica* Nair var. *ziziphi*), fruit rots (*Alternaria alternata, Cladosporium spp. and phoma spp.*) are the major threat in ber cultivation. Among the various diseases, sooty mould caused by (*Isariopsis indica* Nair var. *ziziphi*) is also an important disease and causes heavy losses under favourable condition prevails for longer time particularly during winter month. Disease is characterized by the appearance of sooty tuff-like circular to irregular spot on lower surface of leaves and upper surface of the leaves shows brown discoloration ultimately infected leaves fall off. Keeping in view of the important of the crop particularly in dry land area and also losses cause by the disease, the present investigation was carried out to find out the effect of weather parameters on development of black leaf spot and its management through fungicides and different plant extracts.

Materials and Methods

The effect of weather parameters on development of black leaf spot was studied at Rainfed Research Sub-station for Sub-tropical Fruits Raya, SKUAST-J during two consecutive years 2010-11 and 2011-12. The diseases incidence was recorded at weekly interval after appearance of the disease and correlation coefficient was worked out by using statistical tool.

The trial was laid during 2010-11and 2011-12 crop season in randomized block design, where in, six fungicides i.e. copper oxychloride (0.25%), carbendazim (0.1%), tridemefan (0.1%), mancozeb (0.25%), captan (0.2%) and thiovit (0.2%) along with two plant extracts i.e. Drake (*Azadirachta mellea*) seed kernel extract (DSKE 4.0%) and neem (*Azadirachta indica*) seed kernel extract (NSKE 4.0%) were tested for their efficacy to manage the sooty mould of ber The fungicides and plant extracts were sprayed twice at 15 days intervals commencing from first week of January.

Results and Discussion

The data presented in Table 1 indicates that weather parameters i.e. maximum temperature °C, minimum temperature (°C), relative humidity (morning %), relative humidity (evening %), rainfall (mm), dew point temperature (morning°C) and dew point temperature (evening) °C influenced the leaf spot development. The two year data revealed that weather parameters i.e. maximum temperature °C and minimum temperature °C were negatively correlated with development of black leaf spot of ber. Relative humidity (morning %) had significant positive correlation with disease development and non-significant positive correlation was established with relative humidity% (evening). However, rainfall (mm), dew point temperature°C (Morning) and dew point temperature°C (evening) had negative correlation.

It is revealed from tale 2 that the fungicide carbendazim (0.1%) was found most efficacious in reducing the severity of black leaf spot of ber (68.35). It was followed by triademefon (53.17%) and mancozeb (43.04%). However, plant products NSKE and DSKE were less effective in managing the disease.

Table 1: Correlation between black leaf spot of ber with weather parameters

Weather Parameter	Correlation coefficient (2011-12)	Correlation coefficient (2012-13)
Max. temp. °C	-0.66*	-0.75*
Min. temp. °C	-0.65*	-0.62*
R H (Morning %)	0.78**	0.72*
R H (Evening %)	0.37	0.45*
Rainfall (mm)	-0.18	-0.24
Dew point temp °C (morning)	-0.12	-0.18
Dew point temp. °C (evening)	-0.36	-0.40

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level.

Table 2: Management of Black Leaf spot of Ber

Treatment	Conc. (%)	Black leaf spot incidence (%)			Control (%)
		2010-11	2011-12	Pooled	Control (%)
Copper oxychloride	0.25	34.90	30.50	32.70	17.22
Carbendazim	0.10	15.00	10.00	12.50	68.35
Triademefon	0.10	20.50	16.50	18.50	53.17
Mancozeb	0.25	23.00	22.00	22.50	43.04
Capton	0.20	27.50	28.50	27.00	31.65
DSKE	4.0	26.30	27.50	26.90	31.90
NSKE	4.0	28.00	21.50	24.50	37.98
Control	-	45.00	34.00	39.50	-
SEM(±)		2.4	2.2	2.3	
LSD (P= 0.05)		6.92	6.80	6.86	

DSKE= Drake Seed Kernal Extract, NSKE= Neem Seed Kernal Extract

134.

Effect of Green-extracts, a Nature Friendly Component Against Major Pests Fauna of Tomato (*Solanum lycopersicon* L.)

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Keywords: Tomato, green-extracts, aphid, jassid, whitefly, thrips, fruit borer.

Introduction

Tomato (*S. lycopersicon* L) is the most important vegetable grown widely both for fresh marketing and processing in Madhya Pradesh, tomato crop is cultivated on 60.84 thousand hectare with the annual production of 1484.5 thousand metric tonnes (Anonymous). The production and quality of tomato fruits are considerably affected by array of insect pests. Various approaches are adopted for insect pest management in tomato. Green extracts use as nature friendly components are cheap, safer and affordable for small farmers compared to synthetic pesticides. In view of the above facts, the present study in tomato entitled, 'Effect of green-extracts, a nature friendly component against the major pests fauna of tomato (*S. lycopersicon* L.)

Materials and Methods

A field experiment was conducted at College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during *rabi* 2012-13. The experiment was laid out in randomized block design (RBD) with three replications, and each replication consists of 11 treatments. The pre-treatment observation were recorded at 24 hours before spraying, while the post treatment observations were recorded on 1st, 3rd and 7th days after each three spray at 15 days interval. Overall total variability present in the material under study for each character and for all the populations was determined by statistical analysis as described by Panse and Sukhatme (1963).

Results and Discussion

The efficacy of ten green extracts neem seed kernel extract (NSKE) (*Azadirachta indica*) (2%), neem seed kernel extract (NSKE) (*Azadirachta indica*) (5%), tobacco extract *(Nicotiana spp)* (2%), tobacco extract (*Nicotiana spp*.) (5%), lantana leaf extract (*Lantana camara*) (5%), garlic extract (*Allium sativum*) (5%), zinger fresh tuber extract (*Zingiber officinale*) (5%), green chili extract (*Capsicum anum*) (5%), ipomea leaf extract (*Ipomoea* carnea) (5%) and custured apple leaf extract (*Annona squamosa*) (5%) were tested against leaf minor (*Liriomyza trifolii),* whitefly *(Bemisia tabaci),* jassid *(Amrasca devastans)*, aphid (*Aphis gossypii)* and fruit borer (*Helicoverpa. Armigera)* on tomato. On the basis of average percent leaf infestation due to *L. trifolii, B. tabaci, A. devastans A. gossypii* population and percent fruit infestation, percent yield loss due to *H. armigera* in different treatments and their efficacy was assessed.

Among the green extracts treatments NSKE (5%) was recorded significantly highest fruit yield 147.50 q/ha followed by tobacco extract (5%) 135.57 q/ha. However, untreated control was recorded lowest 25.77 q/ha fruit yield.

On the basis of present investigation, it is concluded that the different green extracts namely, NSKE (5%) and tobacco extract (5%) were most effective treatments against the major pests of tomato. The average less percentage of fruit damage and less percentage yield loss were recorded in NSKE (5%) and tobacco extract (5%) treatments and considered the most effective treatments against *H. armigera*. On the basis of above results, NSKE (5%) and tobacco extract (5%) were most effective treatments against *L. trifolii*, *B. tabaci*, *A. devastans*, *A. gossypii* and *H. armigera*. Treatment, NSKE (5%) was recorded significantly highest fruit yield followed by tobacco extract (5%) than rest of the treatments. NSKE (5%) & tobacco extract (5%) gave highest net return with cost benefit ratio of 1: 3.70 and 1: 3.50, respectively.

Reference

Panse, V. C. and Sukhatme, P. V. 1963. *Statistical methods for agricultural workers*. ICAR Publications, New Delhi.

Table 1: Economics of green extracts against major pests of tomato

Treatments	Dose L./ha	Average yield of healthy fruit (q/ha)	Increase in yield over control (q/ha)	Value of increased yield (Rs.)	Quantity of green extract/ha for 3 sprays	Cost of insecticides for 3 sprays/ha	Labor charge/ha for 3 sprays	Total cost of treatment per ha (Rs/ha)	Net return/ha (Rs.)	Cost benefit ratio
NSKE 2%	10 L L	79.71	53.94	26970	30 Lit.	5000	1200	6200	20770	1: 3.35
NSKE 5%	25 L.	147.50	121.73	60865	75 Lit.	11750	1200	12950	47915	1: 3.70
Tobacco extract 2%	10 L.	74.15	48.38	24190	30 Lit.	4700	1200	5900	18290	1: 3.10
Tobacco extract 5%	25 L.	135.57	109.80	54900	75 Lit.	11000	1200	12200	42700	1: 3.50
Lantana leaf extract 5%	25 L.	38.31	12.54	6270	75 Lit.	700	1200	1900	4370	1: 2.30
Garlic extract 5%	25 L.	93.85	68.08	34040	75 lit	8000	1200	9200	24840	1: 2.70
Ginger fresh tuber extract 5%	25 L.	82.81	57.04	28520	75 Lit.	8000	1200	9200	19320	1: 2.10
Green chili extract 5%	25 L.	81.37	55.6	27800	75 Lit	5750	1200	6950	20850	1: 3.00
Ipomea leaf extract 5%	25 L.	36.41	10.64	5320	75 Lit	700	1200	1900	3420	1: 1.80
Custard apple leaf extract 5%	25 L.	36.91	11.14	5570	75 Lit	700	1200	1900	3610	1: 1.90
Control	-	25.77	-	-	-	-	-	-		

Green extract cost	Neem seed kernel @ Rs. 150/kg	Tobacco leaf @ Rs. 140/kg	Garlic bulb @Rs. 100/kg
	Ginger fresh tuber @ Rs. 100/kg	Green chili @ Rs. 70/kg	Lantana, Ipomea and Custard apple leaf @ Rs.200 for one labor cost

Labor charges @ Rs. 200/ labor/day Selling price of Tomato @ Rs. 500/q. Decoction preparation cast Rs. 500.

135.

Molecular Phylogenetic Analysis and Barcoding of chosen Dipteran Insects

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Keywords: Diptera, molecular phylogeny, barcoding, 28S rDNA sequence

Introduction

Insects are the largest and most successful groups of organisms within the animal kingdom and therefore an updated molecular phylogenetics and barcoding studies are absolutely essential. In India, so far not much attempt has been made, except few works on specific research interests. This formed a basis for creation of a baseline database of molecular phylogeny and barcoding for well known representatives from major families of dipteran insects using 28S rDNA sequences as molecular taxonomic tool.

Materials and Methods

Thirty different species of dipteran insects were collected in and around Chennai and were identified using standard taxonomical keys. DNA was extracted from the tissue samples of collected insects as per the method of Coen *et al.* (1982). The D2 region of 28S rDNA was amplified from the total genomic DNA by PCR using universal primers. PCR was conducted with a total reaction volume of 25 µl consisting of 200 nM of each primer, 100 µM of each dNTP mix, PCR buffer with 15 mM $MgCl_2$ and 0.5 Unit of *Taq* DNA polymerase with 1 µg of template DNA. A control reaction was prepared without template DNA (negative control) and without enzyme (positive control). The tubes were then placed in a thermal cycler preheated at 99°C and the amplifications consisted of first cycle at 94°C for 5 min; 35 cycles of 94°C for 1 min, 56°C for 1 min 30 sec, and 72°C for 1 min; and a final extension cycle of 72°C for 7 min. The amplified product was verified using 1.2% agarose gel electrophoresis. The product was gel purified and sequenced using the service of Chromous Biotech Private Ltd, Bangalore, India. GC content, similarity index and distance matrix of all nucleotide sequences of 28S rDNA D2 region of various dipteran insects were determined using BioEdit programme. The multiple sequence alignment followed by phylogeny was carried out using ClustalW followed by 3D coffee method. The DNA barcode data for all the thirty species was generated, validated and submitted at "The Barcode of Life Data Systems (BOLD)" (http: //www.boldsystems.org).

Results and Discussion

Collected dipteran insects families were grouped into seven different major groups of flies based on their feeding behavior and habit such as Biting flies (Culicidae, Tabanidae, Psychodidae, Ceratopogonidae, Muscidae), Predators (Asilidae, Syrphidae), Scavengers (Calliphoridae, Sarcophagidae), Herbivores (Tephritidae, Drosophilidae) Parasites, (Sciomyzidae, Tachinidae, Anthomyiidae), Coffin flies (Phoridae) and Soldier flies (Stratiomyidae). The 28S rDNA D2 region specific primers amplified a fragment at 0.6 kb using the genomic DNA isolated from these insects. The size of the nucleotide sequence of amplified fragment ranged from 487 bp to 600 bp for various dipteran insects. The analyses based on 28S rDNA nucleotide sequences using ClustalW multiple sequence alignment followed by phylogram analyses revealed a phylogeny as indicated in Fig. 1. Specimen and sequence data of all the thirty insects were submitted at The Barcode of Life Data Systems (BOLD) for making of DNA barcode data. Barcoding generated at BOLD systems based on 28S rDNA nucleotide sequences of thirty dipteran insects were obtained for providing valuable information for insect taxonomists to trouble-free identification of these insects.

Reference

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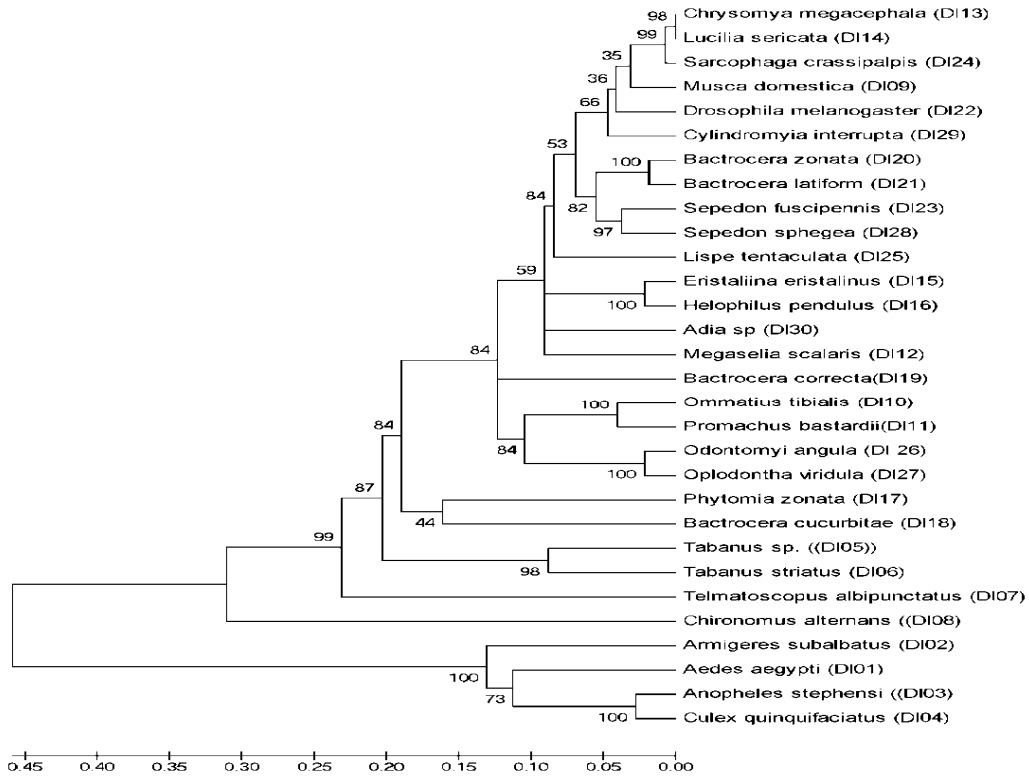

Fig. 1: Phylogram generated based on multiple sequence alignment of 28S rDNA D2 region gene sequences of thirty different adult dipteran insects

136.

Detection, Preliminary Characterization and Isolation of Non-self Recognition Molecule (Agglutinin) from the Hemolymph of Aquatic Insect, *Stenopsyche kodaikanalensis*

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Keywords: Agglutinin, Caddisflies, *Stenopsyche kodaikanalensis*

Introduction

The aim of present work was to detect, characterize and isolate a defence molecule called lectin (agglutinin) in an aquatic insect caddisfly, *Stenopsyche kodaikanalensis* from the streams of Korangani Hills, Western Ghats, Tamil Nadu. Very few species have been reported under this genus all over the world. It is known that *Stenopsyche* diversity is more prone to pollutants that eventually lead to decrease in its abundance. Susceptibility of this insect directed us to study its lectin, which functions in non-self recognition because the genus is also involved in utilizing detritus pathway for its growth and development. By knowing the immune system of aquatic insects there will be possibilities to conserve these species.

Materials and Methods

The aquatic insect, *Stenopsyche kodaikanalensis* were collected from the streams of Korangani Hills, Tamil Nadu. The preliminary characterization includes serum protein estimation (Lowry *et al.,*1951), heamagglutinating activity against various mammalian and avian RBCs (Garvey *et al.,* 1979), divalent cation dependency and EDTA sensitivity of agglutinin, pH and thermal stability of agglutinin. Carbohydrate binding specificity of agglutinin was done by hemagglutination-inhibition assay using 21 types of sugars. Finally, the lectin was isolated using lactose coupled Sepharose 6B by affinity chromatography method.

Results and Discussion

Total protein in the serum was estimated as 22.0 mg/ml. Among the various mammalian Red Blood Cells (RBCs) tested, the buffalo RBC was most agglutinating type with the serum agglutinin. The serum agglutinin is cation dependent and Ethylenediaminetetra Acetic acid (EDTA) sensitive. Moreover, the agglutinin was highly thermal stable (up to 90°C) and highly alkaline stable (*p*H 5-9). Hemagglutination inhibition assay results revealed that the serum agglutinin was highly specific to a disaccharide, lactose (at 12.5mM) (Table 1). The agglutinin molecule was isolated using affinity column chromatography. These preliminary studies could be useful in the study of the immunological functions of hemolymph agglutinin in *S. kodaikanalensis*.

Table 1: Overview of preliminary characters of hemagglutinin from the aquatic insect *S. kodaikanalensis*

Total protein in crude serum	:	22.0mg/ml
Hameagglutinating activity	:	Buffalo RBC (titer value - 32)
Divalent cation dependency & EDTA sensitivity	:	Cation independency & EDTA insensitivity
Temperature stability & pH stability	:	20-90°C & pH 5-9 respectively
Carbohydrate inhibition assay	:	Lactose specificity (12.5mM)

Refernces

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137.

Overwintering of *Aenasius bambawalei* Hayat (Hymenoptera: Encyrtidae) under Screen House Conditions

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Keywords: Overwintering, *A. bambawalei*, pupal period, adult longevity

Introduction

Solenopsis mealybug, *Phenacoccus solenopsis* Tinsley is heavily parasitized (37.6-72.3%) by *Aenasius bambawalei* Hayat on cotton crop in Haryana (Ram *et al.*, 2009). Most studies on overwintering in parasitoids have focused on the genus *Trichogramma* (Hymenoptera: Trichogrammatidae) (Ozder and Saglam, 2005). But no information is available on the overwintering strategies of *A. bambawalei*. Thus the present studies unreveal the overwintering ability of the parasitoid by considering adult survival and temperature dependent development of the immature stages under screen house conditions during winter season.

Materials and Methods

Overwintering studies were carried out by placing newly emerged adults of the parasitoid, *A. bambawalei* and one day old mummies of *P. solenopsis* during winter season Dec., 2012 to Feb., 2013. The parasitoids were placed in six batches (30 mummies or adults/batch) at different exposure dates. Observations were recorded on time taken to emerge from mummies both for males and females (days), per cent emergence, sex of emerged individual and longevity of overwintering adults. Averaged weather data used to calculate the effect of temperature on survival of overwintering parasitoids. The data were analysed using one factor Completely Randomized Design at p=0.05 level of significance.

Results and Discussion

Emergence of parasitoids was recorded maximum in 14th standard week (first week of March) and continued until 16th standard week (third week of March) when all the parasitoid adults had emerged.

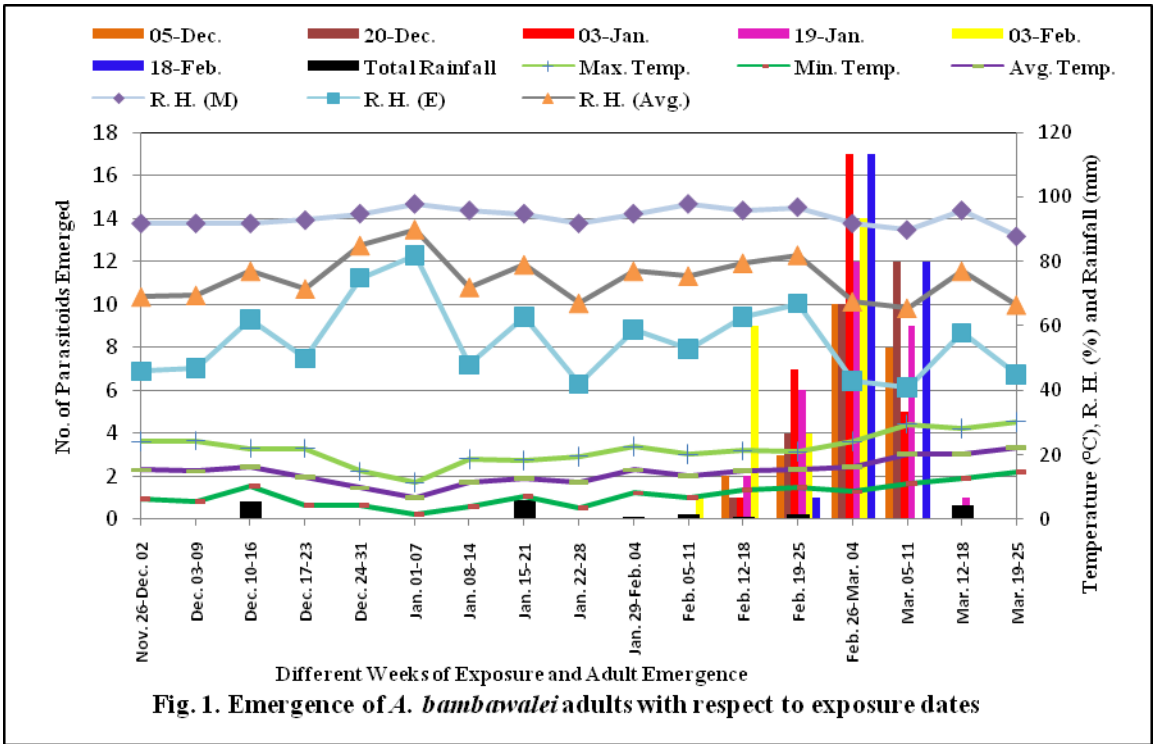

Fig. 1. Emergence of *A. bambawalei* adults with respect to exposure dates

Maximum temperature ranged between 20.3 to 29.6°C and minimum between 6.6 to 12.5°C during the period of adult emergence (Fig. 1). Among different exposure dates, per cent adult emergence increased as the exposure duration decreased. Least emergence of the parasitoid adults occurred from the mummies exposed to winter conditions on 5th December (76.67%) followed by those exposed on 20th December (90%). Maximum pupal period of male and female parasitoids was 86.47 and 92.67 days, respectively, when one day old mummies were exposed on 5th December followed by 73.69 and 82.83 days, respectively, when one day old mummies were exposed on 20th December. Honey fed parasitoid adults i.e. males survived for 52-84 days (69.33 days) and females survived for 69-103 days (83.40 days) during winter season in absence of host, when

exposed on 5th December (Table 1). It is concluded that *A. bambawalei* overwinters as pupae as well as adults by a combination of slowed development in the host mummies and prolonged adult longevity, respectively, hence need to be conserved on left over cotton stubbles.

Table 1: Emergence, pupal period and adult longevity of overwintering *A. bambawalei*

Date of Exposure	Emergence (%)	Pupal period (days)				Longevity of overwintering adults (days)			
		Male		Female		Male		Female	
	Mean	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Dec. 05, 2012	76.67 (61.20)*	86.47 (9.35)	71-93	92.67 (9.67)	85-95	69.33 (8.38)	52-84	83.40 (9.18)	69-103
Dec. 20, 2012	90 (73.61)	73.69 (8.64)	60-78	82.83 (9.15)	76-85	67.33 (8.26)	47-81	80.60 (9.03)	65-100
Jan. 04, 2013	100 (85.91)	50.69 (7.18)	44-58	56.92 (7.61)	54-62	59.47 (7.64)	39-71	68.20 (8.32)	62-77
Jan. 19, 2013	100 (85.91)	27.88 (5.36)	16-39	35.50 (6.04)	21-42	51.26 (7.36)	37-68	61.70 (7.92)	51-68
Feb. 03, 2013	100 (85.91)	18.83 (4.45)	08-28	21.68 (4.75)	11-29	43.40 (6.88)	32-55	55.20 (7.49)	40-67
Feb. 18, 2013	100 (85.91)	12.39 (3.65)	06-19	16.25 (4.15)	09-20	36.93 (6.15)	21-45	40.13 (6.41)	33-54
Control (27°C)	100 (85.91)	05.61 (2.56)	04-08	08.67 (3.10)	06-10	18.43 (4.39)	7-22	32.50 (5.78)	14-38
CD (p=0.05)	(8.03)	(0.42)		(0.37)		(0.38)		(0.29)	

*Figures in parentheses are means of angular transformation

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138.

Seasonal Abundance of Whitefly, *Bemisia tabaci* (Genn.) Population on *Bt* Cotton and Its Relationship with Weather Parameters

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Keywords: Whitefly population, weather parameters, *Bt* cotton

Introduction

Cotton crop has a global significance as it is commercially cultivated on large scale for fibre purpose and also known as "White gold". After the successful introduction of transgenic *Bt* cotton, the specific lepidopteran pests (Arshad *et al.,* 2009) have been effectively controlled, but there is a lack of resistance against sucking insects pests (Sharma and Pampapathy, 2006). Among them, whitefly *Bemisia tabaci* has attained a major pest status and cause considerable damage on *Bt* cotton. Hence, the present study was focused on location specific seasonal occurrence of whitefly and its relation with weather parameters.

Materials and Methods

Recommended agronomic practices were followed in raising the transgenic cotton BIO 6588 BG in an experimental area of 500 m^2 without any insecticidal spray. The observations on whitefly adults and nymphs were recorded at weekly intervals throughout the crop season starting from the end of June, 2013. Whitefly adult and nymphal population were recorded by observing undersides of three fully formed leaves from the upper and middle canopy of each 25 randomly selected plants, respectively. The data on pest population as well as weather variables were averaged for different standard meteorological weeks and subjected to correlation and regression analysis.

Results and Discussion

Results revealed that there were two peaks of whitefly adult and nymphal population througout cropping period *i.e.* 25th to 43rd standard meteorological weeks. Whitefly nymphal population was as high as 45.26 and 62.93 nymphs per leaf during 33rd and 39th SMW (*i.e.* 2nd week of August and last week of September), respectively (Fig. 1).

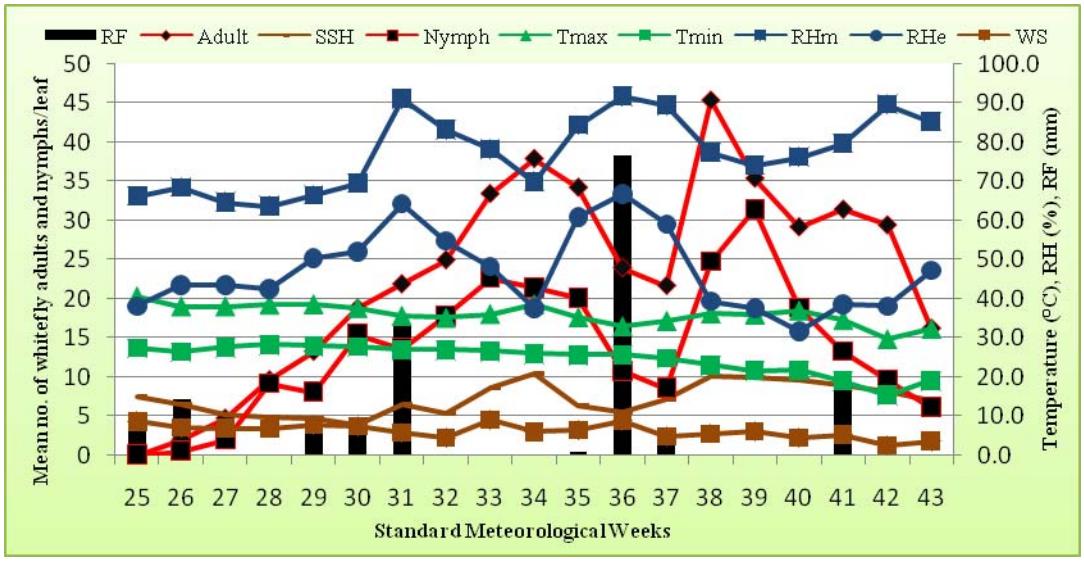

Fig. 1: Population of B. tabaci during different standard meteorological weeks

Whereas, two peaks of whitefly adults were recorded during 34th and 38th SMW (*i.e.* 3rd week of August and 3rd week of September) with number as high as 37.94 and 45.42 adults per leaf, respectively. Multiple regression analysis revealed that all weather parameters collectively accounted for 68 and 49 per cent variability in adult and nymphal population, respectively (Table 1). The correlation study showed significant positive association between whitefly nymphal population and sunshine hours (r=0.543). Whereas, whitefly adults population had significant positive association with morning relative humidity (r=0.455) and sunshine hours (r=0.650) (Table 1).

Table 1: Multiple regression and correlation analysis between weather factors and *B. tabaci* population

	Regression equation	**R^2**
Whitefly adult	Y= 135.65 - 4.49 T_{max} + 1.26 T_{min} - 0.96 RHm + 0.94 RHe - 0.06 RF - 0.87 WS + 7.69 SSH	0.68
Whitefly nymph	Y= 142.40 - 5.38 T_{max} + 2.22 T_{min} - 1.31 RHm + 1.23 RHe - 0.21 RF - 0.16 WS + 9.91 SSH	0.49

Correlation

Weather parameters	**Whitefly adults**	**Whitefly nymph**
Maximum temperature (°C)	-0.404	-0.115
Minimum temperature (°C)	-0.428	-0.161
Morning RH (%)	0.455*	0.181
Evening RH (%)	-0.059	-0.088
Windspeed (km/h)	-0.312	-0.09
Total Rainfall (mm)	-0.097	-0.196
Sunshine hours	0.650*	0.543*

*Significant at p=0.05 level of significance

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139.

Effect of Phosphate Solubilizing Bacteria on Constitutive and Induced Responses of Tomato (*Lycopersicum esculentum*) Against Tobacco Cut Worm (*Spodoptera litura* Fabricus) (Lepidoptera: Noctuidae)

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Keywords: Induced responses, phosphate solubilizing bacteria, *Lycopersicum esculentum*

Introduction

Plants respond to insect attack through various constitutive and induced mechanisms resulting in morphological and chemical changes. Phosphate solubilizing bacteria (PSB) are known to improve plant growth and yield by enhancing the availability of phosphorus in soil (Malik *et al.*, 2012). However, it is still unknown whether such a growth compromises resistance mechanisms in plants. In present study, we evaluated the effect of PSB on morphological and chemical changes in tomato (*Lycopersicum esculentum*) due to damage by the generalist herbivore *Spodoptera litura* Fabricus. We also studied whether these responses translate to resistance mechanisms by analyzing response of insect larvae on damaged plant

Materials and Methods

Tomato seeds (*L. esculentum*) were germinated on glass beads and later transferred individually in pots in the insect free enclosure. A commercial phosphate PSB formulation Phosphofix® was mixed during soil preparation. Third instar *S. litura* larva was placed on 3rd leaf and changes in trichomes, chlorophyll a & b and dry weight of the plants were analyzed after 7 days, while antioxidants such as peroxidase, superoxide dismutase (SOD) were determined after 9 hours of damage. Insect orientation, feeding behaviour and performance was examined on plants after 7 days of damage

Results and Discussion

Trichome density was found to be affected by both insect damage and PSB (Fig. 1). Although no significant difference in shoot dry weight between PSB inoculated and untreated plants was seen, root dry weight was decreased significantly. Insect damage reduces plant shoot as well as root biomass. Consequently, PSB inoculated damaged plants have similar biomass as both the untreated damaged and undamaged plants but lesser dry weight than PSB inoculated undamaged plants. Chlorophyll a was decreased by PSB inoculation as well as damage. However, chlorophyll b concentration was not affected. Larval leaf consumption was highest on untreated damaged followed by PSB damaged, untreated undamaged and PSB treated undamaged plants. Larval weight gain was highest on PSB inoculated undamaged plants and lowest in PSB inoculated damaged plants. The larval efficiency for conversion of digested food was highest in PSB inoculated damaged, followed by its undamaged counterpart. On the other hand, highest efficiency to convert ingested food was found on plants with no PSB treatment and were undamaged, whereas lowest was found in their damaged counterpart. The approximate digestibility was highest in untreated damaged plants and least in PSB treated damaged plants. Among antioxidants, except PPO, all antioxidants had increased specific activity in the untreated damaged plants as well as PSB inoculated undamaged plants. But in their PSB damaged counterparts, markedly decreased specific activity. Therefore, our study suggests that although the quick responses such as antioxidants were not significantly affected by PSB inoculation, but marked increase in trichome density showed that PSB inoculation has enhanced the morphological responses. Consequently, *S. litura* larvae performance was significantly decreased on PSB treated damaged plants. Therefore, PSB not only enhances the plant growth and phosphorus availability to plants, but also boosts plant immunity in *L. esculentum*.

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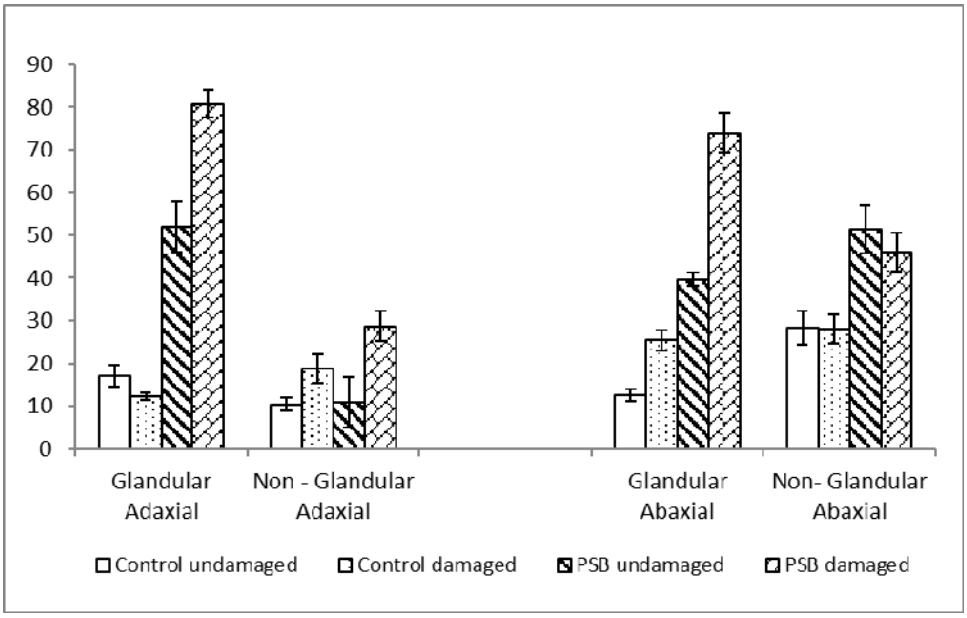

Fig. 1: Adaxial and abaxial trichome density (±SE) on day 7 of S.litura damage in L. esculentum supplemented with Phosphate Solubilizing Bacteria

140.

Studies on Succession and Population Dynamics of Major Insect Pests of Sesame

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Keywords: Sesame, insect pests, succession

Introduction

Sesame (*Sesamum indicum* L.) is an important oil seed *kharif* season crop under rain-fed situation. The productivity of sesame in India is very low (421 kg/ha) and fluctuating. The yield fluctuations are very wide. One of the major constraints in the production of sesame is the colossal damage caused by various insect pests. Earlier, twenty nine insect species (Rai 1976) were reported to damage the crop but recently the scenario has greatly changed and new pest problems have emerged. When all the components are placed into the production system monitoring is required to obtain information on the status of the plant growth, pests and the current and potential damage along with natural enemies. Therefore, present investigation was planned with the objective to study the succession and population dynamics of major insect pests of sesame.

Materials and Methods

Variety TKG 22 was sown in an area of 200 m^2 with normal agronomical practices during *kharif* - *rabi* seasons. Weekly observations on different insect pests were recorded on 10 randomly selected plants starting from germination till their availability or maturity of the crop. No insecticides were applied on the crop.

Results and Discussion

Leaf roller and capsule borer (*Antigastra catalaunalis* Duponchel), Bihar hairy caterpillar (*Spilarctia obliqua* Walker), jassids (*Orosius albicinctus* Distance), til hawk moth (*Acherontia styx* Westwood), whitefly (*Bemisia tabaci* Genadius), Gall fly (*Asphondylia sesami* Felt.) were recorded to be infesting the sesame crop. The peak activity of leaf roller and capsule borer was recorded during 3rd week of October, and peak activity of jassid was recorded during 1st week of October, and the peak activity of til hawk moth and whitefly were recorded during 2nd week of October, Bihar hairy caterpillar and gall fly were recorded during 2nd week of November. Mean population of larvae of leaf roller and capsule borer (2.65), mean population of larvae of Bihar hairy caterpillar (3.21) and mean population of nymph and adult of jassid (1.80) were recorded at higher level and considered as key pests of sesame.Correlation of meteorological parameters i.e maximum and minimum temperature, relative humidity, vapour pressure, evaporation etc. with the population of insect pests viz. whitefly, jassid, gall gly, til leaf roller and til hawk moth were found significant. Correlation between meteorological parameters with Bihar hairy caterpillars population was found non-significant.

Table 1: Population of insect pests of sesame at Jabalpur during semi-*rabi* season (2012-2013)

Standard Meteorological Week	Crop age (in days)	Crop stages	Population					
			Sucking insect pests (Nymph and adult)/ plant		Defoliators (Larvae)/ plant			Maggot/ plant
			Whitefly	Jassid	Leaf roller and capsule borer	Til hawk moth	Bihar hairy caterpillar	Gall fly
37	6	Seedling	1.84	0.18	0.08	0.00	0.02	0.00
38	13	Seedling	1.78	0.36	0.38	0.06	0.02	0.00
39	20	Vegetative	5.12	1.26	0.60	0.10	0.42	0.00
40	27	Vegetative	12.76	2.32	1.18	0.12	1.06	0.00
41	34	Vegetative	12.80	1.36	1.96	0.14	3.88	0.00
42	41	Flowering	6.50	0.38	2.30	0.10	3.10	0.12
43	48	Flowering & podding	3.40	0.10	2.08	0.04	7.18	0.22
44	55	Podding	1.32	0.18	1.66	0.04	3.98	0.28
45	62	Podding	0.00	0.00	0.58	0.04	9.58	0.36
46	69	Maturity	0.00	0.00	0.12	0.04	6.62	0.36
47	76	Maturity	0.00	0.00	0.10	0.14	2.10	0.22

141.

Gall Thrips Infesting *Terminalia chebula*- One of the Most Important Medicinal Plants of Jammu and Kashmir

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Keywords: Harad, *Terminalia chebula* Retz., thrips, galls.

Introduction

Terminalia chebula Retz is considered to be the mother and king of medicines in Ayurveda. Its fruit has astringent, purgative, antibacterial, antifungal and laxative activity. The country's richest germplasm of harad including Raj Harad exists here. Among the various medicinal plants of Jammu and Kashmir, *Terminalia chebula* Retz., is one of them. Though the insecticidal / fungicidal potential of essential oils extracted from harad has been discovered, the tree itself is attacked by several insect pests, which needs to be studied. Relatively few studies of the pests affecting *Terminalia* spp. have been made.

Materials and Methods

Harad trees growing at Advanced Centre for Rainfed Agriculture (ACRA), SKUAST-J, Dhiansar were noticed to be inflicted severely by several insect pests; major among them were the gall forming insects, scales and mealy bugs. Year round study was therefore conducted to identify the gall forming insect; one of the major insect pest. The losses inflicted by them, in terms of reduction in chlorophyll content, photosynthetic area; thereby resulting in economic loss was also assessed.

Results and Discussion

Gall formation was noticed in approximately 30 - 40% of harad leaves on their underside. These galls were of varied sizes ranging from very small to medium sized during July. Curling of leaves also started along with the formation of galls. The galls were green in colour, exactly of the same colour as that of their leaves and harad fruits, creating confusion from a distance. All this greatly reduced the photosynthetic area and efficiency of leaves. During the end of November - December the galls dry up and turn brown in colour. On dissecting these galls at different stages of their formation, thrips were found inside. The number of thrips varied with the gall size and age (Table 1).

Table 1: Variation in number of thrips per gall with the gall size

S. No.	Gall size			Number of thrips / gall
		Length (cm)	Thickness (cm)	
1.	Very small	0.4 - 0.5	0.2 - 0.3	1 - 2 nymphs and 1 - 2 adults
2.	Small	0.8 - 1.0	0.3 - 0.4	5 - 6 nymphs and 1 - 2 adults
3.	Medium sized	1.3 - 1.4	0.5 - 0.6	10 - 15 nymphs and 2 - 3 adults
4.	Large	1.7 - 1.9	1.2 - 1.4	90 - 110 nymphs and 40 - 60 adults

These adults were collected and the specimens were got identified from Zoological Survey of India, Kolkata. Two different species namely, *Rhipiphorothrips cruentatus* and *Liothrips* sps. of the order Thysanoptera were identified.

142.

Diversity of Borer Insect Pests on Peach in Punjab

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Keywords: Peach, flat headed borer, tortrix borer, fruit borer, American bollworm, bark eating caterpillar

Introduction

Peach, *Prunus persica* (L.), belonging to family Rosaceae, is a deciduous fruit crop. Peach is damaged by a number of insect pests including peach leaf curl aphid, *Brachycaudus helichrysi* (Kaltenbach), peach black aphid, *Pterochlorus persicae* (Cholodkovsky), chaffer and other defoliating beetles (*Adoretus* spp.), hairy caterpillars (*Euproctis* sp.), fruit flies, *Bactrocera dorsalis* (Hendel) and *Bactrocera zonata* (Saunders) and flat headed borer, *Sphenoptera dadkhani* Obenberger under Punjab conditions (Anonymous, 2015). Recently, borer insect pests are emerging as a major threat to the peach product

Materials and Methods

Regular fixed plot surveys were conducted in the peach orchards at the Fruit Research Farm of Punjab Agricultural University, Ludhiana, Punjab. Different life stages of borer insect pests were collected and reared in Fruit Entomology Laboratory in the Department of Fruit Science. The specimens were sent to different laboratories for identification

Results and Discussion

Flat headed borer, *Sphenoptera dadkhani* (Obenberger); tortrix, *Archips micaceana* Walker; castor capsule borer, *Conogethes punctiferalis* (Guenee); American bollworm, *Helicoverpa armigera* (Hubner) and bark eating caterpillar, *Indarbela* sp. were observed to be the main borer insect pests (Table 1) of peach. Flat headed borer beetles were observed to appear in middle of March. Young grubs were observed to feed below the bark making minute irregular galleries. Full grown grubs were observed to bore into the wood and oozing of gum globules from the entrance holes was observed. Tortrix, *A. micaceana* is mainly a leaf folder, but when the fruits were adjacent to leaves, the larvae were often observed to attack the fruit also, leaving the external feeding damage and boring into the fruits with visible holes and larval waste with peak activity during April-May. *Conogethes punctiferalis*, was observed to bore into the fruits and feed on the pulp. The hanging of fecal material with the silken webs was observed to be a typical symptom of identification of this borer. Peak activity was observed during April-May. *H. armigera* larvae were observed feeding on the fruits by making hole in the fruit with head inside and rest of the body hanging outside with a clear feeding hole. Peak activity was recorded during last week of April. Bark eating caterpillar damage the bark of the trees by making galleries under the bark and silken webs were observed along with entangled larval waste as a typical identification symptom with peak activity during September-October and March. This study concludes five important insect pests infesting peach plantations under Punjab conditions.

Table 1: Borer insect pests of peach in Punjab

Common name	Scientific name	Order: Family	Peak activity	Damage (%)
Flat headed borer	*Sphenoptera dadkhani* (Obenberger)	Coleoptera: Buprestidae	March-November	10
Tortrix	*Archips micaceana* Walker	Lepidoptera: Tortricidae	April-May	10
Castor capsule borer	*Conogethes punctiferalis* (Guenee)	Lepidoptera: Crambidae	April-May	15
American bollworm	*Helicoverpa armigera* (Hubner)	Lepidoptera: Noctuidae	Last week of April	15
Bark eating caterpillar	*Indarbela* sp.	Lepidoptera: Metarbedelidae	March and September-October	5

Reference

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143.

Effect of Flavone on First Instar Larvae of Melon Fruit Fly, *Bactrocera cucurbitae* (Coquillett)

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Keywords: Flavone, secondary metabolites, *Bacterocera cucurbitae*, growth

Introduction

Pest management by the use of toxic pesticides is a common practice all over the world which affects environment directly or indirectly. Therefore, there is an urgent need to explore some eco-friendly and biodegradable alternatives. There are a variety of secondary metabolites which protect the plants from herbivorous pests and phenolic compounds. Flavone is the one of the secondary metabolite, a phenolic compound produced by the plants and its effect was studied on various growth parameters of melon fruit fly, *Bactrocera cucurbitae* (Coquillett), a major pest of cucurbit plants all over the world.

Materials and Methods

B. cucurbitae cultures were maintained in the insect culture room of the department of Zoology, Guru Nanak Dev University, Amritsar under controlled conditions of temperature (25±2°C), relative humidity (70-80%) and photoperiod (L10: D14). Bioassays were conducted to study the effect of flavones on first instar larvae of *B. cucurbitae*. The larvae were fed on various concentrations (5, 25,125, 625 and 3125 ppm) of flavone incorporated in artificial diet and control diet. The experiments were conducted in Bio-chemical Oxygen Demand (B.O.D) and observed daily for various parameters viz. time taken for pupae formation, number of pupae formed and number of flies emerged.

Results and Discussion

The data recorded was subjected to statistical analysis using Tukey's test. Larval growth index showed a decrease with increase in the concentration of flavone in the diet. A significant effect of the compound was observed on percentage of pupation and emergence of fly. The percentage pupation and emergence decreased significantly with increase in concentration of Flavone and maximum effect was observed at highest concentration (3125 ppm) of the compound incorporated in the artificial diet. The percent of pupation decreased significantly ($F_{5,35}$= 36.51; p< 0.01) and at the highest concentration decreased by 32.22% in comparison to control. The findings thus revealed a toxic and deterrent effect of flavone on the growth and development of first instar larvae of *B. cucurbitae* (Fig. 1).

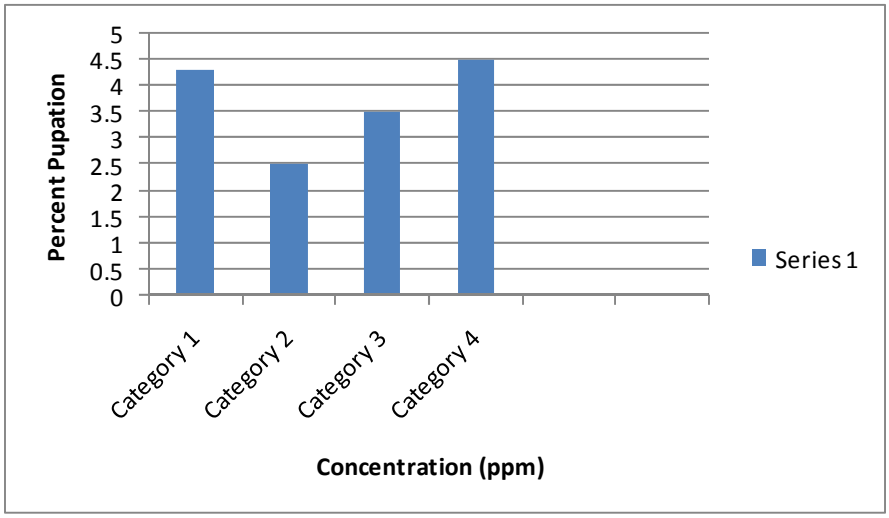

Fig. 1: Effect of flavone on percent pupation

144.

Digama hearseyana (Noctuidae: Lepidoptera) a New Threat to Karonda (*Carissa carandus*) Plant in Rajasthan, India: Incidence and Morphological Analysis

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Keywords: *Digama hearseyana, Carissa carandus,* morphology

Introduction

Karonda (*Carissa carandus*) is one of the many berry-like fruits believed to originate near the Himalayas, though some botanists place the fruit's origin to Java. Its natural range extends from Nepal to Afghanistan. It is a hardy, drought-tolerant plant that thrives well in a wide range of soils (Lim, 2012). The drought-resistant nature of the plant enables the tribal areas of Madhya Pradesh, Rajasthan, Gujarat, and Bihar to grow the fruit. Fruits can be eaten fresh or used for jellies or jam, canning, preserving and pickling. Karonda is no serious pest problem in India. In the early stages, leaf eating caterpillar feed voraciously on the leaves and cause mortality of the plants. Another pest reported karonda plant to be infected by *Simcronyx roridus,* a gall forming weevil almost throughoutyear with its peak from March- May. The *Digama hearseyana* infestation on karonda has not yet been reported. Here, we report the new information on the incidence of *D. hearseyana* infestation on Karonda, its morphological characters and taxonomic identification.

Materials and Methods

Three year old Karonda trees were randomly selected in each of 3 replicates at the Experimental Farm of the ICAR-Central Institute for Arid Horticulture. Each replicate was made at a different site. Incidence of infested trees, number of *D. hearseyana* observed on each tree and symptoms of damage (in comparison with un-infested plants) were recorded from April to October, in 20014 and 2015. The sampling was done by visual observation and manual counting. Average incidence was calculated as the percent of whole trees infested with *D. hearseyana*. Average number of *D. hearseyana* per trees was calculated on the basis of observations recorded on ten randomly selected whole Karonda trees with 3 replications. Twenty *D. hearseyana* (10 males & 10 females) were used for observation and measurements. The *D. hearseyana* were reared under laboratory condition for measurement of different stages. The average linear measurements of various body parts of male and female *D. hearseyana* were obtained under a stereo binoculars microscope (Radical Instruments, Ambala, Haryana, India) using Jenoptic Pro 2.8.0 software (Haldhar *et al.*, 2015).

Results and Discussion

For the first time, *D. hearseyana* were observed on Karonda tree in the hot arid region of north-western India, (i.e., Thar Desert) and identified as *D. hearseyana*. During the present study, the average incidence of *D. hearseyana* on trees ranged between 10.00 to 60.00 and 11.67 to 63.33% during 2014 and 2015, respectively. The incidence and numbers were higher between July-I fortnight and September-I fortnight, and the maximum incidence of 60.00 and 63.33 per cent was recorded in August-II fortnight and the minimum in October-II fortnight (16.67 and 18.33%) during 2014 and 2015. Thus the highest mean number of this *D. hearseyana* per tree was recorded in August-II fortnight (5.77 and 5.97/plant) followed by August-I fortnight (4.80 and 4.83/plant) and the lowest was in October-II fortnight (16.67 and 18.33/plant). During a survey of the natural vegetation, the population of this pest was found to be higher on young trees than the old trees. The larvae damage the fresh emerging leaves and flowers, which led to the suppression of growth of the karonda tree through scraping of leaves and flowers. The females laid single egg on leaves. Eggs were blackish brown light colour. The female was distinctly large than the male in respect to all body parts. The mean body lengths of males and females were 11.28 mm and 12.07 mm, respectively. To our knowledge this is the first report of *D. hearseyana* on Karonda. This *D. hearseyana* is damaging economically important parts of tree, such as leaves and flowers. Therefore, management practices needs to be developed and implemented to minimize the losses caused by this pest.

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Table 1: Mean percent of *Carissa carandus* plants infested by the moth, *Digama hearseyana*, and mean number of larvae per plant in 2014 and 2015 at the experimental farm of the ICAR-Central Institute for Arid Horticulture, Bikaner District, Rajasthan, India.

Sampling month	Mean incidence (%)[a,b]		Mean no. of *D. hearseyana* larvae per plant[b]	
	2014	2015	2014	2015
April-II	10.00 (18.04)	11.67 (19.88)	1.07	1.23
May-I	13.33 (21.33)	15.00 (22.59)	1.47	1.70
May-II	16.67 (24.04)	20.00 (26.55)	1.53	1.73
June-I	20.00 (26.44)	23.33 (28.77)	2.87	3.03
June-II	23.33 (28.77)	26.67 (30.98)	3.20	3.47
July-I	36.67 (37.24)	38.33 (38.23)	3.63	3.87
July-II	46.67 (43.07)	48.33 (44.03)	4.00	4.23
August-I	53.33 (46.89)	55.00 (47.86)	4.80	5.00
August-II	60.00 (50.77)	63.33 (52.75)	5.77	5.97
September0I	43.33 (41.14)	45.00 (42.10)	4.63	4.83
September-II	33.33 (35.20)	35.00 (36.22)	3.93	4.20
October-I	26.67 (31.06)	28.33 (32.13)	2.20	2.40
October-II	16.67 (24.04)	18.33 (25.30)	1.27	1.40
CD	4.64	4.94	0.85	0.95

[a]Parentheses contain the angular transformation value.
[b]Values followed by different letters are significantly different (Tukey's HSD test, $P < 0.05$).

145.

Growth and Development of *Clavigralla gibbosa* Spinola on Different Varieties of Pigeonpea

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Keywords: *Clavigralla gibbosa*, growth, development, pigeonpea

Introduction

Pigeonpea *(Cajanus cajan)* ranks sixth in area and production in comparison to other legumes such as beans *(Vigna spp.*), peas *(Lathyrus spp.)* and chickpea *(Cicer arientum)*. More than 250 insect species recorded feeding on pigeonpea during seedling, bud, flower and pod formation stages of the crop. Among the sucking bugs, tur pod bug *(Clavigralla gibbosa)* is the most important in India. It was once considered to be a minor pest of pigeonpea but, has assumed the status of a major pest. Both the nymphs and adults of the pest suck the cell sap from the developing grains of the green pods. On an average it causes 25.20% pod and 28.38% grain damage.

Materials and Methods

The studies on the biology of tur pod bug were carried out on different varieties *in -vitro* at room temperature 26±1°C and relative humidity 75% from mid October 2013 to January 2014. Eggs laid on pods of each variety were brought and kept in petridishes in laboratory. Freshly hatched nymphs were provided immature pods of different varieties. The fresh pods of the respective varieties were changed daily and the observations on number of eggs per female, incubation period, egg hatchability (%), number of nymphal instars, nymphal period, pre-oviposition, oviposition and post oviposition period, sex ratio and life cycle of adult (egg to adult) were recorded.

Results and Discussion

The data given in Table 1 shows that there was variation in the fecundity of females emerging from different varieties, which ranged from 13-186 in Manak and 64 to 427 in Paras varieties. Maximum egg hatchability of test insect was recorded on Paras and it ranged from 88.5 to 95.2% with an average of 92.4±2.4. Incubation period of *C. gibbosa* on was ranged from 4.3 to 7.4 days with an average of 5.7±1.39 days on Manak and 3.3 to 5.9 days with an average of 4.6±1.17 days on Paras. Nymphal development was completed in five instars with a twofold variation. Varieties also influenced the total life cycle of *C. gibbosa*, which was lowest in Paras ranged between 15.2 and 29.5 days with an average of 22.06±4.62 days and highest in UPAS 120. Oviposition period was minimum 12.8 days in variety Manak and maximum 21.4 days in variety UPAS 120.

Table 1: Biological parameters of *C. gibbosa* on different pigeonpea varieties

Biological parameters	Paras		Manak		H03-41		UPAS 120	
	Range	Mean±S.D	Range	Mean±S.D	Range	Mean±S.D	Range	Mean±S.D
Fecundity	64-427	199.2±119.1	13-186	100.60±56.04	23-178	111.20±50.33	19-214	121.70±66.64
Egg hatchability (%)	88.5-95.2	92.4±2.41	74.2-91.4	83.56±6.06	78.3-86.7	82.06±2.95	76.3-92.7	83.2±5.60
Incubation period	3.3-5.9	4.6±1.17	4.3-7.4	5.7±1.39	3.8-8.5	6.35±1.77	4.8-11.9	7.14±2.33
Nymphal period (days)								
1st instar	1.1-2.4	1.8±0.08	1.4-2.1	1.7±0.24	1.2-2.5	1.8±0.45	1.4-3.3	2.4±0.69
2nd instar	1.5-2.7	2.2±0.44	1.2-2.3	1.9±0.38	1.9-2.9	2.4±0.36	1.5-4.2	2.9±0.90
3rd instar	2.1-3.9	3.1±0.58	1.9-2.8	2.4±0.32	2.6-3.8	3.2±0.45	2.1-6.3	4.3±1.44
4th instar	3.5-4.9	3.9±0.46	3.1-4.7	3.8±0.55	3.7-4.9	4.3±0.42	2.9-6.8	4.9±1.29
5th instar	3.7-5.1	4.3±0.54	4.2-5.9	5.1±0.61	5.1-6.3	5.7±0.41	4.3-8.5	6.4±1.34
Total nymphal duration	11.9-19.2	15.3±2.55	11.8-17.9	14.9±1.97	14.5-20.4	17.4±1.92	12.3-29.2	20.9±5.73
Total life cycle (days)	15.2-29.5	22.06±4.62	16.1-30.1	24.11±4.72	18.3-29.1	23.75±3.84	17.1-41.1	28.04±7.52
Pre-oviposition period (days)	2-16	9.16±5.12	1-12	7.5±3.65	2-19	11.5±5.59	3-18	11.6±5.14
Oviposition period (days)	2-29	19.5±8.18	3-19	12.8±5.37	5-16	13.2±3.89	3-31	21.4±8.59
Post-oviposition period (days)	1-46	17.6±11.45	1-16	8.6±4.66	4-13	8.9±3.56	1-48	12.3±9.58
Total adult life (days)								
Male	3-36	19.6±8.95	2-29	15.6±8.60	1-23	13.8±7.14	3-31	21.3±8.64
Female	6-41	26.5±10.85	4-32	23.7±9.15	6-29	17.5±8.23	2-38	24.6±11.43

146.

A Preliminary Study on the Moth Diversity of Kodagu District in Central Western Ghats of Karnataka, India

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Keywords: Central Western Ghats, Kodagu district, moth diversity, species richness

Introduction

Kodagu district covering an area of 4,102 km^2 is a part of the Western Ghats biodiversity hotspot. The region harbor diverse flora and fauna. Many studies have documented the floral diversity in the district however, there is scanty information available on the insect diversity and in particular, the diversity of moths. Moths, order Lepidoptera, are one of the mega diverse groups of insects and recent reports have recorded 1, 27,000 species of moths from the world of which over 12,000 species are recorded from India.We conducted the preliminary study to assess the moth diversity and to prepare the species checklist.

Materials and Methods

The study was conducted in three taluks of Kodagu district namely Virajpet, Madikeri and Somwarpet in 2014-2015. The light trap and light sheet were set in 9 locations for collection of moth specimens. At each sampling site, collections were made from 7 p.m. to 2 a.m. for three days. In addition, the moths hovering around other light sources were also collected. Moths active during day time were collected from the flowering plants using nets. Three collections were made at each sampling site at monthly interval. All the specimens were identified using keys of Fauna of British India (Hampson, 1892-1896) and their current nomenclature is based on Moth of Borneo (Hollway, 1983-2011)

Results and Discussion

The study revealed 117 species belonging to 101 genera, 32 sub-families, 17 families and 9 super families (Table 1). The family Erebidae dominated with 29.06% of the total species recorded, followed by the family Crambidae (20.51%) and Geometridae (19.66%). Together these 3 families accounted for about 70% of the total moth diversity of the district. The next predominance of species was observed in Saturniidae and Sphingidae with 6 species in each family and Noctuidae with 5 species. These three families accounted for about 14.5% of the total moth species diversity. These results showed that about 5-6 out of 17 families have accounted for the majority (80%) of moths' diversity in the district. Overall higher species richness and diversity was recorded from this region. This study is first of its kind in the peninsular region of India which has recorded and check listed more than hundred species of moths which would form as the basis for developing strategies for conservation and management of insect diversity particularly, of moths diversity which are the important indicators of the ecosystem function and health.

Table 1: The diversity of moths in Kodagu district in Central Western Ghats of Karnataka, India

Super Family	Family	Sub-family	No. of genera	No. of species	Species richness	Species contribution to diversity (%)
Noctuoidea	Erebidae	Arctiinae	12	14	34	29.06
		Calpinae	1	1		
		Catocalinae	1	1		
		Erebinae	7	8		
		Lithosiinae	1	2		
		Lymantriinae	8	8		
	Noctuidae	Aganainae	2	3	5	4.27
		Hadeninae	1	1		
		Noctuinae	1	1		
	Nolidae	Eligminae	1	1	1	0.85
Bombycoidea	Bombaicadae	Bombicenea	1	1	1	0.85
	Eupterotidae	Panacelinae	1	1	1	0.85
	Saturniidae	Saturniinae	4	6	6	5.13
	Sphingidae	Macroglossinae	3	4	6	5.13
		Smerinthinae	1	1		
		Sphinginae	1	1		
Calliduloidea	Callidulidae	Callidulinae	1	1	1	0.85
Pyraloidea	Crambidae	Acentropinae	2	2	24	20.51
		Pyraustinae	2	2		
		Schoenobiinae	2	2		
		Spilomelinae	16	18		
	Pyralidae	Galleriinae	2	2	2	1.71
Geometroidea	Geometridae	Desmobathrinae	2	2	23	19.66
		Ennominea	4	4		
		Geometrinae	7	11		
		Larentiinae	2	2		
		Sterrhinae	3	4		
	Uraniidae	Microniinae	4	4	4	3.42
Hyblaeoidea	Hyblaeidae	-	1	1	1	0.85
Lasiocampoidea	Lasiocampidae	Lasiocampinae	2	3	3	2.56
Cossoidea	Metarbelidae	-	1	1	1	0.85
	Cossidae	Zeuzerinae	1	1	1	0.85
Zygaenoidea	Zygaenidae	Chalcosiinae	2	2	3	2.56
		Eupterotinae	1	1		
Total: 9	**17**	**32**	**101**	**117**	**117**	**100**

147.

Nutritional Indices and Biology of the Armyworm (*Spodoptera litura*) on Five Cotton Varieties

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Keywords: Food consumption of *Spodoptera litura*, life history

Introduction

Armyworm (*Spodoptera litura* Fabricius) has existed as a major pest of cotton in Bangladesh since the last decade. Biological information of this insect regarding the cultivated cotton varieties in Bangladesh is scarce. However, many authors have studied the biology and feeding behavior of this pest on different plant species and varieties of crop. Therefore, the present study was conducted to know the nutritional indices and life history performances of *S. litura* on CB1, CB3, CB5, CB8 and CB12 cotton varieties, with a view to developing an integrated management program of this pest.

Materials and Methods

The study was conducted in the Entomology Laboratory, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh from July 2014 to March 2015. Mass culture of *S. litura* and experimental treatments were maintained at 28±2°C and 60±5% RH with leaves of CB1, CB3, CB5, CB8 and CB12 of cotton varieties. Larval food consumption index, approximate digestibility, efficiency of conversion of ingested food and efficiency of conversion of digested food, feeding and growth indices, pre-oviposition period, fecundity, development durations and survival of the immature stages and longevity of the moths were studied.

Results and Discussion

The nutritional indices and life history of *S. litura* on CB1, CB3, CB5, CB8 and CB12 cotton varieties are presented in Table 1. Larval food consumption indices (FCI) were highest and lowest on CB5 and CB1, respectively. Their approximate digestibility (AD) and efficiency of conversion of ingested food (ECIF) were higher and similar on CB5 and CB8. Efficiency of conversion of digested food (ECDF) was highest on CB8 and lowest on CB1. Larvae exerted higher feeding index (FI) as well as growth index (GI) on CB5 and CB8, and that were lowest on CB12. Cotton varieties did not affect male longevity (ML), female longevity (FL) and preoviposition periods (PP) of the moths but they had highest fecundity (F) on CB8. Larval durations (LD) were found shortest and longest on CB12 and CB8, respectively. Pupal durations (PuD) on CB1 and CB12 were similar and longer than that on others. Egg to adult period (EAP) was shortest on CB12 and it was statistically identical and longer on CB8 and CB5. The percentages survival of egg (SE), survival of larva (SL), survival of pupa (SPu) and survival of egg to adult (SEA) were statistically higher on CB5 and CB8 than on the other varieties. The findings indicated that the armyworm performances were best on CB5 and CB8.

Table 1: Effect of cotton varieties on the nutritional indices and biology of *Spodoptera lituta*

	CB1	CB3	CB5	CB8	CB12
FCI	4.1±0.5d	4.9±0.5bc	6.1±0.5a	5.5±0.5ab	4.4±0.6cd
AD	66.4±3.4b	69.6±3.6ab	72.4±3.5a	72.8±3.5a	68.2±3.8ab
ECIF	16.2±0.5b	16.5±0.4b	17.4±0.4a	17.8±0.5a	16.4±0.5b
ECDF	23.2±0.5c	23.4±0.5bc	24.0±0.6b	25.5±0.5a	23.4±0.5bc
FI	0.054±0.009ab	0.054±0.005ab	0.058±0.008a	0.062±0.008a	0.044±0.005b
GI	1.36±0.11ab	1.38±0.08ab	1.44±0.13a	1.48±0.13a	1.24±0.11b
PP	2.6±0.5a	2.4±0.5a	2.02±0.4a	2.2±0.4a	2.6±0.4a
F	995.4±142.2b	1066.6±231.8b	1247.0±189.9ab	1386.6±224.8a	1063.8±159.4b
LD	27.2±1.9cd	28.4±1.5bc	30.2±1.3ab	30.8±0.4a	26.0±1.2d
PuD	10.6±0.5 a	9.8±0.8 b	9.4±0.5 b	9.4±0.5 b	10.8±0.4 a
EAP	44.2±1.9ab	44.2±1.5ab	45.2±1.3a	46.0±0.7a	43.0±1.2b
SE	59.2±3.7ab	62.4±3.8a	62.8±4.2a	64.4±4.6a	56.8 3.1b
SL	73.2±5.5b	77.6±5.0ab	81.4±4.2a	80.8±4.9a	72.1±4.9b
SPu	60.5±5.3bc	66.5±4.7ac	66.9±3.6ab	69.2±4.1a	60.0±5.8c
SEA	17.6±5.3bc	22.6±4.6ab	23.4±3.6ab	26.8±5.1a	15.6±2.3c
ML	8.2±1.5a	8.0±1.6a	8.4±1.9a	9.0±1.9a	8.0±1.9a
FL	7.6±1.7a	7.6±1.5a	8.2±1.5a	8.4±2.0a	7.2±1.5a

FCI: Food consumption index, AD: Approximate digestibility, ECIF: Efficiency of conversion of ingested food, ECDF: Efficiency of conversion of digested food, FI: Feeding index, GI: Growth index, PP: Pre-oviposition period, F: Fecundity, LD: Larval duration, PuD: Pupal duration, EAP: Egg to adult period, SE: Survival of egg, SL: Survival of larva, SPu: Survival of pupa, SEA: Survival of egg to adult, ML: Male longevity, FL: Female longevity. Means within a row followed by same letter(s) are not significantly different by ($P \leq 0.05$).

148.

Seasonal Density of Stem Fly *Melanagromy zasojae* (Zehntner) (Diptera: Agromyzidae) Describes the Dynamics of Parasitism in Soybean Ecosystem

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Keywords: Abiotic and biotic factors, seasonal incidence, soybean, stem fly

Introduction

Soybean (*Glycine max* L.) is prone to heavy infestation by stem fly *Melanagromyzasojae* (Zehntner) (Diptera: Agromyzidae) at all the stages of crop growth, right from seedling to maturity (Kumar *et al.*, 2009; Sharma *et al.*, 2014). Despite use of variety of chemical insecticides, desired control of stem fly is not achieved as the maggots and puparia lives concealed inside the leaf or stem of the host crop. Unfortunately, there is serious lack of information on density dependence of *M. sojae* parasitoids and concurrent host crop phenology. We establish a relationship between density of *M. sojae* infestation and the level of parasitism in the field samples in soybean.

Materials and Methods

The density dependence of *M. sojae*parasitoids and percentage of parasitism in field were determined for two crop seasons of 2014 and 2015 by fitting weighted least squares regression (WLS).Weekly *M. sojae* density was used as predictor variable to test the density dependence of parasitoid numbers per plant and field parasitism in *M. sojae*. The analysis was conducted separately for parasitoids density and per cent parasitism, by regressing against mean weekly values of host density of two soybean seasons *i.e.* 2014 and 2015. The significance was tested at $P \leq 0.05\%$ level and residual deviance of fit ≤ residual degrees of freedom.

Results and Discussion

*M. sojae*infestation was initiated at second week after sowing, reached its peak during 7th to 10th week and declined towards the end of the season. The mean densities of *M. sojae* measured in our study were 0.75 to 1.58 maggots or puparia per plant, though in few individual cases *M. sojae* number per plant was as high as 4.0. The peak densities generally occurred in the mid-season, by the time most susceptible stage of the crop to *M. sojae* attack had already passed.

A parasitoid complex of ten species from five families namely Eurytomidae, Eucoilidae, Pteromalidae, Eulophidae and Braconidae had significant influence on suppressing *M. sojae* populations with mean highest parasitism of 48.67%. The parasitoid populations built up concomitant to the host populations exhibiting density dependence (Fig. 1). Fitting of host density as an explanatory variable was meaningful in describing significant deviance in the parasitoids density as well as percent parasitism in the field samples of soybean (Parasitoid density: R^2= 0.859, df= 2, 12, F= 36.522, Residual Deviation= 0.124, p= 7.89296E-06; Percent parasitism: R^2= 0.806, df= 2, 12, F= 24.99, Residual Deviation= 11.375, p= 5.26587E-05).

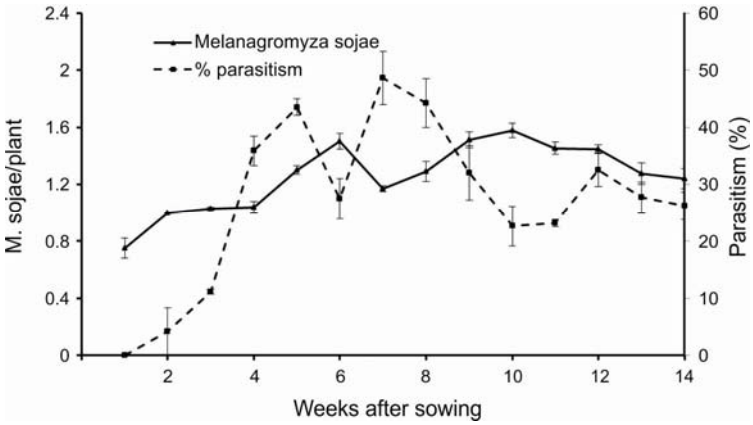

Fig. 1: Mean seasonal densities and percentage parasitism of M. sojae for the soybean seasons 2014 2015 and average of two years.

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149.

Parasitoid Diversity of Stem Fly *Melanagromyzasojae* (Zehntner) (Diptera: Agromyzidae) in Soybean Ecosystem of Peninsular India

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Keywords: Biodiversity, hyperparasitoids, IPM, parasitism, soybean, stem fly

Introduction

Stem fly*Melanagromyzasojae*(Zehntner)is recently emerging as a major pest problem ofsoybean (*Glycine max* L.) in India. This pest is very difficult to control because of itshidden biology. The maggots and puparia lives concealed inside theleaf or stem of the host crop andseem to be well-protected from insecticidal applications as well as natural enemies like predators and parasitoids. There exists very little or scanty information on natural biological control of this pest(Berg *et al.* 1995; Jayappa *et al.* 2003). We explored the diversity of parasitoids associated with *M. sojae* in soybean ecosystem of semi-arid tropics of Maharashtra.

Materials and Methods

Field surveys were carried out at weekly intervals on the experimental farm of ICAR-National Institute of Abiotic Stress Management in Malegaon Khurd village of Pune District in the state of Maharashtra during the *kharif* (rainy) seasons (June - October) of 2014 and 2015 to determine the parasitoid species associated with *M.sojae*. The samples of *M. sojae* infested plants collected from the field were brought to the laboratory for dissection. The live maggots and puparia of *M. sojae*recovered from damaged stems were reared until emergence of stem fly adult or parasitoids. The number and variety of parasitoids emerged were recorded.

Results and Discussion

Ten species of Hymenopteran parasitoids from five families namelyEurytomidae, Eucoilidae, Pteromalidae, Eulophidae and Braconidae emerged from the collections (Table 1). *Eurytoma*spand *Gronotoma*sp (= *Cynipoidea*sp) with average seasonal parasitism of 26.24% and 23.08%, respectively were the most prevalent parasitoid species throughout the season. *Sphegigaster*sp was dominantPteromalidduring the mid-season (mean seasonal parasitism 14%), whereas *S. nigrus, S. carinatus, H. propinqua, Chlorocytus* sp and *C. melghaticus* were present rather in low number towards the end of the season. The Braconidae and Eulophidae were rare.

A variety of parasitoids recorded from *M. sojae* infestation in soybean () ecosystem had a significant influence on suppression of *M. sojae* populations under field condition. However, as all the parasitoids recorded were emerged from the pupal stage of the host insect, the level of parasitism did not directly affect damage by *M. sojae*, but certainly affected the emergence of adult flies of *M. sojae* and thus the pest population size of the next generation. The possibility of some of the parasitoids especially pteromalid species those were prevalent towards the end of the season, acting as hyperparasitoids of *Eurytoma* sp, *Gronotoma* sp and *Sphegigaster* sp cannot be ruled out, which needs further detailed investigations. Our study suggests that the parasitoids *Eurytoma* sp, *Gronotoma* sp and *Sphegigaster* sp. can be potential biocontrol candidates for utilising in integrated pest management programmes for managing *M. sojae* infestations in soybean.

Table 1: Mean seasonal composition (2014-2015) of parasitoid species associated with *M. sojae* in soybean ecosystem of semi-arid tropics of Maharashtra (India)

Parasitoid species	Order/ Family	Composition (%)
Eurytoma sp.	Hymenoptera: Eurytomidae	26.24
Gronotoma sp. (= *Cynipoidea*sp)	Hymenoptera: Eucoilidae	23.08
Sphegigaster sp.	Hymenoptera: Pteromalidae	14.00
*Syntomopusnigrus*Sureshan&Narednran	Hymenoptera: Pteromalidae	6.29
*Syntomopuscarinatus*Sureshan&Narendran	Hymenoptera: Pteromalidae	5.00
Halticopterapropinqua (Waterston)	Hymenoptera: Pteromalidae	4.58
Chlorocytus sp.	Hymenoptera: Pteromalidae	4.00
*Colotrechnusmelghaticus*Narendran& Kumar	Hymenoptera: Pteromalidae	2.16
*Bracon*sp.	Hymenoptera: Braconidae	4.19
Eulophidae	Hymenoptera: Eulophidae	1.11

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150.

Seasonal Incidence of Sapota Bud borer, *Anarsia achrasella* on Sapota under Konkan Condition of Maharashtra

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Keywords: Sapota bud borer, *Anarsia achrasella,* weather parameter, sapota, Seasonal incidence.

Introduction

Sapota is a vital crop. India is considered to be the largest producer of sapota in the world. Of the various factors limiting the yields of fruits, damage caused by insect pests is pertinent. Sapota tree is attacked by more than 25 insect pests (Butani, 1979). It includes *Anarsia achrasella*, *Nephopteryx eugraphella, Acrocercops gemoniella*, *Bactrocera dorsalis* and sucking pests (Shukla, 2011). Among these, *Anarsia achrasella* is a major and regular pest causing damage to the sapota crop under Konkan region of Maharashtra.Excessive use of chemicals to control this pest not only causes the economical restrain on farmers but also produces the harmful side effects on the environment as well as human being. The best way to overcome this situation is to destroy the pest as its initial stage of the life cycle. This is possible if timely prediction of the occurrence of the pest can be made.

Materials and Methods

To study seasonal incidence of sapota bud borer, an experiment was carried out at Agriculture Research Station, Palghar, Palghar (Maharashtra), India for five years from 2010 to 2014. Ten sapota trees of fifteen years old were selected randomly to record the incidence of bud borer in sapota orchard. From each tree ten twigs (20cm length) were selected randomly for recording the observations of number of healthy and damaged buds due to *Anarsia achrasella* was recorded at weekly interval and per cent infestation was worked out by using below formula.

$$\text{Per cent infestation} = \frac{\text{Total no. of infected buds}}{\text{Total no. of buds}} \times 100$$

In order to study the effect of weather parameters, the simple correlation coefficients were worked out.

Results and Discussion

The pooled data on per cent buds damaged caused by bud borer (*Anarsia achrasella*) is presented in Fig. 1. The data shows a varying degree of infestation throughout the year. The maximum bud borer incidence were noticed during March to May (9.79 to 16.82%). Its activity was medium during December to February (3.92 to 9.34%), whereas it was less active during monsoon during June to September (2.42 to 3.88%). The infestation of the pest on bud remained throughout the year in widely grown variety Kalipatti and remained higher during second fortnight of February to June (Deshmukh, 2001). The study on correlation with weather parameters is presented in Table 1. Correlation between minimum temperature and bud damage (r=0.24) was highly significant and positive. The relation between maximum temperature and bud damage (r=0.07) was found non-significant and positive. However, rainfall, morning relative humidity and evening relative humidity had highly significant and negative association with bud damage (r=-0.31, r=-0.41 and r=-0.17, respectively).

Table 1: Correlation between sapota bud borer and weather parameters pooled data

Weather parameters	Pooled data (2010-2014)
Rain fall (mm)	-0.31**
Minimum Temperature (°C)	0.24**
Maximum Temperature (°C)	0.07
Minimum RH (%)	-0.41**
Maximum RH (%)	-0.17**

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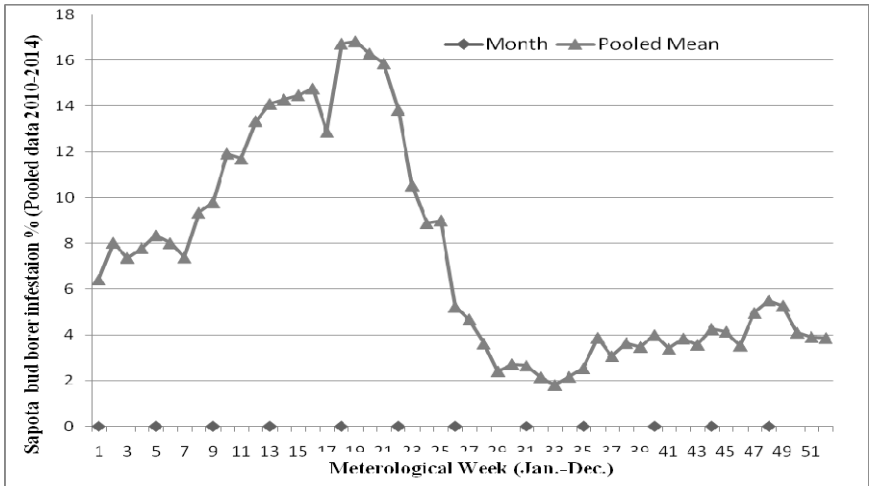

Fig. 1: Seasonal incidence sapota bud borer (2010-2014)

151.

Rangeeni Lac Insect (*Kerria lacca*) Survival and Its Dependence on Biochemical Profile of *Ber* (*Ziziphus mauritiana*) During Summer Crop

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Keywords: *Baisakhi*, *Kerria lacca,* photosynthates

Introduction

Lac is the only natural resin with animal origin, produced by a scale insect, *Kerria lacca* feeding on specific host phloem sap. Due to global trend for safer natural products, lac is gaining more research attention. *Rangeeni* lac insect which was contributing 80% to the national lac crop production has showed a significantly declining trend in the recent past. *Rangeeni* lac insect was found to be severely affected by mortality during pre-summer period, leading to complete crop failure. Since the lac insect cannot shift its position once its mouth part has inserted in to the phloem of host plant, it has to complete its entire life cycle on the nutritional niche offered by its host plant. Present study attempts to get insight for the host-insect interaction at biochemical level focusing on the lac insect survival.

Materials and Methods

Various treatments imposed were as follows. T_1: control plants without irrigation; T_2: control plants with irrigation; T_3: lac inoculated plants without irrigation; T_4: lac inoculated plants with irrigation; T_5: lac inoculated plants without flower removal; T_6: lac inoculated plants with flower removal. Leaves were collected from all the treatments. The collected leaves were then powdered using liquid nitrogen and was used for all of assays other than enzymatic activity assay. In case of enzymatic assay fresh leaves were collected and enzyme extracts were prepared as per the protocol. Estimation of reducing and non-reducing sugars was carried out as per Clegg K M (1956). Proline was estimated according to Bates *et al.* (1973). Leaf samples were used for the estimation of polyphenol as per Conrad and Koeppen (1972). The estimation of phenyl alanine ammonia lyase (PAL) activity was carried out as per Khan and Vaidyanathan (1986). Fresh leaves were taken for assay of polyphenol oxidase (PPO) activity assay according to Augustin *et al.* (1981).

Results and Discussion

Biochemical analysis of leaf extracts of *ber* (*Ziziphus mauritiana*) was carried out for summer crop (*baisakhi)*, to know the relationship between the biochemical status of the host plant and lac insect survival. The data reveals a negative correlation between proline content, an indicator of moisture stress inside the host plant, and lac insect survival. Irrigation reduced the proline content in the *ber* plants resulting in better survival (giving 80% yield over control) of lac insect. Since flowering and fruiting of the *ber* overlaps with the *basisakhi* crop period, flower removal was attempted as a measure to divert the nutritional support more towards lac insect, thereby reducing the nutritional load on the host plant for fruit development. Flower removal showed a positive correlation with lac yield both under irrigated and non-irrigated condition in *ber* (to produce 120% and 130% yield respectively over control). Concomitantly, significant increase in the phosynthates content (total sugar) was also observed due to flower removal which might be playing a role in better nutrition of lac insects, thus more lac production. A hormonal application practice using Napthalene acetic acid at the rate of 50ppm for flower removal was also standardized on *ber* plant which will help in easy implementation of flower removal at large scale. PALactivity, polyphenol content, PPO activity were also found to be positively affected by lac insect infection on *ber* during *bisakhi* crop. Thus the study indicates that the stress status of host plant as indicated by biochemical parameters adversely affect the lac crop performance. Moreover, the availability of photosynthates of host plant to the lac insect plays vital role in survival of lac insect.

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152.

Effect of Different Modes of Pollination on Quantitative and Qualitative Parameters in Indian Mustard (*Brassica juncea*)

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Keywords: *Apis mellifera*, Indian mustard, pollination, seed weight

Introduction

Indian mustard *Brassica juncea* (L.) has gained substantial importance during past few years in India due to its inherent high yielding ability and relative tolerance to biotic and abiotic stresses with wider adaptation. Though India is the largest cultivator of oilseeds at the global level, but 51% of our domestic requirements are imported at a huge cost of Rs. 56910 crores (2013-14). Therefore, there is need to increase the production of rapeseed-mustard by pollination. The present studies were planned to determine the role of domesticated honey bee i.e. *Apis mellifera* Linn. in the seed production of Indian mustard under agro-climatic conditions of Hisar, Haryana.

Materials and Methods

Studies were conducted on RH 30 variety of *B. juncea* at CCS Haryana Agricultural University, Hisar in *rabi* 2014-15. Three treatments namely intensive pollination, open pollination and pollinators' exclusion were planned. Under Intensive pollination one 5 bee-frame strength queen-right *A. mellifera* colony was enclosed with crop under nylon cage (10x10x10m). In open pollination the crop was not caged and was accessible to all the pollinators available in the area while in pollinators' exclusion, the crop plots were caged making it inaccessible to pollinating fauna. Yield parameters were recorded to evaluate the impact of pollination at harvesting

Results and Discussion

The impact of different mode of pollination showed that number of pods per plant and pod length of *B. juncea* was on par between open pollinated plots (199.6, 4.41 cm) and intensive pollinated plots (214.00, 4.57 cm) but differ significantly from control plots caged without bees (188.8, 3.92 cm). Number of seeds per pod differ significantly between open pollinated plots (11.89), intensive pollinated plots (12.73) and control plots caged without bees (9.97). Thousand seed weight (g) of plots caged with *A. mellifera* colony (6.04 g) was on par with open pollinated plots (5.94 g), while differ significantly from plots caged without bees (5.80 g). Seed yield per plot (3x 3 m^2) was highest in plots caged with *A. mellifera* (3.60 kg) followed by open pollinated plots (3.26 Kg) and plots caged without bees/pollinators (2.60 Kg). Significantly the highest yield over control (exclusion of pollinators) was recorded in plots caged with *A. mellifera* colony (38.96%). Seed germination and seed vigour were highest in seeds obtained from plots caged with *A. mellifera* (94.00%, 873.1). Oil content was found on par with each other in all three treatments. Thus findings of present study conclude that *A. mellifera* colonies placed in *B. juncea* crop significantly enhanced quantity and quality of Indian mustard seed.

Table 1: Influence of *A. mellifera* visitation on seed yield and quality parameters of *Brassica juncea*

Treatment	Pods/ Plant (No.)	Pod length (cm)	Number of seeds/pod	Thousand seed weight (g)	Seed yield/plot (9 m^2) Kg	Increase over pollinators' exclusion (%)	Germination (%)	Seed vigour	Oil content
Open pollination	199.6	4.41	11.89	5.94	3.26	25.38	91.80 (73.44)	829.70	41.18
Intensive pollination	214.2	4.57	12.73	6.04	3.60	38.96	94.00 (75.98)	873.10	41.34
Exclusion of pollinators	188.8	3.92	9.97	5.80	2.60	-	88.20 (69.95)	766.96	40.74
C.D. (p=0.05)	10.12	0.25	0.65	0.23			3.32	69.64	N.S.

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Biology and Seasonal History of Cotton Whitefly, *Bemisia tabaci* (Gennadius) in Haryana

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Keywords: *Bemisia tabaci*, biology, seasonal history

Introduction

Whitefly, *Bemisia tabaci* (Gennadius) is a cosmopolitan polyphagous pest (Brown 1994). There was an outbreak of this insect and failure of insecticides in the control of Whitefly in Haryana state during 1994, Sharma and Batra 1995. The time to time study on the biology and seasonal history of such insect becomes essential for the management of this pest in the changing global climatic conditions.

Materials and Methods

The biology of cotton whitefly was studied on cotton and brinjal in laboratory during August-September, 2014 at normal temperature and humidity prevailing in Hisar (India). The populations of whitefly adults were recorded on various host plants throughout the year.

Results and Discussion

The incubation period (5-6 & 7-9 days), crawler period (3-4 & 6-8 days), Nymphal period (11-13 & 9-10 days), pupal period (3-4 & 4-5 days), adult longevity (13-16 & 6-9 days), fecundity (25-50 & 25-30 days), sex ratio (1: 1.2 and 1.14) and total life (20-22 days & 18-22 days) were recorded on cotton and brinjal, respectively Table 1. The female lays eggs singly or in a group of 3-10 eggs. The whitefly remains active throughout the year, however the population fluctuates according to the weather conditions. The adult population of this pest was found on mint, lantana, chillies, cotton, okra, brinjal, cucurbits, mustard, potato, *Ocimum*, jungli ghobi and cucumber during the various months of the year (Table 2). Earlier Patel and Jhala 1992 have also studied the host range, host preference and population dynamics of this pest in south Gujarat (India).

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Table 1: Biology of whitefly

Parameters	Brinjal	Cotton
Incubation Period	7-9 days	5-6 days
Crawler Period	6-8hr	3-4hr
Nymphal Period	9-10 days	11-13 days
Pupal Period	4-5 days	3-4 days
Longevity	6-9 days	13-16 days
Fecundity	5-30 eggs	25-50 eggs
Sex ratio	12: 14	1: 1.2
Total life	18-22 days	20-22 days

Table 2: Seasonal history of whitefly

Month	Host plants
May	Kidney bean, mint, lantana, chillies, cotton, okra, brinjal, ridgegourd, bottlegourd
June	Cotton, lantana
July	Cotton
August	Cotton, brinjal, Kidney bean, ridge gourd, bottlegourd
Setember	Cotton, brinjal, Kidney bean, ridge gourd, bottle gourd
October	Cotton, brinjal, Kidney bean, ridge gourd
November	Cotton, Kidney bean, potato, mustard, Ocimum, jungle gobhi
December	Brinjal, potato, mustard, cucumber
January	Kidney bean, lantana, brinjal
February	Kidney bean, lantana, melon
March	Lantana, cucumber, brinjal
April	Lantana, cucumber, brinjal, Kidney bean

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Characterization and Inhibition Studies of α-Amylase from *Chilopartellus*- The Pest That Adversely Affects Maize Cultivation

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Keywords: α-amylase, *Chilopartellus*, maize

Introduction

Maize (*Zea mays* L.) is an important cereal crop with wide adaptability to diverse agro climatic conditions around the globe. However, its production is greatly reduced by a number of biotic and abiotic stresses. Stem borer, *Chilopartellus* (Lepidoptera) is among the most serious pests that affects maize production. Inhibition of gut α-amylases, which are involved in the starch hydrolysis, can provide resistance against the deleterious effects caused by the pest. Biochemical characterization of stem borer α-amylase and knowledge of their interaction with inhibitors is necessary to control the agricultural losses caused by infestation.

Materials and Methods

The third instar larva of *Chilopartellus* was used for dissection and enzyme extraction. α-amylase was extracted from larval gut with phosphate buffer (8.0) and then partially purified by gel filteration chromatography using sephadex G-100 column. The purified extract was used for characterization of α-amylase. Starch zymogram and paper chromatography studies were done to establish the nature of the enzyme. The various characters viz. pH and temperature optima, substrate specificity and kinetic studies at different substrate concentrations were studied. The effect of stimulating and inhibiting metal ions, determination of effective inhibitors, nature of inhibition was determined.

Results and Discussion

The two fractions of purified extract showed activity of 163.64 and 17.008 nmol of reducing sugars formed/min/ml respectively. Both the fractions gave single band on the starch zymogram. In addition, the results of paper chromatography of the products formed from starch hydrolysis by the enzyme provide further evidence that the purified fractions contained α-amylase activities. The fraction with higher activity was taken for characterization of the enzyme. The optimum pH and temperature of α-amylase were observed to be 8 and 50°C respectively. α- amylase showed high activity when starch, amylose and amylopectin were used as substrates. Dextrin-IV was found to be a poor substrate for α- amylase. Kinetic studies of α- amylase showed Km values of 0.41, 0.28 and 0.40 mg/ml for starch, amylopectin and amylose respectively. Vmax for starch, amylopectin and amylose were observed to be 1.62,1.38 and 1.57 nmoles of reducing sugars formed/min/ml respectively. $CaCl_2$, catechol andrutin were observed to be the activators of α- amylase (Table 1). Citric acid, oxalic acid, zinc chloride, salicylic acid, calcium nitrate and mercuric chloride acted as potent inhibitors of α- amylase activity. $HgCl_2$ completely inhibited the enzyme at 5mM concentration. Citric acid was found to be uncompetitive inhibitor of the enzyme while $ZnCl_2$, oxalic acid and salicylic acid mainly showed competitive inhibition. From the results, it may be concluded that the gut amylase from *Chilopartellus* mainly constituted α-amylase activity. The identification of eco-friendly and effective inhibitors *viz*Zn^{+2}, citric acid, oxalic acid and salicylic acid could be used in pest management strategies

Table 1: Effect of various salts on α- amylase activity of *Chilopartellus*

Salts	% Activity
Control	100
$FeCl_2$	45.8
$MgCl_2$	70.9
$CaCl_2$	108.45
$Ca(NO_3)_2$	20.8
NaCl	48.1
$CuSO_4$	44.5
$Fe(SO_4)_3$	48.1
$FeSO_4$	84.3
Citric Acid	6.9
Oxalic Acid	35.1
$ZnCl_2$	13.7
Piperazine	42.1
Cinnamic Acid	61.1
Salicylic Acid	19.9
Rutin	93.9
Catechol	98.6
Succinic Acid	62.2
Ferulic Acid	62.7
$HgCl_2$	No activity

155.

Identification of Molecular Markers for Karnal Bunt Resistance by Using RGAP in Wheat (*Triticum aestivum* L. em Thell)

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Keywords: Karnal bunt, coefficient of infection

Introduction

Due to quarantine regulation, Karnal bunt (KB) caused by *Neovossia indica* fungus becomes very important disease of wheat [*Triticum aestivum* (L.) em Thell]. This disease has gained bigger dimension in recent years due to its wide spread prevalence in the North Western India. Karnal Bunt adversely affected the quality and palatability of wheat products. The worldwide distribution of *N. indica* is limited but numerous wheat importing countries have quarantines against the import of wheat with KB, so the presence of KB in a region seriously affects the international grain trade. Thus, breeding resistant variety is the only efficient method for combating this disease *via* use of DNA markers linked to KB resistance as conventional methods is time consuming and labor-intensive.

Materials and Methods

One hundred and four recombinant inbred lines (RILs) along with their parents H567.71 (resistant) and WH 542 (susceptible) evaluated for karnal bunt resistance under artificial inoculation condition were grown in the paired rows each of 2 meter length in three replications in randomised block design (RBD) at the experimental area of Department of Genetics and Plant Breeding CCS Haryana Agricultural University, Hisar (India) in the crop seasons of 2011-12. Data recording and Coefficient of infection (CI) and Percentage of infection (PI) has been calculated. DNA extraction and molecular characterization of experimental material has been done by using 18 Resistance Gene Analog Polymorphism (RGAP) primers. Magnitude of the marker associated with infection effect was calculated by single marker analysis (SMA) approach which represented the fraction of variance explained by the polymorphism of the marker.

Results and Discussion

Analysis of variance for CI and PI showed significant variations among all the recombinant inbred lines. The distribution of RILs based on Karnal bunt disease was skewed higher towards the resistant parent H 567.71. In the present study, under molecular diversity analysis total 18 different RGAP primers used for screening of parental genotype and out of total 121 RGAP marker combinations, only 9 were found to be polymorphic. A total of 89 unambiguous bands were amplified by the 9 RGAP of which 46 bands were polymorphic (51.68%) and ranged in size from 150-725 bp. Using single marker analysis, three markers RGAP 7, RGAP 8 and RGAP 9 were found to be associated with coefficient of infection and explained up to 11.5, 7.9 and 7.5 per cent of the phenotypic variance (Table 1). It means that RGAP 7, RGAP 8 and RGAP 9 sequences were directly associated with Karnal bunt resistance genes. So marker assisted selection for Karnal bunt resistant genotypes at early plant growth stage can be practiced on the basis of these three markers. The use of molecular markers is essential for improving the efficiency of traditional plant breeding by facilitating indirect selection through markers linked to genes of interest because these markers are not influenced by the environment and can be scored at all stages of plant growth. In the present study, three RGAP markers found to be directly linked with KB disease, so after validation of these markers the resistance gene can be identified in any genotype with more authenticity and can be exploited as and when required. However, the knowledge of amplification profile of the marker is essential so that a particular gene can be followed through the product it amplifies.

Table 1: Association of Coefficient of infection and RGAP markers detected by single marker analysis (SMA) using RILs population of cross H 567.71 / WH 542

Markers	R^2 (%)
RGAP 7	11.5*
RGAP 8	7.9*
RGAP 9	7.5*

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Biophysical and Biochemical Constituents Influencing Thrips and Jassid Resistance in Groundnut Germplasm

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Keywords: Biophysical and biochemical constituents, thrips and jassid in groundnut.

Introduction

Groundnut (*Arachis hypogaea* L.) (Fabaceae) is a valuable cash crop for millions of small farmers in the semi- arid tropics and it is the principle oilseed crops in India. Its seeds are rich source of vitamins *viz.,* E, K and B. Groundnut cake after oil extraction, is a high protein animal feed and haulm provides quality fodder. Among different pests infesting groundnut crop, thrips and jassid are important sucking pests. Among the thrips four genera commonly infest groundnut namely *Scirtothrips dorsalis* Distant*, Frankliniella schultzei* Trybom, *Thrips palmi* Karny*, Caliothrips indicus* Bagnall. Early season moisture stress associated with thrips and jassid injury intensifies the groundnut yield and quality loss. Groundnut crop contains different types of plants that exhibit variability in phenotype (morphological and anatomical differences) and or genotype (genetically different from one another). One of the means by which thrips and jassid damage on groundnut crop can be curtailed by breeding varieties which can genetically or physically resist the feeding by thrips and jassid. So the first step is to screen groundnut genotypes to thrips and jassid damage in order to identify resistant genotype. Thus host plant resistance provides an additional measure to integrate with other management tactics to reduce yield loss in groundnut. Considering the above facts, a study was undertaken to screen biophysical and biochemical constituents influencing thrips and jassid damage on groundnut.

Materials and Methods

Experiment was conducted during *kharif* 2012 to 2014 at Agriculture research station, Kadiri, Anantapuramu, Andhra Pradesh, India. Different genotypes of groundnut obtained from different centers were screened in the field under natural infestation to identify the resistant ones. Groundnut genotypes were sown in three replications at 30 cm x 10cm between rows and plants, respectively. Absolute jassid and thrips population counts were recorded as number of jassid on each plant and thrips per terminal bud leaves. Observations were recorded on thrips and jassid populations at weekly intervals from 10 days after sowing of the crop to the time crop was harvested. Each cultivar was selected and labelled for observations. Per cent foliage damage was calculated by the following formula.

Percent leaf damage= Total number of leaves / Number of damaged leaves x 100.

The biophysical and biochemical constituents *viz*., leaf thickness, laminar hairs and phenols, sugars were estimated as per the standard procedures.

The data was statistically analyzed by subjecting to the correlation ' r ' and regression' R' formula, between biophysical and biochemical parameters and percent foliage damage by jassid and thrips.

Results and Discussion

Thrips and jassid were found to be active throughout the cropping season from July - October. Weekly observations revealed that among 39 genotypes screened against thrips and jassid damage, 30 were categorized as resistant, 07 as moderately resistant, 2 as susceptible. However, none of the genotypes reacted as a completely resistant to thrips and jassid damage (Table 1). There was a significant and positive correlation between thrips, jassid density and foliage damage (r= 0.363&0.205) indicating that this parameter can be used to asses thrips and jassid resistance in ground nut genotypes.

The plant breeders document all growth parameters of every groundnut genotype in pedigree sheet, identify and designate the genotype. The numbers of thrips and jassid on groundnut genotypes varied from 2.1&1.0 (K-1535 {IPR}& K-1564{IPR}) to 6.4&3.5(DRT43&K-1463), moderately resistant category 2.4&1.2(K-1482{FDR}VG&K-1563{IPR}) to 5.4&4.1(TAG-24&K-1578{LS}). Susceptible genotypes harboured numbers ranging from 6.3&2.1(TIR-9) to 8.6& 5.4(JL-24) thrips/ terminal bud, jassid per plant and none of the variety showed high level of susceptibility (Table 1). The results are in confirmation with Nagaraja *et al.* (2005). Who recorded 2.84, 7.13 and 13.37 at 45 DAS thrips / terminal bud on GPBD-4, TMV-2 and JL-24.

The relationship between thrips, jassid population and percent foliage damage was significant ($p < 0.05$) and positively correlated at five percent level (r=0.363&0.205). The significant lowest foliage damage of thrips and jassid in resistant genotypes ranged from 13.00 to 19.45 and 13.10 to 18.65% compared to susceptible genotypes the foliage damage ranged from 38.00 to 49.15 & 35.50 to 38.00% (Table 1). The variation in damage may be due to differential load of thrips and jassid population on different genotypes based on the morphological/ biochemical variations in plants. Among the genotypes leaf thickness and laminar hairs varied

from 19.58 to 24.80 mm & 19.58 to 29.58 no's. The data showed a significant negative relationship between leaf thickness, laminar hairs and thrips, jassid population (r= -0.923,-0.908&-0.807,-0.855). A similar trend was observed between leaf thickness, laminar hairs and percent foliage damage (=-0.876, -0.843&-0.828,-0.782) at 5% level of significance. The leaf thickness and trichomes of different cotton varieties/hybrid showed significant negative relationship with the incidence of thrips and jassid (Balakrishnan, 2006).

Total sugar content of different groundnut genotypes varied from 1.6 mg (K-1535{IPR}) to 6.8 mg (JL-24) per gram of leaf sample. These contents were positively correlated with thrips and jassid population and foliage damage (r= 0.942,0.949 &0.952,0.929). The data recorded on phenol of different genotypes varied from 0.18 mg (JL-24) to 0.79 mg (K-1604{HY}) per gram of leaf sample among the susceptible and resistance group, respectively. These results showed significant difference at 5% level of significant. There was a negative correlation between phenols and thrips, jassid population (r= -0.866 & -0.919). A similar trend was observed between phenols content and percent foliage damage (r= -0.858&-0.820). Multiple linear regression equation was fitted to foliage damage due to thrips and jassid population. According to regression equation, thrips and jassid population influenced foliage damage to an extent of 91.8% and 94.2% (R^2= 0.918& 0.942), respectively. The regression equation revealed that the influence of leaf thickness, laminar hairs and phenols on thrips, jassid numbers was 94.7% and 92.3% (R^2= 0.947 & 0.923) with foliage damage.

In the current investigation, 39 groundnut genotypes screened in field experiment, upto 30 genotypes were found significantly resistant. These genotypes may prove promising in breeding programme concerning with thrips and jassid resistance. Leaf thickness, laminar hairs and phenols conferred the groundnut genotypes resistant to thrips and jassid damage. This suggests that groundnut varieties with more leaf thickness, laminar hairs and high concentration of phenols play a major role against thrips and jassid damage.

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Table 1: Reaction of groundnut genotypes against thrips and jassid damage, *kharif* 2012-2014.

Entry	Thrips		Jassid		Pod yield (kg ha^{-1})
	Population / top bud leaf	Leaf damage (%)	Population/ plant	Leaf damage (%)	
DRT40	4.2	14.70 (22.90)	1.8	13.95(22.30)	2020
K-1274	3.5	18.80(25.65)	2.1	14.50(22.20)	1818
K-1282	3.0	18.70(25.55)	2.8	14.85(22.40)	1428
K-1320	2.9	16.60(24.00)	3.1	15.45(22.80)	1260
K-1392	3.8	19.45(24.95)	3.3	15.15(22.75)	1822
K-1463	3.4	29.35(26.05)	3.5	24.85(22.45)	2009
K-1470(FDR)	4.1	15.35(23.05)	2.8	14.80(22.20)	1299
K-1535(IPR)	2.1	14.25(22.10)	1.1	13.65(22.10)	1613
ICGV-888	5.6	25.40(23.10)	2.5	26.80(23.95)	1529
ICGV-00350	3.9	16.10(23.60)	1.9	13.95(21.80)	1678
TCGS-750	6.2	16.05(23.65)	2.6	14.10(21.90)	1697
TIR-9	6.3	38.00(26.55)	2.1	35.50(23.05)	1770
ICGV-91114	4.5	18.35(25.35)	2.0	16.50(21.20)	1840
TAG24	5.8	22.25(28.10)	2.0	23.50(22.80)	1903
DRT43	6.4	16.20(23.70)	2.8	14.65(20.90)	1633
K-1451(DT)VG	3.0	16.60(26.15)	2.0	14.40(21.35)	1376
K-1452(DT)VG	3.1	18.00(25.10)	2.1	13.60(21.40)	1303
K-1454(DT)VG	2.5	18.35(25.35)	3.4	14.00(21.70)	1649
K-1468(FDR)VG	2.8	16.00(23.35)	3.0	15.50(21.20)	1809
K-1482(FDR)VG	2.4	25.50(26.20)	2.4	24.65(22.20)	1546
K-1501(LS)	2.5	16.40(23.85)	2.0	14.30(22.00)	1386
K-1504S(LS)	3.8	15.35(23.05)	1.9	13.95(21.70)	1859
K-1504T(LS)	4.1	16.25(23.75)	2.4	15.40(22.90)	1631
K-1563(IPR)	2.8	13.00(22.45)	1.2	13.25(22.20)	2110
K-1564(IPR)	2.5	13.25(22.15)	1.0	13.30(22.90)	2041
K-1569(HY)	5.2	14.25(21.85)	2.6	15.40(21.70)	1639
K-1570(TAF)	3.5	13.90(21.30)	2.1	13.40(20.55)	2111
K-1571(TAF)	3.2	13.75(21.75)	2.4	13.40(21.25)	2104
K-1574(LS)	5.3	14.95(22.75)	3.2	14.85(22.50)	1049
K-1576(LS)	4.2	21.75(27.80)	2.6	23.65(21.35)	1964
K-1577(LS)	3.8	15.80(23.40)	3.5	14.90(22.55)	1761
K-1578(LS)	3.3	23.10(28.75)	4.1	24.60(22.25)	1591
K-1581(LS)	4.0	17.90(25.00)	2.8	18.65(25.40)	1752
K-1604(HY)	3.5	13.00(21.10)	1.8	13.10(26.05)	2055
K-1609(HY)	4.0	15.70(23.30)	3.3	18.30(25.10)	1933
K-1520(HY)	4.1	17.10(24.40)	3.4	18.30(25.00)	1702
K-1621(HY)	5.2	20.90(27.15)	3.3	23.80(25.40)	1859
K-1622(HY)	3.6	16.95(24.25)	3.2	17.80(24.80)	1943
JL-24(Check)	8.6	49.15(35.10)	5.4	38.00(34.30)	698
S.Em±	--	0.6	--	0.8	64.0
CD (*P=0.005*)	--	1.65	--	2.15	181.0

157.

Host Plant Resistance (HPR) Study on Snapmelon (*Cucumis melo* var. *momordica*) Against Melon Fruit Fly (*Bactrocera cucurbitae* (Coquillett)) in Arid Region Rajasthan

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Keywords: HPR, snapmelon, fruitfly

Introduction

Snapmelon (*Cucumis melo* L. var. *momordica* (Roxb.) belongs to family *Cucurbitaceae*, that is a native of India and is used as vegetable in a variety of ways. Host plant resistance (HPR) to insects is an effective, economical, and environment friendly method of pest control. The most attractive feature of HPR is that farmers virtually do not need any skill in application techniques, and there is no cash investment by the resource poor farmers. Considerable progress has been made in identification and development of crop cultivars with resistance to the major pests in different crops. Plants having antibiosis characters like flavinoid, alkaloid, phenols, tannins etc. may cause reduced insect survival, prolonged developmental time, decreased size and reduced fitness of new generation adults (Haldhar *et al.,* 2013). Antixenosis refers to the potential plant morphological traits (length of ovary pubescence, fruit hardness, roughness, rind thickness etc.) that imparts or alters the insect behaviour towards the host preference (Haldhar *et al.,* 2015). Tephritid fruit flies (Diptera: Tephritidae) are the most devastating insect pests having a foremost influence on global agricultural products affecting yield losses, and dropping the value and marketability of horticultural crops. The melon fruit fly, *Bactrocera cucurbitae* (Coquillett)) is a serious pest of snapmelon in India and its outbreak causes substantial crop losses to the growers.

Materials and Methods

Forty-three genotypes of snapmelon were sown at experimental farm of ICAR-Central Institute for Arid Horticulture, Bikaner (28°06'N, 73°21'E). Ten fruits were randomly selected from each picking from each experimental bed (replication) of each genotype and were brought to the laboratory for microscopic examination for fruit fly infestation. The infested fruits were sorted and percent fruit infestation was calculated. Ten fruits from all infested fruits from each picking of each genotype were randomly selected for further examination, and the numbers of larvae were counted in each infested fruit. Two fresh fruits of each genotype from each replication were selected, cut in to small pieces and dried for Total Soluble Solid, flavonoid, phenols content and tannins content. Ten marketable fresh fruits of each of the seventeen snapmelon genotypes were used to record data on the morphological traits (length of pubescence, rind hardness, pericarp thickness, flesh thickness, fruit length and fruit diameter).

Results and Discussion

Forty-three snap melon genotypes were taken for preliminary screening against *B. cucurbitae* and significant differences were found in percentage fruit infestation and larval density per fruit. The larval density per fruit had a significant positive correlation with percentage fruit infestation (r= 0.988; $p < 0.01$). The percentage fruit infestation increased with an increase in larval density per fruit and there was a significant positive correlation (r= 0.988; $p < 0.01$) between per cent fruit infestation and larval density per fruit. The percent fruit infestation was highest in IC-430184 (69.67%) and lowest in IC-430190 (11.21%) followed by DKS-AHS-2011/4 (14.97%). The larval density ranged from 8.63 to 17.57 and 8.30 to 17.20 larvae per fruit in the rainy season of 2014 and summer, 2015, respectively. The larval density was maximum in IC-430169 (17.37 larvae per fruit) and minimum in IC-430190 (8.47 larvae per fruit) followed by DKS-AHS 2011/3 (8.8 larvae per fruit) (Table 1). The percentage fruit infestation and the larval density per fruit with free amino acid (0.97 & 0.96) and TSS (0.3 & 0.3) of fruit had a significant positive correlation whereas; flavonoid (-0.98 & -0.96), tannins (-0.97 & -0.95), phenols (-0.96 & -0.95) and total alkaloid (-0.97 & -0.94) had significant negative correlation. The length of ovary pubescence (-0.99 & -0.96), rind hardness at immature stage (-0.93 & -0.90), rind hardness at mature stage (-0.59 & -0.54) and pericarp thickness (-0.78 & -0.75) had significant negative correlations whereas; flesh thickness (0.62 & 0.61), fruit length (0.61 & 0.62) and fruit diameter (0.76 & 0.77) had significant positive correlations with the percentage fruit infestation and the larval density per fruit.

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Table 1: Larval density and per-cent fruit infestation of melon fruit fly on different genotypes of snapmelon, *C. melo* var. *momordica* during final screening trials.

Genotypes	Larval density/ fruit	Fruit infestation (%)	Resistance category
IC-430169	17.37^{f}	68.46 (55.85)^{j*}	S
DKS-AHS 2011/3	8.80^{ab}	18.57 (25.51)^{bc}	R
IC-430172	17.17^{f}	66.29 (54.55)^{ij}	S
IC-430175	11.92^{cd}	41.13 (39.85)^{f}	MR
IC-369788	9.32^{ab}	25.26 (30.15)^{de}	MR
IC-430160	8.88^{ab}	22.47 (28.28)^{cd}	MR
IC-430162	9.63^{ab}	26.43 (30.91)^{de}	MR
IC-430171	14.85^{e}	53.64 (47.08)^{gh}	S
IC-430179	13.72^{de}	47.63 (43.63)^{fg}	MR
IC-430180	14.57^{e}	48.28 (44.00)^{g}	MR
IC-430190	8.47^{a}	11.21 (19.56)^{a}	R
DKS-AHS 2011/2	10.62^{bc}	29.07 (32.56)^{e}	MR
IC-430185	14.53^{e}	48.48 (44.11)^{g}	MR
IC-430184	17.42^{f}	69.67 (56.64)^{j}	S
IC-430155	14.48^{e}	54.12 (47.35)^{gh}	S
DKS-AHS 2011/4	8.88^{ab}	14.97 (22.75)^{ab}	R
IC-430164	15.23^{e}	59.88 (50.71)^{hi}	S
Mean±SD	12.70±3.30	41.50±19.47	
SEm±	0.63	1.39	
LSD (P= 0.05)	1.83	4.01	
F calculated	27.16	70.70	
Error degree of freedom	32	32	

*Values in parenthesis are angular-transformed
Value following different letter down the column are significantly different using Tukey's HSD test, R- resistant, MR- moderately resistant and S- susceptible

158.

Effect of Host Plants on Ecological Life Table Parameters of *Pieris brassicae* L.

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Keywords: *Pieris brassicae* L., crucifers, life table, age stage specific, life table parameters

Introduction

The great cabbage white butterfly, *Piersis brassicae* L. is one of the most serious pests of cruciferous vegetables and has been reported as major pest from Jammu and Kashmir, Punjab, Haryana, West Bengal, Bihar, Andhra Pradesh, Orissa and Meghalaya. The strategies to control any insect pest generally need a detailed study of the life history parameters. There is a considerable interest to explore alternative methods, including host plant resistance to efficiently control the *P. brassicae* and diminish its damages on the crops. Life tables are powerful tools for analyzing and understanding the impact that an external factor has upon the growth, survival, reproduction, and rate of increase of an insect population. Knowledge of the biology and life table parameters of *P. brassicae* on different cole crops could be effective in detecting and monitoring the pest infestation, variety selection and crop breeding. Keeping in view the problems associated with this insect pest, the present study was conducted to study life table parameters of *P. brassicae* on crucifers.

Materials and Methods

The experiment was conducted in laboratory in the Division of Entomology, Chatha, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. Five hosts i.e. *Brassica oleracea* var. *botrytis* L., *Brassica oleracea* var. *capitata* L., *Brassica oleracea* var. *italica* L. Plenck. *Brassica campestris* var. *toria* L., and *Brassica campestris* var. *yellow sarson* L. were used. A cohort, comprising 100 eggs were collected from the field and kept in an incubator. After hatching, the cluster of 10 caterpillars (zero day old) in 10 replications, making a cohort of 100, were reared in plastic vial (6x10 cm) on leaves of respective host plant. When the caterpillars reached in to second larval instar, they were reared individually in separate vials till formation of adult and their subsequent death was also noticed. On adult emergence, the male and female reared in nylon mesh cage on respective host plant. Age specific data on the survival and mortality of the larvae was recorded at every 24 hrs interval. The different vital statistics of age and stage specific life-tables were calculated as per suggestions of Birch (1948) and Southwood (1978).

Results and Discussion

Life table studies revealed that most of the mortality occurred early and late stages in the life and expectancy of life continuously decreased till the end of generation on each crucifer host plant. *P. brassicae* required maximum of days to complete generation on toria followed by yellow sarson, broccoli, cauliflower and cabbage. The mortality factors at different growth stages were infertility, parasitization, bacterial infection, failure to pupate, development of malformed adults, non-emergence, unfavourable climatic factors, migration and unknown causes. On the basis of age specific life table parameters namely net reproductive rate, intrinsic rate of increase, finite rate of increase, weekly multiplication of population, annual rate of increase, hypothetical second generation females, mean length of generation and doubling time cabbage was recorded as highly preferred by *P. brassicae* as compared to other crucifers. The toria was least preferred by the *P. brassicae* as compared to other crucifer crops.

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Table 1: Age specific life table parameters for *P. brassicae* on crucifers

Population growth statistics	Formula	Cabbage	Cauliflower	Broccoli	Toria	Yellow Saraon
Net reproductive rate (R_O)	$R_O= \sum l_x m_x$	44.75 females/female	18.50 females/female	14.17 females/female	1.40 females/female	6.33 females/female
mean length of generation (T_C)	$T_C=\sum l_x m_x/R_O$	32.7598 days	34.25838 days	35.3469 days	40.9286 days	37.8451 days
Intrinsic rate of increase (r_m)	$r_m=Log_e R_O/T_C$	0.0504 females/females/day	0.0369 females/females/day	0.0326 females/females/day	0.0036 females/females/day	0.0212 females/females/day
Finite rate of increase (λ)	$\lambda=antilog_e r_m$	1.0517 females/females/day	1.0377 females/females/day	1.0331 females/females/day	1.00357 females/females/day	1.0214 females/females/day
Doubling Time (DT)	$DT= Log_e 2/r$	5.9740 days	8.1384 days	9.2399 days	84.3146 days	14.2157 days
weekly multiplication of population	$(\lambda)^7$	1.4229 times	1.2955 times	1.2562 times	1.0253 times	1.1598 times
Annual Rate of Increase (ARI)	$ARI= e^{365r}$	97191147.07 times	730046.29 times	146019.27 times	3.68 times	2273.74 times
hypothetical F_2 females	$(R_o)^2$	2002.20	342.25	200.9873	1.96	40.07

159.

Evaluation of Plant Resistance in Progenitors of Wheat Against Aphids (*Rhopalosiphum* species)

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Keywords: evaluation, plant resistance, corn leaf aphid, progenitors, wheat

Introduction

Wheat is the second most important cereal crop after rice. It is attacked by a number of insect pests, out of which aphids are the most destructive pest. Among the different aphid species attacking wheat crop bird cherry oat aphid (BCOA) *Rhopalosiphum padi* L. and corn leaf aphid (CLA) *Rhopalosiphum maidis* Fitch. appear regularly on wheat crop. Aphids cause 3.5-21.0% yield losses in wheat crop (Singh and Deol, 2003). Deol *et al* (1995) identified eight Russian wheat aphid (*Diuraphis noxia* Mordvilko) resistant wild accessions. Since the resistance is present in wild wheat against Russian wheat aphids, there exists a possibility of its presence against aphid species prevalent in India. Keeping this in view, this study was planned to identify sources of resistance against aphids (*Rhopalosiphum* spp.) under screen house conditions.

Materials and Methods

We determined aphid reaction of 162 progenitors of wheat including *Aegilops tauschii, Aegilops speltoides, Triticum dicoccoides, T. monococcom, T. boeoticum*, synthetics wheats for three years. The aphids were transferred from insect culture to screen house from mid-January onwards using detached leaf method. Each accession was observed for aphid incidence twice or more at 7 days interval in the season in order to confirm their reaction. The three observations were taken into consideration for the classification of test material in different groups. Four weeks after infestation, the insect damage was scored using 1 to 5 rating scale.

Results and Discussion

The majority of wheat accessions were susceptible or highly susceptible to aphids. In first year of screening (2012-13), four resistant (R) and twenty-nine moderately resistant (MR) wheat accessions were identified. The further evaluation of R and MR accessions in succeeding year (2013-14) yielded, one R and six MR accessions to aphids. The rescreening was done in 2014-15 to confirm potential resistance sources. In third year, the seven promising accessions showed same reaction and confirmed the results of 2013-14 screening. Thus, after three years of screening one homogenous resistant (*Aegilops tauschii* 14096) and six moderately resistant accessions (*Aegilops tauschii* 14135, 14232, 14339, 14348, 14576 and 3733) were identified from a collection of 162 wild accessions.

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160.

Evaluation of Promising Potato Genotypes Against Potato Apical Leaf-Curl Disease Incidence

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Keywords: *Solanum tuberosum*, genotypes, percent apical leaf-curl disease, whitefly

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops of Haryana. The productivity of potato crop in the state is lower (22.33 t/ha) than the potential yield mainly due to viral diseases with an average of 30-40% incidence and about 25-30% yield reduction annually (Khurana, 1999, Lakra, 2002). Hence, it was realized to evaluate some promising genotypes against major viral disease of potato *i.e.* apical leaf curl disease, transmitted by whitefly, *Bemisia tabaci*.

Materials and Methods

Studies on evaluation of potato genotypes against apical leaf-curl disease incidence were conducted during winter (*Rabi*) season of 2012-13. Eight promising genotypes namely Kufri Bahar, Kufri Pushkar, Kufri Surya, Kufri Pukhraj, Kufri Khyati, Kufri Sadabahar, Kufri Badshah and CP 1588 were planted on 16 October 2012 in a RBD with three replicates and evaluated against whitefly infestation and incidence of apical leaf curl disease. Number of whitefly was counted on three compound leaves at different positions, *i.e.*, bottom, middle and top of the plant and averaged. Number of plants showing apical leaf curl symptoms were counted in each plot/genotype and percent disease incidence was calculated as below:

$$\text{Apical leaf curl disease (\%)} = \frac{\text{No. of plants effected with apical leaf curl disease per plot}}{\text{Total no. of plants per plot}} \times 100$$

Results and Discussion

Significant differences were observed among the genotypes with regard to whitefly population and PALCD (Potato apical leaf curl disease) incidence which ranged from 10.00 (Kufri Surya) to 116.66 (CP 1588) at 10 days after emergence.

Table 1: Whitefly infestation and incidence of Potato apical leaf curl disease

Varieties	Whitefly population			PALCD incidence at 40 DAE (%)	PALCD incidence at 60 DAE (%)	PALCD incidence at 80 DAE (%)
	at 10 DAE	at 20 DAE	at 30 DAE			
Kufri Bahar	26.00	15.00	3.66	0.00	0.00	0.00
Kufri Pushkar	35.00	16.00	4.00	3.66	6.66	9.33
Kufri Surya	10.00	2.33	1.33	5.00	15.89	19.67
Kufri Pukhraj	75.66	46.66	9.33	26.66	63.66	95.00
Kufri Khyati	96.66	58.66	9.66	27.33	66.66	100.00
Kufri Sadabahar	16.00	9.00	3.00	6.33	12.33	33.66
Kufri Badshah	19.33	7.33	3.33	3.33	6.66	12.66
CP 1588	116.66	79.33	14.00	35.66	69.33	100
CD (5%)	10.87	12.07	1.62	5.12	13.28	7.73
SE (m)	5.02	5.57	0.74	2.36	6.13	2.18

Significant at 5%, PALCD= Potato apical leaf curl disease, DAP= Days after planting, DAE= Days after emergence

It is concluded that low population of whitefly and less number of stomata were the main characters, which contributed towards potato apical leaf-curl disease resistance. At 80 DAE Significantly maximum disease incidence was recorded in CP 1588 (100%) closely followed by Kufri Khyati (100%) and Kufri Pukhraj (95%) which were statistically at par and they were considered highly susceptible genotype. Kufri Bahar was completely free from disease (0.00%) while Kufri Pushkar showed (9.33%) less than 10% and considered as resistant variety. The genotypes identified resistant to apical leaf curl disease incidence can be exploited for developing high yielding and disease resistant verities in potato.

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161.

Evaluation of Chilli Genotypes against Chilli Leaf Curl Virus under Natural and Artificial Epiphytotic Conditions

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Keywords: Viruliferous, inoculated, begomovirus, symptomless, disease reaction

Introduction

Chilli (*Capsicum annuum* L.) suffers from a large number of viral, fungal, bacterial, nematode and phytoplasmal diseases. Viral diseases are an important factor contributing to low yields and reduced fruit quality. Natural occurrence of more than 45 viruses, including, pepper leaf curl virus, pepper veinal mottle virus and pepper vein bending virus have been reported by different workers infecting chilli pepper worldwide. Among all, whitefly (*Bemisia tabaci*) transmitted chilli leaf curl disease (syn. Pepper leaf curl disease, PepLCD) is the most destructive disease. To sustain production and enhance profitability of chilli cultivation, it is important to identify confirmed sources of resistance and utilize them in resistance breeding programme by employing conventional and molecular breeding approaches.

Materials and Methods

A total of 155 genotypes along with local checks (Punjab Surkh and CH-1) were raised at Vegetable Research Farm, Department of Vegetable Sciences Punjab Agriculture University, Ludhiana during 2012, as per recommended agronomic practices. The symptom severity was recorded on each genotype following the severity scale 0-5 (Banerjee and Kalloo, 1987). The chilli plant infected with frequently occurring tomato leaf curl Joydebpur virus (ToLCJV) was maintained under isolated conditions in insect proof cage. After 24 hours of inoculation feeding period the cages were sprayed with an insecticide triazophos @ 0.15 per cent to kill the flies and these cages were removed. Ten seedlings of each selected resistant lines along with susceptible checks were grown in pots under insect proof conditions. Single plant inoculation technique was used for screening. The seedlings were inoculated at 2 true leaf stages. Each seedling was exposed to 10 viruliferous whiteflies after acquiring virus from infected source. The inoculated seedlings were kept in growth chamber. The inoculated plants were observed up to six weeks. The disease incidence and severity was recorded on visual basis. The severity of plants was categorized as highly resistant, resistant, moderately resistant, susceptible and highly susceptible. After six weeks all the inoculated plants (both symptomatic and asymptomatic) were subjected to PCR to confirm the presence of virus. The young leaves of all the ten inoculated plants from individual lines were pooled. The total DNA was extracted using CTAB method. These DNA samples were subjected to PCR using AV/AC primers and analysed for the presence or absence of virus.

Results and Discussion

The reactions of 155 genotypes of chilli (*Capsicum annum* L.) to ChiLCD under natural conditions (field conditions) are summarized in (Table 1). On the basis of Coefficient of Infection (CI), all the 155 genotypes were assigned specific disease reaction. Thus the coefficient combined the amount of infection and its severity. It was inferred that out of 155 genotypes screened, 150 were prone to ChiLCD and a handful of genotypes (5) under consideration showed high resistance to the ChiLCD. Maximum number of genotypes were moderately susceptible (MS) (125), followed by susceptible (S) (16), moderately resistant (MR) (6), resistant (R) (3), highly resistant (HR) (3) and symptomless (2). Japani lounge and Perennial were found resistant with CI value of 10. The genotypes that were screened as resistant, highly resistant and symptomless under field conditions were subjected to artificial inoculation.

Table 1: Screening of chilli genotypes under field conditions

Genotype	Symptom severity grade	Response value	Coefficient of infection (CI)	Disease reaction
2011/Chivar-3	4.0	0.75	37.5	Moderately Susceptible(MS)
Saurian-2010	0	0	0	Symptomless
VS-7	3.0	0.5	15.0	Moderately Resistant (MR)
S-217621	2.0	0.25	10.0	Resistant (R)
CH-22221	0	0	0	Symptomless
SEL-40	3.0	0.5	20	Moderately Resistant (MR)
Japani Loungi	2.0	0.25	10.0	Resistant (R)
Perennial	2.0	0.25	10.0	Resistant (R)
VS-9	1.0	0.05	3.0	Highly Resistant (HR)
ICPN-21-6	5.0	1.0	70	Susceptible (S)

After 28 days of inoculation, symptom appearance was noticed in all the genotypes. Typical symptoms of begomovirus like mild puckering, pronounced puckering; crinkling, blistering of leaves, downward curling and twisting of leaf was noticed in artificially inoculated plants. The susceptible check ICPN- 21-6 showed most prominent symptoms of ChiLCD. As per this scale we calculated only appearance of symptoms after inoculation, type of symptoms and disease reaction. All the artificially inoculated lines showed presence of virus. Since virus is present in all the inoculated lines but the apparent symptoms vary with lines, which shows that there is a resistant mechanism working in the lines. Capsicum germplasm screening so far reported are based on occurrence of disease under field conditions. Hence, the field reaction of genotypes to particular organism may not be considered for having true resistance as this could be possibly due to the non-preference of whitefly under field conditions. As the genotypes tested were planted along with several other genotypes, which may or may not be suitable for whitefly multiplication but suitable for virus multiplication and vice-versa.

Reference

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162.

Knowledge of Cauliflower Growers about Integrated Pest Management

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Keywords: IPM, crop rotation, pesticide, sustainability and purposely

Introduction

Cauliflower is one of several vegetables in the species *Brassica oleracea*, in the family Brassicaceae. It is grown for its white tender head or curd, which is used as a vegetable, soup and pickle. It is having a good nutritive value. It contains good amount of vitamins and fair amount of proteins and fibers. The cauliflower is also a good source of minerals like P, Ca, Mg, S, Fe, and Na but there are several insect-pests which attacks on cauliflower and reduces its nutritional value. Generally farmers are using pesticides for controlling insect-pests in cauliflower, which are harmful for human health. So, there is essential to give a focus on IPM to maintain the nutritional level and sustainability in production of vegetables. Keeping in view of this background, the present study was undertaken with the specific aim to assess the "Knowledge level of Cauliflower growers about Integrated Pest Management in Udaipur District of Rajasthan".

Materials and Methods

The present study was conducted in the purposely selected Udaipur district of Rajasthan. There are total eleven tehsils in Udaipur district of Rajasthan, out of which two tehsils namely Badgaon and Girwa were selected on the basis of maximum area under cultivation of cauliflower. Four villages from each selected tehsil were taken on the basis of maximum area under cauliflower cultivation. From each selected village, 12 respondents were selected random basis. Thus, in all 96 farmers were included in the sample of the study. Data were collected through pre-structured interview schedule and collected data were analyzed, tabulated and results were interpreted in light of the present study.

Results and Discussion

To get an overview of the extent of knowledge regarding various major aspects of IPM possessed by the respondents, the scores for each major head was computed and results have been presented in Table 1. Data incorporated in Table 1 reveal that among the major practices, respondents had highest knowledge about cultural practices which was 71.37 per cent and ranked first by the cauliflower growers. The extent of knowledge about conceptual framework of IPM was 66.25 per cent and ranked second by the cauliflower growers. The extent of knowledge about key pests of cauliflower was 60.37 per cent and ranked third by the cauliflower growers. On the other hand the extent of knowledge of the respondents about chemical pesticidal practices was 50.96 MPS whereas, knowledge of the respondents about biocontrol practices was 26.60 per cent and it was ranked last by the cauliflower growers. Further concluded that overall knowledge of the respondents regarding IPM practices in cauliflower was found 63.37 per cent which can be considered as good level of knowledge of the respondents in the study area.

Table 1: Extent of knowledge of the respondents regarding major IPM practices in cauliflower cultivation (n=96)

S.No.	IPM practices	MPS	Rank
1.	Conceptual framework of IPM	66.25	2
2.	Key pest of cauliflower	60.37	3
3.	Cultural practices	71.37	1
4.	Biocontrol practices	26.60	5
5.	Chemical pesticidal practices	50.96	4
	Overall	63.37	

MPS= Mean Per cent Score

The present findings are in confirmation with the findings of Ganesan and Seethalakshmi (2002) who revealed that majority of the respondents had high knowledge about integrated pest management in rice cultivation.

Reference

Ganesan, R. and Seethalakshmi, R. 2002. Participation pattern of women on IPM in rice. *Agricultural Extension Review* **14**(5): 28-30.

163.

Impact of Integrated Pest Management Programme of Vegetable Crops in Jammu Region of Jammu and Kashmir State

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Keywords: Impact of IPM programme, pesticide use, productivity

Introduction

Farmers are frequently applying unnecessarily high doses and inappropriate combinations of pesticides to combat pest problems. This costs farmers' money and reduces their profitability. To overcome the negative outcomes from excessive use of pesticides, vegetable integrated pest management (IPM) programmes are implemented on a large scale by Central Integrated Pest Management Centres (CIPMCs) since the early 1990s. Between 2004-05 and 2009-10, 50 Integrated Pest Management-Farmers Field Schools integrated pest management-farmers field schools (IPM-FFS) in vegetable crops by CIPMC Jammu were conducted. To analyze the impact of the vegetable IPM programmes on reducing pesticide use, pesticide spray frequency and pesticide expenditure, present study was conducted in the sub-tropical area of the Jammu region of Jammu and Kashmir (J&K) state.

Materials and Methods

Jammu, Samba and Kathua districts were selected as the maximum numbers of IPM-FFS were conducted by the CIPMC Jammu in these three districts. Two sets of samples and data were collected. One, quasi-experimental before/after and with/without data were collected where IPM was being implemented between 2008 and 2010 by CIPMC. Second, *ex-post facto* with/without data were collected where IPM was implemented by CIPMC between 2002 and 2008. Meta-analysis of these two data sets collected from 136 IPM farmers and 129 non-IPM farmers selected from 16 IPM and 11 non-IPM villages, respectively was done. Thus, the total sample size for the study was 265. The data were collected with the help of a questionnaire by personal interview method. The data were analyzed by applying two sample t-test for testing the difference between the IPM and non-IPM farmers using SPSS 16 package

Results and Discussion

The average number of pesticide applications in the IPM villages was 2.83 compared to 2.71 in non-IPM villages. The pesticide use (active ingredients) in the IPM villages was 0.553 kg/ha whereas in the non-IPM villages it was 0.449 kg/ha. The mean pesticide expenditure in the IPM and non-IPM villages was Rs. 2583 and Rs. 2455 per hectare respectively (Table 1). The mean yield of the vegetable crops in the IPM villages was 228 q/ha whereas it was 240 q/ha in the non-IPM villages. The IPM farmers mean gross income from vegetables was Rs. 207254 and non-IPM farmers mean gross income from vegetables was Rs. 205026. There was no significant difference between IPM and non-IPM villages in mean pesticide use by weight (kg/ha), mean pesticide spray intensity, mean pesticide expenditure (Rs/ha), mean yield (q/ha) and mean income (Rs/ha). The vegetable IPM programme implemented in the sub-tropics of Jammu by CIPMC in no way contributed as there is hardly any difference in pesticide use, pesticide sprays, pesticide expenditure, mean yield and mean income between IPM and NIPM villages. The study shows that IPM farmers did not change their practices and continued with conventional pesticide practices at the same rate as their counterparts in the NIPM villages. More needs to be done with IPM extension for educating farmers about use of non-chemical pest management practices and reduce the dependence on pesticides.

Table 1: Pesticide use, pesticide spray and pesticide expenditure (per ha)

Evaluation indicator	IPM (n=136)	NIPM (n= 129)	Difference	Statistics
Pesticide use (% farmers)	77	82	05	z= 1.154, p=0.250
Pesticide use by weight (kg/ha)±Sem	552.73±45.99	449.02±34.18	103.71	t= 1.810, p= 0.072, d.f= 208
Mean number of pesticide sprays±Sem	2.83±0.18	2.71±0.17	0.12	t= 0.496, p= 0.621, d.f= 208
Mean pesticide expenditure (Rs./ha)±Sem	2583.42±162.87	2455.12±215.46	128.30	t= 0.475, p= 0.635, d.f= 208
Mean yield (q/ha)±Sem	227.64±7.19	239.85±8.51	-12.21	t= 1.101, p= 0.272, d.f= 264
Mean income (Rs./ha)±Sem	207253.70±4373.25	205025.5±4778.01	2228.17	t= 0.345, p= 0.731, d.f= 264

164.

Impact of IPM Technology on Knowledge and Adoption of Cotton Growers in Guntur District of Andhra Pradesh

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Keywords: IPM technology, knowledge, adoption, impact

Introduction

Integrated Pest Management (IPM) approach is gaining importance and is being increasingly adopted in the Cotton occupies 8% of the total cropped area with an area of 11.73 Million Hectares [CICR] distributed among three different agro climatic zones in India, and consumes 33% pesticide share accounting for 40% of total production costs. This figure reflects the excessive use of pesticides on cotton. The approach to overcome these ill effects as pesticides to a certain extent is IPM practices. Hence, a study was conducted to assess the impact of IPM technology. The impact evaluation indicators were knowledge of cotton growers about IPM and adoption of IPM practices by cotton growers.

Materials and Methods

The study was conducted in Guntur district of Andhra Pradesh state in 2015. Guntur district was selected purposively on the basis of leading hybrid cotton growing area. Four mandals were selected from the district, two villages from each mandal were selected purposively from villages where IPM programme/training was conducted SV Veterinary University Krishi Vigyan Kendra. A sample of 120 IPM trained cotton growers and 120 non-IPM cotton farmers were selected. Thus the total sample size was 240 the data was collected with the help of pre-tested well structured interview schedule and statistically analyzed with the help of frequencies, percentage and ranking. To measure the Impact of the IPM technology, knowledge and adoption test were administered to the respondents.

Results and Discussion

Majority of the cotton growers middle aged(43%),illiterates(25%) with small landholding (1.1 to 2.0 ha, (33%), high farming experience(50%), medium social participation(57%), medium socio-economic status(58%), Medium innovativeness(39%), medium scientific orientation(58%), medium risk orientation (43%), medium economic orientation(57%), medium market orientation(42%), medium Mass media exposure(53%), medium extension contact(60%). Eighty per cent of the cotton farmers received training from Krishi Vigyan Kendra.

The mean knowledge and adoption score of IPM trained and untrained cotton growers was 79.65 and 68.15%, respectively was found to be higher than the mean of untrained cotton growers 43.15 and 38.75%, respectively and the computed impact percentage is 32.95. It can be inferred that, the trained cotton growers differed significantly over the untrained cotton growers in possession of knowledge and adoption regarding IPM technology. Majority of the cotton growers expressed 15 constraints in the adoption of IPM technology. Lack of assured irrigation was the most serious constraint mentioned by more than two third of IPM (74%) and non-IPM farmers (81%). Lack of persuasion by extension agents and inability to contact the extension agents, poor quality of inputs, difficulty in remembering Economic Threshold Level (ETL) were the other constraints expressed by cotton growers

Table 2: Impact in terms of knowledge and adoption

Particular	Trained	Untrained	Difference
Mean Knowledge Index	79.65	43.15	36.50
Mean Adoption Index	68.15	38.75	29.40
Total	147.8	81.9	65.90
Impact (In Percent) = Sum of Difference of Index / 2			32.95

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165.

Knowledge and Adoption of Plant Protection Practices in Rice

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Keywords: Plant protection practices**,** pesticides, knowledge, adoption, rice.

Introduction

Rice is one of the most important cereal crop and staple food for more than half of the world's population. In Jammu and Kashmir State (J&K), rice is cultivated in an area of 262.17 thousand hectares with an annual production of 5447 thousand quintals. It is the second important crop and staple food for majority of the population in the state. Insect pests, weeds and diseases usually in combination with other stresses are severe constraints to rice production, and have been one of the reasons for huge losses in production. External inputs play a vital role in modern agriculture. Pesticide use in J&K increased from 142 metric tons (MT) in 1994-1995 to 1711 MT in 2011-2012. Pesticide intensive pest management practices in apple and vegetable crops have propelled this increase. However, meager data is available about the pesticide use and pest management practices adopted in rice crop in the sub-tropics of the state. A study was carried out on 120 rice growing farmers (predominantly Basmati growers) of sub-tropical Jammu district of the state to find out the knowledge and adoption of plant protection practices by rice farmers.

Materials and Methods

The present study was conducted in the Jammu district of the J&K state in 2014. Multi-stage sampling method was employed for selection of villages and rice farmers. All agricultural sub-divisions of the Jammu district namely R.S. Pura, Marh, Akhnoor and Dansal were taken up for the study. On the basis of area under Basmati rice, a proportionate sample of villages was drawn from each sub-division and twelve villages were selected for the study. Out of each selected village, 10 rice growers were selected randomly without replacement. Thus total sample size of the rice farmers was 120. Data were collected by personally interviewing the sampled farmers. Linear regression model was employed to find out the socio-economic factors affecting the adoption of plant protection practices.

Results and Discussion

Majority of the rice growers (82%) had the knowledge of herbicide butachlor, a recommended chemical for weed control. Similarly 50% and 21% respondents have knowledge about herbicides 2, 4-D and bis-pyribac sodium, respectively. The knowledge of insecticides to control stem borer in rice crop was very low as only 3% of the respondents had knowledge of insecticide fipronil as a recommended insecticide against stem borer (Table 1).

Adoption commonly refers to the decision to use a technology or practice by economic units on a regular basis. Chemical method of weed control was adopted by majority of the respondents. Overall 94 percent respondents (113) adopted different herbicides in rice crop, out of which 82 percent respondents applied butachlor percent granules, 50 percent respondents used either in addition to butachlor or only 2,4-D, and 15 percent of the respondents used bispyribac sodium. The practice of treating seed before sowing was adopted by only 7 respondents (6%) treated their seed before sowing. Insecticide Fipronil 5 percent SC was used by three percent farmers only (Table 1).

Table 1: Knowledge and adoption of plant protection practices (% farmers)

Pesticide	Knowledge	Adoption
Herbicides		
Butachlor 5% GR	82	82
2,4-D 38% EC	50	50
Bispyribac sodium 10% SC	21	15
Insecticides		
Fipronil 5% SC	03	03
Fungicides		
Carbendazim 50%WP	06	06

The overall knowledge score of the respondents regarding plant protection measures revealed that majority of the farmers (58%) in district Jammu fall under medium knowledge score (21-26). High knowledge score of (26-31) was obtained by 12 percent of the farmers whereas low knowledge score (15-21) obtained by 30 percent of the respondents. The mean knowledge score of rice growers of Jammu district was 21.91 (Table 2).

Table 2: Overall knowledge score of farmers about plant protection measure

Knowledge score	Percent farmers
Low (15-21)	30
Medium (21-26)	58
High (26-31)	12
Mean knowledge score	**21.91**
SEm	**0.29**

Overall, the farmers have low level of knowledge about seed treating chemicals and insecticides to control insect pests in rice crop. The use of agro-chemicals in rice was on the lower side especially the adoption of seed treating chemical and insecticides. It is concluded on the basis of the findings that majority of the farmers had medium level of knowledge about plant protection measures.

166.

Analysis of Technology Gap and Relative Importance of Banana Pseudostem Borer, *Odoiporus longicollis*, Olivier in Tamil Nadu

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Keywords: Pseudostem injector, pseudostem borer, technological gap index

Introduction

Banana is one of the most important major fruit crops grown in India. Banana is ravaged by number of insect pests, among which, the pseudostem borer *Odoiporus longicollis* (Olivier) is one of the serious monophagous pest limiting the production and productivity of bananas. In recent years, it is becoming very serious problem in southern India particularly in Tamil Nadu and Kerala (Gailce *et al.,* 2008). Considering the economic losses caused by this pest, the study was undertaken to assess the incidence of pseudostem borer in major banana growing districts in Tamil Nadu and to assess the farmer's perception on the awareness about this pest and its relative importance over other key pests of banana.

Materials and Methods

A survey was conducted in 2014-2015, in major banana growing districts of Tamil Nadu, for assessing the distribution, infestation level and the relative importance of banana pseudostem borer *Odoiporus longicollis* Olivier and the farmer's perception on the pest and management practices. The distribution of the pseudostem weevil was assessed by recording per cent infestation in each district and in different varieties. Technology gap index (TGI) was calculated by the formula:

$$\text{Technological Gap Index (TGI)} = \frac{R-A}{R} \times 100$$

Where, R= Recommended Practice
A= Adopted Practice

On the basis of responses given and on the basis of TGI, banana growers were grouped in high (TGI 70 and above), medium (between 40 to 70) and low technology gap (below 40) categories.

Results and Discussion

Pseudostem borer was the major pest in Kanyakumari, Coimbatore and Dindigul. In Kanyakumari, the common susceptible cultivar Nendran recorded 43.90% infestation, followed by Coimbatore (13.70%) and Tiruchirapalli (10.24%). In Dindigul 18.84% infestation was observed in hill banana. Matti and Red Matti were specifically grown in Kanyakumari were found susceptible with 19.62 and 18% infestation, respectively. Rasthali was the least susceptible variety (0.16%), followed by Singan (0.18%). Fifty one per cent respondents ranked pseudostem borer as 1st important pest (Table 1). Sixty six per cent respondents responded that the susceptible stage at which the pest attacked is above 8 months whereas 48.75% respondents feel that the incidence of the pseudostem weevil is severe in October to January. The technological gap index (TGI) was high in use of pseudostem traps (76.23%), biological control agent (82.79%) and the use of pseudostem injector (79.51%), which are the effective management practices for the management of pseudo\stem borer. A majority of the respondents (54.10%) belonged to the high technological gap category whereas, only whereas 7.38% of the respondents were found in low level of technology gap. Thus, in the extension programmes, a special emphasis should be given to promote eco-friendly bio-control methods against pseudostem borer as well as other pests of banana by conducting skilled demonstrations and specialized participatory trainings.

Table 1: Ranking of pest by banana growers

Pest	Percent farmers reporting pest	Percent farmers ranking important pest
Pseudostem borer (*Odoiporus longicollis*)	84.58	50.83
Corm weevil (*Cosmopolites sordidus*)	26.67	14.58
Thrips (*Chaetanaphothrips signipennis*)	10.42	3.33
Tingid (*Stephanitis typicus*)	18.75	3.75
Aphid (*Pentalonia nigronervosa f. typica*)	37.92	10.00
Mealy bug (different specis)	9.58	1.67
Whitefly (*Aleurodicus disperses*)	14.17	4.58
Lepidopteran feeders	34.58	13.75
Others	4.58	1.25

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167.

Knowledge and Perception of Vegetable Farmers about Pesticide Use and Handling

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Keywords: Pesticides, knowledge, perception, use and handling, natural resource.

Introduction

Pesticides are now part and parcel of modern agriculture in the world. Its use has increased manifold in the production of food grains and vegetable crops especially after the advent of the Green Revolution. Use of pesticides has definitely increased the production of vegetable crops but simultaneously has resulted into various ill-effects. Rapid increase in the application of pesticides has posed threats to the environment and adverse health effects on farmers (Snelder *et al*., 2008). A proportion of the pesticide that is not absorbed by the plants will be moved and transferred to the environment through wind, water and soil (Igbedioh, 1991). In relation to this, various reports of ill health associated with those applying pesticides has been reported by Food and Agricultural Organisation (FAO,2014).In Jammu and Kashmir (J&K) pesticide use by weight (a.i) has increased exponentially from 142 tonnes (0.155kg/ha) in 1994-95 to 1711 tones (2.410 kg/ha) in 2011-12 (Directorate of Plant Protection Quarantine and Storage, GOI) which is an increase of 1105% with a slope of 217.5 tonnes/year(R^2=0.69) (Peshin *et al*., 2014). Vegetable growers heavily rely on chemical pesticides for controlling insect pests. The average pesticide use in vegetable crops is 1.274kg/ha (Peshin *et al*., 2014). A study was undertaken to assess the knowledge and perception of vegetable growers about different pesticides, its use and safe handling and possible health hazards of different pesticides.

Materials and Methods

The study was conducted in R.S. Pura area of Jammu district. A list of 250 vegetable growers was obtained from the sub-division office located at Miran Sahib, Jammu. From the list 42 vegetable growers were selected randomly by using random number generator located in different villages of R.S. Pura tehsil. Data were collected by using pre-structured schedule employing face to face interview method. Data were collected as a pretesting exercise of testing the interview schedule.

Results and Discussion

Analysis of data presented in Fig. 1 reveals that 83% of total respondents had low to medium level of knowledge about different aspects of pesticide use in vegetable crops and only 17% farmers had good knowledge about pesticide use in vegetable crops. Further in the study majority of farmers 63% reported skin irritation followed by headache (48%) and respiration problem (24%) after application of pesticides. Thus it is concluded from the study that majority of the farmers had awareness- knowledge only and lacked how- to - knowledge regarding safe pesticides use and handling in vegetable crops. Extension functionaries need to put more efforts in field for enhancing the knowledge level of farmers about safe use and handling of pesticides in vegetable crops to minimize its negative impact on human health.

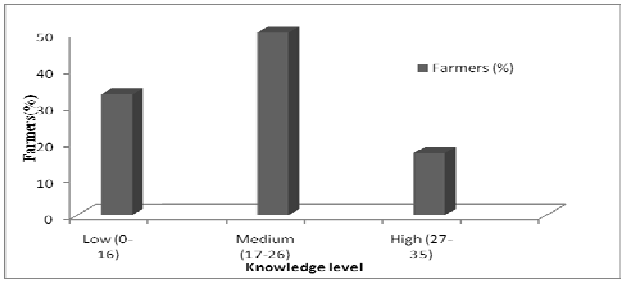

Fig. 1: Vegetable framers knowledge about safe handling and use of pesticides

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168.

Effect of Weather Parameters on Activity of Sapota Seed borer, *Trymalitis margaritas* Meyrick under Konkan Conditions of Maharashtra

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Keywords: Sapota seed borer, *Trymalitis margaritas,* weather parameter.

Introduction

Sapota (*Manilkara achras* (Mill.) Forsberg) commonly known as "Chiku" belongs to family sapotaceae. Sapota is a native of mexico and spread to other countries. The fruit was introduced during 1888 in a village of Gholwad of Palghar district of Maharashtra in India (Cheema *et al.*, 1954). Sapota is one of the most important irrigated tropical fruit crop in Maharashtra. The area under this crop in Maharashtra is around 69000 hectares, out of which 70 per cent area is in only Palghar district. It has unique importance in the economy of the farmers in the district. The sapota fruits of 'Gholwad pockets in Palghar' are very famous in India as 'Gholwad Chikoo'. Among these, *Trymalitis margarias* a major and regular pest causing damage to the sapota crop under Konkan region of Maharashtra. For the management of sapota seed borer, *Trymalitis margaritas* Meyrick, it is prime need to know occurrence and economic status of insect pests. This is possible if timely predication of the occurrence of the pest can be made. Hence, an investigation on seasonal incidence of the bud borer on sapota in relation with different weather parameters was carried out.

Materials and Methods

To study an effect of weather parameters on activity of sapota seed borer was carried out at Agriculture Research Station, Palghar (Maharashtra), India for five years from 2010 to 2014. Ten sapota trees of fifteen years old were selected randomly to record the incidence of seed borer in sapota orchard. From each tree ten twigs (20cm length) were selected randomly for recording the observations of number of healthy and damaged buds due to *Trymalitis margaritas* was recorded at weekly interval and per cent infestation was worked out by using below formula.

$$\text{Per cent infestation} = \frac{\text{Total no. of infected buds}}{\text{Total no. of buds}} \times 100$$

In order to study the effect of weather parameters, the simple correlation coefficients were worked out.

Results and Discussion

The pooled data on per cent seed borer *Trymalitis margaritas* infestation is presented in table Fig. 1. It is seen that the infestation noticed throughout the year. During pooled data of the years *viz.,* 2010 to 2014 the incidence of this pest was peak in the months of November to January (7.65 to 11.02%). Its activity was found medium in the months of March and April (5.73 to 4.71%) and it was recorded minimum in the month of July and August (0.46 to 2.93%). These results also lined with correlation studies Table 1. The results revealed that, there was highly significant and negative correlation between seed borer incidence and rainfall, minimum temperature and morning relative humidity (r=-0.41, r=-0.39 and r=-0.52, respectively) which is in agreement with the findings of Shukla (2009) reported that the larval population of sapota seed borer fluctuated throughout the year with peak period in January.

Table 1: Correlation between sapota seed borer and weather parameters pooled data

Weather parameters	Pooled data (2010-2014)
Rain fall (mm)	-0.41**
Minimum Temperature (°C)	0.39**
Maximum Temperature (°C)	0.06
Minimum RH (%)	-0.11
Maximum RH (%)	-0.52**

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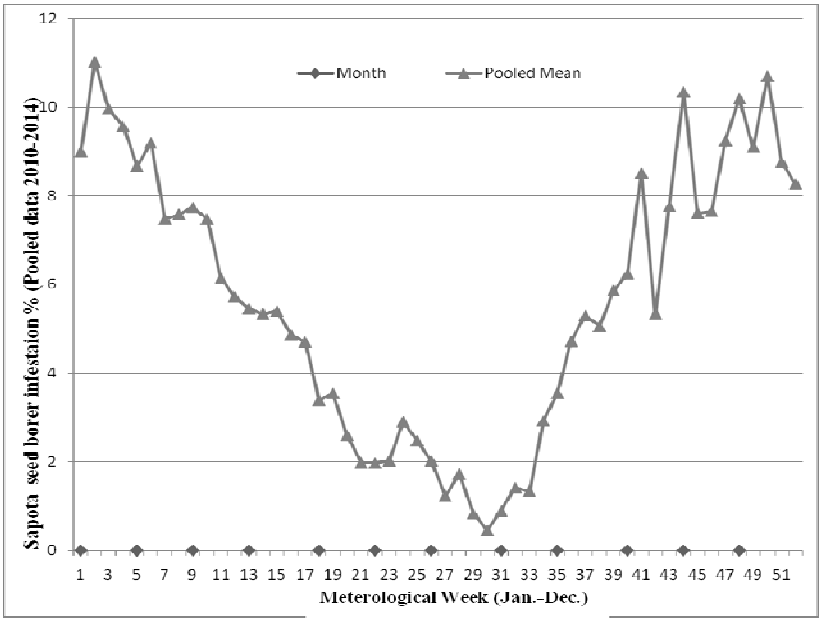

Fig. 1: Seasonal incidence Sapota seed borer (2010-2014)

169.

Impact of Pheromone Traps on Fruit Infestation in Guava by Fruit Fly *Bactrocera correcta*

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Keywords: Pheromone traps, guava, Bactrocera

Introduction

Fruit flies (Diptera: Tephritidae) have worldwide distribution covering tropical, sub-tropical and temperate regions. In India, fruit flies have been recognized among the ten most serious pests of agricultural crops causing annual monetary losses to the tune of 7000 crores. Guava fruit fly, *Bactrocera correcta* is the most destructive pest of guava. Losses as high as 70 to 80% have been reported due to this insect pest. Present study was conducted to find out the efficacy of pheromone traps in managing the fruit fly population in guava orchards as a trigger to adopt other management practices.

Materials and Methods

The present study was conducted at farmer's orchard at two different places in Rajouri district. Pheromone traps were installed at the rate of 15 per hectare in the guava orchards. Traps were prepared by cutting three holes of 1 sq. inch in 1 liter water bottle and hanging lures in it. Observations on number of fruit flies trapped in the bottle were recorded on weekly intervals. Observations on number of fruits infested were also recorded at weekly intervals. With the onset of fruit fly infestation, fly baits were placed in the orchards at the rate of 10 per hectare.

Results and Discussion

Results of the present study reveal that two species of fruit flies *Bactrocera correcta* and *Bactrocera dorsalis* ravaged the guava crop. However, *B. correcta* was more prevalent in the orchards as compared to *B. dorsalis*. Flies started appearing in the trap in 26th standard week (5 per trap) and peak population was observed in 31st standard week (33 per trap). However, maximum fruit infestation was observed in 34th standard week. After attaining peak populations, there was a gradual decline in fruit fly catch per trap from September onwards. Data recorded on per cent fruit infestation in orchards with pheromone traps and orchards without traps revealed that there was considerable reduction in per cent fruit infestation in guava fruits. A maximum of 56% fruit infestation was recorded in orchards without traps where as only 31% infestation was recorded in orchard installed with pheromone traps and fruit fly baits. Moreover, it was observed that yield of guava in orchards with traps and baits was as high as 18 kg per plant as compared to 15 kg per plant in orchards without traps and baits. The results of the present study reveal that pheromone traps can be effectively used as a monitoring and management triggering tool in IPM programme in guava.

170.

Effect of Different Shapes of Methyl Eugenol Based Traps Against Fruit Flies, *Bactrocera* Spp. on Pear in Punjab

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Keywords: Pear, fruit flies, *Bactrocera* spp., methyl eugenol, traps

Introduction

Pear (*Pyrus pyrifolia* L.) is an important fruit crop of Punjab occupying 2.89 thousand hectare area (Anonymous 2015) but fruit flies are the major limiting factor in the successful cultivation. Important fruit flies damaging fruit crops in Punjab are *Bactrocera dorsalis* (Hendal) and *B. zonata* (Saunders). These fruit flies are difficult to manage as they are polyphagous, multivoltine, adults have high fecundity and mobility, and all the developmental stages are unexposed. So, the most widely used technique is male annihilation technique (M.A.T.) where methyl eugenol, a para-pheromone is used together with an insecticide impregnated into a suitable substrate (Singh *et al.,* 2014).

Materials and Methods

Adult fruit flies use visual and olfactory stimuli to locate hosts. Present study was, therefore, conducted on the attraction of fruit flies towards different shapes of the traps i.e. spherical, cylindrical, triangular traps and compared with PAU fruit fly traps (based on empty water bottle) in pear orchards in the Fruit Research Farm of the Punjab Agricultural University, Ludhiana, during 2014-15. A total of 16 traps/acre were used in this study, replicated thrice. Four traps each of four different shapes were fixed in 1 acre area.

Results and Discussion

The results revealed that the significantly highest number of fruit flies were captured in triangular traps numbering 127.92 males/trap/week (Table 1) followed by PAU fruit fly traps (55.30 males) The mean percentage of fruit fly damage was also lowest in triangular traps i.e. 6.72 per cent as compared to PAU fruit fly traps (7.06%), spherical traps (7.78%) and cylindrical traps (8.30%). However, cost: benefit ratio was quite low in triangular traps (1: 20.93) as compared to other traps. This study concludes that triangular trap is most effective in capturing fruit flies and reduction in per cent damage but PAU fruit fly trap is better if considering cost: benefit ratio. Therefore, traps that combine visual and olfactory cue proved to be most effective for capturing fruit flies.

Table 1: Pooled mean population of *Bactrocera* spp. males captured, per cent damage and cost: benefit ratio of different shapes of traps in pear during 2014-15

Treatments	Pooled mean of *Bactrocera* males captured	Pooled mean of per cent damage	Cost: Benefit Ratio
Cylindrical traps	51.08	8.30	1: 35.31
Spherical traps	42.44	7.78	1: 54.79
Triangular traps	127.92	6.72	1: 20.93
PAU fruit fly traps	55.30	7.06	1: 64.25

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171.

Pesticide Use and Application Pattern among Farmers in Barnala District of Punjab

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Keywords: Insect pest, wheat, ETL and pesticides

Introduction

Wheat, *Triticum aestivum* L. is major *rabi* crop of Barnala district of Punjab state. It is cultivated on the 115 thousand hectare with the average production of 554 thousand tonnes. With the introduction of high yielding varieties, expansion in irrigation facilities and indiscriminate use nitrogenous fertilizers with a view to increase productivity has resulted in heavy crop losses due to insect-pests and disease attack in wheat crop. In this Agro-climatic conditions of Barnala district the major insect-pest of wheat are wheat aphid and termite.

Materials and Methods

A bench mark survey was conducted in Handiaya village of Barnala district. The village was selected purposely and it is located on 30°19'57.81" N to 75°28' 29.95" E. A total 75 farmers were selected randomly and data were collected with the help of pre-tested questioner by personal interview method. The points covered under survey were knowledge and use about the recommended insecticides, dose of insecticide, time of application and economic threshold levels (ETL) of wheat aphid, *Sitobion miscanthi, Rhopalosiphum maidis, Sitibion avenae*.

Results and Discussion

Analysis of data indicated that wheat crop was infested by aphids and termites. For control of aphid in wheat, all the farmers are applying insecticides either confidor 200 SL at the rate of 250- 375 ml per ha or thiamethoxam 25 WG at the rate of 200-250 g per ha (1-2 sprays) per cropping cycle. Most of the farmers apply higher doses of insecticide for the management of aphid against recommendations. As regarding time of application of pesticides, 97% of the farmers sprayed insecticide in routine in the month of February-March without observing any ETL. About 3% farmers applied insecticides before earhead stage formation. About 19% farmers applied mixture of imdachloropid and synthetic pythroids. Most of the farmers were using recommended dose of chlorpyriphos for control of termite in wheat.

Table 1: Application pattern of Insecticides

Crop	Insect-pest	Insecticide use	Dose	ETL	Time of aaplication
Wheat (*Triticum aestivum*)	Aphid complex (*Sitobion miscanthi, Rhopalosiphum maidis, Sitibion avenae*)	Confidor 200 SL	250-375 ml per ha	Not Followed	3% before earhead (leaf stage) 97% at earhead stage
		Thiamethoxam 25 WG	200-250 g per ha		
	Termite (*Microtermes obesi*)	Chlorpyriphos	2.5 lt per ha	No ETL	First irrigation

172.

Pattern of Pesticide Use for the Control of Whitefly in Bt Cotton

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Keywords: pesticide use, white fly, sprays, Bt cotton

Introduction

Although Bt cotton has been effective in managing boll-worms and improving yields, new problems have started emerging with its adoption at larger scale, namely incidence of sucking pests especially white fly (*Bemesia tabaci*), susceptibility to Cotton Leaf Curl Virus (CLCuV), etc. Recently, there has been continuous reduction in the area of cotton in south western districts of Punjab. In Fazilka district, it has been estimated that during 2015, 16.26% of the cotton area has been shifted to other crops since 2014. High incidence of white fly and cost of cultivation are the main reasons for this change in area besides other natural causeslike erratic rainfall and water-logged or salt affected soils.

Materials and Methods

A survey from the four blocks of Fazilka district (cotton growing belt) was conducted to study the pesticide use pattern. The total number of respondents selected for the survey was 86 farmers having 896 acres area under cotton crop. The data was collected with the help of questionnaire by personal interview method. The data was subjected to descriptive statistics for extracting the information related to the pesticide use.

Results and Discussion

In 2014, about 33.7% of the farmers applied more than 7 sprays of pesticides on the cotton crop, while 43% of farmers applied pesticides 5-6 times on the crop (Fig. 1). There was no farmer who had not done 1 or 2 sprays of pesticides. The nature of the most used chemicals at the farmers' fields suggests that much of the expenditure related to pesticides, was incurred on the control of sucking pests. Although the major sucking pest have been found to be whitefly, the recommended chemicals (Diafenthiuron, spiromesifen, trizophos and ethion) for the control of this pest have been used by lesser proportion of farmers. Thiomethoxam, trizophos, acetamiprid and imidacloprid are the pesticides used by major proportion of farmers (40-53%), while only 12-14% of farmers used ethion, spiromesifen and diafenthiuron in their spray schedule (Table 1). This suggests the wrong choice of chemicals by the farmers might have resulted in poor control of the pest, while increasing the cost of cultivation. During this year also, there have been much damage caused by the whitefly and number of sprays have increased considerably. In order to save the area under cotton and revive the productivity, farmers must be guided about the pesticide use on the Bt cotton.

Table 1: Use of insecticide/ pesticides by the farmers on cotton in 2014

Name of insecticide/ pesticide used	Number of farmers*	Per cent use
Imidacloprid 17.8SL(confidor)	34	39.5
Thiomethoxam 25WG (actara)	46	53.5
Acetamaprid (pride)	36	41.9
Fipronil SC(regent)	22	25.6
Flonicamid 50WG(ulala)	8	9.3
Difenthiuron 50WP(polo)	10	11.6
Spiromesfen 240SC (oberon)	12	14.0
Trizophos 40 EC (sutathion)	39	45.3
Ethion 50EC (fosmite)	12	14.0
Monocrotophos (monocil)	10	11.6
Chlorantralinprole18.5 SL (corogen)	10	11.6
Carbendazim (bavistin)	10	11.6
Mancozeb (dithane -M-45)	8	9.3
Carbendazim12%+mamcozeb 63%(SAFF)	20	23.3
COC (Blitox)	10	11.6
Thiophenate Methyl (roko)	10	11.6
Strubulerin fungicide (Headline /Castodia)	8	9.3
Streptocyclin, sulphate	16	18.6

*Who used molecule in their spray programme

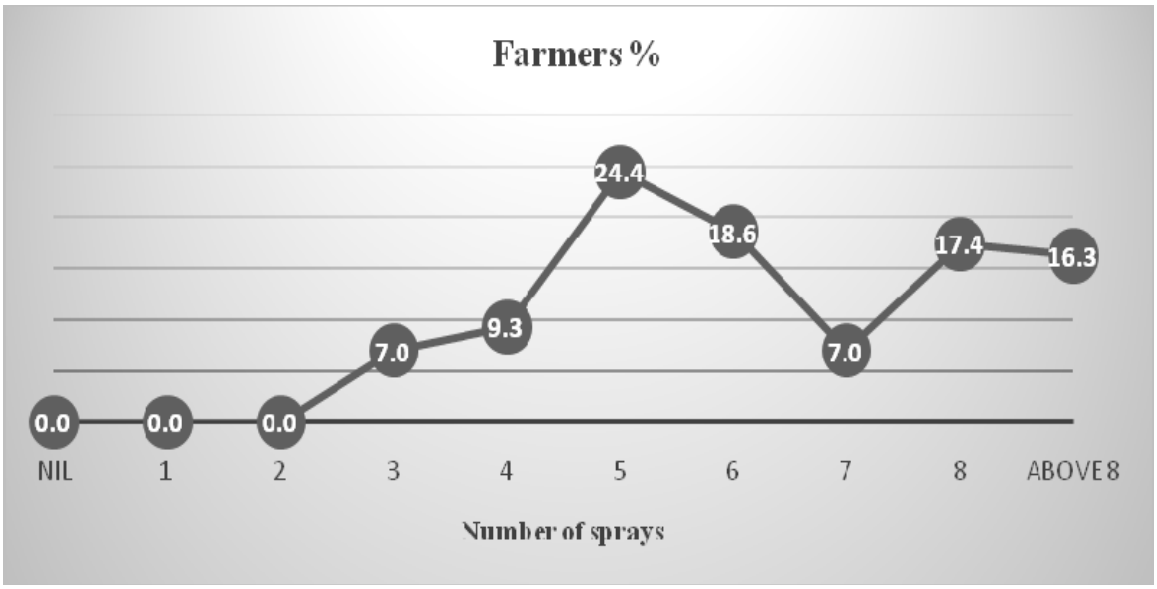

Fig. 1: Frequency of pesticides applications on cotton in 2014

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Biodegradation of Chlorpyrifos *Pseudomonas resinovarans* Strain AST2.2 Isolated from Apple Orchard Soils Using Enrichment Techniques

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Keywords: Chlorpyrifos, organophosphate hydrolase (OPH), gas chromatography, *Pseudomonas resinovarans*

Introduction

Chlorpyrifos [O,O-diethyl-O-(3,5,6-trichloro-2- pyridinyl) phosphorothioate] is one of the most widely used broad-spectrum chlorinated organophosphorus insecticide, acaricide, and termiticide against San Jose scale (*Quadraspidiotus perniciosus*), wooly apple aphid (*Eriosoma lanigerum*), Blossom thrips (*Thrips flavus*), Apple leaf roller (*Archips termid*), Root borer (*Dorysthenes hugelli*), Two-spotted spider mite (*Tetranychus urticae*) etc. Excessive pesticide usage resulted in accumulation of pesticide residues in crops, soils, and biosphere creating an ecological stress. Microbial degradation of chlorpyrifos pesticide is of particular interest because of the high mammalian toxicity of chlorpyrifos and their widespread and extensive use. The main objective of the present study involved the isolation and identification of chlorpyrifos-utilizing bacteria from *Malus domestica* (Apple) orchard soil using an enrichment culture technique, and to assess the growth response and degradation of chlorpyrifos by the isolate in liquid medium. The study aims at elucidating a possible application of an isolated bacterial strain for remediation of the chlorpyrifos-contaminated environment.

Materials and Methods

Soil sample were collected from apple orchard soil with previous history of chlorpyrifos application. Mineral salt medium (MSM) was used enrichment, isolation and characterization of chlorpyrifos degrading bacteria. Morphological, biochemical and molecular characterization followed by *in silico* analysis (BLASTn, EzTaxon) of chlorpyrifos degrading bacteria was done. Selected bacterial isolate was further screened for organophosphate hydrolase (OPH) activity by quantitative method. Chlorpyrifos degradation by bacteria was studied using gas chromatography flame ionization detector (GC-FID) and further breakdown metabolites were identified using gas chromatography mass spectrometry (GC-MS). The total ion current (TIC) chromatograms were recorded between 40-500 *m/z*. The individual constituents showed by GC were identified by comparing their mass spectra (MS) with standard library of National Institute for Standard Technology (NIST-07) mass spectra data.

Results and Discussion

Isolate AST2.2 was able to tolerate 800 mg/l of chlorpyrifos and grew well up to 400 mg/l of chlorpyrifos was selected for further studies. Strain AST2.2 colonies were creamish in colour, circular shaped with smooth texture and entire margin. Strain AST2.2 was gram-negative, rod shaped, strictly aerobic, non-spore forming and motile. It was positive in biochemical tests for catalase, oxidase, citrate utilization, urease, and fermentation of glucose, but negative for lactose and sucrose fermentation, indole utilization, gelatin liquefaction, casein hydrolysis, methyl red and Voges-Proskauer. On the basis of morphological and biochemical characteristics, the bacterial isolate ASK3.2 was identified as member of the genus *Pseudomonas* by standard protocol set in Bergey's Manual of Determinative Bacteriology. Results of partial sequencing of 16S rRNA gene (1231bp) of AST2.2 isolate and BLASTn analysis, showed more than 99% similarity with species of *Pseudomonas*. Using EzTaxon server 16S rRNA sequence of strain AST2.2 was identified as *Pseudomonas resinovarans* as its 16S rRNA sequence exhibited 97.70% similarity with *Pseudomonas resinovorans* LMG 2274. *Pseudomonas resinovarans* strain AST2.2 (accession number KP322753.1) exhibited both extracellular and intracellular organophosphorus hydrolase activity. GC-FID studies revealed that *Pseudomonas resinovarans* AST2.2 degraded chlorpyrifos rapidly and chlorpyrifos recovery was 99.78% after zero hours which was gradually reduced to 56.10% from MSM after 96 hours (Table 1). The mass spectra obtained from GC-MS studies showed that chlorpyrifos was degraded to small metabolites which could not be identified using the available library database (Fig. 1).

For the purpose of ecological restoration, bioremediation/biodegradation based techniques are gaining popularity. The results confirmed that the newly isolated chlorpyrifos degrading bacterium *Pseudomonas resinovarans* AST2.2 can be successfully used for bioremediation of contaminated soils.

Reference

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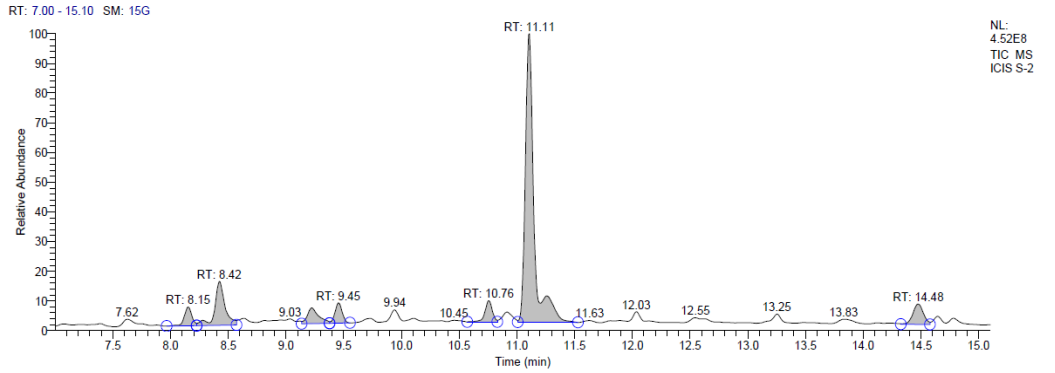
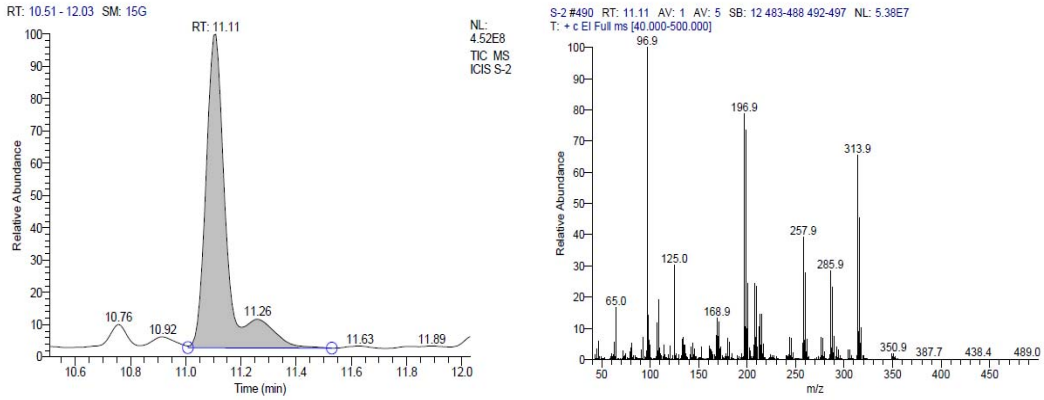
Table 1: Percentage recovery of residual chlorpyrifos from mineral salt medium inoculated with *Pseudomonas resinovorans* strain AST2.2

Time (hrs)	RT for Standard Chlorpyrifos	Peak Height of standard chlorpyrifos	RT for Sample	Peak Height of sample	Percent recovery of chlorpyrifos	Amount degraded (mg)	Percent degraded
0	16.03	542502.30	16.04	541329.30	99.78	0.018	0.22
24	16.03	542502.30	16.02	499401.66	92.00	0.640	8.00
48	16.03	542502.30	16.00	409507.40	75.40	1.968	24.60
72	16.03	542502.30	15.99	357849.18	65.96	2.723	34.03
96	16.03	542502.30	15.98	304361.51	56.10	3.512	43.90



Qual Peak Table

RT	Peak Area	Area %	Peak Height
8.15	130496146.43	3.77	28658511.47
8.42	411879568.56	11.91	66771127.20
9.22	163860337.06	4.74	23976265.93
9.45	132733794.87	3.84	30937554.95
10.76	142410374.52	4.12	32560319.47
11.11	2280441361.97	65.96	439248610.85
14.48	195486078.32	5.65	30890276.15



Library Search Results Table

Compound Name	RT	Molecular Formula	Cas #
Chlorpyrifos	11.11	C9H11Cl3NO3PS	2921-88-2
Phosphoric acid, diethyl 3,5,6-trichloro-2-pyridyl ester	11.11	C9H11Cl3NO4P	5598-15-2
2,3-Dichloro-4-hydroxy-5,8-methano-5,6,7,8-tetrahydronaphthalene, 1-methoxycarbonyl-	11.11	C13H12Cl2O3	NA

Fig. 1: Total ion current chromatogram and mass spectrum of chlorpyrifos after 48 hrs incubation with Pseudomonas resinovarans strain AST2.2 in mineral salt medium

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Dose Mortality Response of European Red Mite to Various Acaricides by Two Bioassay Techniques

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Keywords: Acaricides, bioassay, LC_{50}, mortality, toxicity.

Introduction

European red mite (*Panonychus ulmi* Koch) has become the most common pest of apple in recent years. A major problem with chemical control of tetranychid mites is the continued development of resistance to a wide range of chemical groups. This has necessitated the development of further chemical groups with novel modes of action. The acaricides, propargite, hexythiazox, bifenthrin and spiromesifen have recently been introduced for some horticultural crops in most parts of India. The response of the *P.ulmi* to these newly introduced acaricides has not been fully studied in vitro. The data regarding these four acaricides with respect to the *P. ulmi* has been minimal, partly due to their recent introduction and partly because of insufficient laboratory data. So all of these factors stand out as reasons for carrying out this investigation.

Materials and Methods

The acaricides used were spiromesifen 240 SC, propargite 57% EC, bifenthrin 8% SC and hexythiazox 5.4% EC. This study was performed under graded response bioassay. For each acaricide, 3 concentrations were prepared, besides control where only water was sprayed. So thirteen treatments were put in use and each treatment replicated thrice. Bioassay was performed by two methods namely leaf spray and leaf dip. Apple seedlings were reared in pots and used for bioassay by spraying and dipping their leaves in different treatments and releasing adult mites on them. Mortality counts were done after 24 hours. The mortality of both the bioassay methods was subjected to probit-regression analysis (Finney, 1971) after percentage mortalities for each concentration was corrected by Abbott's formula (Abbott, 1925) for calculating LC_{50} values.

Results and Discussion

The findings revealed that the most toxic chemical (lowest LC_{50}) was hexythiazox with LC_{50} value of 0.0036 per cent in case of leaf spray bioassay and 0.0019% in case of leaf dip bioassay. The highest LC_{50} was found in spiromesifen i.e. 0.0312% for leaf spray bioassay and 0.0202% in case of leaf dip bioassay which indicates its least toxicity. Relative toxicity was also evaluated while comparing the toxicity of two bioassay techniques. Highest toxicity fold was found in case of hexythiazox as it was found to be 8.6 times more toxic to spiromesifen. Similarly, propargite was 3.7 times and bifenthrin 3.3 times more toxic than spiromesifen in case of leaf spray bioassay. In case of leaf dip bioassay the highest toxicity fold was found again in case of hexythiazox as it was found to be 10.6 times more toxic to spiromesifen. Similarly, propargite was 4.1 times and bifenthrin 3.5 times more toxic than spiromesifen. The comparison of LC_{50} values and relative toxicity fold was also done which indicated that in case of propargite, leaf dip method showed 58.28% toxic fold than leaf spray method. Similarly, leaf dip methods of hexythiazox, bifenthrin and spiromesifen showed 52.78, 61.29 and 64.74% toxic folds respectively than leaf spray method. Overall, leaf dip bioassay was found to be more toxic than leaf spray. The studies on four acaricides thus indicated that the most toxic of all the chemicals used, based on LC_{50} was hexythiazox followed by propargite, then bifenthrin and finally the least toxic of all was spiromesifen which had the highest LC_{50} value (Table 1).

Table 1: Comparison of toxicity of various acaricides based on two different bioassay methods

Acaricides	Bioassay method	LC_{50} value	Relative toxicity fold	Percentage toxicity fold*
Propargite	Leaf spray	0.00827	3.7	
	Leaf dip	0.00482	4.1	58.28
Hexythiazox	Leaf spray	0.0036	8.6	
	Leaf dip	0.0019	10.6	52.78
Bifenthrin	Leaf spray	0.0093	3.3	
	Leaf dip	0.0057	3.5	61.29
Spiromesifen	Leaf spray	0.0312	1.00	
	Leaf dip	0.0202	1.00	64.74

*based on LC_{50}; $P < 0.05$

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Evaluation of Thiomethoxam 25% WG against Major Insect Pests of Rice (*Oryza sativa* L.)

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Keywords: Thiomethoxam, insect pests, Rice, Neonicotinicde insecticide

Introduction

Among various constraints of rice production, damage due to insect pests is substantial and needs regular attention. Almost 20 insect pests have major significance in different rice growing regions of India. Among the insect pests, yellow stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*), brown plant hopper (*Nilaparvata lugens*) and gallmidge (*Orseolia oryzae*) are predominant in Madhya Pradesh. These pests infest the crop at different stages of plant growth and cause a variety of damage such as tissue boring, leaf scrapping and juice sucking from ear head. The primary mode of managing these insects is by the application of insecticides.

Materials and Methods

The field experiment was conducted at the Agriculture College, Balaghat, Madhya Pradesh. Attempts were made to evaluate the effect of five doses of thiamethoxam at the rate of 20, 25, 30, 50 & 100 g active ingredient (a.i.) /ha with one insecticidal check imidacloprid 17.8 SL at the rate of 30 ml a.i./ha and control against major insect pests of rice. The experiment was laid out in randomized block design with seven treatments including control and each treatment was replicated thrice. Three plants of each row out of selected five rows were randomly selected and insect pests population were recorded before and 5, 10 and 15 days after each spray.

Results and Discussion

All the treatments showed significant impact on reducing yellow stem borer, leaf folder, gall midge and leaf hopper infestations at 5, 10 and 15 days after spray (DAS) and increased the grain yield over control. Among the different doses of thiamethoxam 25% WG, the dose of 50 g a.i./ha significantly minimized the percent dead heart, white ear head infestation by stem borer, leaf infestation by leaf folder, silver shoot by gall midge and populations of green leaf and brown plant hopper after the spraying. Bio-efficacy of thiamethoxam 25 WG in reducing sucking pests in other crops was reported by earlier workers. Efficacy of thiamethoxam in reducing thrips (Nali *et al.*, 2004 and Sreekanth *et al.,* 2004) and jassids (Patel *et al.*, 2003) was reported in various crops. The natural enemies such as dragon and damsel flies, coccinellids, carabids and spiders were observed during both the phase of the crop. However their population was almost similar both in vegetative and reproductive phase of the crop. Tiwari *et al.* (2001) reported the occurrence of spider, dragonfly (*Crocothemis sp*.), damselfly (*Agriocnemis sp*.), and ground beetle (*Ophionea indica* [*Casnoidea indica*]) as the natural enemies of paddy ecosystem in Jabalpur, Madhya Pradesh, which supports the present findings. Thiamethoxam 25% WG at the rate of 50 g a.i./ha harvested highest grain yield (48.15 q/ha) and cost benefit ratio (2.35). The untreated check recorded lowest yield (36.60 q/ha) and cost benefit ratio (1.95).

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Table 1: Efficacy of different dose of thiomethoxam 25% WG against major insect pests in rice crop

Treatments	Dosage a.i./ha	Mean Dead heart (%)	Mean White ears (%)	Mean Leaf damage (%)	Silver shoot %	GLH/hill	BPH/hill	Grain yield (q/ha)	BCR
T_1 - THIAMETHOXAM 25% WG	20 g	7.19	11.87	7.25	3.05	1.81	2.45	41.23	2.11
T_2 - THIAMETHOXAM 25% WG	25 g	5.10	8.03	6.17	2.56	0.67	0.87	45.24	2.12
T_3 - THIAMETHOXAM 25% WG	30 g	5.03	7.87	6.00	0.86	0.26	0.42	47.64	2.23
T_4 - THIAMETHOXAM 25% WG	50 g	4.94	7.15	5.12	4.42	1.14	1.75	48.15	2.35
T_5 -THIAMETHOXAM 25% WG	100 g	5.91	8.99	5.08	5.86	3.71	4.22	44.79	2.34
T_6 - Imidacloprid 17.8 SL	30 ml	6.06	9.55	7.19	3.01	2.60	3.33	42.67	2.20
T_7 - Control	-	8.03	17.15	9.32	7.11	5.40	7.44	36.60	1.95
CV		15.01	14.45	15.69	17.21	16.49	17.03	5.60	
SEm±		0.48	0.75	0.57	0.67	0.62	0.64	1.50	-
CD @ 5%		1.41	2.22	1.70	1.88	1.72	1.77	4.41	

GLH= Green leaf hopper, BPH= Brown plant hopper

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Bioefficacy of Mitlar Against Sucking Pests of Cotton Under Field Conditions

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Keywords: Bioefficacy, herbal pesticide, sucking pests of cotton.

Introduction

Studies were conducted to evaluate mitlar (a herbal extract based on Acorus, piper shaheera, adhatoda, plumbago etc.) for its bioefficacy against sucking pests of cotton namely leafhopper *Amrasca biguttula biguttula*, aphids *Aphis gossypii* and thrips *Thrips tabaci* at Cotton Breeding Sation, Tamil Nadu Agricultural University, Coimbatore. Considering the hazardous effects of chemical insecticides, recent trends in pest management clearly demonstrate the scope for the use of herbal pesticides and bio pesticides in integrated pest management system. To mitigate the hazards of chemical insecticides, the present study was conducted to evaluate the efficacy of mitlar against sucking pests of cotton.

Materials and Methods

Field trial was conducted at Cotton Breeding station, Tamil Nadu Agricultural University, Coimbatore in randomized block design (RBD). Sowing was done in *kharif* season 2012 using cotton cultivar, Surabhi at a spacing of 90 x 45 cm to evaluate the bioefficacy of mitlar against sucking pests. Insecticides namely acetamiprid 20SP, imidacloprid 17.8% SL, thiamethoxam 25 WG, dimethoate 30 EC and a untreated check to compare with mitlar 2ml/lit of water and mitlar 1ml/lit of water. Population of sucking pests namely leafhopper, *A. biguttula biguttula*, aphid, *A. gossypii* and thrips, *T. tabaci* were recorded on three leaves one each at top, middle and bottom leaves of 5 randomly selected plants per plot prior to spraying, 3, 7, 10 and 14 days after spraying.

Results and Discussion

Spraying was done on 30 DAS (Days After Sowing), 45 DAS and 60 DAS. Acetamiprid 20SP 100g a.i ha^{-1} was effective in checking the population of sucking pests namely leafhopper with a mean of 1.11, aphids (7.71) and thrips (4.85) which was followed by thiamethoxam 25 WG 25g a.i ha^{-1} with a mean of 1.81, 12.44 and 9.03 of leafhopper, aphids and thrips respectively at 60 DAS (Table 1). Mitlar 2ml / lit of water with a population mean of 2.83 in case of leafhopper, aphids (20.32) and thrips (13.75). Mitlar 1ml / lit of water and imidacloprid 17.8% SL 22.5g a.i ha^{-1} were on par with each other followed by dimethoate 30 EC 0.03% ha^{-1}. However untreated plot recorded highest population in all sprays.

Table 1: Mean and percent reduction over control of sucking pests under various treatments.

Treatments	Leafhopper		Aphids		Thrips	
	Mean	Reduction over control (%)	Mean	Reduction over control (%)	Mean	Reduction over control (%)
Mitlar 1 ml/lit of water	4.83	66.75	24.17	72.14	18.20	67.98
Mitlar 2 ml/lit of water	2.83	80.52	20.32	76.58	13.75	75.80
Imidacloprid 17.8% SL 22.5g a.i/ha	4.88	66.41	25.38	70.75	26.13	54.02
Acetamiprid 20 SP 100g a.i/ha	1.11	92.36	7.71	91.11	4.85	91.46
Thiamethoxam 25 WG 25g a.i/ha	1.81	87.54	12.44	85.66	9.03	84.11
Dimethoate 30 EC 0.03% 500ml	6.23	57.12	33.75	61.10	21.88	61.50
Untreated check	14.53		86.78		56.84	

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Bio-efficacy of Novaluron 10 EC against Castor Semilooper (*Achaea janata* L.) in Castor

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Keywords: *Novaluron, Castor Semilooper and castor*

Introduction

The Castor (*Ricinus communis* L.) is an important non-edible oilseed crop of dry lands, which is becoming popular as a commercial oilseed crop owing to its high export potential and industrial uses. Major castor growing countries are India, China, Brazil, Africa, USA, and many Asian countries (Watt, 1892) of which India, China and Brazil accounting for 90% of world production. India, ranks first among the major castor producing countries in the world with 68 per cent of area and 76% of world castor production (Anonymous, 2008). Castor semilooper (*Achaea janata)* (Noctuidae: Lepidoptera) is one of the major defoliator of castor in India, as well as in Haryana. Novaluron 0.01% gave 48.3, 83.3 and 100% mortality on the one, three and seven days after first spray on caster semilooper. Deltamethrin 0.003% gave 26.7, 66.7 and 66.7 per cent mortality on the one, three and seven days after first spray.

Materials and Methods

Studies on the bio-efficacy of different insecticides against castor semilooper were carried out under the field condition on the crop sown at experimental area of Regional Research Station, Bawal. There were nine treatments including the control (given in Table 1) and all the treatments were replicated thricely. The size of each plot was 5 x 5 meter with two meter inter-plot distance. Only one foliar application of different insecticides were applied with knapsack sprayer, on September, 23, 2013 when the castor semilooper population cross the economics threshold level which is 4-5 larvae per plant. Second spray was not made because after first spray of insecticides the castor semilooper larvae population remains below the economics threshold level. Observation of castor semilooper before and after spray: the larval population recorded one day prior to spraying and population of larvae was counted after the first, third and seven day after spraying. The larval population data was recorded on 5 randomly selected and tagged plants in each treatments.

Results and Discussion

The data revealed that at three days after spraying, it was found that novaluron at the rate of 100 g a.i./ha was the most effective with 82.55 per cent mean reduction in the larval population which was at par with novaluron at the rate of 75 g a.i./ha causing 81.94 per cent mean reduction in the larval population (Table 2). Similarly, thiodicarb at the rate of 468 g a.i./ha caused larval reduction of 73.66 per cent which was at par with deltamethrin at the rate of 11.2 g a.i./ha and thiodicarb at the rate of 375 g a.i./ha which caused 71.88 and 71.35 per cent mean reduction in the larval population, respectively. Deltamethrin at the rate of 10.5 g a.i./ha caused 68.10 reduction in larval population which was at par with quinalphos at the rate of 250 g a.i./ha which reduced 65.30 per cent larval reduction. Quinalphos at the rate of 200 g a.i./ha was the least effective with 62.22 per cent mean reduction in larval population.at seven days after spraying novaluron at the rate of 100g a.i./ha was the most effective with 96.51 per cent mean reduction in the larval population, while quinalphos at the rate of 200 g a.i./ha was the least effective with 72.00 per cent mean larval reduction. Thiodicarb at the rate of 468 g a.i./ha caused 82.13 per cent larval reduction which was followed by thiodicarb at the rate of 375 g a.i./ha (80.81%), deltamethrin at the rate of 11.2 g (79.16%) deltamethrin at the rate of 10.5 g a.i./ha (75.20%) quinalphos @ 250 g a.i./ha (74.06%) and quinalphos at the rate of 200 g a.i./ha (72.00%), respectively. All the insecticides continued to give higher mortality of *A. janata* larvae after seven days of spraying.

Table 1: Insecticides used for evaluation of their efficacy against *A. janata* on castor

Treatments	Dosage (ga.i./ha)	Chemical name
T_1- Rimon10 EC (Novaluron)	75	1-[3chloro-4-(1, 1, 2-trifloro-2- trifluoromethoxy ethoxy) phenyl] -3-(2, 6-diflurobenzoyl) urea.
T2- Rimon10 EC (Novaluron)	100	1-[3chloro-4-(1, 1, 2-trifloro-2- trifluoromethoxy ethoxy) phenyl] -3-(2, 6-diflurobenzoyl) urea.
T3- Larvin 75 WP (Thiodicarb)	375	dmethyl n, n^1 - thio bis (methylimino) Carbonyloxy bis ethanimidothioate.
T4- Larvin 75 WP (Thiodicarb)	468	dmethyl n, n^1 - thio bis (methylimino) Carbonyloxy bis ethanimidothioate.
T5- Ekalux 25 EC (Quinalphos)	200	O, O- diethyl-O-(quinoxalinyl -2-yl phosphorothioate.
T6- Ekalux 25 EC (Quinalphos)	250	O, O- diethyl-O-(quinoxalinyl -2-yl phosphorothioate.
T7- Decis2.8 EC(Deltamethrin)	10.5	α,cyano-3-phenoxy benzyl-3-(2, 2- dibromovinyl)-2,2-dimethylcy-clopropane, carboxylate.
T8- Decis2.8 EC(Deltamethrin)	11.2	α,cyano-3-phenoxy benzyl-3-(2, 2- dibromovinyl)-2,2-dimethylcy-clopropane, carboxylate.
T9- Control (No spray)	-	-

Table 2: Bio-efficacy of different insecticides against *A. janata* infesting castor

Treatment	Mean number of larvae before spray	Mean* % larval reduction (Days after spray)			Pooled mean per cent larval reduction
		1	3	7	
Novaluron 10 EC at the rate of 75 g a.i. per ha	5.80	46.05 (42.71)	81.94 (64.87)	90.85 (72.45)	72.95 (59.97)
Novaluron 10 EC at the rate of 100 g a.i. per ha	5.73	48.85 (44.32)	82.55 (65.29)	96.51 (79.20)	75.97 (62.94)
Thiodicarb 75 WP at the rate of 375 g a.i. per ha	5.67	58.75 (50.04)	71.35 (57.62)	80.81 (64.05)	70.30 (57.21)
Thiodicarb 75 WP at the rate of 468 g a.i. per ha	5.60	60.64 (51.13)	73.66 (59.20)	82.13 (64.97)	72.14 (58.40)
Quinalphos 25 EC at the rate of 200 g a.i. per ha	5.67	51.69 (45.95)	62.22 (52.09)	72.00 (58.09)	61.97 (52.01)
Quinalphos 25 EC at the rate of 250 g a.i. per ha	5.40	53.19 (46.81)	65.30 (53.92)	74.06 (59.39)	64.18 (53.35)
Deltamethrin 2.8 EC at the rate of 10.5 g a.i. per ha	5.67	55.87 (48.36)	68.10 (55.63)	75.20 (60.16)	66.39 (54.68)
Deltamethrin 2.8 EC at the rate of 11.2 g a.i. per ha	5.73	58.27 (49.75)	71.88 (58.02)	79.16 (62.83)	69.77 (56.84)
Control (No spray)	5.80	1.13** (6.09)	1.87** (7.73)	2.24** (8.61)	1.74** (7.52)
SE(m)	0.17	1.01	1.36	1.06	2.96
C.D.	NS	3.02***	4.10***	3.21***	(8.95)***

Figures in parentheses are angular transformed values
Based on 5 plants /repeat **per cent increase
***Significant at 0.05 probability levels, NS= Non-Significant

178.

Field Evaluation of Different Insecticides against Wheat Aphid

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Keywords: Insecticides, neem, wheat aphid

Introduction

Among the insect pest attacking wheat crop in India, cereal aphids are of economic importance and become regular pests in all major wheat growing areas. Under favorable conditions, wheat aphids *Sitobion avenae* (F.), *and Rhopalosiphum maidis* (titch) may cause damage yield loss upto 30-40%. During spring season (February-March) aphid population increases, at the same time biocontrol agents like *coccinellids* also increase as natural check on this pest. Control of aphids with synthetic insecticides is most common practice, but it has some bad effects like pesticide residues, destruction of predators and parasites, environmental pollution and enhanced resistance to insecticides in pests. So, there is a need to explore eco-friendly control methods. Among available non-chemical weapons, neem (*Azadirachta indica*) has the potential to be used as a substitute of synthetic insecticides.

Materials and Methods

A field experiment was carried out at three locations namely Krishi Vigyan Kendra, Sri Muktsar Sahib, Punjab and two farmers' field in *rabi* 2014. Three insecticidal treatments namely clothianidin 50 WDG at the rate of 30 g/ha, thiamethoxam 25 EC at the rate of 125 g/ha, neem formulation 0.015% EC at the rate of 1250 ml/ha along with untreated control were compared for their effectiveness against aphids of wheat and their bio safety to *Coccinellid*. Population density of aphids ear-^{1} was recorded. Insecticides were applied after the pests reached economic threshold levels i.e. 5 aphids/ ear. Data were recorded 24 hours before chemical application and then 7 and 15 DAS (days after spray) after chemical treatment. *Coccinellid* population was recorded at 7 DAS and yield data was also recorded.

Results and Discussion

One day before spray, the number of aphids per ear ranged from 10.33 to 13.00 and difference was not significant (Table 1). At 7 DAS, aphids population was significantly lower in all the insecticidal treated plots (0.18-1.48 per ear) as compared to untreated control (12.00 per ear). At 15 DAS, though the aphid population in plots sprayed with neem formulation was higher (3.92 per ear) than thiamethoxam (0.41 per ear) and clothianidin (0.38 per ear), but it was below ETL and significantly lower than unsprayed plots (20.33 per ear). The coccinellid population at 7 DAS being highest in unsprayed plots (1.67 per ear) was on par with neem treated plots, but significantly less in thiamethoxam and clothianidin sprayed plots. The grain yield in neem treated plot (4767 kg/ha) was on par with other insecticidal treated plot but significantly higher than untreated plot (4658 kg/ha). The results revealed that readymade neem formulation 0.015% EC at the dose of 1250 ml/ha was comparable to thiamethoxam and clothianidin against wheat aphids and relatively safer to *coccinellids*. Bushra *et al* (2014) also reported that neem oil can be used for efficient aphid control in wheat. Benefit: cost (B: C) ratio of different treatments were worked out and it was higher in case of thiamethoxam (1.93: 1) followed by clothianidin (1.92: 1),control (1.90: 1) and neem formulation (1.88: 1). B: C ratio of neem was lower as compare to other treatment due to its high cost. Thus, considering efficacy data and safety to predators, it is concluded that spray of neem formulations can be integrated in management practice against wheat aphid.

Table 1: Effect of different treatments against wheat aphid, lady bird beetle population and returns

Treatment	Dose/ha	Aphid count/ear			Lady bird beetle/ear 7 DAS	Yield (kg/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B: C ratio
		Before Spray	7 DAS	15 DAS					
Clothianidin 50WDG	30 g	10.67	0.18	0.38	0.20	4775	27695	18195	1.92: 1
Thiamethoxam 25 EC	125 g	12.67	0.28	0.41	0.08	4750	27550	18130	1.93: 1
Neem formulation	1250 ml	13.00	1.48	3.92	1.40	4767	27646	18046	1.88: 1
Untreated Control	-	10.33	12.00	20.33	1.67	4658	27018	17698	1.90: 1
CD (p=0.05)		NS	3.66	2.61	0.91	67			

Reference

Bushra S, Tariq M, Naeem M and Ashfaq M. 2014. Efficacy of neem oil and turmeric powder against *Sitobion avenae* and *Rhopalosiphum padi*. *International Journal of Biosciences,* **5**: 439-448

179.

Evaluation of Newer Insectides as Seed Protectant against Pulse Beetle (*Callosobruchus* Spp.) in Stored Mungbean Seeds

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Keywords: Mungbean, pulse beetle, insecticides

Introduction

Use of quality seed is the most essential basic input in crop protection as this helps in maintaining require plant population per unit area. Survey conducted by Food and Agriculture Organization revealed that, Pulse beetle*, Callosobruchus spp.* is the major pest of pulses in India. The farmers as well as traders mostly store the pulses at least for few months before they sell it. Unfortunately, in storage, pulses suffer enormous losses due to bruchid attack. Some pre storage seed treatment is needed to take care of insect pests during storage with the aim of improving the shelf life of seed. Keeping the above facts in view, investigations were carried out on **"**Evaluation of newer insectides as seed protectant against pulse beetle (*Callosobruchus* spp.) in stored mungbean seeds".

Materials and Methods

A laboratory experiment conducted at Seed Technology Research Unit. MPKV, Rahuri in completely randomized design with eight treatments and three replications. Freshly harvested 1 Kg mungbean seed with very high germination percentage and low moisture content was taken for each treatment. Require quantity of insecticide was diluted in 5 ml. of water to treat 1 Kg of seed for proper coating. After drying in shade, seeds were packed in 2 Kg capacity gunny bag lets and kept in storage under ambient conditions. Samples of treated seed were drawn and observation of per cent germination, infestation and moisture content percentage were recorded at three months interval of storage period.

Results and Discussion

The data on effect of insecticides on Mungbean (*Vigna mungo*) seed quality and insect damage during storage under ambient conditions revealed that, all the insecticidal seed treatments maintained the mungbean seed germination above seed certification standards (75%) up to 6 month of storage without any adverse effect on seed germination. The maximum seed germination at 9 month was recorded in deltamethrin 2.8 EC applied at the rate of 1ppm (81%) and was at par with emamectin benzoate 5 SG at the rate of 2ppm (79%) and spinosad 45 SC at the rate of 2ppm (78%) per kg of seed. The remaining treatments recorded germination below seed certification standards. The data on seed moisture content during storage indicates that the insecticides had no effect on seed moisture per cent. The moisture content ranged between 8.03 and 8.20%. At 9 month of storage, seed treatment with deltamethrin 2.8 EC at the rate of 1ppm kept the seed free from insect infestation, whereas emamectin benzoate 5 SG at the rate of 2ppm (0.33%) and spinosad 45 SC at the rate of 2 ppm (0.33%) per kg of seed were found at par with deltamethrin seed treatment. Thus, the result revealed that, deltamethrin 2.8 EC at the rate of 1ppm, emamectin benzoate 5 SG at the rate of 2ppm and spinosad 45 SC at the rate of 2 ppm per kg of seed were found effective for the management of pulse beetle (*Callosobruchus spp*) of mungbean and maintain the seed germination above MSCS up to 9 months.

Table 1: Effect of insecticide treatments on mungbean seed quality and insect damage during storage under ambient conditions

Tr. No	Treatments	Germination (%) (storage period -months)				Moisture (%) (storage period -months)				Seed Damage (%) (storage period -months)			
	(Quantity per kg seed)	3	6	9	12	3	6	9	12	3	6	9	12
1.	Emamectin benzoate 5SG @2ppm (40 mg)	88 (69.74)	83(65.66)	79 (62.73)	68 (55.59)	10.20 (18.62)	9.10 (17.56)	8.17 (16.60)	8.07 (16.50)	0.00 (4.05)	0.00 (4.05)	0.33 (4.62)	1.00 (5.73)
2.	Spinosad 45 SC@ 2ppm (4.4 mg)	86 (68.31)	82(64.90)	78 (62.03)	66 (54.37)	10.30 (18.67)	9.08 (17.54)	8.20 (16.63)	8.12 (16.55)	0.00 (4.05)	0.00 (4.05)	0.33 (4.621)	1.33 (6.54)
3.	Indoxacarb 14.5 SC @ 2ppm (13.8 mg)	85 (67.22)	79(62.73)	73 (58.70)	62 (52.00)	10.30 (18.73)	9.0 (17.46)	8.32 (16.76)	8.20 (16.64)	0.00 (4.05)	0.33 (4.62)	0.67 (5.18)	1.33 (6.54)
4.	Rynaxypyr 20SC @2ppm (9.9mg)	89 (70.67)	80(63.70)	73 (58.50)	61 (51.38)	10.30 (18.72)	9.17 (17.63)	8.28 (16.73)	8.20 (16.64)	1.00 (5.97)	2.00 (7.95)	3.00 (9.88)	4.00 (11.48)
5.	Chlorfenapyr 10 SC @2ppm (20 mg)	88 (69.77)	80(63.44)	72 (58.06)	62 (51.81)	10.20 (18.60)	9.12 (17.57)	8.22 (16.66)	8.08 (16.52)	1.00 (5.97)	2.00 (7.95)	3.33 (10.50)	4.00 (11.54)
6.	Profenofos 50 EC @ 2 ppm(0.004 ml)	87 (68.89)	81(64.18)	73 (58.70)	60 (50.81)	10.30 (18.72)	9.22 (17.67)	8.13 (16.57)	8.05 (16.48)	0.00 (4.05)	0.33 (4.62)	0.67 (5.18)	1.67 (7.33)
7.	Novaluron 10 EC@ 5ppm (0.05ml)	87 (68.59)	78(62.03)	70 (57.02)	58 (49.62)	10.30 (18.69)	8.97 (17.42)	8.12 (16.55)	8.03 (16.46)	1.00 (5.97)	2.00 (7.95)	4.00 (11.48)	5.00 (12.88)
8.	Deltamethrin 2.8 EC @ 1ppm (0.04 ml)	88 (70.03)	84(66.43)	81 (64.17)	71 (57.42)	10.30 (18.72)	9.10 (17.56)	8.23 (16.67)	8.12 (16.55)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.67 (5.18)
9.	Untreated control	83 (65.65)	74(59.36)	64 (53.14)	52 (46.15)	10.40 (18.81)	9.12 (7.57)	8.20 (16.64)	8.10 (16.53)	4.00 (11.48)	6.33 (14.57)	10.00 (18.38)	12.67 (20.84)
S.Em.±		**0.63**	**0.66**	**0.77**	**1.99**	**0.04**	**0.12**	**0.08**	**0.07**	**0.74**	**0.77**	**0.70**	**0.65**
CD at 5%		**1.86**	**1.95**	**2.28**	**5.92**	**NS**	**NS**	**NS**	**NS**	**2.20**	**2.28**	**2.09**	**1.94**

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In Silico Designing, Synthesis and *In Vitro* Antifungal Evaluation of Novel 1,2,4-Triazol-2-yldithiocarbamates

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Keywords: Triazol-2-yldithiocarbamates, lipinski filtration, toxtree analysis, antifungal activity, 14α demethylase, docking studies

Introduction

The control of plant diseases caused by fungal plant pathogens is extremely important for achieving high crop efficiency. The rising dominance of resistances to various commercially used agrochemicals, are posing threat to existing food security. Continuing our efforts towards synthesis of novel hybrid compounds having broad spectrum antifungal potential, we planned to derivatise the backbone of dithiocarbamate with 1,2,4-triazole, the proven leads in agriculture, to provide series of 1,2,4-triazol-2-yldithiocarbamates. *In silico* studies, Molecular docking, Lipinski filtration and toxicity analysis were made for the pre-rationalization of the biological activities, interactions and to explain the structural activity relationship.

Materials and Methods

Argus Lab 4.0.1., Toxtree v2.6.6 and online Molinspiration Cheminformatics Softwares were used for *in silico* studies. The molecules having comparable or better results than the standards were synthesized by the two step reaction protocol, synthesis of dithiocarbamate sodium salts by reaction of 1,2,4-triazoles with carbon disulphide under basic conditions and their reaction with different halo-alkanes. The TLC and spectral analysis confirmed the formation of products. *In vitro* antifungal assay of synthesized compounds was made against various phytopathogenic fungi by spore germination technique and EC_{50} values were calculated and expressed in terms of milli moles/L.

Results and Discussion

The lead combination of 1,2,4-triazole and dithiocarbamates inflicted synergistic effect of *in vitro* antifungal evaluation against various phytopathogenic fungi. The results are reported in Table 1. Most of the compounds had shown better results than the standard dithiocarbamate fungicide, Indofil M-45 and comparable to standard triazole fungicide Tilt in some cases. Compound 7a, 9a, 10a, 4b, 6b, 8b, 9b and 10b were found to be universally active against all the test fungi. The results are in consonance with the i*n silico* predictions. All the test compounds were qualifying the limit of log p, molecular weight and number of hydrogen donors except the compound 10a whose number of hydrogen acceptors were greater than five. The high docking scores and low log p values were simultaneously found to affect the antifungal potential in all the cases except in 7a, clearly indicating the effect of some other factor affecting the potential in this case. The high fungitoxicity of the compound 10a despite of the fact that it crosses the Lipinski limits is favoured by the large docking score. Toxicity analysis had also shown that, compounds belong to class III level of toxicity, which was same as that of the toxicity level of standards fungicides.

Table 1: Antifungal potential of the synthesized compounds against various phytopathogenic fungi EC_{50} (m moles/L)

Compd	*A. alternata*	*B. graminis*	*H. oryzae*	*P. striiformis*	*P. triticina*	*U. tritici*
1a	2.39	3.98	1.46	3.98	3.71	1.33
2a	0.81	1.16	1.62	1.73	-	1.73
3a	1.08	1.08	1.30	2.93	3.70	1.52
4a	1.95	1.23	1.74	1.43	1.64	0.41
5a	1.55	1.35	1.84	1.45	0.46	1.94
6a	1.56	1.47	1.65	1.28	1.38	1.47
7a	0.66	1.41	0.99	2.33	1.50	0.89
8a	1.25	1.87	1.25	1.75	1.75	0.59
9a	0.94	1.40	0.60	1.50	1.60	0.54
10a	0.64	0.64	0.64	0.95	0.51	0.48
11a	1.29	2.06	2.06	2.06	2.12	2.20
1b	0.87	2.88	2.05	2.31	1.44	1.73
2b	1.27	0.99	1.49	1.74	-	1.62
3b	0.81	1.28	0.93	1.16	1.28	0.70
4b	0.87	1.09	1.09	1.42	0.30	1.96
5b	0.72	1.13	0.92	2.16	0.82	0.82
6b	1.55	0.97	1.07	1.07	0.64	0.97
7b	1.05	0.70	0.61	1.31	0.82	0.70
8b	1.62	0.81	0.67	0.94	0.54	0.67
9b	0.61	0.53	0.59	0.64	0.38	0.53
10b	0.67	1.50	1.25	0.84	2.34	0.42
11b	2.00	2.54	2.40	2.14	2.40	2.67
Indofil M-45*	0.62	0.54	0.63	0.68	0.65	0.55
Tilt*	0.17	0.13	0.15	0.18	0.20	0.15

*Standard fungicide against *A.alternata, B. graminis, H. oryzae, P. striiformis, P. triticina, and U. tritici.*

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Synthesis and *In Vitro* Antifungal Evaluation of Benzothiazol-2-ylcarbamodithioates Capped Silver Nanoparticles

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Keywords: Benzothiazol-2-ylcarbamodithioates, Silver Nanoparticles (AgNPs), Antifungal activity.

Introduction

Silver nanoparticles owing to their unique physical characteristics provide enormous hope for their use in combating pathogens in agriculture. On the other hand, benzothiazoles and carbamodithioates belong to aza-thio class of bioactive compounds that has received overwhelming response owing to its diversified molecular design in pesticide industry. But to improve the bioavailability of these moieties, we planned to synthesize hybrid benzothiazol-2-ylcarbamodithioates capped silver nanoparticles having broad spectrum antifungal potential.

Materials and Methods

Benzothiazol-2-amines were synthesized by method reported in literature. Further, they were reacted with carbon disulfide to give benzothiazol-2-ylcarbamodithioates under basic conditions followed by addition of alkyl halides. The thin layer chromatography and spectral analysis confirmed the formation of products. Naked AgNPs were synthesized by standard chemical reduction method. Above synthesized benzothiazol-2-ylcarbamodithioate derivative were loaded over naked silver nanoparticles with sonication. Capping was optimized using UV-Visible spectrophotometric technique and transmission electron microscopy was used for detection of particle size. *In vitro* antifungal assay of synthesized compounds was made against phytopathogenic fungi *viz. Drechslera oryzae, Fusarium moniliform* by spore germination technique.

Results and Discussion

Spectroscopical analysis of all the compounds had confirmed the formation of organic molecules. Further, the UV visible results were used to find the appropriate concentration for loading of different compounds. TEM analysis had proved the formation of nanoparticles with size of lesser than 50 nm. *In vitro* anti-fungal evaluation had shown that the most of the synthesized compounds were active against *Drechslera oryzae,* with EC_{50} values comparable to standard, whereas, in case of *Fusarium moniliform*, chloro substituted benzothiazol-2-ylcarbamodithioates derivatives were found to be more effective than their flouro analogues. On the basis of alkylation, the butyl and hexyl substituted derivatives gave the better results in comparison to the molecules with longer alkyl chains. Further, the carbamodithioate coated silver nanoparticles have size lesser than 50 nm, thus show a good permeability in the fungal spores and it was proved from the EC_{50} values that was further decreased after their conversion to silver coated nanoparticles. Dithiocarbamate fungicide, Indofil M-45 was used as standard in all cases. So it was concluded that loading of an organic compound over a nanoparticles will leads to a higher antifungal potency against various phytopathogenic fungi.

182.

Quaternary Quinolinium Salts as a New Antifungal Agent for the Protection of Rice Crop

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Keywords: Quaternary quinolinium salts, rice, *D. oryzae* and *F. verticilloides*.

Introduction

Rice (*Oryza sativa*) is the agricultural commodity with the third highest worldwide production after maize (*Zea mays*) and sugarcane (*Saccharum officinarum*) but from last two decades it is being widely exploited by several phytopathogens and many others which effect its production and economy. So, the development of fungicides against disease is thus main focus for plant breeders and researchers. Several pesticides containing quinoline moiety were designed for the development of new fungicides. As quaternary ammonium salts are the emerging new biopotential molecules. So present work was aimed to incorporate the different alkyl halides in quinoline moiety to obtain their quaternary salts and to evaluate their effectiveness as fungicides against pathogens of rice.

Materials and Methods

Quaternary quinolinium salts were prepared by condensing quinoline and 2-methyl quinoline separately in the presence of ethanol with various alkyl halides. The stock solution of synthesized compounds and standard fungicides i.e.Tilt 25 EC (propiconazole) were prepared by dissolving the chemical (20 mg) in 1 ml of Tween 20 (polyoxyethylenesorbitan) and volume was made 10 ml with sterilized distilled water separately. The required dilutions of 1000, 500, 250, 100, 50 and 25 µg/ml were subsequently made from the stock solution. All the test compounds were screened against various phytopathogenic fungi namely *F. verticilloides* and *D. oryzae.* The quinoline and their quaternary salts were synthesized and characterized by physical and spectral techniques. The synthesized compounds were evaluated *in vitro* for their antifungal potential against *F. verticilloides* and *D. oryzae* by spore germination method at different concentrations i.e.1000, 500, 250, 100 and 50 µg/ml and per cent spore inhibition was calculated for the synthesized compounds. Then evaluation of fungi-toxicity of all compounds was done by calculating the ED_{50} and ED_{90} values (effective dose at which 50 and 90 per cent inhibition taken place).

Results and Discussion

The information of the statistical analysis and per cent spore inhibition is given in Table 1 and Table 2. Statistical analysis showed that there is a correlation between all concentrations and synthesized quinolinium salts and the obtained values of per cent spore inhibition were significant at different concentrations. It was found that in case of *F. verticilloides* C-16quinolinium bromide and C-8quinolinium bromide whereas in the case of D. oryzae C-6quinolinium bromide, C-7quinolinium bromide and C-8quinolinium bromide shown ED_{50} values less than 100 µg/ml. So, all the quinolinium salts that are possessing higher hydrocarbon chain length found prominent compounds against the two fungi as compared to the quinolinium salts containing lower hydrocarbon chain length. But N-hexyl quinolinium bromide found highly fungi-toxic against the *D. oryzae* as its ED_{50} is less (37 µg/ml) than the Tilt 25 EC (50 µg/ml).

Table 1: Antifungal activity of quarternary quinolinium salts at different concentrations against *Fusarium verticilloides*

Quaternary quinolinium salt	Concentrations (ppm)				
	1000	500	250	100	50
C-1quinoliniumiodide	66.6 (54.8)	43.3 (41.1)	28.3 (31.9)	26.6 (30.6)	8.3 (13.7)
C-3quinoliniumbromide	81.6 (64.6)	70 (56.8)	53.3 (46.9)	28.3 (31.9)	13.3 (20.4)
C-4quinoliniumbromide	85 (67.3)	80 (67.3)	65 (53.7)	53.3 (46.8)	35 (36.2)
isoC-3quinoliniumbromide	80 (63.5)	76.6 (61.1)	68.3 (55.7)	46.6 (43.0)	33.3 (35.1)
C-5quinoliniumbromide	88.3 (68.8)	76.6 (61.1)	58.3 (49.8)	43.3 (41.1)	16.6 (23.7)
secC-4quinoliniumbromide	88.3 (70.0)	75 (60.0)	58.3 (49.7)	35 (36.2)	13.3 (17.5)
C-6quinoliniumbromide	81.6 (64.9)	73.5 (59.2)	61.6 (51.9)	40 (39.1)	15 (21.8)
C-7quinoliniumbromide	93.3 (75.2)	80 (63.4)	66.6 (54.8)	46.6 (43.0)	30 (28.6)
C-8quinoliniumbromide	95 (77.0)	86.6 (68.8)	68.3 (55.7)	58.3 (49.7)	38.3 (38.2)
C-10quinoliniumbromide	91.6 (73.3)	83.3 (65.9)	61.6 (51.7)	48.8 (44.0)	31.6 (34.1)
C-16quinoliniumbromide	98.3 (85.6)	90 (71.9)	81.6 (64.6)	60 (50.7)	43.3 (41.1)
Allylquinoliniumbromide	86.6 (68.6)	71.6 (57.8)	63.3 (52.7)	50 (44.9)	45 (42.1)
C-1quinaldiniumiodide	78.3 (62.2)	60 (50.7)	43 (41.1)	33.5 (35.2)	20 (26.5)
C-10quinaldiniumbromide	91.6 (73.3)	83.3 (65.9)	60 (50.7)	41.6 (40.1)	23.3 (28.6)
isoC-3quinaldiniumbromide	81.6 (64.6)	63.3 (52.7)	43.3 (41.1)	35 (36.2)	26.6 (31.0)
Tilt 25 EC	93.3 (75.2)	71.6 (57.8)	63.3 (52.7)	59 (47.8)	41.6 (40.1)
Quinoline	93.3 (75.2)	83.5 (65.9)	70.7 (56.8)	56.6 (48.8)	36.6 (37.2)
Control	0.0	0.0	0.0	0.0	0.0

Values are in parentheses arc sine transformations.
C.D. (p=0.05) Compounds: 3.18
Concentrations: 1.70
Interaction: 7.11

Table 2: Antifungal activity of quarternary quinolinium salts at different concentrations against *Drechslera oryzae*

Quaternary quinolinium salt	Concentrations (ppm)				
	1000	500	250	100	50
C-1quinoliniumiodide	76.6 (61.1)	70 (56.8)	58 (49.8)	38.5 (38.0)	5 (10.4)
C-3quinoliniumbromide	75 (59.9)	50 (44.9)	45 (42.1)	26.6 (30.6)	0 (0.0)
C-4quinoliniumbromide	78 (62.2)	66.6 (54.7)	48.3 (44.0)	41.6 (40.1)	20 (26.4)
isoC-3quinoliniumbromide	71.6 (55.8)	53.3 (46.9)	38.3 (38.2)	23.3 (28.8)	0 (0.0)
C-5quinoliniumbromide	80 (63.5)	73 (58.9)	57 (48.8)	40 (39.2)	0 (0.0)
secC-4quinoliniumbromide	78 (62.3)	63.3 (52.7)	56.6 (48.8)	43.3 (41.1)	30 (32.1)
C-6quinoliniumbromide	93.5 (75.2)	85 (67.3)	77 (61.7)	67 (54.8)	53.5 (46.9)
C-7quinoliniumbromide	90 (71.9)	80 (63.5)	68.5 (56.1)	61 (51.7)	28 (31.9)
C-8quinoliniumbromide	95 (77.0)	86.6 (69.5)	80 (63.5)	58 (49.8)	38 (38.1)
C-10quinoliniumbromide	90 (71.5)	70 (56.7)	58.5 (49.8)	40 (39.1)	16.6 (23.7)
C-16quinoliniumbromide	80 (63.5)	61.6 (51.7)	50 (44.9)	31.6 (34.1)	23.3 (28.6)
Allylquinoliniumbromide	91 (73.3)	81.6 (64.9)	43.3 (40.1)	38.3 (38.0)	0 (10.4)
C-1quinaldiniumiodide	75 (60.0)	66.6 (54.9)	51.6 (45.9)	35 (36.2)	0 (0.0)
C-10quinaldiniumbromide	90 (71.5)	76.6 (61.1)	66.6 (54.8)	50 (44.9)	28.3 (31.9)
isoC-3quinaldiniumbromide	83.5 (66.1)	76 (61.1)	63.3 (52.7)	43 (41.1)	21.6 (27.6)
Tilt 25 EC	98.3 (85.6)	88 (70.0)	70 (61.1)	68.3 (52.7)	48.3 (44.0)
Quinoline	95 (77.0)	88.3 (70.0)	78.5 (62.2)	53.3 (46.9)	38.3 (38.2)
Control	0.0	0.0	0.0	0.0	0.0

Values are in parentheses arc sine transformation
C.D. (p=0.05) Compounds: 3.06
Concentrations: 1.66
Interaction: 6.84

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Efficacy of Emamectin Benzoate against Diamond Back Moth in Cabbage

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Keywords: Emamectin benzoate, cabbage, *Plutella xylostella*, yield.

Introduction

Cabbage is one of the important vegetable crops grown in India. Among the insect pests, diamondback moth (DBM), *Plutella xylostella* L., (Plutellidae: Lepidoptera) and cabbage aphid, *Brevicoryne brassicae* L. (Aphididae: Hemiptera) are the most important pests causing severe yield loss to cabbage every year. In India, marketable yield loss of cabbage has been reported up to 50-80% due to attack of *P. xylostella*. Chemical insect management in cabbage has been found effective and economical.

Materials and Methods

A field experiment was carried out for two years during 2012-13 and 201314 at Breeder seed production unit farm, JNKVV, Jabalpur (MP) to evaluate the performance of Emamectin benzoate 5%SG in cabbage variety Supreeya against diamond back moth. The trial was carried out with eight treatments and replicated thrice following the Randomized block design. Plot size was kept 5x5m with row x plant spacing of 60x45cm. Observation was recorded at primordial stage of the crop. Post treatment count was recorded at 3, 5, 7 and 10 days after application of the treatments. Ten plants were selected randomly and number of DBM larvae head^{-1} was counted before sprays as well as on third, fifth, seventh and tenth days after each spraying.

Results and Discussion

During both the years the population of diamondback moth larvae was found to be non- significant in pretreatment before first spray (Table 1). During both the years the larval population in all the treatments at 10days after first and second spray was significantly lower than the untreated control (12.77 and 15.63 larvae plant^{-1}). However, in T_5 lowest larval population (2.20 and 0.10 larvae plant^{-1}) was recorded during both the years. Treatments, T_4 and T_5 recorded 100% reduction in DBM larval population at 10 days after second spray which was at par with T_7 (90.31%) in first year. Untreated control (T_8) was recorded least larval reduction throughout the cropping season. Similar trend was also recorded during second year of study. The present findings confirm the findings of Prasad and Devappa (2006). They also reported that Emamectin benzoate 5%SG at the rate of 150g and 200g *a.i.* ha^{-1} was found to be highly effective in suppressing the DBM larval population with higher cabbage yield. Highest head yield (274.45 and 329.52 q ha^{-1}) was recorded from the treatment T_5 during both the years. Thus, maximum increase in yield (28.51 q ha^{-1}) over control was obtained from T_5. The present findings are in accordance with the findings of Mahmoudvand *et al.* (2011). It can be concluded that Emamectin benzoate 5%SG at the rate of 20g *a.i.* ha^{-1} was found to be highly effective against DBM and registered highest head yield over all the treatments without any adverse effect on the crop.

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Table 1: Effect of different treatments of Emamectin benzoate 5% SG against DBM with respect to yield of cabbage (2012-13 and 2013-14)

S. No.	Treatments	Dosage (g *a.i.* ha^{-1})	Pre-treatment count (larvae head^{-1})	Number of Diamond Back Moth (DBM) larvae head^{-1} at 10 DAS		Yield (q ha^{-1})	% increase in yield over control
				1st Spray	2nd Spray		
T_1	Emamectin benzoate 5% SG	5	6.78(2.70)	4.70(2.28)	3.35(1.96)	253.95	8.11
T_2	Emamectin benzoate 5% SG	7.5	6.69(2.68)	3.15(1.91)	0.81(1.14)	291.73	24.22
T_3	Emamectin benzoate 5% SG	10	6.83(2.71)	2.92(1.85)	0.66(1.07)	296.75	26.35
T_4	Emamectin benzoate 5% SG	15	6.64(2.67)	2.60(1.76)	0.14(0.79)	301.25	28.19
T_5	Emamectin benzoate 5% SG	20	6.57(2.66)	2.20(1.64)	0.10(0.77)	301.99	28.51
T_6	Emamectin benzoate 5% SG (MISSILE)	7.5	6.80(2.69)	3.78(2.06)	1.54(1.43)	284.96	21.31
T_7	Emamectin benzoate 5% SG (MISSILE)	10	6.70(2.68)	3.37(1.97)	1.29(1.34)	290.74	23.74
T_8	Untreated Control	-	7.00(2.73)	12.77(3.64)	15.63(4.02)	234.55	-
	SEm±	-	0.34	0.19	0.14	7.72	-
	CD(p=0.05)	-	NS	0.58	0.42	23.41	-

Figures in parentheses are angular transformed value, NS- Non significant.

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Evaluation of Newer Insecticides for Predator Management of *Kerria lacca* (Kerr)

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Keywords: Sticklac, newer insecticides, broolac, *Rangeeni*

Introduction

Lac is produced by lac insect *Kerria lacca* (Kerr). It is a commodity of commerce and export. *K lacca* is susceptible to parasites and predators infestation which can cause lac yield loss 35-40% respectively **(**Khobragade *et al.* 2012). A management initiatives predator increased the yield of *kusmi* lac and *Rangeeni* lac upto 29.82 and 29.67%, respectively over lac growers practice of over looking the predator infestation (Patel *et al.* 2014). The present work was to study of evaluation of newer insecticides for predator management of *kerria lacca* (kerr).

Materials and Methods

A field trial evaluation of newer insecticides -cartap hydrochloride and emamectin benzoate against predators of *K lacca* was carried out on the natural stand of *Butea monosperma* trees of 10 women lac growers of village Malhara Seoni district Madhya Pradesh in July- October 2012. Two sprays of both insecticides in combination with fungicide -mancozeb at 30 and 60 days after broodlac inoculation was carried out. At maturity of lac crop, mean weight of three sticklac of 30cm length per *B monosperma* per treatment was measured on digital balance to record difference in weight in different treatments. One hundred mature lac cells (each lac insect secretes resin body cover to protect itself) from different treatments were recorded in both fresh and shade dry stages. Finally the yield of broodlac per tree was recorded.

Results and Discussion

The mean weight of 30 cm sticklac at harvest among different treatments varied from 28.74 g to 58.91 g. The difference was significant. It was highest in emamectin benzoate + mancozeb (47.81 g), control (39.74 g) and cartap hydrochloride + mancozeb (36.74 g). Higher weight of stick lac yield from insecticide treated plants than control indicates that insecticides - cartap hydrochloride and emamectin benzoate are safer for *Kerria lacca*. Though there was a difference in the mean fresh weight of 100 mature healthy lac cells obtained from the sticklac at harvest but the difference was no significant among three treatments. The mean weight of 100 mature lac cells was highest 4.08 g in emamectin benzoate + mancozeb followed 4.04 g (cartap hydrochloride + mancozeb) and control (3.66). The mean dry weight of 100 healthy cells of lac insect was obtained seven days after shady drying. It was highest (2.54 g) in case of emamectin benzoate + mancozeb followed cartap hydrochloride + mancozeb(2.43 g) and control T_3 (2.24 g). The mean dry weight (g) of 100 lac cells of *Kusmi* lac insect in nutrient management *Zizyphus mauritiana* varied from 5.18 to 7.08g. The brood lac yield per *B monosperma* was highest (6.72 kg/ tree) in emamectin benzoate + mancozeb(T2), followed by (5.68 kg/ tree) cartap hydrochloride + mancozeb(T1) and control T3 (4.96 kg/ tree)(Table 1). Cartap hydrochloride and emamectin benzoate were safe for lac insects.

Table 1: Total estimated mean of broodlac yield (kg) per tree at harvest

Lac growers (Replication)	Total estimated mean of broodlac yield (kg) per tree at harvest		
	T_1	T_2	T_3
R_1	6.74	5.81	5.67
R_2	6.33	6.00	4.16
R_3	5.17	5.67	5.00
R_4	5.00	7.33	4.00
R_5	4.67	7.71	4.39
R_6	6.00	7.67	4.67
R_7	7.33	6.67	6.00
R_8	5.67	7.00	5.67
R_9	5.00	6.67	4.33
R_{10}	4.84	6.67	5.67
Mean	5.68	6.72	4.96
SEm±	0.26		
CD 5%	0.76		

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185.

Studies on Histopathological Effects of Deltamethrin on the Midgut of Oriental Latrine Fly, *Chrysomya megacephala* (Fabricius) (Diptera: Calliphoridae).

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Keywords: *Chrysomya megacephala*, midgut, deltamethrin

Introduction

Chrysomya megacephala (Fabricius), the oriental latrine fly, is a medically important blow fly species. Adults feed on food sources including nectar, animal carcasses, and other filth materials, or even human food. Alternate movement between filth and human food enables the adult *C. megacephala* to be a mechanical transmitter of numerous pathogens, such as bacteria, viruses, protozoa, and helminth eggs, which may cause diseases (e.g. diarrhoea, gastroenteritis, ulcers, nosocomial infections, cholera and dysentery) in humans, whereas larvae have been recorded as myiasis-producing agents (Zumpt, 1965).

Materials and Methods

Adults of *C. megacephala* were collected and reared in BOD cabinet on the mixture of sugar, protein & milk in the ratio of 1: 1: 3, soaked in cotton at temperature of 27±2°C and relative humidity of 60±5. Chopped buffalo meat was provided as egg laying medium. Larvae were reared on buffalo meat and cotton was provided at 3rd larval stage for pupation. 3rd day adults flies were dissected to observe the normal histology of midgut. Insecticide deltamethrin of the concentration 0.005% was provided in food to 3rd day adult flies to examine the alteration from normal histology of midgut.

Results and Discussion

The midgut proper begins with the posterior midgut tissue of the cardia just anterior to the gastric caeca (Boonsriwong, 2006). Four long tubular gastric caeca were observed, and their external surfaces were markedly smooth with irregular swelling. Both inner circular and outer longitudinal muscles were evident. Most of the nuclei of the cells are large and oval. The inner margin of these gastric caeca cells forms microvilli. The anterior midgut emerges from the cardia and junction of the gastric caeca. Its external appearance is also very smooth with inner circular and outer longitudinal muscles. Anterior midgut tissue contains peritrophic membrane within its central lumen and is surrounded by a single layer of cuboidal epithelial cells. The composition of the middle midgut resembles that of the anterior midgut in having a plasma membrane and the lumen surrounded by a monolayer of cuboidal epithelial cells. Moreover, fat body cells were also evident between these epithelial cells. These cells project inward from their basement membranes and each possess long microvilli. Midgut treated with 0.005% deltamethrin show a significant increase in the epithelium thickness in anterior midgut. The epithelial cells became enlarged and lumen of the midgut decreased. In middle and posterior midgut, the epithelial cells were completely ruptured and separated from the basement membrane. The peritrophic membrane was not closely lying to the epithelial cells and the space in between the epithelium and peritrophic membrane was filled with few cytoplasmic vesicles. Atrophied microvilli were also observed.

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Evaluation of IPM Modules for the Management of Lepidopteron Insect Pests and Diseases in Cabbage

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Keywords: IPM modules, lepidopteron insect pests

Introduction

Cabbage (*Brassica oleracea* var. *capitata* Linn.) is an important vegetable crop of Himachal Pradesh. This crop is jeopardized by the ravages of many species of insects at one or the other stage of its growth and among them lepidopterous insect pests are the most serious. Besides, the crop is also attacked by several diseases, mostly caused by fungi and bacteria leading to severe crop losses. The present investigations were carried out with an objective to evaluate the efficacy of IPM modules consisting of soil, seed and seedling treatment followed by the spray of mixtures of insecticides and fungicides taking in to account their compatibility for the eco-friendly and economical management of lepidopterous insect pests and diseases in cabbage.

Materials and Methods

Field trials were conducted during summer 2012 at 3 sites at and around HAREC, Bajaura. The experiments were laid out in randomized block design with 5 treatments, each replicated 4 times. About 1 month old seedlings of cabbage (cv. Varun) were transplanted during the third week of March 2012 at a spacing of 45 cm x 30 cm in plots of 3.15 x 2.70 m. Nursery beds were treated with formaldehyde at the rate 1: 7. Seeds were treated in hot water at 52°C for 30 minutes followed by treatment with streptocycline at the rate of 200 mg / L of water for 30 minutes. Nursery beds were drenched with Companion 0.25% after 7 and 14 days of seedling/ plant emergence for the control of damping off. Nursery was sprayed with Ridomil M Z at the rate of 0.25% after 25 days of plant emergence for the control of downy mildew. Seedlings were dipped before transplanting in a mixture of streptocycline (0.2 g) + carbendazim (1g) per litre of water for 30 minutes. Details of spray modules evaluated against insect-pest and diseases of cabbage are given as under:

M_1: Spraying with lambda - cyhalothrin at the rate 0.004% (Bravo 5%) after 45 days of transplanting followed by the second spray of mixture of lambda-cyhalothrin at the rate 0.004% (Bravo 5%) and difenconazol at the rate 0.02% (Score 25 EC) after 15 days of 1st spray.

M_2: Spraying with azadirachtin at the rate 5ml/L (Neembaan 0.15%) after 45 days of transplanting followed by the second spray of mixture of azedarachtin at the rate (Neembaan 0.15%) and difenconazol at the rate 0.02% (Score 25 EC) after 15 days of 1st spray.

M_3: Spraying with lambda-cyhalothrin at the rate 0.004% (Bravo 5%) after 45 days of transplanting followed by the second spray of mixture of malathion (0.05%) and zineb at the rate 0.25% (Dithane Z78) after 15 days of 1st spray.

M_4: Spraying with azadirachtin at the rate 5ml/L (Neembaan 0.15%) after 45 days of transplanting followed by the second spray of mixture of Btk (15g/10 L) and zineb at the rate 0.25% (Dithane Z 78) after 15 days of 1st spray.

M_5: Control (No treatment)

Data on the incidence of lepidopterous larvae, alternaria blight and black rot were recorded on 10 plants per plot. Yield was recorded plot wise and converted to q/ha. Data of all the three sites were pooled and were analyzed statistically after appropriate transformation. Economics of different pest management modules was calculated.

Results and Discussion

All the modules were significantly superior to untreated control in protecting cabbage crop from lepidopterous insect pests and diseases. The module M_3 was the most effective IPM strategy against lepidopteron insect pests and diseases resulting in hundred per reduction in larval population and plant infestation (Table 1). This module also resulted in minimum alternaria blight severity with 5.32% (76.88% reduction over untreated control) and black rot incidence with 7.93% (68.55% reduction over untreated control). Among the modules, highest marketable yield (370.48 q/ha) as well as per cent increase over control (37.89) was obtained from M_3. The highest net returns/rupee invested (16.26) were recorded in case of M_3 followed by M_1 which recorded the net returns/rupee invested as 13.17 (Table 1).

Table 1: Incidence of lepidopterous larvae and diseases on cabbage

Modules	Pre-treatment larval incidence		Post - treatment larval incidence		Plant infestation (%)with lepidopterous. insects		Disease incidence				Average market-able Yield (q/ha)	Net return per Rs. invested
	No. of larvae**/ 10 plant)	Plant infestation** (%)	No. of larvae/ 10 plant*	ROC	Plant infestation* (%)	ROC	Alternaria blight* severity (%)	ROC	Black rot* incidence (%)	ROC		
M_1	41.25 (39.94)	44.58 (41.86)	0.50 (1.18)	97.63	3.00 (1.90)	91.11	8.50 (3.07)	63.05	10.82 (3.43)	53.95	362.48	13.17
M_2	39.97 (38.68)	41.25 (39.94)	2.53 (1.81)	88.04	5.00 (2.29)	85.18	9.39 (3.18)	59.19	11.33 (3.50)	51.78	326.43	6.52
M_3	43.17 (40.57)	42.58 (40.70)	0.00 (1.00)	100.00	0.00 (1.00)	100.00	5.32 (2.50)	76.88	7.93 (2.98)	68.55	370.48	16.26
M_4	41.80 (39.77)	47.91 (43.78)	1.25 (1.43)	94.04	5.41 (2.38)	83.97	11.22 (3.49)	51.23	12.29 (3.64)	47.70	328.36	7.80
M_5	39.97 (38.68)	48.83 (44.31)	21.16 (4.37)		33.75 (5.88)		23.01 (4.89)		23.50 (4.94)		268.66	0.00
CD (5%)	NS	NS	(1.40)		(0.96)		(0.44)		(0.37)		37.51	

Figures within the parentheses are: * √n+1 transformation and ** arc sine transformation, ROC= Reduction over control

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Potential of Organic Materials against Stem Rot of Jute Caused by *Macrophomina phaseolina* (Tassi) Goid

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Keywords: Stem rot of jute, *Corchorus olitorius, C. capsularis, Macrophomina phaseolina*, botanicals, *Phytohthora parasitica* var. *sabdariffae,* foot and stem rot of mesta, *Hibiscus sabdariffae, H. cannabinnus.*

Introduction

Jute *(Corchorus olitorius* L. and *C. capsularis* L.), also known as 'golden fibre', is one of the important commercial fibre crops of India and grown mostly in eastern region with an area of 0.91 million hectares and production 11.82 million bales (one bale= 180 kg) dry fibres with fibre productivity of 2349 kg/ha. It is cultivated as pre-*kharif* (summer) crop mainly in the states of West Bengal, Bihar and Assam with percentage contributions to National production jute fibres are 79.54, 10.80 and 6.22, respectively. Recently jute has emerged with stronger attributes due to its eco-friendliness with more oxygen producing, carbon dioxide absorbing and higher fuel wood producing capabilities, apart from its biodegradable diversified products. Stem rot of jute caused by *Macrophomina phaseolina* (Tassi) Goid. is economically important disease affecting yield and quality of fibre in both cultivated species. The disease is seed, soil as well as air borne and continues to damage the crop in all jute growing areas in India and other countries starting from germination to maturity in both seed and fibre crops. The average loss of yield in jute and mesta due to the diseases is around 10 - 25%. Therefore, the present investigation have been designed to target manipulation of soil, pre-sowing seed treatment and foliar spraying of fungicides or judicious combination of all to determine the field efficacy of conventional and new fungicide molecules on stem rot disease of jute.

Materials and Methods

The efficacy of botanicals was tested *in-vitro* against *M. phaseolina* on potato dextrose agar media using standard food poisoned technique. The experiment was laid out in completely randomized design using formula $V_1S_1 = V_2S_2$ (where, V_1, S_1, and V_2, S_2 were initial and final volumes and concentrations, respectively) to determine final concentrations with minor modifications. In field, botanicals were applied as pre-sowing seed treatment and followed by a foliar spraying at the rate of 0.6% active ingredient at 30 days later in randomized block design with three replications on a new jute variety, JRO 8432 at main farm of CRIJAF, Nilganj, Barrackpore, India during normal cropping season. Percentage incidence of stem rot was noted at fortnightly intervals starting from 30 days after sowing (DAS) after final thinning of crop. No other plant protection chemical was applied.

Results and Discussion

In the present investigation, organic materials, namely, devil's cotton (*Abroma augustum)*, neem (*Azadirchta indica*), ramie (*Boehemeria nivea*), hatisoor (*Heliatroium indicum*), bilakhani (Tephrosia indica), garlic (Allium sativum), kalmegh (Andrographis paniculata), turmeric (*Curcuma longa*), curcumin mixture, bleaching powder, Dorina and Stup were tested against *Macrophomina phaseolina* causing stem rot of jute (*Corchorus olitorius, C. capsularis*) and *Phytohthora parasitica* var. *sabdariffae* causing foot and stem rot of mesta (*Hibiscus sabdariffae* L.=roselle and *H. cannabinnus* L.=kenaf) *in- vitro* and in field experiment with JRO 8432.

Neem components, particularly leaf extract and seed kernel suspension exhibited high inhibition of both the pathogens at 10-100%. *Tephrosia indica* showed 10-30% inhibition of *M. phaseolina* whereas ramie leaf appeared ineffective on both pathogens. Extract of neem leaf at 100 and 50% concentration reduced mycelial growth of *M. phaseolina* and *P. parasitica*. Neem seed kernel extract was effective at 100 and 50% inhibiting the pathogens. Neem oil suspension was less effective against *M. phaseolina* while considerably effective against *Phytophthora* inhibiting them *in-vitro.* Poor efficacy was noted in young and old leaf extract of *Abroma.* Dorina was more effective than Stup. Turmeric oil at10 µg/ml, curcumin mixture at100 µg/ml and bleaching powder at 5000 µg/ were highly effective on *M. phaseolina*. Leaf extract of neem was most effective in reducing incidence of stem rot of jute from 22.75% in check to 12.06%. Neem was followed by extracts of turmeric, garlic and kalmegh at maturity of the crop. The rate of increase of stem rot incidence was very low in neem extract in comparison to untreated check, followed by turmeric, *kalmegh*. Overnight seed soaking in turmeric, garlic and *kalmegh* extract boosted seedling growth and vigour initially indicating growth promotion effect. Pre-sowing soil application of bleaching powder at 20- 30 kg/ha was highly effective against jute stem rot in the field (Table 1). The specific active components in these botanicals may be identified and open a new avenue of opportunities for better and sustainable management of important diseases of jute, mesta and other crops in future.

Table 1: Effectiveness of different organic materials/ botanicals/ fungicides on *Macrophomina phaseolina*, *Botryodiplodia theobromae*, *Phytophthora parasitica* var. *sabdariffae* and *Sclerotium rolfsii* on jute and mesta *in vitro*

Crop	Disease	Pathogen	Organic materials/ botanicals /fungicides	Maximum dosage (µg/ml*) tested	Dosage (µg/ml*) causing 100% inhibition	Remarks	May be recommended (Yes / No)
Jute	Stem rot	*Macrophomina phaseolina*	Thiram	5000	2000	OK	Yes
			Carbendazim 50 WP	5000	25	Excellent	Yes
			Copper oxychloride 50 WP	5000	50	Very good	Yes
			Mancozeb 75 WP	5000	-	-	No
			Hexaconazole EC	1000	100	Good	Yes
			Tebuconazole EC	1000	50	Very good	Yes
			Propiconazole 25% EC	10000	10	Excellent	Yes
			Tricyclazole 75% WP	10000	10000	Poor	No
			Turmeric oil	10000	10	Excellent	Yes
			Curcumin mixture	10000	100	Very good	Yes
			Bleaching powder [$Ca(OCl)_2$]	5000	5000	Excellent	Yes
			Dorina - Organic fungicide	25 000	10000	Very good	Yes
			Stup - Organic fungicide	10 000	-	-	-
Jute	Black band	*Botryodiplodiatheobromae*	Carbendazim 50 WP	1500	5	Excellent	
Mesta	Foot and stem rot	*Phytophthora parasitica* var. *sabdariffae*	Copper oxychloride 50 WP	5000	-	-	No
			Mancozeb	5000	2000	OK	Yes
			Carbendazim 50 WP	1000	-	-	No
			Copper oxychloride 50 WP	5000	50	Very good	Yes
			Mancozeb 75 WP	5000	100	Good	Yes
			Metalaxyl	5000	2	Excellent	Yes
			Carbendazim 50 WP	1500	-	-	No
			Copper oxychloride 50 WP	5000	-	-	No
			Mancozeb	5000	2000	OK	Yes
Jute and Mesta	Soft rot or Collar rot	*Sclerotium rolfsii*	Carbendazim 50 WP	1500	-	-	No
			Copper oxychloride 50 WP	5000	-	-	No
			Mancozeb	5000	2000	OK	Yes

*µg/ml= Parts per million (ppm) and 1%= 10000 µg/ml or ppm

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Eco-friendly Pest Management Strategies for Sustainable Tobacco Production

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Keywords: Tobacco, insect pests, pest management

Introduction

Tobacco an important commercial crop of India plays an important role in the country's agricultural economy. India is producing 750 M kg of cured leaf from an area of 0.45 M ha. India exports 225 M kg of tobacco and its products to about 100 countries earning foreign exchange to the tune of Rs 6060 crores and an internal revenue generation of about Rs 19, 8900 crores. It is the life line for 6 million farmers besides supporting 30 million workers. As a result of scientific research activities in tobacco during last six decades there has been a steady increase in tobacco productivity in India. Though the area under tobacco has increased marginally from 3, 60, 000 M ha in 1947 to 4, 50,000 M ha at present, the production of tobacco has increased from 265 to 750 m kg and productivity from 730 to 1665 kg/ha. Today there is growing concern about the sustainability of tobacco production due to various reasons. Though the introduction of high yielding varieties, improved production practices, large scale use of chemical fertilizers and pesticides helped in increasing the tobacco production simultaneously the pest problems have also undergone quick changes and the insect pests and diseases which were minor and manageable became major and causing considerable damage in the recent past, thereby threatening production of quality tobacco.

Among tobacco production constraints identified, increasing incidence of insect pests and diseases are economically important, particularly in sub-tropical agricultural ecosystem where due to a more conducive environment for pest build-up, losses incurred are substantially high in terms of both quantity and quality. The problem of pesticide residues is one of the limiting factors in the export of tobacco. Sole dependence & indiscriminate use of synthetic pesticides for pest control is beset with problems such as irreversible damage to the public health, development of insecticide resistance in insect pests, annihilation of beneficial organisms, insect pest resurgence, secondary pest out breaks, environmental pollution etc. These problems have forced the Scientists and farmers to resort to eco-friendly integrated pest management (IPM) to achieve long term sustainable systems of crop protection and production.

Materials and Methods

Experiments were conducted to find out suitable trap crop, crop geometry and integrating trap crop and bio-pesticides to develop an eco-friendly IPM strategy for management of budworm, *Helicoverpa armigera* and *Spodoptera litura* in Virginia tobacco. Similarly for management of sucking pests viz., *Myzus nicotianae* and *Bemisia tabaci*, barrier crops were evaluated in field experiments. Efforts were made to develop tolerant varieties, use of biological control, conservation enhancement and integration of natural enemies, use of natural products, eco-friendly baiting techniques and preferential use of selective insecticides for eco-friendly management of insect pests in tobacco.

Results and Discussion

Marigold and rustica tobacco planted in East- West direction and castor trap crop with conjunctive use of neem was found promising for management of *H.armigera* and *S.litura* respectively in tobacco (Sreedhar 2011). Maize, sorghum and bajra as border crops minimized sucking pest incidence, enhanced natural enemy activity and increased yields of tobacco. An interspecific hybrid, TBST 2 tolerant to tobacco aphid *M.nicotianae* was developed; natural products neem and pongamia proved effective in management of ground beetles that damage newly planted tobacco; use of biological resources, particularly NPV was found effective and their effectiveness was demonstrated in farmers' fields. Eco-friendly baits were developed for management of *S.litura* under cyclonic weather conditions and out break situations. Broad spectrum insecticides were replaced with new insecticide molecules which are highly selective, with low a.i. requirement and higher guidance residue levels (Sreedhar 2010). Thus eco-friendly strategies proved effective in management of insect pests and help in production of clean tobacco with acceptable levels of CPAs for export purpose.

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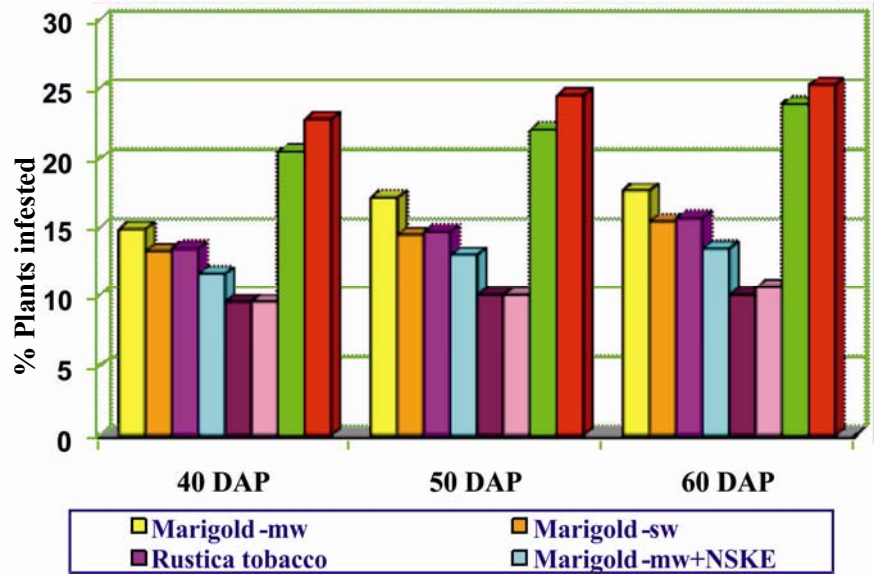

Fig. 1: Effect of conjunctive use of trap crops and neem against H. armigera in FCV tobacco

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Management of Tobacco Aphid (*Myzus nicotianae*) in FCV Tobacco

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Keywords: Tobacco, *Myzus nicotianae,* Management

Introduction

Tobacco aphid, *Myzus nicotiane* is one of the key pests of Virgiana tobacco cultivated in Andhra Pradesh and Karnataka in India. It causes significant losses to tobacco directly by feeding and honeydew deposition on which sooty mold grow and make the leaves unfit for curing. It was reported that tobacco aphid cause an avoidable loss of green leaf, cured leaf and bright leaf to an extent of 607 kg, 125 kg and 70.3 kg/ha respectively [1]. It was reported that its infestation was as high 80 - 100% in unprotected fields in the years of severe incidence in Andhra Pradesh [2]. The registered insecticides that provide adequate control of the pest continued to decrease. Due to repeated use of the recommended insecticides, tobacco leaves with large surface to weight ratio are vulnerable to retain the pesticide residue, which is not desirable. In view of the above new selective insecticides with different mode of action were evaluated.

Materials and Methods

Field studies were conducted on the efficacy of new insecticdes viz., Pymetrozine 50 WG, flonicamid 50 WG, spiromesifen 240 SC and spirotetramet + imidacloprid 240 SC in comparison with imidacloprid 200 SL and thiamethoxam 25 WG against tobacco aphid, *M. nicotinae* on FCV tobacco for two seasons (2012-13&13-14 in a replicated experiment. Observation on aphid population was recorded before and after the treatments periodically at 2, 4, 8 and 15 days after spray (DAS). Experiments were also conducted in laboratory with the promising insecticides for aphid control to determine their safety to eggs, larvae, pupae and adults of the native predatory coccinellid beetle, *Coccinella repanda* Thunberg and syrphid predator *Xanthogramma scutellare* Fabricus. Yield parameters of FCV tobacco were recorded and the residues in the cured leaf were also assessed.

Results and Discussion

The results showed that flonicamid 50 WG and pymetrozine WG @ 0.02% were most effective against tobacco aphid, as they provided cent per cent control up to 16 days after treatment. Both the insecticides were found to be relatively safe to the native aphid predators *C. repanda* and *X. scutellare* as per IOBC classification (class 1). These treatments also recorded significantly higher cured leaf and bright leaf and showed better grade index. The residues of flonicamid and pymetrozine @ 0.02% in the cured leaf of tobacco were 0.40 and 0.94 ppm 15 days after spray. Based on their efficacy, relative safety to the native predators, yiled parameters of FCV tobacco and the residues in the cured leaf, it can be inferred that the new insecticides, flonicamid 50 WG and pymetrozine 50 WG @ 0.02% are highly effective and can be potential alternatives to the recommended insecticides for the management of tobacco aphid, *M.nicotianae* on flue cured Virginia tobacco.

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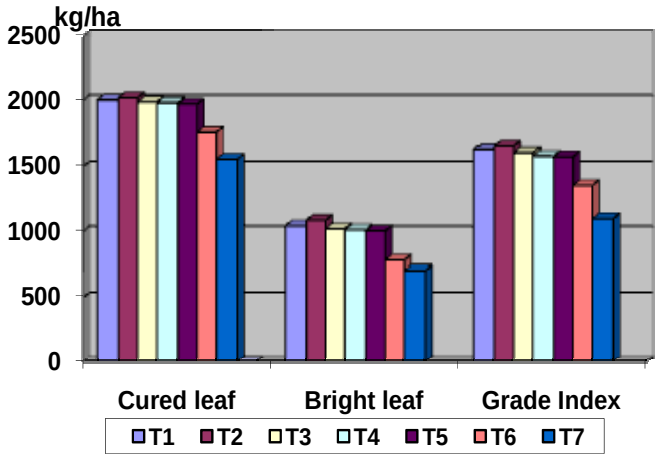

Fig. Effect of new insecticides against aphid on yield parameters of FCV tobacco 2012-14 [T1 Pymetrozine 50 WG 0.02%; T2 Flonicamid 50 WG 0.02%; T3 Spirotetramet + Imidacloprid 240 SC 0.018%; T4 Imidacloprid 200SL 0.005%; T5 Thiamethoxam 25 WG 0.005%; T6 Spiromesifen 240 SC 0.02%; T7 Control (untreated)]

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Efficacy of Bio-pesticides against the Whitefly *Bemesia tabaci* in Okra at Bhubaneswar

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Keywords: Bio pesticides, evaluation, okra, whitefly

Introduction

Okra is ravaged by as many as 45 species of insect-pests throughout its growth period. Adoptions of IPM strategies ensure safety of environment. In this regard encouragement of natural enemies occupies a central position in integrated pest management because biological control of pests and weeds through natural enemies is eco-friendly. The effectiveness of bio pesticides like *Beauveria bassiana*, *Verticillum lecanii* and *Metarhizium anisopliae* and neem pesticide against whitefly has been tested. The chrysopid predator, *C.zastrowi sillemi* has also been tested.Keeping all these in view, a field experiments were taken up at the Orissa University of Agriculture and Technology, Bhubaneswar to evaluate bio pesticides against whitefly.

Materials and Methods

The field experiments were taken up in the Central Research Station of Orissa University of Agriculture and Technology (OUAT), Bhubaneswar during *Kharif* 2013 and Summer 2013-14. The experiments were laid in Randomized Block Design (RBD) with three replications and eight treatments. The plot size was 5m x 5m. Treatment schedule was as follows:

Treatment details

Treatment No.	Treatment Name	Dose	DAG (Days after Germination)
T_1	*Beauveria bassiana*	1x 10^8cfu/g	at 15 and 30
T_2	*Metarrhizium anisopliae*	1x 10^8cfu/g	at 15 and 30
T_3	*Verticillium lecanii*	1x 10^8cfu/g	at 15 and 30
T_4	Neemazal 4%	1x 10^8cfu/g	at 15 and 30
T_5	*Chrysoperla zastrowi sillemi*	75000 1st instar larvae/ha	at 15 and 30
T_6	*Chrysoperla zastrowi sillemi*	100,0001stinstar larvae /ha	at 15 and 30
T_7	Acetamiprid	0.025%	at 15 and 30
T_8	Control	Untreated	

Results and Discussion

Over the two seasons (Table 1) the mean whitefly population before application of treatments ranged from 1.68 in T7 to 3.93 in T8. Acetamiprid application reduced the population of whitefly from 1.68whiteflies/plant to 0.59 in three days time and 0.17whiteflies/plant in 7 days time there was a population reduction of 97.59%. It was followed by T3 application of *V.lecanii* which recorded 1.76 and 1.49 whitefly after 3 and 7 days respectively with a mean population of 78.90% Neemazol was also found to be effective against the whiteflies by recording 1.93 and 1.73 whiteflies/plant and population reduction of 75.50%.*M.anisopliae* was the next best biopesticide recording 2.46 and 1.85 whiteflies/plant and 73.80% mean reduction *B.bassiana* recorded 2.43 and 2.21 whiteflies/ plant at 3 and 7 day after application respectively and reduced the population by 68.70%.

Table 1: Effect of different BIPM schedules on the whitefly population at Bhubaneswar (pooled over *Kharif* 2013 and summer 2013-14)

Treatment	DBA	18 DAG 33 DAG	25 DAG 40 DAG	Reduction in (%)
T_1	3.01 (1.76)	2.43 (1.55)	2.21 (1.48)	68.70
T_2	2.89 (1.70)	2.46 (1.56)	1.85 (1.36)	73.80
T_3	2.34 (1.52)	1.76 (1.32)	1.49 (1.22)	78.90
T_4	2.46 (1.56)	1.93 (1.38)	1.73 (1.31)	75.50
T_5	3.01 1.23)	2.44 (1.57)	2.24 (1.49)	68.28
T_6	2.86 (1.69)	2.17 (1.47)	2.01 (1.91)	71.53
T_7	1.68 (1.29)	0.59 (0.76)	0.17 (0.41)	97.59
T_8	3.93 (1.98)	5.29 (2.30)	7.06 (2.65)	-
SE(m)±	NS	0.07	0.07	
CD(0.05)	NS	0.21	0.22	

Figures in parentheses are √x values

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Development and Evaluation of Pest Management Modules against *Thrips tabaci* (Lindeman) in Onion

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Keywords: Onion, thrips tabaci, pest management module

Introduction

Productivity of onion (*Allium cepa* L.) is affected by many insect pests namely thrips (*Thrips tabaci* L.), cutworm (*Spodoptera litura* F.), head borer (*Helicoverpa armigera* Hub.) and onion fly (*Delia* sp. L.), of which onion thrips is one of the most important pests. Adult thrips migrate from exiting onion field to neighboring newly sown onion crop. Therefore, barrier the adult thrips to reach onion crop may be greatly helpful in reducing the initial pest load and subsequent multiplication of pest (Srinivas and Lawande, 2006). Keeping these points in view, four pest management modules were evaluated against thrips in onion crop.

Materials and Methods

The field trial was conducted at College of Agriculture Jabalpur. Four pests management modules i) outer row of *Zea mays* and 2 inner row of *Triticum aestivum* (M1) ii) chemical based module consist of 1st spray monocrotophos 36 SL, 0.04%, 2nd spray profenofos 50 EC, 0.2%, 3rd spray lambda-cyhalothrin 25 EC, 0.2% (M2) botanical and consist of 1st spray Neem oil 1%, 2nd spray karanj oil 1% (M3) and iv) control (M4) against thrips. Five plants were randomly tagged for counting of thrips at one day prior, 5, 10 and 14 days after each spray.

Results and Discussion

The thrips population was recorded lowest in M2 module and highest in M4 module during both the year of studies after 5, 10 and 14 days after spray, which may be due to the fact that monocrotophos, 36 SL, 0.04%, profenofos 50 EC, 0.2% and lambda-cyhelothrin 25 EC, 0.02%, has long lasting protection period and high insecticidal potency than the others. Sollam & Hosseny (2003) reported that profenofos gave significantly better control of thrips. Malik *et al.* (2003) observed monocrotophos 40 SL was superior for effective control of *Thrips tabaci* in onion. The barrier crop of maize and wheat effectively blocked the mean nymphs and adults thrips by 13.60/plant at 10 days after spray in comparison to control (28.85 thrips/plant at 10 days after spray). Similarly, Srinivas and Lawande (2006) reported maize barrier as cultural method for management of thrips in onion. The perusal of data (Table 1) revealed that minimum pooled damage rating 2.33 was recorded in Pest management module M2.

Table 1: Efficacy of different Pest management modules on thrips population, damage rating and marketable yield of onion

Module	Pooled data of both year						
	Mean thrips nymph and adults/plant				Damage rating	Marketable yield (q/ha)	B: C
	BS	5 DAS	10 DAS	14 DAS			
M1	19.34	21.01 (4.63)	17.38 (4.22)	13.60 (3.75)	3.46	300.51	**1: 82.6**
M2	23.01	6.23 (2.63)	12.80 (3.64)	13.50 (3.74)	2.33	320.56	1: 23.2
M3	23.51	15.29 (3.97)	15.23 (3.96)	17.23 (4.21)	3.97	282.25	1: 16.6
M4	23.44	28.33 (5.36)	28.85 (5.41)	29.41 (5.46)	5.16	228.27	-
CD5%	NS	0.81	1.03	1.10	0.38	17.36	-

BS= before spray, DAS= Days after spray

Highest marketable bulb yield (320.56 q/ha) was obtained from pest management module M2. As the data presented in Table 1 indicates that the highest B: C ratio was obtained from module M1 (1: 82.6). In the module M1 chemical spray cost was zero, therefore due to low damage and cost, yield was high which resulted to high B: C ratio.

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Evaluation of Botanicals, Antagonists and Fungicides against *Rhizoctonia solani* F. Sp. S*asakii* Causing Banded Leaf and Sheath Blight of Maize

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Keywords: Botanicals, antagonists, fungicides leaf and sheath blight, maize

Introduction

Banded leaf and sheath blight disease of maize caused by *Rhizoctonia solani* f. sp. *sasakii*, occurs both at pre- flowering and flowering stage causing direct losses and resulting in premature death, stalk breakage ear rot, and indirect losses by reducing the grain yield. So, out of the estimated 13.2 per cent annual loss in grain yield in India, the losses due to sheath blight contributes one per cent (Payak and Sharma, 1985). In Haryana, the disease occurred severe form in last few years and caused losses up to 100 per cent. Keeping in view the importance of the disease and lack of information available on this aspect, the present investigations were undertaken to evaluate the efficacy of different chemicals against disease.

Materials and Methods

Pathogen were collected from infected maize plants and purified by hyphal tip culture technique. Six botanicals and four antagonists were tested against *R. solani* f. sp. *sasakii* pathogen under *in vitro* conditions. Botanicals and fungicides were also evaluated against banded leaf and sheath blight disease of maize cultivar HM-4 hybrid in 4 x 3m plot size with spacing 75 x 20 cm using randomized block design under field conditions during *Kharif* season 2011-12 and 2012-13 at Regional Research Station (RRS), Karnal. The observation of the disease symptoms was recorded on the basis of 1-5 scale and disease intensity was calculated as formula of Wheeler (1969), and grain yield per hectare was also recorded.

Results and Discussion

The efficacy of different botanicals, antagonists and fungicides was tested against *R. solani* f. sp. s*asakii* causing banded leaf and sheath blight of maize. The botanicals and antagonists were found effective under *in vitro* and *in vivo* conditions. Among the botanicals taken for the study, garlic clove extract completely inhibited the mycelial growth (95.56%) at 15% concentration under *in vitro* condition (Fig. 1), followed by neem leaves extract (53.33%). The garlic cloves and neem leaves extracts were not effective only in the field condition in reducing disease severity as low as 50.6 per cent and 38.8 per cent, respectively, but also were positively correlated with the significant increase in yield. The antagonists *Trichoderma viride* was found superior to all other antagonists selected, viz. *T. harzianum*, *Pseudomonas fluorescens, P. maltophila* and *Bacillus subtilis* in inhibiting the mycelial growth of *R. solani* f. sp. s*asakii* and reduced the disease severity upto 32.2 per cent, whereas, *P. maltophila* was least effective and reduced only 1.90 per cent disease under screen house condition. Although, the chemicals were more effective as compared to botanical and antagonists in controlling the disease, the maximum disease control was observed with spray of propiconazole (72.2%) followed by validamycine (62.2%), hexaconazole (51.0%), garlic cloves (50.6%), carbendazim+flusilazole (47.6%) and moncern (44. 7%) revealed in Table 1. In present investigation, garlic cloves, *T. viride,* propiconazole and validamycin were found effective against banded leaf and sheath blight of maize. These botanicals provide either certain toxic principles or strengthens the plant metabolic systems, whereas, the bio-agents uses different antagonistic as well as resistance inducing mechanisms, competition and secretion of certain toxic principles/ antibiotics against the pathogen.

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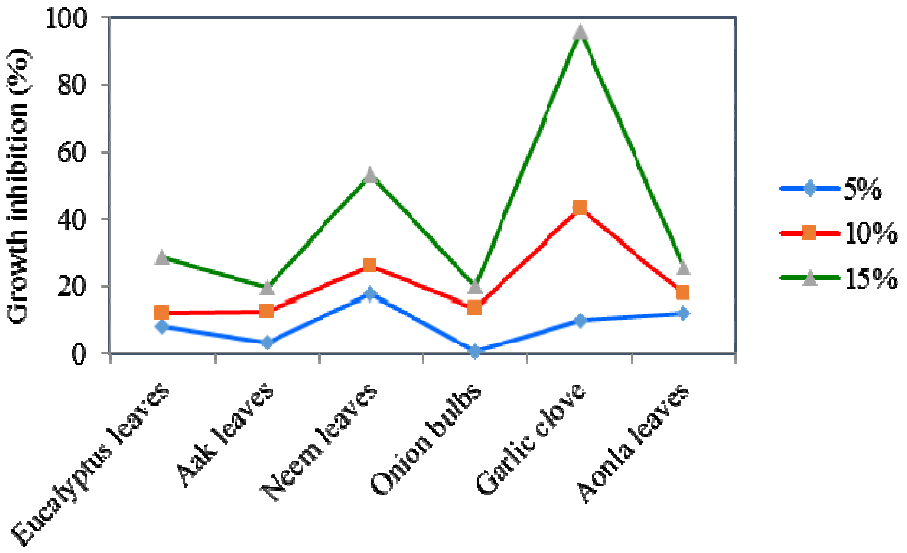

Fig. 1: Inhibition of mycelial growth of R. solani f. sp. sasakii at different concentration of botanicals under in vitro condition

Table 1: Efficacy of various fungicides against banded leaf and sheath blight of maize under field condition

Treatments	PDI (%)	Per cent disease control	Yield (q/ha)
Moncern @ 0.1%	48.3 (44.0)^{cd}	44.7	37.0^{d}
Validamycin @ 0.2%	33.0 (35.1)^{b}	62.2	45.8^{f}
Hexaconazole @ 0.25%	42.8 (40.8)^{c}	51.0	41.6^{e}
Carbendazim @ 0.2%	51.9 (46.1)^{d}	40.5	35.8^{cd}
Carbendazim+flusilazole @ 0.2%	45.7 (42.5)^{cd}	47.6	38.0^{de}
Propiconazole @ 0.1%	24.3 (29.5)^{a}	72.2	47.8^{f}
Copper oxychloride @ 0.25%	69.9 (56.7)^{e}	19.9	23.6^{b}
Carbendazim seed treatment @ 2.5 g/kg seeds	64.9 (53.6)^{e}	25.6	24.5^{b}
Stripping of lower leaves	51.1 (45.6)^{d}	41.5	32.5^{c}
Control	91.1 (72.7)^{f}	---	11.0^{a}
CD (P≤0.05)	(4.25)	---	3.21
CV	5.34	---	5.92

Pooled mean of season 2011-12 and 2012-13
Figures in parentheses are arcsine transformed values
Values indicated by similar letters are statistically non-significant

193.

Development of an Integrated Rodent Pest Management Approach Using Capsicum Oleoresin as an Aversive Agent against Rodents

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Keywords: *Rattus rattus,* red chilli powder, capsaicin

Introduction

Rodents are the most important mammalian pests causing extensive damage to agricultural crops (Singla and Babbar, 2010) in addition to acting as reservoirs of parasites of man and livestock. Plant products acting as repellents/antifeedants against pests could become part of an integrated pest management strategy to reduce damage with decreased reliance on lethal methods. Capsaicin is the major active ingredient of red chilli powder of genus *Capsicum* causing pungency. Capsicum oleoresin is extracted from red chilli powder by distilling in a solvent. These derivatives of red chilli are mammalian irritants that depolarize sensory receptor cells and cause pain. Capsicum oleoresin is successfully used as an in-soil repellent for pocket gophers (Sterner *et al.*, 2005).

Materials and Methods

Male house rats (*Rattus rattus)* were divided into four groups (n=5 each). Rats of control group (group I) were fed on plain WSO bait (loose mixture of cracked wheat, powdered sugar and groundnut oil in ratio 96: 2: 2). Rats of groups II, III and IV were fed on WSO bait containing 0.1, 0.3 and 0.5% capsicum oleoresin, respectively in bi-choice with plain WSO bait for two weeks with an intervening gap period of 7 days. Bait consumption was recorded after every 24 h. In the present study, aversion of treated bait by rats was investigated along with observations on histomorphological and histochemical changes caused in the liver.

Results and Discussion

Consumption of bait from treated side was significantly low from that on untreated side indicating an aversive effect of the capsicum oleoresin (Table 1). There was a significant difference in antifeedant index ($P < 0.05$) at 0.3% and 0.5% concentration. The overall antifeedant index during the two treatment periods varied from 57.88 to 87.98% at all the three concentrations tested. The histomorphological studies on liver revealed disorganization of hepatic cords, dilatation of the sinusoids, vacuolization and degeneration of hepatocytes in the central area. The rats fed with 0.1% capsicum oleoresin showed more severe changes as there was lymphocytic infiltration and exudate in the hepatic tissue. The histochemical studies showed a strong reaction of all the oxidoreductases studied (Succinate Dehydrogenase, Lactate Dehyrogenase, Glutamate Dehydrogenase, Nicotinamide Adenine Dinucleotide Hydrogenase and Nicotinamide Adenine Dinucleotide phosphate-oxidase) in the central zone, whereas, a weak activity was seen in the peripheral zone. The change in structural organization and enzymatic activity in the liver of treated rats may be correlated with the functional status of the liver after ingestion of bait containing capsicum oleoresin. These findings showed that capsaicin possesses some chemical and pharmacological properties similar to the classes of drugs that are capable of inducing liver damage. Present study reveals the potential of capsicum oleoresin as an aversive agent against *R. rattus.* This aversion may be due to post-ingestional changes caused in the liver of rats which led to the avoidance of treated food in subsequent exposures. Study suggests the use of capsicum oleoresin in the form of spray or mixed in bait to reduce damage caused by rats.

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Table 1: Antifeedant index of capsicum oleoresin against male *Rattus rattus* during treatment weeks I and II

Days	Antifeedant index (%) (Mean±SD)					
	Treatment week I			Treatment week II		
	0.1%	0.3%	0.5%	0.1%	0.3%	0.5%
Day 1	43.86±32.76^{a}	62.52±14.34^{b}	69.10±28.17^{b}	46.13±22.12^{a}	87.90±24.18^{b}	65.61±16.69^{b}
Day 2	48.52±27.95^{a}	65.60±4.27^{b}	67.46±26.65^{b}	78.05±28.48^{a}	71.28±24.85^{b}	68.02±24.10^{b}
Day 3	60.16±16.45^{a}	69.96±15.83^{a}	60.97±10.50^{a}	28.37±7.19^{a}	73.69±18.53^{b}	76.80±22.24^{b}
Day 4	63.17±21.03^{a}	67.59±14.20^{a}	65.69±20.45^{a}	30.16±12.85^{a}	87.14±11.68^{b}	87.96±14.43^{b}
Day 5	66.56±20.67^{a}	92.99±8.71^{b}	84.02±31.96^{b}	54.57±7.59^{a}	100±0^{b}	80.84±26.11^{b}
Day 6	69.83±21.33^{a}	91.99±6.67^{b}	91.33±6.67^{b}	56.49±12.08^{a}	100±0^{b}	89.91±12.40^{b}
Day 7	53.11±36.63^{a}	89.80±8.56^{b}	87.86±9.92^{b}	63.85±10.74^{a}	95.90±6.05^{b}	94.43±6.82^{b}
Average	57.88±8.93^{A}	77.20±12.65^{B}	75.20±11.26^{B}	51.08±16.51^{A}	87.98±10.92^{B}	80.51±10.20^{B}

The values with different superscripts (a, b) in a row on each day indicate significant difference at P <0.05. The values with similar superscript (a) in a column for each concentration indicate no significant difference. The values with different superscripts (A, B) in a row for average values for each concentration indicate significant difference at P <0.05.

194.

Efficacy Evaluation of Greenhouse Whitefly Management Modules in Tomato under Protected Cultivation

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Keywords: *Trialeurodes vaporariorum*, tomato, protected cultivation, pest management

Introduction

Protected cultivation ensures quality production of high value crops. Tomato, *Solanum lycopersicum* L. is an important crop grown under protected structures. The abiotic conditions under protected environment are conductive for plant growth which also favours multiplication of insect-pests. In Himachal Pradesh, greenhouse whitefly (GHWF), *Trialeurodes vaporariorum* (Westwood) is a key pest of tomato under protected environment. In present studies, efforts were made to evaluate modules comprising insecticides registered with Central Insecticides Board and Registration Committee for use on tomato to manage greenhouse whitefly under naturally ventilated polyhouses.

Materials and Methods

Study was undertaken in naturally ventilated polyhouse at Palampur, Himachal Pradesh, 1200 masl. Tomato crop was got infested artificially 10 days after transplanting (DAT) by releasing GHWF adults in large numbers. Eight modules comprising imidacloprid 17.8 SL, azadirachtin 1500 ppm, spiromesifen 22.9 SC and thiamethoxam 25 WG as detailed in Table 1, were formulated and evaluated in autumn-winter crop of tomato during 2014 (September- January) and summer crop during 2015 (April- August). The observations were recorded on number of adult whiteflies from fully opened terminal three leaves from five randomly selected plants in each module at weekly interval.

Results and Discussion

In autumn-winter crop and summer crop the population of GHWF oscillated between 0.6 to 7.9 and 0.4 to 47.9 per leaf, respectively. In autumn-winter crop, soil drenching of imidacloprid twice 1 DAT and 45 DAT (M_2) was observed to result in minimum seasonal population of GHWF (Fig. 1). It was followed by M_7. Module M_3 comprising foliar application of azadirachtin (0.00045%) at 10 days interval starting 10 DAT also proved effective. However, azadirachtin at tested concentration resulted in leaf necrosis. Whereas in summer crop, among different modules evaluated, M_7 (imidacloprid soil drench at transplanting followed by alternate foliar applications of spiromesifen and thiamethoxam) resulted in least seasonal mean of whitefly population. It was followed by M_5 (alternate foliar application of spiromesifen and thiamethoxam at 15 days interval initiated 15 DAT) (Fig. 1). Both the modules were superior to M_6 and M_8 where foliar application was initiated when population level goes beyond 5 GHWF adults per leaf. In summer season, azadirachtin evaluated at lower concentration (0.0003%) proved least effective in regulating GHWF population, though was superior to untreated check.

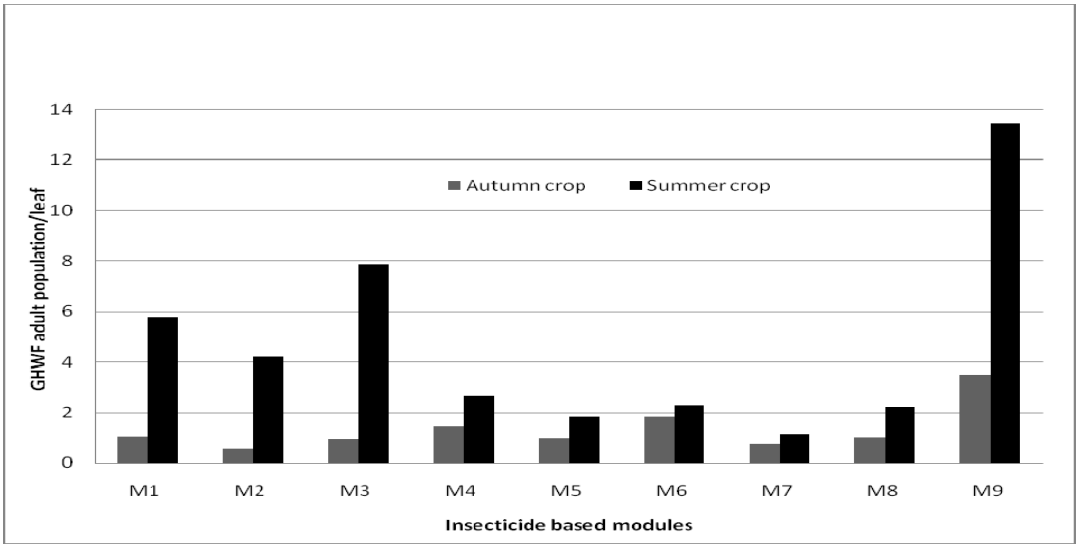

Fig. 1: Seasonal mean of GHWF adult population in different management modules

Table 1: Details of insecticide based management modules evaluated against greenhouse whitefly

Module	Treatment (dose)	Method and time of application	Number of applications#	
			Autumn crop	Summer crop
M_1	Imidacloprid 17.8 SL (0.009%)	Soil application at transplanting	1 (S)	1(S)
M_2	Imidacloprid 17.8 SL (0.009%)	Soil application once at transplanting and another 45 DAT*	2 (S)	2 (S)
M_3	azadirachtin 0.15% (0.00045 and 0.0003%)**	Foliar application at 10 days interval initiated 10 DAT	11 (F)	12 (F)
M_4	Imidacloprid 17.8 SL (0.009%) + azadirachtin 0.15% (0.00045 and 0.0003%)**	Soil application of imidacloprid at transplanting followed by foliar application of azadirachtin initiated 45 DAT at 10 days interval	1(S) 8(F)	1(S) 9(F)
M_5	Spiromesifen 22.9 SC (0.02%) and thiamethoxam 25 WG (0.01%)	Alternate foliar applications of spiromesifen and thiamethoxam at 15 days interval initiated 15 DAT	7(F)	8(F)
M_6	Spiromesifen 22.9 SC (0.02%) and thiamethoxam 25 WG (0.01%)	Initiating foliar application when population level goes beyond 5 adults/leaf (15 adults per three terminal leaves) at 15 days interval	3(F)	5(F)
M_7	Imidacloprid 17.8 SL (0.009%), spiromesifen 22.9 SC (0.02%) and thiamethoxam 25 WG (0.01%)	Soil application of imidacloprid at transplanting followed by alternate foliar applications of spiromesifen and thiamethoxam initiated 45 DAT at 15 days interval	1(S) 5(F)	1(S) 6(F)
M_8	Imidacloprid 17.8 SL (0.009%), spiromesifen 22.9 SC (0.02%) and thiamethoxam 25 WG (0.01%)	Soil application of imidacloprid at transplanting followed by alternate foliar applications of spiromesifen and thiamethoxam initiated when adult population goes beyond 5 adults/leaf at 15 days interval	1(S)	1(S) 3(F)
M_9	Untreated check	No application of insecticides		

* DAT: days after transplanting
**Azadirachtin (0.00045 in autumn-winter crop and 0.0003% in summer crop)
S: Soil application; F: Foliar application

195.

High Performance Liquid Chromatographic Determination of Chlorpyriphos and Glyphosate Residues in Mango Orchard Soil

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Keywords: Chlorpyriphos, glyphosate, residues, mango orchard soil

Introduction

Chlorpyriphos, an organophosphate insecticide with contact mode of action, is used widely in mango ecosystem for the management of various insect pests and glyphosate, a broad spectrum systemic herbicide, is widely used to control various weeds. Chlorpyriphos (2.5 and 5.0 ml l^{-1} of water) and glyphosate (8.0 and 16.0 ml l^{-1} of water) were applied to mango (*Mangifera indica* L.) (cv. Dashehari) orchard soil to study their dissipation pattern in soil and subsequent uptake in fruit.

Materials and Methods

Soil samples were collected periodically at 10 days interval up to 50 days and fruit samples were collected at 15 days interval from second week of May to third week of June, 2013 (up to harvest) for both the pesticides. Chlorpyriphos and glyphosate were extracted from soil samples with hexane: acetone (1: 1, v/v) and water: dichloromethane (4: 1, v/v) mixtures, respectively, by mechanical agitation with a shaker. Both the pesticides were analyzed by HPLC coupled with a photodiode array detector and rheodyne injector.

Results and Discussion

Chlorpyriphos persisted in mango orchard soil up to 50 days and dissipated from 5.05 and 8.30 mg kg^{-1} after 1h of application to 0.75 and 1.07 mg kg^{-1} after 50 days of application at single and double doses, respectively (Fig. 1). Glyphosate dissipated in mango orchard soil from 3.37 and 6.12 mg kg^{-1} after 1h of treatment to 0.61 and 1.04 mg kg^{-1} after 30 days of treatment at single and double doses, respectively (Fig. 2). No residue was detected in soil beyond 30 days after its application. The residual half-lives in mango orchard soil were calculated as 18 and 17 days for chlorpyriphos, and 13 and 12 days for glyphosate from normal and higher doses, respectively. The rate of their dissipation followed first-order kinetics in soil at both the concentrations. No residues of either chlorpyriphos or glyphosate were detected in unripe as well as ripe mango fruits. Hence, both the pesticides can be considered safe for their respective use.

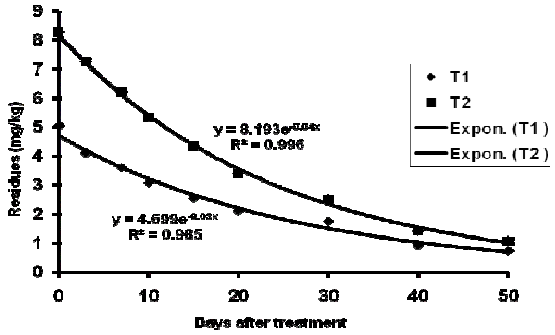

Fig. 1: Chlorpyriphos residues in mango orchard soil

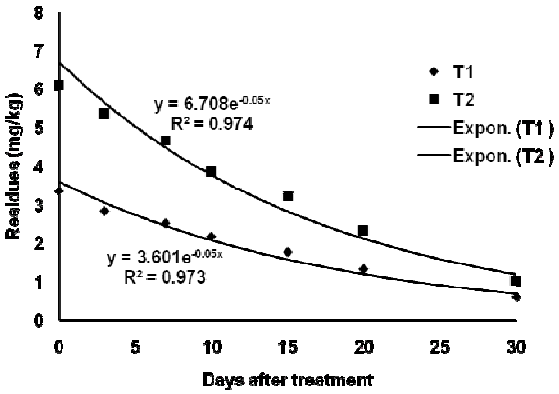

Fig. 2: Residues of glyphosate in mango orchard soil

196.

GC MS-MS Multi Residue Evaluation Protocol for Coriander *(Coriandrum sativum)* Seeds

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Keywords: Coriander, maximum residue levels, GC MS-MS, pesticides and insecticides

Introduction

India is the main producer country of seed spices and a major exporter also. Coriander (*Coriandrum sativum*) is one of the main export commodities after cumin from India. It is cultivated as a *rabi* crop in arid and semi-arid parts of Rajasthan, Gujarat and other parts of the country. The crop faces severe management issues from fungal diseases such as wilt, blight, powdery mildew, damping off and insect infestation by aphids and thrips in moderate to severe form. A broad array of fungicides and insecticides are used to control these diseases by the growers and sometimes these control agents are used injudiciously also. Being an export commodity the importers are very much conscious about the residue levels of various insecticides and pesticides and a stringent rider has been imposed in terms of maximum residue levels by the various controlling agencies such as the European Union Quality control Agency and Codex Alimentarious. An attempt has been made to derive and standardise a gas chromatography mass spectrometer- mass spectrometer (GC MS-MS) based simplified multi residue methodology for at a stroke evaluation of some commonly used pesticides namely carbofuran, melaoxon, propiconazole, dimethoate, ethoxyquin, butachlor, resmethrin, thiacloprid, phorate sulfone, deltamethrin, paraxon, penconazole, triazophos, phorate sulfoxide, hexaconazole, penconazole and chloropyrifos.

Materials and Methods

Coriander samples harvested from the experimental field trials conducted at the ICAR- National Research Centre on Seed Spices (NRCSS), Tabiji, Ajmer were processed, extracted, purified and concentrated using standard protocols and were analysed at APEDA laboratory at ICAR-NRC on Grapes, Pune using GC MS-MS (Thermo TSQ 8000 Evo) and the confirmation was also carried out with tandem LCMS/MS. The operation parameters and flow diagram for the same has been shown below.

Oven temperature program - Rate-10°C/min, temperature- 65-320 (°C), hold time- 1.5 5 (min); injection parameters- injection mode- splitless, split flow-10 ml/min, Flow rate-1 ml/min, sample volume-2.5 µl, Ion source temperature - 280, MS transfer line temperature - 310.

- Two gram of powdered seeds + 8 ml of chilled distilled water in 50 ml capacity centrifuge tube, Soak for 30 min
- 10 ml of acetonitrile + 4.0 g $MgSO_4$ + 1.0 g heat treated NaCl
- The whole mixture was then vortexed for 2.0 minute and centrifuged at 5000 rpm for 5 minutes
- About 1.0 ml of the aliquot from the upper organic/acetonitrile layer was taken into centrifuge tube using micropipette
- 25mg PSA + 150 mg $MgSO_4$ + 100 mg C - 18 bulk adsorbent was added and centrifuged at 3500 rpm for 2.0 minute
- About 2.0 ml of the aliquot (equivalent to 0.6 g sample) was taken in 15 mL test tube and evaporated to dryness in turbovap concentrartor
- Later a final volume of 1.0 mL was made by adding the mixture of
- Methanol: water (1: 1, v/v) + 0.1% Acetic acid in water
- Taken in vial for analyzing the multi residues of pesticides using GC-MS/MS and LC-MS/MS

The pesticides were applied in different combinations to test and evaluate their effectiveness towards various diseases and insects in coriander so as to derive an effective combination for further recommendations and use. The residues were analysed easily and perfectly.

Results and Discussion

The recovery factor for the various pesticides standards analysed was 85 to 108%. The pesticides had been applied in recommended doses and as per pre decided schedules. The analytical results have been presented in the Table 1.

Table 1: Analytical results

Sample label	Pesticide compound	Concentration mg/kg
1	Carbofuran Melaoxon propiconazole	0.23 0.02 0.01
2	Carbofuran Melaoxon dimethoate	0.02 0.01 0.17
3	Melaoxon Carbofuran Dimethoate	0.016 - 0.011
4	Ethoxyquin Butachlor Resmethrin	0.01 0.01 0.02
5	Thiacloprid Phorate sulfone	- 0.011
6	Deltamethrin Paraxon -methy Butachlor	0.01 0.01 0.01
7	Butachlor Deltamethrin Penconazole Triazophos	0.01 0.15 0.02 -
8	deltamethrin	0.03
9	Deltamethrin Butachlor	0.20 0.01
10	Deltamethrin phorate sulfoxide	0.017 0.017
11	Butachlor Carbofuran Phorate sulfoxide	0.01 - 0.06
12	Butachlor Carbofuran Hexaconazole Kresoxim methyl penconazole	0.02 0.02 0.07 0.02 0.54
13	Butachlor Chloropyrifos Penconazole	0.02 0.05 0.02

The results were interpreted in terms of extent of retention of various pesticides as residues and it was observed that the combination with sample no. 4 and 13 was more effective in terms of minimum residue levels in the produce after harvest well within the prescribed MRLs for coriander.

197.

Degradative Nature of *Bacillus alkalinitrilicus* in Imidacloprid

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Keywords: Degradation, imidacloprid

Introduction

Imidacloprid is commonly used against sucking insect pests. Due to its systemic nature, it persists in soil for more than 100 days (Leicht, 1993). The parent compound, imidacloprid is more toxic as compared to its other metabolites. Several bacterial species were reported to degrade imidacloprid in laboratory conditions. So, understanding the degradative nature of microbial species and their response to the contaminants is very essential. Therefore, the present study was undertaken to study the degradative nature of imidacloprid with the use of bacterium, *Bacillus alkalinitrilicus.*

Materials and Methods

The study was experimented in Pesticide Residue Laboratory and Insect Molecular Biology Laboratory, Department of Entomology, Punjab Agricultural University (PAU), Ludhiana, India. Soil samples were collected from PAU fields and were treated with imidacloprid at the rate of 50 mg kg^{-1} along with $45x10^7$ colony forming unit (cfu) of *B. alkalinitrilicus*. The samples were compared with the soil treated with the same dose of the insecticide but without treatment of bacteria. The residues of imidacloprid and its metabolites were analyzed by high performance liquid chromatography equipped with photodiode array detector system, C_{18} column.

Results and Discussion

Control samples were spiked at different levels and were found above 80 percent recovery. In the soil treated with *B. alkalinitrilicus*, the percent reduction recorded at 7 days was found as 15 as compared to 20 in case of soil treated with the bacteria. The percent reduction for the untreated (bacteria) soil, at 15, 30, 45, 60, 90 and 120 days was found to be 30, 50, 65, 80, 90 and 95 respectively. However, the percent reduction of the bacteria treated soil was found as 50, 70, 85, 95 and 100 respectively at 15, 30, 45, 60, 90 days after amendment. The percent reduction value attained 100 at 90 days after treatment with bacteria. However, in case of soil with only imidacloprid, even upto 120 days, the percent reduction reached only 95. In this connection, application of imidacloprid @ 100 mg kg^{-1} soil and amended with an imidacloprid degrading bacterial strain, BCL-1 (*Ochrobactrum anthropic*) 1.0 x 10^6 cfu g^{-1}, 67.67 percent of imidacloprid was degraded within 48 hours (Hu *et al.*, 2013).

Table 1: Percent reduction of imidacloprid residues in soil fortified @ 50 mg kg^{-1} treated and untreated with *B. alkalinitrilicus*

Days after treatment	Percent reduction	
	Soil without treatment of bacteria	Soil treated with bacteria
7	15	20
15	30	50
30	50	70
45	65	85
60	80	95
90	90	100
120	95	100

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198.

Influence of Pesticides on Soil Enzymes in Tomato Crop under Polyhouse and Open Condition

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Keywords: Polyhouse; pesticide; soil enzyme; vegetable

Introduction

Cultivation of vegetables namely tomato (*Solanum lycopersicum*), capsicum (*Capsicum annuum)*, garden pea *(Pisum sativum),* eggplant *(Solanum melongena)* during off-season in polyhouse condition is practised largely in Uttarakhand. A variety of pesticides is used in polyhouses to maintain high crop yields. Soil is a living dynamic system containing many free enzymes and extracellular enzymes within microbial cells. Soil enzymes are the soil quality indicators which play an important role in organic matter decomposition and nutrient cycling (Garcı'a *et al.* 2008 and Omar *et al.* 2001). Thus, it is required to estimate soil biological responses to the pesticides in terms of soil enzyme activities. Therefore, the present study was aimed to determine the effects of pesticides on important soil enzymes such as, dehydrogenase, phosphomonoesterase (acid and alkaline phosphatase) and urease in tomato crop under open and polyhouse condition.

Materials and Methods

The experiment was conducted at the experimental farm (29°36' N and 79°40' E, 1250 m above msl) of Indian Council of Agricultural Research-Vivekananda Parvatiya Krishi Anusandhan Sansthan (ICAR-VPKAS), Hawalbagh, India. The experimental layout consists of nine treatments: recommended doses of carbendazim (0.25 kg a.i. per ha.) (1.0 CD); half of the recommended doses of carbendazim (0.5 CD); double doses of carbendazim (2.0 CD); recommended doses of carbofuran (1.0 kg a.i. per ha.) (1.0 CF); half of the recommended doses of carbofuran (0.5 CF); double doses of carbofuran (2.0 CF); recommended doses of both pesticides (1.0 CD + 1.0 CF) and half of the recommended doses of both pesticides (0.5 CD + 0.5 CF) along with control. Soil samples were collected randomly from the field at surface layer (0-20 cm), sieved (2 mm mesh) and kept at 4°C until further analysis.

Results and Discussion

In our study it was observed that all the pesticides treatments significantly influenced soil enzymatic activities as compared to control under both condition. The higher enzymatic activities were recorded under polyhouse condition as compared to open field (Table 1). Among all the treatments, application of recommended doses of carbendazim in polyhouse provided best phosphatase and dehydrogenase activities (436.6 mg PNP/gm soil/hr acid phosphatase, 287.3 mg PNP/gm soil/hr alkaline phosphatase and 52.8 µg TPF g $soil^{-1}$ h^{-1} dehydrogenase activity) followed by recommended doses of both pesticides; (420.3mg PNP/gm soil/hr acid phosphatase, 276.1 mg PNP/gm soil/hr alkaline phosphatase and 44.2 µg TPF g $soil^{-1}$ h^{-1} dehydrogenase respectively). However, different doses of carbofuran influenced the negative effects on above mentioned soil enzymes. In case of urease activity, significantly higher value was recorded with application of recommended doses of carbofuran (398.8 mg urea/kg soil/hr) followed by control plot (398.7 mg urea/kg soil/hr). The double doses of carbendazim provided the lowest activity (398.1 mg urea/kg soil/hr).

It can be concluded that enzyme activities were strongly influenced by the type of pesticides used in crops and condition (open and polyhouse) in this region. The micro-climate within the polyhouse condition provided the better enzymatic activity than open condition. Among the two soil applied pesticides, carbendazim provided the positive effect on enzymes except urease, while carbofuran showed the negative effects.

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Table 1: Effects of pesticides treatments on soil enzyme under open and polyhouse condition

Treatment	Acid Phosphatase (mg PNP/gm soil/hr)		Alkaline Phosphatase (mg PNP/gm soil/hr)		Dehydrogenase (µg TPF/g soil/hr)		Urease (mg urea/kg soil/hr)	
	Polyhouse	Open	Polyhouse	Open	Polyhouse	Open	Polyhouse	Open
1.0 CD	436.6±6.1	372.8±4.2	287.3±2.6	236.2±1.7	52.8±2.2	36.5±1.9	398.5±0.2	397.2±0.1
0.5 CD	395.0±3.8	328.4±1.8	265.7±3.4	213.8±4.1	40.8±2.4	29.4±0.9	398.7±0.2	397.8±0.2
2.0 CD	379.7±2.2	297.5±6.1	254.9±2.8	194.9±3.8	38.2±1.0	27.4±0.6	398.1±0.1	397.2±0.1
1.0 CF	282.8±2.8	230.9±2.6	183.0±2.8	137.8±5.1	27.9±0.9	24.3±0.8	398.8±0.2	397.8±0.1
0.5 CF	318.4±3.6	247.4±3.1	208.8±3.3	152.6±2.2	38.6±1.8	29.8±0.9	398.6±0.1	397.6±0.1
2.0 CF	269.1±3.8	213.3±2.7	167.5±4.1	178.6±2.3	24.2±0.9	18.8±0.3	398.5±0.1	397.5±0.1
1.0 CD + 1.0 CF	420.3±4.1	336.3±3.7	276.1±3.2	137.0±3.8	44.2±1.5	39.4±1.9	398.6±0.1	397.8±0.1
0.5 CD + 0.5 CF	390.6±4.4	327.3±2.8	260.9±1.2	223.1±6.9	39.7±1.7	30.5±1.2	398.5±0.1	397.6±0.1
Control	352.0±3.2	285.3±5.2	240.2±4.2	184.3±4.3	39.0±0.8	27.0±1.5	398.7±0.2	397.8±0.1
Initial	328.9±4.6	276.8±4.7	222.9±2.3	185.2±1.8	29.6±1.6	25.2±3.1	397.6±0.3	397.4±0.1

199.

Impact of Lead Pollution on Survival and Growth of Slug, *Filicaulis alte* and Snail, *Macrochlamys indica* Godwin-Austen

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Keywords: *Filicaulis alte, Macrochlamys indica,* lead contamination, bioindicators

Introduction

Lead pollution occurs as a consequence of combustion of petrol additives in automobiles and reaches soil by means of atmospheric precipitation (Amusan *et al.,* 2002). It has been substantiated that invertebrates tend to concentrate lead more than other aquatic organism. To reveal the presence of pollutants in the environment and to measure their toxic effects biological indicators can be used. *Filicaulis alte* and *Macrochlamys indica* are ideal species for environmental monitoring, because of their abundance, wide geographical distribution, relative longer life span, size, weight, easy identification and collection. They are suitable for hazard and risk assessment (Gupta and Singh 2011).

Materials and Methods

Slugs and snails were acclimatized for a week in plastic trays (each 18 x 15 x 4 cm) covered by moist muslin cloth on top. Soil was kept moist throughout the experiment by sprinkling water. Feeding and mortality experiment using different concentrations of lead (50, 100, 200, 400 and 800 µg/g of lead as Pb $(NO_3)_2$ mixed in *Triticum aestivum* (wheat bran) were conducted in plastic trays using 5 slugs (3-6 g body weight) and 5 snails (1.5- 2 g body weight) in each tray. Each treatment was replicated 3 times. Control experiment was run along with each test. Daily observations were made for their mortality during test period.

Results and Discussion

There was significant time dependent decrease in mean daily intake (MDI) of Pb contaminated bait as compared to uncontaminated one, resulted in reduction in mean body weight of snail, *M. indica*. The faecal matter was dark orange in colour in Pb treated snails when compared with the untreated ones, whose faecal matter was white in colour which might indicate that Pb is excreted through the body of snail through detoxification process. It was observed that in snails exposed to highest concentration of Pb (800 µg/g), there was thinning of shell near the operculum which indicate that highest concentration of Pb is detrimental to snail shell. So, snails were found to be tolerant to Pb with no mortalities.

Similar observations were recorded in case of slug, *F. alte* however they were found to be more sensitive than snails, showed 13.33% mortality with adverse morphological effects i.e. thinning of skin from ventral surface of body of one of the slug was noticed at highest Pb concentration (800µg/g). So based on these observations it was concluded that slug and snail could be used as bioindicators to monitor adverse effects of environmental Pb pollution.

Table: Effect of different concentrations of Pb in wheat bran on feeding responses of the snail, *Macrochlamys indica* (n= 5 snails/ replicate) in no-choice laboratory feeding tests

Treatment	Body weight of slug (g)		Increase (+)/ decrease (-) in body weight (%)	Overall bait intake (g/10g body weight)
	Before treatment	After treatment		
UT_1	3.76±0.97	4.17±0.33	10.9 (+)	1.54±0.08*
T_1-50ppm	4.36±0.19	4.19±1.08	3.89 (-)	0.78±0.10
UT_2	4.0±1.04	4.23±0.09	5.43 (+)	1.31±0.07*
T_2-100ppm	5.19±0.09	4.06±1.04	21.7 (-)	0.53±0.46
UT_3	4.50±1.41	4.87±0.16	7.59 (+)	1.45±0.06*
T_3-200ppm	5.58±0.16	5.49±1.4	1.61 (-)	0.39±0.12
UT_4	5.05±1.30	5.34±0.58	5.61 (+)	1.36±0.07*
T_4-400ppm	6.16±0.14	5.90±1.05	4.22 (-)	0.42±0.11
UT_5	6.33±0.24	6.47±0.23	2.16 (+)	1.16±0.21*
T_5-800ppm	7.06±0.23	6.38±0.24	9.63 (-)	0.19±0.04

Values are, Mean±S.E
%(+) - increase in body weight, %(-) - decrease in body weight, UT - Untreated, T- Treated
* Differences between consumption of untreated and treated baits significant at $p > 0.05$

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200.

Effect of Modified Atmospheres on *Caryedon serratus* (Olivier) in stored Groundnut

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Keywords: Modified atmospheres, groundnut, *Caryedon serratus*

Introduction

Groundnuts (*Arachis hypogaea* L.) are attacked by a plethora of insect pests in storage. Though most of the insect pests attack kernels, groundnut bruchid, *Caryedon serratus* (Olivier) is the major pest of groundnut that infests pods and kernels. Apart from the direct loss caused due to insect infestation, indirect loss in terms of quality of the produce, *i.e.,* loss in oil percentage, increase in free fatty acids and crude protein percentage also impacts oil and processing industry. Though effective insecticides are available, concerns over residues limit their use and necessitate the alternate methods for control of this insect pest. Use of carbon dioxide (CO_2) has gained importance as an effective alternative to hazardous chemicals for protecting the stored produce from various insects. Concentrations of CO_2 at 30, 40, and 50% of the volume in airtight plastic containers were effective in controlling the groundnut pod borer without affecting the germination (Bhogeesh *et al.*, 2013).

Materials and Methods

An experiment was conducted at Post Harvest Technology Centre, Bapatla in 2013 and 2014 to know the effect of different modified atmospheres on the development of the bruchid in groundnut stored in different packaging material. The packaging systems; namely, aluminium pouches with different atmospheres, Magik bag (M/s Coromandel International Limited) and jute bag were tested against groundnut bruchid at different exposure periods. There were eight treatments with gas mixtures of different concentrations of (T_1) CO_2 at the rate of 30% + N_2 at the rate of 56% + O_2 at the rate of 14%; (T_2) CO_2 at the rate of 50% + N_2 at the rate of 40% + O_2 at the rate of 10%; (T_3) CO_2 at the rate of 70% + N_2 at the rate of 24% + O_2 at the rate of 6%; and (T_4) CO_2 at the rate of 90% + N_2 at the rate of 8% + O_2 at the rate of 2%; (T_5) normal air with airtight seal; (T_6) normal air without seal; (T_7) Magik bag storage; and (T_8) jute bag storage. For the first six treatments aluminium pouches were used. Kernels of groundnut variety; TAG 24 free from insect infestation were taken and fumigated prior to use to ensure complete kill of field infestation, if any. Kernels (250 g) were taken in each bag of 500 ml capacity and five pairs of mating adults were introduced before filling with gas mixture. Gas mixtures of CO_2, N_2 and O_2 at required concentrations (v/v) were adjusted by removing the equivalent volume of air and subsequently required volume of gas mixture was injected using the modified atmospheric packaging (MAP) system and then sealed. The insects were exposed to four different periods *i.e.,* 40, 80, 120 and 160 days. There were three replications arranged in completely randomized design for each set of exposure period.

Results and Discussion

A decrease in percent grain damage was observed with the increase of CO_2 concentration at all the storage periods tested. Even at higher concentration of CO_2 (90%), a grain damage of 23.5% (Table 1) was observed as the CO_2 diffused out within few days. The grain damage was significantly less in Magik bag packing compared to all other treatments. While, highest damage was observed in the pack without seal. Similar trend was observed in the number of bruchid emergence also. Very less number of bruchids (4.33) emerged from the grain stored in Magik bag even after 160 days of storage. Magic bag was effective in protecting groundnuts from *C. serratus* damage for long time as the number of adults emerged and grain damage caused by them were minimum because of the hermetic conditions developed within, due to their impermeable nature to the external gases. The results also indicated that apart from the concentration of CO_2, permeability of packaging material is much more important parameter to be considered for maintaining modified atmosphere for a desired period and at a level that can achieve effective management of the insect. The results also suggested that CO_2 fumigation in airtight containers may be a better alternative for control of storage pests in high valued low volume produce.

Table 1: Effect of gas mixtures on bruchid emergence and grain damage in groundnut after storage of 160 days

Treatment	Treatment	*Caryedon adult emergence (No.)	**Grain damage%
T_1	CO_2 @ 30% + N_2 @ 56% + O_2 @ 14%	7.83 (2.80)	40.67 (39.6)
T_2	CO_2 @ 50% + N_2 @ 40% + O_2 @ 10%	6.83 (2.61)	36.33 (37.04)
T_3	CO_2 @ 70% + N_2 @ 24% + O_2 @ 6%	5.5 (2.34)	27.33 (31.48)
T_4	CO_2 @ 90% + N_2 @ 8% + O_2 @ 2%	4.83 (2.20)	23.5 (28.98)
T_5	Normal air with airtight seal	7.83 (2.80)	37.67 (37.84)
T_6	Normal air without seal	24.5 (4.95)	79.17 (62.87)
T_7	Magik bag storage	4.33 (2.07)	11.17 (19.51)
T_8	Jute bag storage	9.83 (3.14)	42.0 (40.38)
	CD (0.05)	0.16	1.77
	SEm±	0.05	0.58
	CV%	5.39	4.69

The values in parentheses are transformed (* Square root, ** angular) values.

201.

Impact of Climate Variability and Crop Phenology on Abundance of Mango Thrips

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Keywords: Thrips, weather, crop stage

Introduction

Mango (*Mangifera indica L.*) is one of the most important fruit crops of tropics in India and cultivated in 1.25 lakh hectares in Gujarat with 8.56 lakh tonnes of fruit production. Mango is attacked by many pests of which thrips (*Scirtothrips dorsalis, S. mangiferae,* and *Rhipiphorothrips cruentatus*) is another important pest of mango apart from hopper which remains persistent on the crop. Lee and Wen (1982) reported that injury is caused by puncturing and sucking sap from the epidermis of leaves and the affected area turn dark or develop scars curling and finally fall down. Flower and fruit drop at marble stages has also been reported under south Gujarat agro-climatic conditions (Anonymous, 2008). Significant impact of major abiotic factors and appropriate crop stages on thrips dominance inflict severe damages resulting into enormous crop losses. Due to these reasons, a study was planned in late nineties and later carried out during 2004-2014.

Materials and Methods

Seasonal abundance of mango thrips was studied in relation to weather factors and crop stages under field condition at standard week wise interval from July 2004 to June 2014 at AES, Navsari Agricultural University, Paria, Valsad, Gujarat. Ten unsprayed trees of mango cv. Alphonso were selected randomly in one hectare plot in **"W" design**. Ten twigs or panicles from lower canopy of each tree were sampled during vegetative and flowering stages of the crop, respectively and population was counted by tapping technique. Weather parameters of the preceding week was observed and relationship with thrips was studied along with crop stages.

Results and Discussion

During ten years of experimental period, the highest thrips population was noticed in 2010-2011. Thrips population varied from 0 to 61.00 thrips per panicle (average 18.96/panicle) during peak year of activity. The highest thrips (61.00/panicle) were noticed on 6th SW followed by 51.00 during 5th SW.

The total contribution of all the factors on fluctuation of thrips population was 65.48 per cent (R= 0.8420 significant at 1%). Regression equation of thrips population during peak activity year was:

$$\hat{Y}= 114.8857 + 2.5991 (X_2) + 0.0193 (X_3) + 1.2214 (X_5) - 1.5413 (X_6) - 0.0206 (X_7) - 0.0274 (X_8) + 0.5983 (X_9) - 1.9620 (X_{10})$$

Where, Y= Thrips/twig or panicle, X_2= Minimum temperature,X_3= Average temperature, X_5= Evening Relative humidity, X_6= Average temperature, X_7= Rainfall,X_8= Rainfall days, X_9= Sun shine, X_{10}= Wind velocity.

It is evident from the above results that slight increase in maximum temperature from 32.04 to 32.05°C (0.01), minimum temperature from 18.67 to 18.75°C(0.08), average temperature from 24.67 to 25.40°C (0.73), morning relative humidity from 87.84 to 89.62 per cent (1.78), average relative humidity from 71.15 to 73.68 per cent (2.53), rainfall from 43.90 to 55.68 mm (11.78), rainy days from 1.66 to 1.81 (0.15), sun shine from 7.67 to 7.79 hours (0.12) and wind velocity from 4.07 to 4.13 kms/hours (0.06) and with slight decrease in evening relative humidity from 57.89 to 57.74 per cent (0.15) indicated sharp rise in thrips population from 12.16 to 18.96 per twig or panicle i.e. a rise of 5.97 which is much more than the threshold value (presence of thrips) of the pest under consideration.

From the results, it can be summarized that during the entire experimental period there were two active periods, first between 41-50 SW (8 October - 16 December) which had its peak (19.30 thrips/twig in pooled observation) on 49th SW (3-9 December) coinciding with bud burst stage of the crop, whereas second active period was between 2-17 SW (8 January - 29 April) which showed its peak (29.70/ panicle) on 9th SW (26 February - 4 March) coinciding with pea cum marble stages of crop.

Slight increase of temperature (0.73°C), relative humidity (2.53%), rainfall (11.78 mm), rainy days (0.15), sun shine (0.12 hours) and wind velocity (0.06 km/hours) which in turn increased dampness in the environmental conditions conducive for sharp rise in thrips population. If wind velocity increased even by 0.06 kms per hour, migration of thrips on mango trees increased leading to higher population and its oriented damage. These results are also supplemented by results based on decrease in evening relative humidity (0.15%).

Correlation of thrips in relation to various crop stages was significant and positive ('r'= 0.1747) implying that population increased with the advancement of crop growth. So, as the crop growth advanced from new flush to new twig, the thrips oviposition and multiplication increased which might have led to increased population and subsequently higher damage. Similarly from new twig to bud or bud burst stage, the pest population increased further which ultimately reached to its peak either during peak flowering or marble sized fruit stage.

As the annual crop cycle was near to its completion i.e. from flowering to fruiting or ripening, the pest population increased initially but later on decreased to its minimum at harvest stage. This clearly proves that succulent crop stages like new flush, twigs, bud, flowering and marble sized fruit stage were preferred most by the pest under consideration whereas, hard crop stages like mature or ripened fruits were less preferred by the pest under consideration.

In the above reports higher thrips population has been recorded during flowering and fruiting stages of the crop. In the present investigation, higher population of thrips was observed on new flush (9.05-13.05 thrips/twig) and reproductive (16.02-27.95) stages of crop growth which is nearly the same as reported earlier, thus conform the ongoing discussion.

So, it may be concluded that thrips population peaked during 2010-11 wherein slight increase in temperature, relative humidity and rainfall, rainy days, sun shine and wind velocity accounted for increased dampness in the environmental conditions which appeared to be conducive for sharp rise in thrips population. These results are also supplemented by results based on decrease in evening relative humidity (0.06). Wind velocity increase by 0.06 km/h per hour, migration of the pest increased correspondingly, that led to higher damage. The pea cum marble sized fruit stage of the crop was preferred most by the pest under discussion.

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202.

Diversity and Seasonal Activity of Insect Pollinators Visiting Apple Bloom in Relation to Weather Parameters

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Keywords: Seasonal activity, Malus, Apis.

Introduction

Process of pollination is complex and is influenced by several environmental factors like temperature, light intensity, wind, etc. Such factors strongly affect the foraging activity of pollinating insects; appear to act by imposing thresholds which limit the duration of activity (Joshi and Joshi, 2010). Bee species differ in their responses to climatic conditions and are indicative of their different physiological adaptation and partitioning of food resources in sympatric condition (Knoxfield, 2002). Seasonal activity of pollinators visiting apple bloom depicted that total of 59 insect visitors belonging to 5 orders and 28 families visit apple during bloom time. Among these insect visitors 12 species *Apis mellifera* L.*, Apis cerana indica* F, *Bombus funerarius* Smith, *Xylocopa fenestrata* F., *Lasioglossum moroi* (Fabricius), *Halictus confuses* Smith, *Vespa auraria* Smith, *Syrphus balteatus* De Geer, *Eristalis tenax* (L.), *Musca domestica* L.*, Pieris brassicae* (L.) and *Coccinella septumpunctata* L. were frequently present at all the locations in Anantnag, Baramulla and Srinagar (Kashmir valley). Rests of the insects were occasional visitors visiting the bloom at interrupted intervals. The seasonal activity and abundance of these visitors vary in relation to environmental variables.

Materials and Methods

The Study was conducted in 2011 & 2012 in three major districts of the Kashmir valley namely Anantnag, Baramulla and Srinagar. The observations were recorded throughout the day at hourly intervals after two days of commencement of flowering and continued till 90% flowering. The counts of insect visits were taken in one square meter bloom area for fifteen minutes in the beginning of each hour, replicated five times. Atmospheric temperature, relative humidity and light intensity on pollinator activity of released pollinators (Introduced bees hives put by us in orchids in addition to the already pollinators of the said orchid) in the respective locations during the experiment were also recorded. The atmospheric temperature and relative humidity were measured with the help of Aasman type cyclometer (Wet and Dry bulb thermometer) and light intensity was recorded with the help of Luximeter.

Results and Discussion

A total of 59 insects belonging to 5 orders and 28 families of class insect were recorded visiting apple bloom in three districts of the Kashmir Valley. Out of these, 27 insect visitors belonged to hymenoptera, 24 to diptera, 3 to lepidoptera, 3 to coleopteran and 2 to odonata. Among these insect visitors 12 species *Apis mellifera* L.*, Apis cerana indica* F, *Bombus funerarius* Smith, *Xylocopa fenestrata* F., *Lasioglossum moroi* (Fabricius), *Halictus confuses* Smith, *Vespa auraria* Smith, *Syrphus balteatus* De Geer, *Eristalis tenax* (L.), *Musca domestica* L.*, Pieris brassicae* (L.) and *Coccinella septumpunctata* L. were frequently present at all the locations in Anantnag, Baramulla and Srinagar. Rests of the insects were occasional visitors visiting the bloom at interrupted intervals the present findings draw the support from the observations of Raj *et al.* (2012) who reported that apple flowers in Solan (H.P) were visited by 46 species of insects belonging to 5 orders and 17 families of class Insecta. Dashad and Sharma (1993) reported a total of 19 insects belonging to 11 genera of 6 families Kumar (1988) reported a total of 49 insect species, while as Thakur (2005) reported 48 species of insects belonging to 5 orders and 18 families of class insect. Differences in number of species recorded by different workers including the present investigation are attributed to differences in agro climatic conditions of the localities, differential adaptability of a particular native species to its local environmental conditions or due to orientation of other insect visitors to apple during bloom.

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Table 1: Insect visitors of apple bloom with taxonomic status in three districts of Kashmir during 2011 & 2012

Order	Family	Genus/Species	Anantnag	Srinagar	Baramulla
Coleoptera	Coccinellidae	*Coccinella septumpunctata* L.	✓	✓	✓
		Hippodamia variegata (Goeze)	✓	X	✓
	Chrysomelidae	*Altica cyanea* Weber	✓	✓	✓
Hymenoptera	Apidae	*Apis mellifera* L.	✓	✓	✓
		Apis cerana indica F.	✓	✓	✓
		Eucera vernalis (Morawitz)	X	✓	X
		Anthophora sp.	✓	X	✓
		Xylocopa fenestrata F.	✓	✓	✓
		Anthophora confuse Smith	✓	X	✓
		Bombus funerarius Smith	✓	✓	✓
		Thyreus nitidulus (Fabricius)	X	✓	X
		Melissodes bimaculata nulla Laberge	✓	X	✓
	Halictidae	*Lasioglossum morio* (Fabricius)	✓	✓	✓
		Ceratina hieroglyphica Smith	✓	✓	X
		Halictus confuses Smith	✓	✓	✓
		Ceratina calcerata Robt	✓	X	X
		Polistes maculipennis Saussure	X	✓	X
	Vespidae	*Polistes* sp.	X	✓	X
		Odynerus sp.	✓	✓	X
		Vespa auraria Smith	✓	✓	✓
	Andrenidae	*Andrena gravida* Imhoff	X	✓	✓
	Ichneumonidae	*Pimpla* sp.	✓	X	✓
	Megachilidae	*Megachile* sp.	X	✓	✓
		Osmia sp.	✓	✓	X
	Sphecidae	*Pison punctifrons* Shuckard	✓	✓	X
	Sapygidae	*Eusaphyga verticalis* (Cresson)	X	X	✓
	Pompilidae	*Pepsis* sp	X	✓	✓
	Tenthredinidae	*Athalia proxima* Klug	✓	X	✓
	Scoliidae	*Megascolia haemorrhoidalis* F.	X	X	✓
	Eumenidae	*Rhychium* sp	✓	✓	X
Diptera	Syrphidae	*Eristalis soliatus* Walker	✓	✓	✓
		Eristalinus sp.indet.	✓	✓	X
		Didea fasciata Macquart	X	✓	✓
		Scaeva pyrastri L	X	✓	✓
		Syrphus balteatus De Geer	✓	✓	✓
		Syritta sp.indet	✓	X	X
		Sphaerophoria sp.	X	✓	✓
		Syritta orientalis (L.)	X	✓	X
		Eristalis tenax (L.)	✓	✓	✓
		Eristalis arbustorum (L.)	✓	X	X
		Eristalis sp.	X	✓	✓

203.

Studies on Various Pollinator Attractants on Seed Yield of Knol Khol

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Keywords: Pollinator attractants, fruit boost, knol khol, yield.

Introduction

Knol khol (*Brassica oleracea var, gongylodes*), is widely used in Kashmir as vegetableand grown in almost all kitchen gardens. This crop is highly cross-pollinated (91%) and mode of pollination is entomophily.Any material to increase the visit of honey bees or other pollinators to thiscrop would be of greater practical value to harness the benefits of cross pollination. Commercial and some chemical bee attractants namely fruit boost, citral, geraniol and sugar solution were evaluated for their attractiveness to pollinators. However, in India the studies on the use of bee attractants are meagre and it is the first attempt in Kashmir in this direction.

Materials and Methods

The following experiments was carried out at Vegetable Seed Production Unit, Division of Vegetable Science, Shuhama Campus, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir in *rabi* 2013-14. The experiment was laid out in randomised block design (RBD) in the plots of 3m × 3m with a buffer zone of 5m × 5m between treatments and replications. Treatments namely fruit boost at the rate of 1% and 0.5%, geraniol at the rate of 1%, citral at the rate of 1%, at the rate of 1%+citral1% and sugar solution at the rate of 10% were evaluated. The qualitative and quantitative seed parameters were recorded were: number of seeds siliqua^{-1}, number of pod plant^{-1}, thousand seeds weight (test weight),seed yield plant^{-1},increase in yield over control, and germination percentage. The data were subjected to suitable statistical analysis and later DMRT (Duncans Multiple Range Test) was made to assess their significance.

Results and Discussion

The crop sprayed with fruit boost (1%) was found superior by recording highest number of siliqua (291.67 siliqua/plant) with14.74% increase over control and it was at par with fruit boost at the rate of 0.5% (285.33 siliqua/plant) with12.26% increase over control (Table 1). While as sugar solution of 10% (260 siliqua/plant) was at par with unsprayed control (254.33 siliqua/plant).For seed/siliqua, the crop sprayed with fruit boost at the rate of 1% was found superior by recording highest number of seeds (10.45 seeds/siliqua) However, all other treatments were was at par with unsprayed control (7.33 seeds/siliqua).In case of seed yield, again crop treated with fruit boost at the rate of 1% produced significantly higher yield of 10.74 g/plant and resulted in 104.79% increase in the yield over control. However, Sugar solution at the rate of 10% recording 6.18 g/plant was at par with unsprayed control recording 5.3 g/plant. Test weight of crop treated with fruit boost at the rate of 1% was significantly superior (3.52 g/1000 seed) with an increase of 23.34% over control. Whereas unsprayed control recorded least test weight of 2.56 g/1000 seeds.Significantly higher germination per cent of 95.64 was recorded from crop sprayed with fruit boost at the rate of 1% which accounted for 14.27% increase over unsprayed control. Butsugar solution of 10% recording 83.73% germination was at par with unsprayed control recording 83.70% germination (Table 1).

Table 1: Influence of pollinator attractants on quantitative seed yield parameters of knol khol

Treatment	No. of siliqua plant^{-1}	Increase over control (%)	No. of seeds pod^{-1}	Increase over control (%)	Yield/plant (g)	Increase over control (%)	Test weight	Increase over control (%)	Germination (%)	Increase over control (%)
Geraniol @1%	273.00^{bcd}	7.33 (2.80)	8.33^{ab}	14.02 (3.86)	7.44^{c}	39.88 (3.61)*	3.27^{c}	14.48 (3.88)	85.69^{b}	2.28 (1.80)**
Citral @ 1%	269.33^{bc}	5.93 (2.61)	8.00^{a}	9.26 (2.89)	6.98^{bc}	31.13 (3.16)*	3.24^{c}	13.38 (3.76)	84.80^{b}	1.32 (1.58)**
Geraniol 1% + citral 1%	278.67^{cd}	9.59 (3.22)	8.67^{ab}	18.78 (4.37)	8.02^{c}	51.2 (4.1)*	3.33^{cd}	16.4 (4.15)	87.15^{b}	4.13 (2.21)**
Fruit boost @ 1%	291.67^{e}	14.74 (3.94)	10.45^{c}	45.89 (6.65)	10.74^{e}	104.79 (5.86)	3.52^{e}	23.34 (4.90)	95.64^{d}	14.27 (3.90)**
Fruit boost @ 0.50%	285.33^{de}	12.26 (3.57)	9.56^{bc}	33.97 (5.54)	9.23^{d}	76.81* (4.98)	3.39^{d}	18.47 (4.40)	92.46^{c}	10.47 (3.38)**
Sugar solution 10%	260.00^{ab}	2.27 (1.71)	7.67^{a}	5.56 (2.06)	6.18^{ab}	16.53 (2.32)*	3.10^{b}	8.42 (2.90)	83.73^{a}	0.03 (1.07)**
Control (Unsprayed plot)	254.33^{a}	_	7.33^{a}	_	5.3^{a}	_	2.86^{a}	_	83.70^{a}	--
SEm±	4.68	0.32	0.43	0.78	0.37	0.74	0.03	0.19	0.89	0.21
C.D ($p \leq 0.05$)	14.59	1.05	1.35	2.48	1.15	2.37	0.11	0.63	2.79	0.69

Values in the parenthesis are square root transformed values.
*Values in the parenthesis are arc sign transformed values.
**Values in the parenthesis are square root transformed values.
SE: Standard error
CD: Critical difference
Means followed by same letter in a column do not differ significantly by DMRT.

204.

Foraging Behaviour of Honeybees (*Apis spp.*) (Hymenoptera: Apidae) in Seed Production of Broccoli (*Brassica oleracea* var. *italica* Plenck)

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Keywords: *Brassica oleracea* var. *italica* Plenck., *Apis spp.,* foraging behavior, seed production

Introduction

Pollination by insects is inevitable for *Brassica*, since they are generally incompatible and the pollen is heavier and sticky unable to carried by wind. Even though, the bees are reported as marvelously coevolved pollen transferring devices for *Brassicas*, the pollination potential and economic importance of the effect of honeybees on these vegetables still need to be established. The present study was conducted to study the pollinator diversity and their foraging behaviour and to evaluate the role of insect pollinators on seed crop production.

Materials and Methods

Experiments were conducted under field conditions at University Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus Chatha, Jammu, during *rabi* 2014-15. Diversity and population density of pollinators (Number of insect pollinators of each species visiting broccoli); relative abundance of pollinators (number of flowers visited by pollinators during different times of the day); foraging behaviour (Number of flowers (Number of pollinators/m^2/minute) visited by insect pollinators at different hours of the day, foraging rate of honey bees (Mean number of flowers visited/minute), foraging speed i.e. time spent by different insect pollinators in sec (Time spent on flowers) and impact of mode of pollination on quantitative yield parameters namely number of siliqua per plant, siliqua length, seeds per siliqua, 1000 seed weight (g) and seed yield (q/ha) were recorded.

Results and Discussion

The blooming crop of the broccoli was visited by 17 species of insects belonging to 6 orders and 11 families of class insecta. Hymenopterans were the most dominant visitors constituting 98.18%of the insect visitors. Their abundance was in the order: *A.dorsata> A. mellifera > A cerana > A. florea.* Multiple regression coefficient of determination (R^2) established that abiotic factors contributed 95.40, 79.50, 94.90, 99.80 and 99.40% variation in *A.mellifera*, *A.cerana, A.dorsata*, *A. florea* and syrphids population, respectively. The mean foraging rate irrespective of different dates and times was the highest for *A. dorsata* (5.35±0.33 flowers min^{-1}) followed by that of *A. mellifera* (4.87±0.34 flowers min^{-1}), *A. cerana* (1.75±0.23 flowers min^{-1}) and *A. florea* (0.11±0.09 flowers min^{-1}). Mean time spent (in seconds) irrespective of different dates and times was the highest for *A. dorsata* (5.20±0.5.20 seconds) followed by that of *A. mellifera* (3.87±0.22 seconds), *A. cerana* (1.72±0.23 seconds) and *A. florea* (1.05±0.58 seconds). Significantly highest seed yield (Table 1) was recorded in the treatment that was open pollinated plots (563.57 $kgha^{-1}$) followed by *A. mellifera* (323.12 $kgha^{-1}$) plots and caged pollination (234.46 kg ha^{-1}). Enhancement of insect pollinators as part of crop management should be considered by farmers.

Table 1: Effect of mode of pollination on yield parameters of broccoli.

Yield parameters	Bee pollination	Caged pollination	Open pollination
Siliqua length (cm)	5.32±0.36	5.12±0.34	5.68±0.16
Siliqua /plant	355±19.33	328±43.35	474±25.07
Seed/Siliqua	12.80±0.58	10.40±1.53	14.40±0.92
1000 grain weight (g)	2.56±0.13	2.53±0.09	2.97±0.15
Yield/ha (kg)	323.12	234.46	563.57
Per cent increase in yield	37.81	-	140.37

205.

Abundance and Foraging behaviour of Major Insect Pollinators on Seed Crop of Broccoli (*Brassica oleracea* L. var. *italica* Plenck) Variety GH-1

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Keywords: Honey bees, species, broccoli, abundance and foraging

Introduction

Broccoli (*Brassica oleracea* L. var. *italica* Plenck) belongs to family Cruciferae and its flower head is used as a vegetable. It is an Italian word from Latin *Brochium* meaning an arm branch. It is the most nutritious among the cole group of vegetable crops. It is an entomophilous crop and insect play major role in pollination. Among the insects honey bees are the major pollinator of the broccoli. Being a cross-pollinated crop its seed production is expected to be effected by the visits of the pollinating insects. Devkota and Thapa (2005) studied that two bee species *(A. cerana* and *A. mellifera*) differed significantaly (P<0.05) on the number of flower visits per minut on broccoli. *A. cerana* showed higher flower visiting efficiency as compared to *A. mellifera*. The average number of flower visited by *A. cerana* bee was 11.387 and 12.107 per minute as compared to 9.033 and 10.889 flower per minute by *A. mellifera* under caged and open conditions respectively.

Materials and Methods

For recording abundance, numbers of pollinators visiting per square meter area of crop/5 minutes were noted from five randomly selected areas. These observations were recorded from 0700 to 1900 hours at an interval of 2 hours. Observations were recorded for 7 days after the initiation of 10 days flowering in the crop, at peak flowering and before the cessation of flowering in the crop. Foraging speed of bees was recorded in terms of time (seconds) spent by them on each flower A total of ten bees of each species were observed for recording time spent by them per flower at peak flowering period of the crop. Foraging rate of bees was recorded in terms of the number of flowers they visited per minute. A total of ten bees of each species were observed for recording the number of flowers visited per minute at peak activity time of particular species at peak flowering period of the crop.

Results and Discussion

The cumulative mean abundance of important bee species revealed that *Apis mellifera* (7.34) was the most abundant visitor followed by *Apis florea* (6.67), *Apis dorsata* (2.15), syrphid fly (1.84), and *Apis cerana* was least frequent (1.22) visitors (Table 1). For *A. mellifera*, the maximum bee population was observed at 1100-1300 h (14.20 bees/m^2/5 minutes), followed by 1300-1500 h (13.80 bees/m^2/5 minutes), 0900-1100 h (2.17 bees/m^2/5 minutes), 1500-1700 h (6.37 bees/m^2/5 minutes), 1700-1900 h (2.17 bees/m^2/5 minutes) and 0700-0900 h (0.80 bees/m^2/5 minutes). Irrespective of species, abundance of bees was the lowest at 0700-0900 h (0.50 bees/m^2/5 minutes) and the highest at 1100-1300 h (7.51 bees/m^2/5 minutes). The highest foraging rate (no. of flowers visited/minute) was of syrphid fly (18.71) followed by *A. cerana* (12.87), *A. mellifera* (12.12), *A. dorsata* (10.55) and *A. florea* (1.89). Mean maximum foraging rate of syrphid fly, *A. cerana, A. mellifera, A. dorsata,* and *A. florea* was observed during 1500-1700, 1100-1300, 1300-1500, 1100-1300 and 0900-1100 h of the day respectively (Fig. 1). The highest foraging speed was of *A. florea* (44.70) followed by *A. dorsata* (6.05), *A. mellifera* (5.64), *A. cerana* (4.71) and syrphid fly (3.50). Mean maximum foraging speed of *A. florea, A. dorsata, A. mellifera, A. cerana* and syrphid fly was observed during 1700-1900, 1500-1700, 1500-1700, 1500-1700 and 1700-1900 h of the day respectively. Foraging speed of *A. florea* during peak flowering irrespective of day hours was observed maximum (38.54) followed by *A. dorsata* (5.24), *A. mellifera* (4.54), and *A. cerana* (3.51) and syrphid fly (2.65).

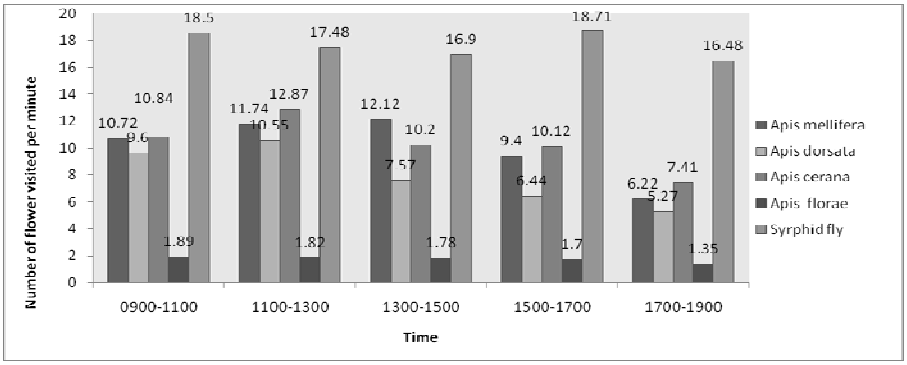

Fig. 1: Foraging rate of different honey bee species on broccoli flowers variety GH-1 at different hours of the day

Table 1: Diurnal abundance (irrespective of flowering stage of crop) of major insect pollinators on blossoms of broccoli variety GH-1 during Feb- March, 2014

Species	Number of bees/m^2/5 minutes during different day hours						
	0700-0900	**0900-1100**	**1100-1300**	**1300-1500**	**1500-1700**	**1700-1900**	**Mean**
Apis mellifera	0.80 (1.34)	6.58 (2.75)	14.20 (3.89)	13.80 (3.84)	6.37 (2.71)	2.17 (1.74)	**7.34 (2.71)**
Apis dorsata	1.68 (1.63)	2.16 (1.77)	2.27 (1.80)	2.47 (1.86)	2.32 (1.82)	2.01 (1.58)	**2.15 (1.78)**
Apis cerana	0.01 (1.01)	1.59 (1.60)	1.92 (1.71)	2.00 (1.71)	1.30 (1.50)	0.47 (1.20)	**1.22 (1.45)**
Apis florea	0.00 (1.00)	3.20 (2.03)	15.5 (4.05)	14.03 (3.86)	5.17 (2.43)	2.03 (1.68)	**6.67 (2.51)**
Syrphid fly	0.03 (1.01)	0.84 (1.34)	3.53 (2.12)	3.57 (2.13)	2.12 (1.71)	0.93 (1.36)	**1.84 (1.61)**
Mean	**0.50 (1.20)**	**2.88 (1.90)**	**7.51 (2.71)**	**7.18 (2.68)**	**3.45 (2.03)**	**1.52 (1.56)**	

Each value represents mean of 5 observations at each sampling time
Figures in parentheses are √(x+1) transformed values

Factors	SE(m)	SE(d)	C.D. (p=0.05)
Species	0.005	0.007	0.013
Day hours	0.005	0.007	0.014
Species X day hours	0.011	0.016	0.032

206.

Growth and Yield Enhancement of Two Extrafloral Nectary-bearing Plants by Ants

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Keywords: Extrafloral nectary, ant- nest, plant growth, soil nitrogen

Introduction

Extrafloral nectaries (EFNs) are nectar-secreting glands of plants visited by insect species such as ants and wasps (Koptur 1992). EFNs secrete aqueous solutions composed chiefly of sugars and sometimes containing small amounts of amino acids and other compounds (Baker *et al.*, 1978). Ants could benefit plants by providing them with nutrients. When ants store food, discard debris, and defecate, they tend to concentrate organic matter in and around their nests. We hypothesize that plant- derived food sources, such as extrafloral nectar, influence the foraging and nesting behaviour of soil-dwelling ant colonies and this in turn has positive impact in promoting plant growth and yield.

Materials and Methods

Study was conducted at the Botanical Garden and the Zoology Department Garden, Banaras Hindu University campus, Varanasi.

Study system and experimental design: *Vigna unguiculata* L. Walp (Family: Fabaceae) is a vegetable crop plant commonly known as cowpea while *Impatiens balsamina* Linn., (Family Balsaminaceae) is an ornamental plant commonly known as balsam. The seeds of *Vigna unguiculata* were sown in polybags (12.5 cm x 25.5 cm), containing garden soil, in the Botanical garden. Seeds of *Impatiens balsamina* were sown in an area (5m×1m) with 25 plants in each plot (n=4) in zoology department garden. Seedlings (n=30) were transplanted into polybags (12.5 cm x 25.5 cm), containing garden soil, in the botanical garden. Ants were excluded by application of a 2cm ring of tangletrap on control plants of both the species (n=50). Plant growth parameters and yield were analyzed and total nitrogen content of soil was determined by Micro- Kjeldahl method in both control and experimental plants

Results and Discussion

Colonies of the ant, *Camponotus compressus* preferred to nest at the base of the experimental EFN- bearing plants. The growth parameter values of the cowpea and balsam plants i.e. root length, shoot length, root fresh weight, shoot fresh weight, leaves fresh weight, fruits fresh weight, root dry weight, shoot dry weight, leaves dry weight, fruits dry weight, leaf area and total biomass were significantly higher in the ant- included plants where *C. compressus* nests were present at the plant base as compared to the ant- excluded, control plants. Total nitrogen content in the ant- nest debris soil and in the ant- included plant soil was significantly higher than the control soil. This study thus demonstrates that the presence of *C. compressus* nests at the EFN- bearing plant base increases total soil nitrogen content resulting in enhanced plant growth and yield.

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207.

Genetic Association of Lac Insect (genus: *Kerria*) Genotypes using EST-Microsatellite Markers

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Keywords: Lac insects, molecular marker, microsatellites

Introduction

Lac insects are economically important insects producing resin, dye and wax. The most commonly found and cultivated species of lac insects in India is *Kerria lacca* (Kerr). However, 32 species of *Kerria* have been reported. Since the lac insect genetic base is very diverse and development of markers is a pre requisite for its conservation and improvement through molecular breeding, this study is carried out for developing microsatellite markers for lac insects which belong to the genus *Kerria*. The primers developed from transcriptome data have been utilized in this study for deciphering genetic diversity of 26 lac insect lines collected from different parts of India and one exotic line.

Materials and Methods

The lac insect lines maintained on potted *Flemingia macrophylla* plants under protected conditions were used. These included different species of *Kerria* (*K. lacca, Kerria chinensis and Kerria sharda*) from the principal lac growing states, geographical races, cross bred lines, infra-subspecific forms of *K. lacca* namely, *kusmi* and *rangeeni* and different coloured lac insects. A total of 86 SSR primers designed from the transcriptome data of *K. lacca* were used to amplify the genomic DNA of lac insects. The data obtained from the PCRs was analyzed using NTSYSpc 2.02i software package and the unweighted pair group method with arithmetic mean (UPGMA) dendrogram was constructed to study the genetic relatedness of the lac insect lines.

Results and Discussion

Out of the 86 microsatellite markers, 31 produced polymorphic, satisfactory, clear and reproducible banding patterns for all the genotypes. The selected primers showed a range of polymorphism from 66.67 to 100%. The number of alleles per locus ranged from 2 to 6 and mean number of alleles per locus was 2.80, and the size of amplified products varied from 154 bp to 400 bp. The UPGMA dendrogram based on Jaccard's similarity coefficient grouped 27 *Kerria* accessions into three major clusters consisting of 2, 13 and 12 genotypes (Fig. 1). The similarity coefficients range varied from 0.62 to 0.84 with a mean value of 0.73 for *K. sharda*, 0.52 to 0.82 with a mean value of 0.67 for *K. chinensis* and 0.52 to 0.95 with a mean value of 0.735 for *K. lacca*. This study reveals a higher genetic diversity existing among *Kerria* genotypes and especially higher intra *Kerria* polymorphism within species. The identified markers could be used in future lac crop improvement programmes to develop high lac resin yielding insects. The conservation strategies either *in situ* or *ex situ* can also rely on these markers for better conservation and utilization of lac insect genetic resources available in the country. There is a future scope for using more number of markers and complementing with other markers to better understand the genetic relatedness within the genotypes under study.

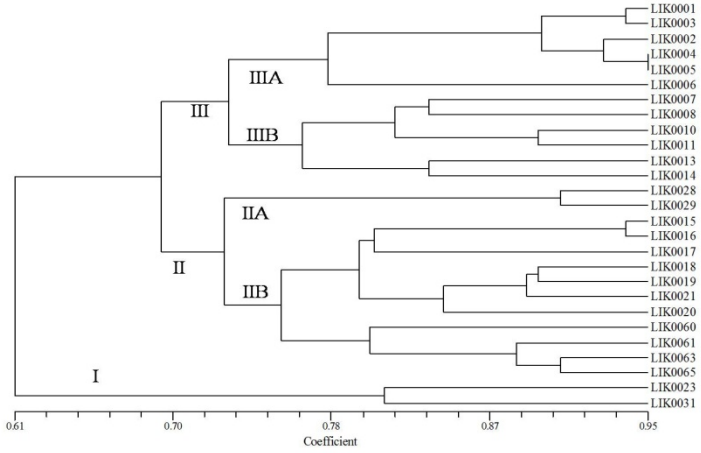

Fig. 1: UPGMA dendrogram of 27 genotypes of Kerria spp. based on the 31 EST-SSR primers

208.

The Effect of Number of Visits by *Apis dorsata* on Pumpkin, *Cucurbita moschata* (Duch.ex Lam) Flowers on Fruit Set, Yield and Quality Parameters

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Keywords: Honey bee species, pumpkin, fruit set, yield and quality parameters.

Introduction

The word pumpkin originates from the Greek word *pepon* meaning for large melon and refers to the broader category called *winter squash* in North America. Pumpkin, *Cucurbita moschata* (Duch.ex Lam) is a gourd like squash belonging to the family Cucurbitaceae. Pumpkins are grown all around the world for a variety of reasons ranging from agricultural purposes to ornamental sales. The female flowers are distinguished by small ovary at the base of the petals. In both type of flowers, opening is initiated before dawn. The size and complexity of floral display used to advertise their location is one of the several factors influencing the behaviour of pollinators.

Materials and Methods

The studies were carried out at the Research farm and Apiculture Laboratory of the Department of Entomology and Laboratory of Department of Seed Science and Technology, Chaudhary Charan Singh Haryana Agricultural University, Hisar during June to December, 2013 on two cultivars of pumpkin viz., C-1076. For comparing the effect of number of *Apis dorsata* visits on a single female flowers on fruit set and yield of pumpkin, ten female flowers for each treatment were enclosed with butter paper bags a day before their opening. The butter paper bags were removed after the flowers opening and each such set of flowers were allowed for one, two, three, four and five visits of *A. dorsata* and observations on fruit set, yield and quality parameters namely fruit size (length and diameter in cm), fruit weight (g), number of seeds per fruit, seed test weight (g), seed germination percentage and seed vigour.

Per cent fruit set:

$$\text{Per cent fruit set} = \frac{\text{Total number of fruit set}}{\text{Total number of flowers tagged}} \times 100$$

Seed vigour I: Seed vigour I= Germination (%) x seedling length (cm)
Seed vigour II: Seed vigour II= germination (%) x seedling dry weight (g)

Results and Discussion

The perusal of data presented in Table 1. Reveal that the mean per cent fruit set by different number of visits on the flowers by *A. dorsata* differed significantly. Results show that the highest per cent fruit set per plant was found to be 77.84 in five visit by *A. dorsata* followed by four, three and two visits in cultivar C-1076 respectively. The least per cent (36.08 and 32.84) fruit set was observed in one bee visit. Ali *et al.* (2014) reported that in *Cucurbita pepo,* single visit efficacy in terms of fruit set percentage was the highest in *Nomia* sp. (36.66) followed by *A. dorsata* (23.33) and *Halictus* sp. (20.0). Highest mean fruit weight (g) was recorded as 2787.80 in five visits by *A. dorsata* followed by four, three, two and one visits. The least fruit weight 656.20 g was observed in one bee visit. Highest mean fruit length (cm) was recorded as 38.15 cm in five visit by *A. dorsata* followed by four, three and two visits. The average fruit diameter (cm) was maximum in five visits by *A. dorsata* followed by four, three and two visits which was significantly higher than the fruit diameter under one visit. Fruit production occurs only when the insects visits the flowers up to 9 h. Fruit set, fruit size and weight and number of seed increase as the number of visits by *A. mellifera* also increased up to 16 visits per female flowers, at which the highest fruit set level was reached. The flowers open to visitation until 0900 h originated fruit with 35% fruit set, 171.14 mm in length, 100.29 mm in width, weight of 1340 g and 120.57 seeds. Mean number of seeds per fruit, seed test weight, germination percentage, vigour I and vigour II, all parameters were recorded maximum in 5 visits by *A. dorsata* followed by 4, 3, 2 and 1 visit in C-1076 cultivars.

Table 1: Effect of different visits on the flowers of pumpkin by *Apis dorsata* on fruit set, yield and quality parameters

No. of visits	Fruit set	Fruit weight	Fruit length	Fruit diameter	number of seeds per fruit	Seed test weight	Germination %	Vigour 1	Vigour 11
One	36.08(34.62)	656.20	18.20	27.78	125 (11.21)	75.13	86.00 (65.10)	2378.50	3.80
Two	45.35(42.08)	951.90	22.75	32.57	179 (13.36)	76.24	87.88 (65.40)	2588.61	4.02
Three	57.24(49.04)	1625.40	29.90	37.65	279 (16.70)	79.67	90.00 (72.16)	2603.34	4.53
Four	67.77(54.93)	2274.00	33.00	41.35	350 (16.79)	83.25	92.65 (76.94)	2743.07	4.57
Five	77.84(61.39)	2787.80	38.15	43.52	370 (17.62)	85.74	94.85 (80.01)	2796.03	4.59
C.D. (p=0.05)	(4.54)	2.15	0.29	0.30	(1.40)	N/S	(4.24)	N/S	N/S

Each value represents mean of 10 observations; Figures in parentheses are angular root transformed values

209.

Diversity of Pollinator Fauna on Underutilized Fruit, Bael (*Aegle marmelos* (L) Corr.)

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Keywords: Bael, hymenoptera, insect, pollinators

Introduction

A large number of underutilized edible fruits exist in tropic and subtropics of the world, but their full potential has not been exploited. Pollination is one of the principal mechanisms in the maintenance and conservation of biodiversity. Over 80% pollination activities are performed by insects and bees. Scanty information is available on underutilized fruit crops as bee forage. The information on these plants as bee forage is need of the hour as they serve as good source of nectar and/or pollen. Keeping this in view, *Aegle marmelos* (L) Corr. Was selected for recording the diversity of insect pollinators.

Materials and Methods

The insect visitors and pollinators of *Aegle marmelos* flowers were collected by hand net with 30 cm ring diameter during their flowering period to observe the diversity. For this, sweeps were made throughout flowering period of the crop at two hourly intervals from the morning to the evening. Captured insects were killed by using ethyl alcohol and preserved as dry specimens and were got identified.

Results and Discussion

Total twenty-four insect species belonging to eight families of four orders were recorded on bael flowers. Among the insect pollinators, *A. dorsata*, *Pieris* sp., *Catopsilapyranthe* L. and *Eristalinusobscuritarsus* (de Meijere) were the most frequent pollinators (Table 1).

Table 1: Insects visiting beal flowers

Insect Species	Family	Order
Apis dorsata F.	Apidae	Hymenoptera
Apisflorea	Apidae	Hymenoptera
*Apismelliferа*L.	Apidae	Hymenoptera
*Apiscerana*Fabricius	Apidae	Hymenoptera
*Megachilecephalotes*Smith	Megachilidae	Hymenoptera
Delta esuriens (Fabricius)	Vespidae	Hymenoptera
Monomorium sp.	Formicidae	Hymenoptera
Xylocopa pubescence (Spinola)	Apidae	Hymenoptera
Eumenesdimidatipennis Sauss	Vespidae	Hymenoptera
Papiliodemoleus	Papilionidae	Lepidoptera
Danauschrysippus L.	Nymphalidae	Lepidoptera
Junoniaalomona L.	Nymphalidae	Lepidoptera
Junonialemorias L.	Nymphalidae	Lepidoptera
Catopsiliapyranthe L.	Pieridae	Lepidoptera
Pieris sp.	Pieridae	Lepidoptera
Venessacordui L.	Nymphalidae	Lepidoptera
Phalantaphalanta Drury	Nymphalidae	Lepidoptera
Lampidesboeticus Linnaeus	Lycaenidae	Lepidoptera
Utethesiapulchella Moore	Arctiidae	Lepidoptera
Amata sp.	Arctiidae	Lepidoptera
Eristalinusobscuritarsis(de Meijere)	Syrphidae	Diptera
*Eristalinusobliquus*Wiedemann	Syrphidae	Diptera
Coccinellaseptempunctata L.	Coccinellidae	Coleoptera
Mylabrispustulata	Meloidae	Coleoptera

Earlier only eight insect species i.e. *A. dorsata*, hover fly, *Amatacyssea*, *Anaphaeisaurota*, *Pierisbrassicae*, *Polestisherbreus*, *Solenopsisgeminata*, *Xylocopapubescens* were recorded on the flowers of bael trees growing in Patiala region by Singhal *et al.* (2011).

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210.

Influence of Spray Time for the Management of Ber Fruit Borer (*Meridarchis scyrodes* Merick) in South West Haryana

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Keywords: *Zizyphus mauritiana*, *Meridarchis scyrodes,* tropical, deformed

Introduction

Ber (*Zizyphus mauritiana* Lamk.) is an economically important tropical fruit tree, which is grown all over the drier parts of the Indian subcontinent, Africa and northern Australia for its fresh fruits. Its cultivation does not require much care and input. Many insect species are infesting ber crop but fruit fly (*Carpomyia vesuviana* Costa) and fruit borer *Meridarchis scyrodes* Myerick (Carposoncidae: Lepidoptera) are the major pest, causing low yield and poor quality of fruits. Earlier, fruit borer was not reported as a pest of ber crop in Haryana but now, due to climate change it is causing considerable damage in South West Haryana. The larvae of this insect feed on pulp of developing fruits and affected fruits deformed, ripened early and drop down.

Materials and Methods

Studies on influence of spray time for the management of ber fruit borer were carried out at CCS HAU, Regional Research Station, Bawal, from 2012-13 to 2014-15 The research station is located in the low rainfall zone of south-western Haryana. Seven plants of ber of uniform crown were selected for each treatment. To find out the influence of spray time, insecticides/biopesticides were applied under spray schedule with Neem Seed Kernel Extract 5% (1st spray), acephate 75 Soluble Powder @ 1 g/l (2 nd spray) and NSKE 5% (3 rd spray) at 15 days interval when spray initiated on 15th September (Treatment 1), 30th September (Treatment 2), 15th October (Treatment 3) and Control (Treatment 4), respectively. Per cent fruit infestation was recorded at each picking for each treatment.

Results and Discussion

The minimum fruit infestation (4.36%) was recorded when spray initiated on 15th October under spray schedule with NSKE 5% (1st spray), acephate 75 SP @ 1 g/l (2 nd spray) and NSKE 5% (3 rd spray) at 15 days interval. The values under 30th September and 15th September were 7.97 per cent and 11.34 per cent, respectively. The mean fruit borer infestation in the control was 14.13 per cent. The maximum yield (43.77 kg/plant) was also recorded in this schedule where as spray initiation on 30 th September and 15 th September resulted in fruit yield of 38.87 kg and 35.87 kg/plant. The average yield in control was 32.23 kg/plant. The residues of acephate, applied @ 1gm/l was got analyzed at Pesticide Residue Laboratory of Dept. of Entomology, CCSHAU, Hisar and the residual level was observed as 0.164mg/kg^{-1}. On the basis of pooled data of three years**,** it can be thus concluded and proposed that 15th October was observed to be the best time for sprays initiation to minimize the infestation of ber fruit borer in South West Haryana.

Table 1: Influence of spray time on ber fruit borer infestation at RRS Bawal

Fruit borer infestation (%)				
Treatment	**2012-13**	**2013-14**	**2014-15**	**Pooled mean**
1st Spray 15th September	11.71 (19.96)	10.50 (18.81)	11.85 (20.06)	11.34
1st Spray 30th September	8.30 (16.70)	7.50 (15.84)	8.28 (16.99)	7.97
1st Spray 15th October	5.30 (13.22)	4.25 (11.73)	3.57 (10.68)	4.36
Control	13.00 (21.10)	12.00 (20.07)	17.42 (24.62)	14.13
SEm±	0.55	0.918	0.670	0.516
CD at 5%	1.65	2.74	2.00	1.54

Figures in parentheses () are angular transformed values

Table 2: Effect of spray time on ber fruits yields at RRS Bawal

Yield kg/plant				
Treatment	**2012-13**	**2013-14**	**2014-15**	**Pooled mean**
1st Spray 15th September	39.14 (38.70)	36.50 (37.713)	32.00 (34.41)	35.87
1st Spray 30th September	42.50 (40.65)	39.00 (38.60)	35.14 (36.30)	38.87
1st Spray 15th October	49.70 (44.80)	42.35 (40.56)	39.28 (38.78)	43.77
Control	35.20 (36.35)	34.50 (35.93)	27.00 (31.27)	32.23
SEm±	0.93	0.836	0.850	0.516
CD at 5%	2.78	2.50	2.54	2.82

Figures in parentheses () are angular transformed values

211.

Oxidative Stress in Brain and Blood of Female *Bandicota bengalensis* and *Tatera indica* Collected from South-west Region of Punjab

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Keywords: Oxidative stress, pesticides.

Introduction

The South-west region of Punjab, India, is facing an unprecedented crisis of environmental health linked to indiscriminate, excessive, and unsafe use of pesticides, fertilizers, and poor groundwater quality. Pesticides toxic manifestations have been associated with enhanced generation of reactive oxygen species (ROS) via changes in the normal antioxidant homeostasis that result in the depletion of antioxidants. Oxidative stress is one mechanism that has been assessed as possible link for pesticide exposures to a number of health outcomes observed in epidemiological studies.

Materials and Methods

Bandicota bengalensis and *Tatera indica* were trapped from fields of Bathinda district of South-west region of Punjab. Same species of rats were collected from Punjab Agricultural University (PAU) Ludhiana which served as control rats. The rats were mildly anaesthetized, blood was collected and processed to obtain plasma. Brain was excised, cleaned off and homogenised. Plasma and brain supernatant was used for the estimation of proteins (Lowry *et al.,* 1951), Catalase (Aebi, 1983), superoxide dismutase (Marklund and Marklund, 1974), glutathione-S-transferase (Habig *et al.* 1974), glutathione reductase (Carlberg and Mannervik 1985), glutathione peroxidase (Hafeman *et al.*, 1984) and lipid peroxidation (Stocks and Dormandy 1974).

Results and Discussion

There was a significant decrease in the weight of brain of *Bandicota bengalensis* (1.27±1.12) collected from South-west Punjab as compared to control rats (1.72±0.08). In brain, the value of total proteins decreased significantly in *Tatera indica* while a non-significant increase was observed in *Bandicota bengalensis* collected from the study area (Table 1). OS biomarkers level namely catalase (CAT) and glutathione peroxidase (GPx) showed a non-significant decrease while superoxide dismutase (SOD), glutathione-S-transferase (GST) and lipid peroxidation (LPO) increased non-significantly in rats collected from South west Punjab as compared to control rats. In blood, the value of total proteins showed decrease in *Bandicota bengalensis* while non-significant increase was observed in *Tatera indica* collected from the study area. CAT and GST and GPx showed a non-significant decrease while glutathione reductase (GR), SOD, and LPO increased non-significantly in rats collected from South west Punjab as compared to control rats (Table 1). The results infer that environmental contaminants are responsible for altering antioxidant defense system and inducing oxidative stress in rats inhabiting south- west region of Punjab.

Table 1: Brain and blood enzymatic antioxidant parameters (mg/g wet weight of tissue) of *Bandicota bengalensis* and *Tatera indica*

	Bandicota bengalensis		***Tatera indica***	
	Control	**Bathinda**	**Control**	**Bathinda**
	Br Bd	**Br Bd**	**Br Bd**	**Br Bd**
Protein	4.50±0.10 35.5±1.58	4.96±0.25 33.56±1.83	3.96±0.29 34.80±4.8	3.52±0.46* 35.24±4.56
GPx	0.27±0.13 0.04±0.00	0.26±0.00 0.03±0.00	0.30±0.02 0.03±0.01	0.27±0.09 0.03±0.02
SOD	9.00±0.65 3.15±0.18	10.75±2.33 3.30±0.74	13.33±1.46 3.09±0.19	16.66±2.38 3.07±0.27
CAT	41.32±4.33 10.67±1.67	40.67±3.99 9.44±1.07	41.02±2.74 10.74±0.14	40.06±6.76 10.02±0.53
GR	0.06±0.01 0.008±0.00	0.06±0.02 0.009±0.00	0.08±0.03 0.007±0.00	0.09±0.03 0.008±0.00
GST	0.49±0.01 0.009±0.00	0.50±0.02 0.007±0.00	0.40±0.32 0.008±0.00	0.43±0.04 0.007±0.00
LPO	8.90±0.13 148.1±0.15	9.13±0.14 175.8±0.32*	8.01±0.25 123.8±0.23	9.35±2.66 165±0.02*

Br-Brain, Bl- Blood, Values are Mean±SE,*Significant difference at ($p \leq 0.05$) as compared to control

212.

Effect of Blends and Processing Methods on the Nutritional Quality of Protein Rich Supplementary Powder

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Keywords: Malting, roasting, malnutrition, bulk density, water solubility index, protein enriched

Introduction

In India protein malnutrition is a serious problem due to cereal based dietary pattern. The use of protein source of vegetable origin can be used as a solution to this problem. Cereals are usually fortified with lysine or pulse proteins. Traditional methods like roasting, germination, and fermentation of grains are often used separately or in combination which are most effective and convenient ways for improvement of nutritional value and flavour of grains. Considering the above mentioned facts a protein rich supplementary powder was developed from malted and roasted cereal and legume and evaluated for functional, nutritional and sensory parameters.

Materials and Methods

The dried grains of both the cereals (wheat and barley) and legumes (soybean and chickpea) were divided into two equal lots and were malted and roasted separately. Malted/Roasted grains were milled into flour which was stored in an air tight container till further use. Supplementary powder was prepared with substitution of legume flour to cereal flour at different ratios. The physico-chemical, functional and sensory evaluation was done and results obtained were statistically analysed and tabulated.

Results and Discussion

The findings of our research highlights that a supplementation upto 25 per cent of soy bean and chickpea flour can be done successfully for developing nutritionally superior supplementary powder than that of the whole wheat and barley based flour. Organoleptically, treatment T_8 (45:45:5:5::RBF:RWF:RSF:RCF) was found to be the best, whereas biochemically treatment T_5 (25:25:25:25:: MBF: MWF: MSF: MCF) was noticed to be the best from the rest of the combinations. It might be because the treatment T_5 (25:25:25:25:: MBF: MWF: MSF: MCF) had highest content of soy bean and chickpea flour (25 per cent) which being rich in protein, fat and mineral contents. It can be concluded that cereal and legume blended products can be developed which will help in increasing the intake of protein, fibre, fat and other nutrients for eradicating malnutrition.

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Policy for Sustainable Development of Agriculture

213.

Scientific Rationality and Adoption of Indigenous Field Bean *(Lablab purpureus)* Cultivated by Tribal Farmers of Tamil Nadu

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Keywords: Indigenous Tribal Agricultural Practices, Field beans, Tribal farmers, Rationality, Adoption

Introduction

The wise wisdom of Indigenous Tribal Agricultural Practices (ITAPs) in field bean, *Lablab purpureus L.* (Sweet), cultivated by the tribes of the Kolli hills in Tamil Nadu should to be documented before they become totally obsolete. In this context a study was done for collecting, classifying, documenting, analyzing the rationality and studying the adoption of the selected ITAPs in Field bean. Rationality analyses of the selected 10 ITAPs on Field beans were performed and further analysis was undertaken to test verify their extent of adoption. The rational and effective ecofriendly practices should be blended into the technology package for transfer of technology.

Materials and Methods

The study was performed in Kolli Hills, Namakkal district of Tamil Nadu. ITAPs in Field beans were collected from 140 aged farmers through informal interview method. Then the rationality of indigenous technologies in Field bean was assessed using the scoring procedure of Sakeer Husain (2010). If an ITAP scored, a mean score ≥ 2.5, it was considered as a "rational" and < 2.5, then considered as "irrational". Having identified and selected the list of ITAPs with their rationality scores, further analysis was undertaken to test verify their extent of adoption using the adoption quotient formula of Sundaramari *et al.* ((2003).

Results and Discussion

The selected 10 ITAPs on Field bean cultivation were studied for their individual rationality and adoption. After Rationality analysis, thirty farmers were contacted to assess their extent of adoption. The details on the extent of adoption of individual ITAPs along with their rationality have been presented in the Table 1. It could be seen from the Table 1 that 10 ITAPs were (1,2,3,4,5,6,7,8,9 and 10) adopted by more than 75 per cent of the farmers, of which 8 ITAPs were rational and 2 ITAPs were (1 and 2) irrational. Two local land races of Field beans viz., Karuppu mochai and Sem mochai are found only in Kolli hills. This crop is raised thrice a year during May-June (Vaikasi), Sep-Oct (Purattasi) and (Thai-Masi) Jan-Feb. Sowing behind to the country plough and covering by the return plough is the most common practice followed. Mixed cropping with Mustard, Millets and Castor, in prominent in this area (Fig. 1).

Removing seeds from the pods

Red field beans (Sem mochai)

Black field beans(Karuppu mochai)

Intercropping of field beans with Tapioca

Intercropping of field beans with millets

Unopened field bean pods are stored

Fig. 1: Indigenous Tribal Agricultural Practices on field beans cultivation

Table 1: Rationality and adoption of ITAPs on Field beans cultivation (n=30)

ITAPs on Field beans cultivation	Rationality score	Adoption	
		No.	%
A. Crop production			
Local land races of Field beans, such as Karuppu mochai (Black beans) and Sem mochai (Red beans) are generally grown.	1.80 IR	30	100.00
Field beans (Karupu mochai and Sem mochai) is suited only for rain fed or upland cultivation.	1.90 IR	27	90.00
Field beans can be raised thrice a year during May-June (Vaikasi) Sep-Oct (Purattasi) and (Thai-Masi) Jan-Feb provided if good rainfall has occurred, otherwise it is raised for two times only.	3.20 R	26	86.67
Black field beans (Karuppu mochai) as well as Red field beans (Sem mochai) comes to bearing on 3rd month onwards with a total duration of is 4 months with an average yields about 2-3 kg.	3.70 R	27	90.00
Field bean is sown behind to the country plough and covered by the return plough (marusaal).	3.20 R	27	90.00
Field bean is mixed cropped with mustard, Finger millet, Italian millet, Kodo millet, Common millet and Castor.	2.70 R	29	96.67
Dry pods are harvested for grain purpose when they turn straw yellow in colour.	3.90 R	28	93.33
Unopened field bean pods as such are stored for longer time.	2.68 R	24	80.00
B. Crop protection			
Mixing 2½ kg. of red earth slurry with 50kg. of field bean seeds and drying them before storage. Seeds coated with red earth acts as pest repellent.	3.34 R	23	76.67
A mixture of extracts of nochi (*vitex negundo*) leaves and neem cake is sprayed to control the shedding of flowers and pre mature fall of pods in field bean.	2.98 R	24	80.00

A mixture of extracts of notchi (*Vitex negundo.L.*) leaves and neem cake is sprayed to control the shedding of flowers and pre mature fall of pods in field bean, since notchi leaves have polyalcohol & IAA which acts as growth regulator. When the straw turns yellow they harvest the pod for grain purpose and unopened pods are stored as such for longer time to retain the moisture content (Fig. 1). 50 Kg of Field bean seed is mixed with red earth slurry of 2½ kg is mixed and dried before storage. The studies of Sakeer Husain (2010) support the above finding.

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214.

A Study of Livelihood Diversification in Hills of Uttarakhand

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Keywords: Farm households, hills, livelihood diversification

Introduction

The economy of Uttarakhand is predominantly agrarian, Uttarakhand has only 14% of the total land under cultivation and about 65% of population depends on agriculture for their livelihood. Being a state with diverse agro-climatic endowments, conditions under which agriculture is carried out differ remarkably across areas. Broadly the plains and hills present different scenario for agriculture in Uttarakhand. It has the lowest net irrigated area in hills. Two-third of Uttarakhand rural hilly families are reported to Below Poverty Line (BPL) families. It has a poor rural female literacy level (Food insecurity analysis of Uttarakhand, 2002)**.** In hills, cropping pattern is dominated by traditional and low yielding crops responsible for providing basic livelihood for the vast majority of the population. Continued vicious cycle of low production, low productivity and low input supply, unawareness of new technologies and lack of adequate extension support leaves the farmer practicing the conventional agriculture which is not sufficient for him to sustain his livelihood. Present study aimed to assess the livelihood diversification in hills of Uttarakhand.

Materials and Methods

There are various indicators and indices used to measure livelihood diversification, but Simpson (1949) index, was widely used to construct diversification index. Therefore, in this study Simpson index is used to construct livelihood indices across altitudes because of its computational simplicity, robustness and wider applicability. Its value lies between 0 and 1. The Simpson diversification index has been constructed for farm household level on the basis of its popularity to analyze the extent of livelihood diversification using following formula-

$$DI = 1 - \sum_{i=1}^{N} Pi^2$$

Where,

DI=Livelihood diversification index,

N=Total number of income sources.

Pi= Income proportion of the i^{th} source.

Results and Discussion

Livelihood diversification has been determined using the Diversification Index (DI). The DI value ranges between zeros to one (0 to 1). The value is near to zero shows less diversified farm households i.e. having one or few major sources of income. While the value tending to one shows the farm household is diversified i.e. having more sources of income for their livelihood. The value of diversification indices for the livelihood of farm households across the hill altitudes are presented in the Table 1.

Table 1: Livelihood diversification index of farm households at different hill altitudes

Hill altitude	Diversification Index
Low hill	0.38
Mid hill	0.41
High hill	0.45

It could be deduced from the table that the livelihood diversification indices varied from 0.38 to 0.45 across the altitudes with the lowest diversification in the farm households at low hills and highest at high hills. Here it can be concluded that livelihood diversification among farm households was found to be directly related with the hill altitudes.

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215.

Adaptation Strategies Followed By the Dairy Farmers to Combat Climate Variability in Karnataka State

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Keywords: Adaptation, climate variability, dairy farmers, northern dry of Karnataka

Introduction

Dairy farming plays a prominent role in strengthening India's rural economy. It has the potential to act as an instrument to bring about socio-economic transformation, but in recent days climate variability affects the dairy farming. Climate variability refers to the way climate fluctuates yearly above or below a long-term average value. It has been considered as one of the most serious long-term challenge faced by dairy farmers. In this context it is important to know about the adaptation strategies followed by the dairy farmers in combating the climate vagaries. Keeping this in view the present study was conducted with an objective "To ascertain the adaptation strategies followed by the dairy farmers to combat climate variability".

Materials and Methods

The study was conducted in Northern dry zone area which was purposively selected because of this zone is most frequently exposed to climate variability. Raichur and Bellary Districts were selected purposively for the study, as these districts holds largest livestock population in study area, and 120 dairy farmers were selected for the study. Respondents were asked whether they adopt any measure to cope up with the negative impact of climate change on the binary response yes or no. Those who responded yes, again they were requested to put their response on a three point continuum, namely continued the adoption, discontinued the adoption and never adopted with the score of 2, 1, and 0 on a prelisted adaptation strategies

Results and Discussion

Table 1: distribution of respondents based on their adaptation practices followed in dairying (N=120)

Adaptation strategies	AC (P)	AD (P)	NA (P)
Keeping and interested in local breeds	61	26	7
Providing extra concentrate, minerals supplementation and feed additives to livestock	47	35	2
Change in feeding schedule to farm animals	31	30	46
Change in micro-climate in cattle shed/stall	42	36	23
Livestock farming to non -farming (Business)	8	33	76
Shifting from large ruminants to small ruminants	44	32	25
Reduction in herd size	38	25	39
Plantation of fodder trees around animal shed/ house to reduce effects of cold and heat waves	21	31	57
Seasonal migration along with livestock	4	31	68
Providing bedding material for livestock during extreme winter/ cold conditions	79	6	0.00

AC- Adoption continued, AD- Adoption discontinued, NA- Never adopted, P- Percentage

From Table 1 following inferences can be easily drawn. Majority of the respondents were following adaptation strategies like keeping and interested in local breeds (61%). Farmers told that local breeds require less water, resistant to many diseases and well survive in adverse climatic condition. About 42% of dairy farmers made changes in micro-climate in cattle shed/stall in such a way that where animals can live without stress for example planting a tree in the mid of shed for providing shade. And change in feeding schedule (31%) farmers felt that day time feeding during hot summer is the cause of restlessness and discomfort for their animal. Shifting from large ruminants to small ruminants (44%) it is because of many animals was died during this devastating extreme climatic event. Therefore, to minimize the risk of huge monetary loss and to get relief from fodder scarcity, they adopted small ruminant rearing like sheep and goat.

Migration along with livestock was one of the coping strategies of many of the farmers (14%) during adverse climatic conditions they will migrate towards the south Karnataka in searching of fodder sources and again after peak summer they turn back to their original places.

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Resource Use in Punjab Agriculture: Moving towards Unsustainability

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Keywords: Resource sustainability, Punjab

Introduction

Intensive agricultural practices in Punjab, after the success of the Green Revolution, have led to excessive use of chemical fertilizers, agro-chemicals and the ground water resources. The major problem of unsustainable use of resources arises due to rice-wheat cropping system in the state. The fertiliser use of 249 kg/ha of gross cropped area is much higher than the recommended levels and chemical use is also about 5750 thousand tonnes of technical grade during 2013-14(PAU, 2015). The ground water table is declining in 110 out of 142 blocks in Punjab due to its overexploitation (Kaur and Vatta, 2014). This paper develops a sustainability index to examine the trends in sustainability of resource use in Punjab agriculture.

Materials and Methods

The sustainability index was estimated at the district level and four key indicators were shortlisted for which credible time-series data was available. The index measures the trend of land and water resources for examining the sustainability of farm system in Punjab. These indicators were fertilizer consumption (kg/ha), cropping intensity (per cent), combined productivity rice and wheat (kg/ha) and water deficit (cm/ha). The data were obtained from the Statistical Abstracts of Punjab for all districts of Punjab for specific years. The data was normalized and a composite index was developed using the method developed by Iyengar and Sudarshan,1982. The following steps were involved for developing the index

a) ***Normalization of indicator values*** - The initial step involves normalizing the indicators, since these are expressed in different units. If the indicator values are positively related to sustainability, the standardization is achieved by using following equations:

$$Y_{id} = \frac{X_{id} - Min_d\, X_{id}}{Max_d\, X_{id} - Min_d\, X_{id}} \qquad (1a)$$

Where X_{id} represents the size or value of the ith indicator in the district of the state (i=1, 2… m) & d (1,2,….,n). Min X_{id} and Max X_{id} are respectively, the minimum and maximum of (X_{i1}, $X_{i2...}$ X_{in}). If X_i is negatively related, then the equation used is:

$$Y_{id} = \frac{Max_d\, X_{id} - X_{id}}{Max_d\, X_{id} - Min_d\, X_{id}} \qquad (1b)$$

b) ***Assigning weights*** - The second step was to assign weights to the standardized values of the indicators

$$Y_{id} = \sum_{i=1}^{m} w_i y_{id} \qquad (2a)$$

Where w represents the weights given by the equations

$$w_i = \frac{k}{\sqrt{var(y_i)}} \qquad (2b)$$

and *k* represents,

$$k = \left[\sum_{i=1}^{m} \frac{1}{\sqrt{var(y_i)}}\right]^{-1} \qquad (2c)$$

c) ***Index development*** - The weights were then obtained for each indicator and the respective weights were multiplied with the standardized values and final indices were obtained for resource sustainability for each year.

Based on the above method, the index was computed for some selected years. Post this, a triennium average method was applied, index was estimated for four periods i.e. 1980-82, 1990-92, 2000-02 & 2009-11 to study and compare decadal changes.

Results and Discussion

There was a continuous decline in the index of resource sustainability for all the districts during the four periods. The highest index value had declined from 0.80 in 1980-82 to 0.71 in 1990-92 and further to 0.54 in 2009-11. A similar trend was seen in the minimum value of the index from 0.56 in 1980-82 to 0.29 in 2009-11. In 1980-82, out of the twelve districts in Punjab, nine were moderately sustainable and three were highly sustainable (Fig. 1). The number of moderately sustainable districts declined to six in 1990-92 and the remaining six districts entered into the least sustainable categories, thereby showing a march towards greater unsustainability. Later, from 2000 to 2002 almost all the districts in the central zone of Punjab (Amritsar, Kapurthala, Jalandhar, Ludhiana, Sangrur and Patiala) and a few districts belonging to the south western zone (Ferozepur, Muktsar, Moga and Mansa) turned out to be the least sustainable ones, depicting highly unsustainable use of resources in agriculture. Subsequently, by 2009-11 the entire Punjab region shifted towards the least sustainable category. Within the least sustainable districts, those with the minimum index values were Amritsar, Kapurthala, Jalandhar, Ludhiana, Moga, Sangrur and Patiala with the values ranging between 0.3 and 0.35. It points to the need for a greater focus on addressing the sustainability issues in these districts. There is need to promote the sustainable use of resources through resource conservation technologies and practices. The current sustainability index can be used as an input tool for better decision making at the district level.

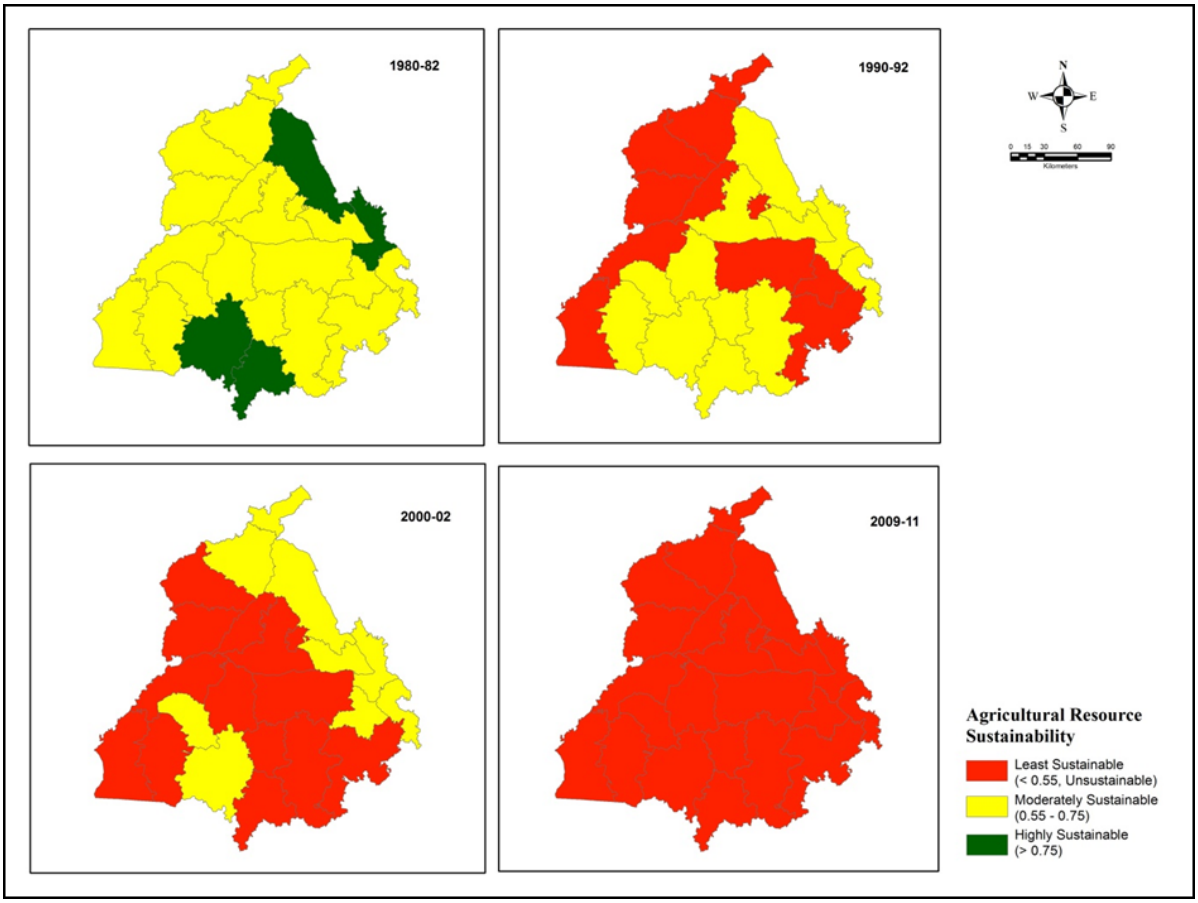

Fig. 1: District-wise spatial and temporal variability of agricultural resource sustainability in Punjab

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217.

Bioprocess Optimization for Production of Ionic Liquid Stable Cellulase from *Bacillus subtilis* I-2 Using Agroresidues as Substrates

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Keywords: Bioprocess, cellulase production, optimization, agroresidues, ionic liquid stable

Introduction

Cellulases have got enormous applications several industries especially in lignocellulosic biomass i.e. LB (agro/forestry residues) transformation into sugars for production of bioethanol-fuel and variety of other products. Most of LB-pretreatment approaches are cost/energy intensive, hazardous, and polluting, ionic liquid (IL) based pretreatments have gained attention. However, traces of IL left in pretreated LB may be inhibitory for saccharifying enzymes i.e. cellulases, therefore, IL-stable cellulases are sought after. Since huge quantities of cellulase are required for industries, cost-effective enzyme production is absolutely important. Current study illustrates the optimized production of IL-stable cellulase from a bacterial isolate *Bacillus subtilis* I-2.

Materials and Methods

Cellulolytic activity was examined qualitatively (congo red staining) and quantitatively (assay of reducing sugars from carboxy methyl cellulose). Bacterial isolate was identified based on 16S rDNA sequence analysis. Ionic liquid used was 1-ethyl-3-methylimidazolium methanesulfonate, EMIMS. IL-stability of cellulase was examined by incubating the enzyme with IL EMIMS and assaying the residual cellulase activity. Design of experiment (DoE) i.e. response surface methodology (RSM) was executed for optimizing medium (wheat bran, cotton seed cake, potato peel and soybean meal) and environmental (pH, agitation and temperature) parameters for cellulase production by employing agricultural residues as carbon and nitrogen sources.

Results and Discussion

Bacillus subtilis I-2 produced substantial titre of cellulase that exhibited excellent IL-stability for prolonged time periods, and activity/stability over a broad pH range (4.0-10) and at elevated temperatures (60-90°C). RSM based optimization of medium components i.e. wheat bran, potato peel, cotton seed cake and soybean meal led to 2-fold enhanced cellulase yield (150.8 U/ml *vs* 76 U/ml in unoptimized medium). Wheat bran and cotton seed cake were the most positive significant variables, followed by potato peel and soybean meal. The most significant interaction was observed between potato peel and cotton seed (Fig. 1). Further optimization of environmental variables *viz.* medium pH, agitation rate and incubation temperature, resulted in 2-fold more enhancement of cellulase yield i.e. 315.90 U/ml. Thus, an over-all 4-fold increased cellulase yield was obtained after optimization. The pH had positive significance while agitation rate and temperature, were negatively significant for cellulase production. The design was validated, and optimized values of variables were: wheat bran 2.0% w/v, potato peel 1.5% w/v, cotton seed cake and soybean meal each 0.8% w/v, temperature 48.41°C, pH 7.0 and agitation rate 180 rpm. Thus, *B. subtilis* I-2 successfully utilized agriculture based residues as carbon and nitrogen sources for production of IL-stable, broad range pH and thermostable cellulase. Cellulase production was enhanced by 4.1-fold using RSM based optimization of cultural and environmental variables. Strategies focusing upon cost-effective bulk production of process-suitable cellulases may have substantial implications for industrial biotechnology.

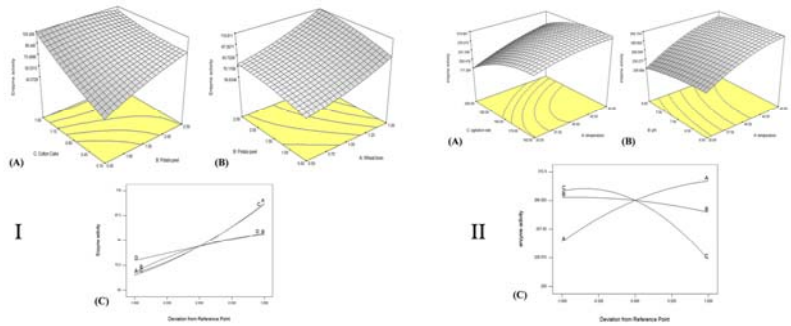

Fig. 1: Response surface plots showing the interactions between cultural (I) and environmental variables (II) for cellulase production by B. subtilis I-2. I: (A) cotton cake and potato peel, (B) potato peel and wheat bran, (C) perturbation plot showing the response changes with change of each variable; II: (A) agitation rate and temperature, (B) pH and temperature, (C) perturbation plot showing the response changes with change of each variable.

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Status of *Orobanche* in Bhiwani and Hisar Districts of Haryana and Constraints in its Control

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Keywords: *Orobanche*, Indian mustard, infestation, awareness

Introduction

Orobanche, commonly known as 'Margoja', 'rukhri', 'gulli', or 'khumbhi', an annual, branched, achlorophyllous, noxious, obligate root holoparasite, reproduces only by seeds. *Orobanche* fulfill its entire carbon, nutrition and water requirement from the host plant which causes moisture and assimilate starvation, host plant stress and growth inhibition causing extensive reduction in crop yield and quality in the infested fields. *Orobanche aegyptiaca* has spread over an area of 0.25 mha in mustard fields of Bhiwani, Hisar and adjoining districts of the South-western Haryana.

Materials and Methods

An intensive survey was conducted for two consecutive years to determine the status of *Orobanche* infestation in Indian mustard in Bhiwani and Hisar districts of Haryana. From each district, 90 farmers were selected during *rabi* 2013-14 and 2014-15. The mustard fields of respective farmers were surveyed to record the population of *Orobanche* by throwing quadrate randomly at 4 different spots. The awareness among the farmers regarding seriousness of *Orobanche* problem and its control measures was analysed on the basis of a predetermined questionnaire which was framed purposefully.

Results and Discussion

The data of survey conducted in Bhiwani and Hisar districts over two years are shown in Table 1. It was observed that the average landholding of farmers of Bhiwani district was less as compared to Hisar district during both the years. The literacy rate of farmers of Hisar district (66 and 69% in 2013-14 and 2014-15, respectively) was observed to be slightly more than farmers of Bhiwani district (62 and 65% in 2013-14 and 2014-15, respectively) but the difference in literacy rate was non-significant in these two districts. Infestation of *Orobanche aegyptiaca* was significantly higher in Bhiwani district as compared to Hisar district during both the years. *Orobanche* infested maximum area in 2013-14 in Bhiwani district (82 fields) whereas Hisar district (16 fields) in 2013-14 recorded least infestation of *Orobanche*. Data on farmers' perception revealed that 83 and 74% farmers of Bhiwani district considered *Orobanche* a serious problem as compared to farmers of Hisar district (30.0 and 36.7%) in years 2013-14 and 2014-15, respectively. A few among total farmers knew about the available control measures of *Orobanche*. Farmers of Bhiwani district were less aware about the control measures available for controlling *Orobanche* as well as the less interested in adopting the control measures. These findings show that the government should organize training programmes in Bhiwani and Hisar to inform farmers about the problem of *Orobanche* in Indian mustard and to aware and encourage them in adopting the control measures of *Orobanche*.

Table 1: Opinion of farmers about *Orobanche* infestation and its control measures in Indian mustard (in percent)

Parameters		2013-14		2014-15	
		Bhiwani	Hisar	Bhiwani	Hisar
No. of farmers surveyed		90	90	90	90
Average landholding (ha)		2.02	2.46	2.37	2.90
Education level	Literate	62	66	65	69
	Illiterate	38	34	35	31
Fields infested with *Orobanche*		91	18	84	21
Farmer's perception towards *Orobanche*					
No. of farmers considering it a serious problem		83	30	74	37
Farmers having knowledge of control measures		13	29	19	27
No. of farmers adopted control measures		4	18	7	20

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Strengthening Value Chains for Fruits and Vegetables in Punjab: Alternative for Faster Growth in Agriculture

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Keywords: Value chains, stake-holders, fruits and vegetables

Introduction

Rice (*Oryza sativa*)-wheat (*Triticum aestivum*) monoculture induced a decelerating agricultural trend in Punjab which has been felt in the form of deteriorating productivity, environmental degradation, declining farm incomes and de-peasantization (Sharma and Singh, 2013). Increasing area under fruits and vegetables helps improve farm incomes, overall agricultural output and water conservation. High perishability of fruits and vegetables requires special storage, processing, transportation and marketing infrastructure, which have a strong bearing on output supply and prices, affecting each stakeholder in the value chain. In light of the above discussion, an in-depth analysis of issues affecting value chains of fruits and vegetables in Punjab is presented in this paper.

Materials and Methods

For the purpose of mapping out traditional and modern value chains in Punjab a survey of 50 respondents (25 farmers involved in traditional value chains and 25 in modern value chains) was conducted in the Ludhiana district of the state. The information was collected with the help of a questionnaire by personal interview. A major subset of modern value chain development work is concerned with ways of linking producers to companies. Contract farmers and executives of two corporate companies, Fieldfresh and Pepsico, dealing with fruits and vegetables, were interviewed in order to examine the modern value chains from both perspectives.

Results and Discussion

The sequence of steps and participants involved in the process from *production to delivery* of a product to market is called a *value chain* (Webber, 2007). The premise for adopting a value chain approach is that higher financial returns can be realized through value-enhancing inputs than simply through supply chains. In the traditional model (Fig. 1a), farmers sell their products, (fresh and perishable), to the customers mostly through various intermediaries who gain most of the share in profit. In modern value chains (Fig. 1b) producers are mainly contract farmers or those that are leased out land for farming. Value is added in each step and supply of produce (fresh or processed) is steady because of the existence of specialized cold chains, processing, better transportation, credit linked to storage and market intelligence facilities.

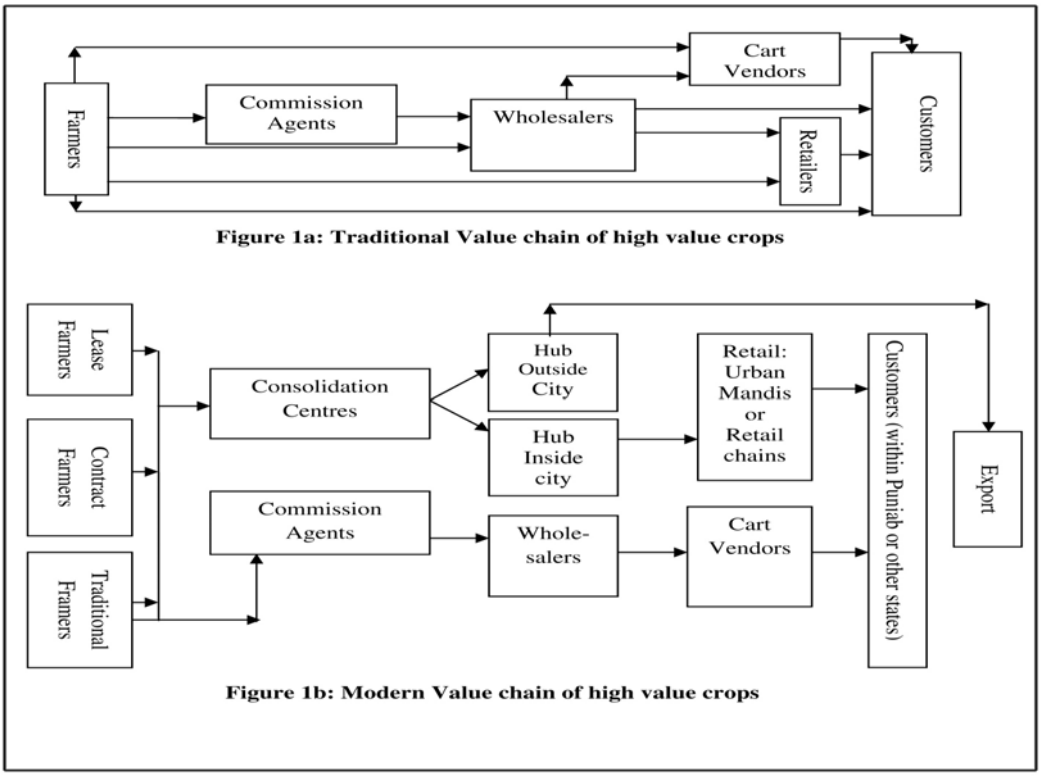

Figure 1a: Traditional Value chain of high value crops

Figure 1b: Modern Value chain of high value crops

The study revealed that contract farming aided capital starved small and marginal farmers by providing them with quality inputs, technical guidance and management skills thereby helping them increase overall crop productivity. While for corporate bodies, contract farming reduced supply risks, it helped farmers involved in contractual arrangements with companies, minimize price risks. Timely market information, enabled producers to respond to changes in market prices and demand, thus improving their negotiating power with middlemen. Transparency between farmers and contracting agencies is pertinent to maintaining a steady supply of products in the market. Scaling up of operations in modern value chains should be explored so that all the participants can benefit from them.

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220.

Success Factors for Enhancing Entrepreneurship among Rural Youth: A Study of Successful Agripreneurs

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Keywords: Case study method, facilitative factors, inhibitive factors

Introduction

Average size of operational holdings as per different agricultural census of India is decreasing steadily over the years; it has come to 1.16 ha in the year 2010-11 from 2.8 ha of 1970-71. The farming situation gets precarious with steadily increasing population (1.23 millions in 2013) with an alarming unemployment rate. To mitigate the precarious situation, entrepreneurship has emerged as the central force of economic growth and development. Farming must move towards agribusiness management and development of entrepreneurial competencies among farmers is essential. Delineation of factors of success of agri-enterprises will enable to replicate such examples in other areas as well. Documentation of successful farmers' experiences may be used as lessons for other farmers. Best practices followed by achievers need to be highlighted so as to make relevant policy changes. Farmers may be trained to be entrepreneurial to manage agriculture not as a way of life but as an enterprise and trained cadre of youth having capabilities for agri-entrepreneurial endeavours. Awareness, motivation, technical skill, right assistance and support from family at extension level and government and other organizational help to the entrepreneurs at policy level can strengthen capacities besides adding to the family income and national productivity (Nain *et al.* 2013). Individual's motivation, aspirations and entrepreneurial competencies trigger agripreneurship development whereas adoption of best practices, dodging of inhibitive factors and facilitative socio economic factors play sequential role in reaching agripreneurial success (Singh *et al* 2014). Present study is the outcome of the study of 52 successful agripreneurs in 12 kinds of enterprises spread over 12 Indian states.

Materials and Methods

Case development using personal interviews, collecting data for delineation of success factors for agri-enterprise development, facilitating linkages, marketing and supply chain study and communication pattern of the successful entrepreneurs in specialization of diversified farming agripreneurship, fruit and vegetable cultivation, post-harvest processing and marketing, commercial seed production, dairying, poultry production, spice export, mushroom production and processing, specialty agriculture, processing and value addition in farm produce and new niches like vermicomposting were studied. The selection of entrepreneurs for the study was conducted on the basis of available records of recognition of farm entrepreneurs from different organisation. The states covered included 12 states namely; Andhra Pradesh, Assam, Delhi, Madhya Pradesh., Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Rajasthan, Uttar Pradesh, West Bengal, and Uttarakhand. The data on entrepreneurial competencies and psychological parameters were collected on standard scales and analyzed with simple tools like frequency, weighted score and mean etc.

Results and Discussion

The study revealed that it is possible to build entrepreneurial competencies of farmers and farm women through appropriate training interventions, mentoring and linking them with other agencies. The process of agripreneurship development was found to be a dynamic interplay of self-sphere of the individual and environmental sphere resulting in the profit making venture marked by higher profits, yields, innovative behaviour and brand establishment. It was found that possessing entrepreneurial competencies like opportunity recognition, innovativeness, quality concern & need for achievement in tandem with adequate technical knowledge gear up an entrepreneur to take advantage of available resources into a profitable venture. Inhibitive factors were identified and it was found that, who bogged down by inhibitive factors present in environment, experienced failure whereas the others who capitalized the promotional factors available in environment and dodged the inhibitive factors accomplished their targets and achieved success (Table 1). The nature of support available and capitalized by the farm entrepreneurs acted as facilitators were: financial support in terms of loans, subsidy, sales tax waiver or special rates of interest on loans for women entrepreneurs; motivational support in terms of awareness and entrepreneurial motivation, special marketing avenues; infrastructural support, mentorship and handholding and recognition / awards

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Table 1: Best Practices and Facilitative and Inhibiting factors for agri enterprise development

Factors	Weighted mean score/ Rank
Facilitative factors	
Farming Background	4.8
Innovativeness	4.7
Expert interaction	4.6
Marketing linkages	4.4
Entrepreneurial competencies	4.2
Nearness to market	3.9
Brand establishment	3.8
Niche market	3.5
Growing high value crops	3.5
Inhibitive factors	
Lack of critical technical guidance	4.83
Lack of infrastructure	4.62
Nonm availability of skilled labour	4.31
Fluctuating market demand	3.9
Lack of resources	3.54
Lack of awareness	3.3
Best Practices	
Recognizing opportunities in the surrounding	II
Diversified cropping	I
Innovative varieties developed and intercultural operations	III
Strive for excellence	IV
Concern for maintaining quality of products	VI
Use of latest recommended technology	II
Developing effective marketing linkages	IV
Maintenance of standards as per marketing requirements	V
Plantation timing to meet the market demand	III
Capitalizing on previous experience and ones own strengths	V
Ability to calculate profits and keeping track of leakages	VII
Networking with all stakeholders	IV

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Resource Integration and Sustainable Production for Food and Nutritional Security in Tropical Home Gardens of Southern Kerala

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Keywords: homestead, organic, integration, recycling, vermicompost

Introduction

Kerala, the southernmost state in India has the unique agricultural practice of homestead farming which involves an *in-situ* food production mechanism, a resource conservation and management strategy prevalent to combat the unpredictable elements involved in commercial farming. Although the practice has been in vogue from time immemorial, research studies have been mostly confined to the structural diversity and composition of selected home gardens. The multi faceted advantages offered by the practice upholdits importance in the food, nutritional and livelihood security of the farm family. The paper attempts to explore the socio economic status of homestead farmers in Kollam district, Kerala, the utilization pattern existing and attempts to restructure selected homesteads for resource use efficiency and income maximization for sustainability.

Materials and Methods

A detailed survey was conducted in the 11 blocks of Kollam district covering the four agro-ecological zones. The data on the homesteads, including the socio economic characteristics, were collected with a well structured pre tested questionnaire and personal interview. Based on the resource availability, location and willingness of farmers, interventions were selected for restructuring three homesteads representing the physiography of lowlands, midland and highlands into sustainable model units, in a participatory mode. The interventions made in the homesteads were:

1. Inclusion of more agricultural components increasing the cropping intensity
2. Lopping of branches to regulate shade
3. Vegetable cultivation in grow bags near to the house building
4. Inclusion of Azolla unit
5. Introduction of poultry and apiary component
6. Recycling of biowastes as nutrient sources
7. Encouraging ecofriendly pest and disease management options

Results and Discussion

Analysis of the socioeconomic status of the homestead farmers in Kollam revealed majority of the respondent farmers (84%) to be marginal farmers. Homesteads were mostly coconut based, but, rubber was catching up in mid and lowlands during the project period. Crop components were generally fruits, vegetables and tubers apart from the perennial tree components, but, were maintained/ grown as per the interests of the farmer, mostly in a non-scientific manner. The unutilized or fallow lands in the three homesteads were brought under cultivation and inter- cropping was promoted for higher cropping intensities. The homestead in Agro Ecological Unit (AEU) 14 of Kollam district was characterized by an adjoining paddy land that was brought to cultivation ensuring the farm family's staple food and feed of the livestock component. Homesteads in Agro Ecological Units 3 and 9 had taken up vermicomposting reducing the dependence on external inputs for nutrient management and newer enterprises of poultry. In addition to the bio wastes in the form of crop residues, tree litter served as an organic mulch which on decay release nutrients and add to the soil nutrient pool. Kumar and Nair (2006) have reported that the dominance of perennial crops in a system is likely to have positive contributions towards soil fertility replenishment, soil-water conservation and microclimate improvement through its nutrient cycling and shading effects.

The benefits of interventions in the homestead in terms of increased cropping intensity, employment generation and profitability are presented in Table 1.

Table 1: Economic Analysis and benefits with interventions

Location (*AEU)	Homestead Area (ha)	Cropping intensity (%)	Addl. Man days	Net returns	Benefit cost ratio
I- AEU 14	0.54	134.5	52	151100	1.79
II- AEU 3	0.52	180.0	152	48825	1.29
III- AEU 9	0.80	147.2	48	134562	1.80

*Agro Ecological Unit

It is evident that there has been significant increase in the gross returns with inclusion of newer components and increased cropping intensity, but, the higher cost of cultivation (family labour included as cost input) narrowed the net returns and profit. However, the increase in employment opportunities in terms of mandays indicates positive effect of intensive integrated farming practices.

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222.

Resource Use Efficiency of Small Broiler Units in Jammu & Kashmir State of India

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Keywords: Resource use efficiency, Cobb-Douglas, broiler, marginal value productivity

Introduction

Animal production constitutes an important and most crucial sub sector of agriculture keeping the production and supplementary income generated from it. Poultry is one of the enterprises of animal husbandry sector, of which meat is the major component. Poultry meat (boiler) is an important source of high quality proteins, minerals and vitamins to balance the human diet. Depending on the farm size, broiler farming can be a main source of family income or can provide subsidiary income. Keeping in view the importance of such studies, a study has also been conducted in and around Jammu city of Jammu & Kashmir state to find out the economic viability of broiler production and to determine the resource use efficiency through its production function.

Materials and Methods

Jammu district of J&K state has more conducive environment for broiler production compared to other districts of the state. The majority of broiler farms are existed in and around Jammu city of Jammu district. Therefore, an economic analysis of broiler farms in and around Jammu city were conducted through single broiler production cycle during the year 2013. The Cobb-Douglas production function was used to analyze the marginal productivity of factors, marginal rate of substitution, factor intensity and the efficiency of production. The efficiency of economic resources was estimated on the basis of conventional neo-classical test i.e. the ratio of the Marginal Value of productivity of an input and its unit price must equals unity.

Results and Discussion

The regression coefficient of chicks was 0.38 and is significant at 1% level of significance with p-value is 0.005. The regression coefficient of human labour was positive and non-significant at both 1 and 5% levels of significance (R^2=0.42). The regression coefficients for vaccine, drugs & veterinary fee and feeds were both significant at 1% level of significance. The coefficient of multiple determination (R^2) was 0.94, which indicates that 94% of variation in broiler production was explained by the four independent variables included in the model, remaining 6% of variation was explained by error term.

Table 1: Estimates of Cobb-Douglas production function and ratios of MVP to MFC for broiler production

Particulars	Intercept	Chicks	Human Labour	Vaccine, drugs & Veterinary fee	Feeds	R^2	Adjusted R^2
Regression Coefficients	0.86265	0.38*** (0.0050)	0.053 (0.4466)	0.423*** (0.0044)	0.1363*** (0.0027)	0.95	0.94
MVP		44.31	236.883	401.479	6.934		
MFC		30.00	170.00	75.00	12.00		
r=MVP/MFC		1.47	1.394	5.353	0.577		
Interpretation		Under-Utilized	Under-Utilized	Under-Utilized	Over-Utilized		

***Significant at 1% level of significance

The ratios of marginal value product (MVP) to marginal factor cost (MFC) for various resources worked out and were also presented in the same table. The ratios of MVP to MFC were positive and more than unity for chicks, human labour and vaccine, drugs & veterinary fee i.e. 1.477, 1.393 and 5.353 respectively, indicating the under-utilization of these resources, whereas for feeds, the ratio although came positive but it was less than unity i.e. 0.578, indicating that the resource was over-utilized.

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Citrus Fruit (*C. limon* L and *C. sinensis* L) Peels as Potent Antimicrobial Agents

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Introduction

Medicinal plants represent a rich source of antimicrobial agent (Srivastava *et al.,* 1996). A wide range of medicinal plant parts used to exhibit varying medicinal properties had been used as raw drugs. Citrus fruits are known to be used as natural drugs to treat a variety of diseases. Considering the vast potentiality of plants as sources for antimicrobial drugs, the current investigation was carried out to screen the antibacterial activity of *Citrus limon* L and *Citrus sinensis* L peels belonging to the family Rutaceae that are being used for herbal treatment against.

Materials and Methods

Methanolic and ethanolic extract of *C. limon* and *C. sinensis* were extracted by soxhlet extractor and subjected to antibacterial assay against *E. coli, P. aeruginosa, K. pneumonia and S. aureus* by using disc diffusion method (Mukharjee *et al.*, 1995). The test microorganisms *E. coli, P. aeruginosa, K. pneumonia and S. aureus* were isolated from soil samples and confirmed by sending the samples to Institute of Microbial Technology, Chandigarh. The bacterial cultures were maintained on Nutrient Agar slants at 37°C and stored at 4°C. Both the extracts of both materials were then also subjected to phytochemical analysis. The standard method of Harbarne (Harbarne, 1973) was used to test for the presence of Phytochemicals.

Results and Discussion

In our study, the peel of *C. limon* and *C. sinensis* showed marked antibiotic activity against *B. subtilis, E.coli, S.aureus, and P. aeruginosa*. In the antimicrobial study, methanolic extract of *C. limon*L. against *E. coli* showed maximum antibacterial activity with maximum inhibition zone of 13 mm and minimum activity with maximum zone of inhibition of 9 mm) was shown against *P. aeruginosa* while that of *C. sinensis* showed maximum activity with maximum zone of inhibition 17 mm against *S. aureus* and minimum activity with the inhibition zone of 13 mm against *P. aeruginosa* whereas in ethanolic extract of *C. limon* L. against *E. coli* maximum activity with maximum inhibition zone of 12 mm was shown, and minimum activity with the inhibition zone of 9 mm was shown against *B. subtilis* while that of *C. sinensis* showed the maximum activity with inhibition zone of 13 mm against *S. aureus* and minimum activity with inhibition zone of 10 mm against *E. coli.* It can be concluded on the basis of the above results that the waste parts of the citrus fruits like the peels could be found to be a very good source for the extraction of antimicrobial components. These extracts could further be used as a drug after proper pharmacological evaluation and clinical trials. Thus, the study ascertains the value of plants used in ayurveda, which could be of considerable interest to the development of new drug.

Table 1: showing maximum and minimum inhibition zones by methanolic and ethanolic extract of *C. limon* L and *C. sinensis* L respectively

Diameter of growth of inhibition zones (mm)	Minimum inhibitory concentration (MIC) mg/ml (mm)			
	C. limon L.		*C. sinesis* L.	
Microorganisms used	Methanolic	Ethanolic	Methanolic	Ethanolic
B. subtilis	-	9	-	-
S. aureus	-	-	17	13
E. coli	13	12	-	-
P. aeruginosa	9 min.	-	13	10

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Development of *In-vitro* Propagation Protocol of *Alstroemeria hybrida* Cv. Pluto

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Keywords: Alstroemeria, rhizome tips, rhizome sections and tissue culture.

Introduction

Alstroemeria is a rhizomatous monocot belonging to family *Alstroemeriaceae*. *Alstroemeria* hybrids are among top ten cut flowers globally owing to diversity of colours, low energy cultivation and long vase life. *Alstroemeria* is a relatively recent introduction into the world's floriculture scene and has become a major cut flower. *In vitro* multiplication of elite genotypes of *Alstroemeria* is widely used in commercial multiplication and offers immense opportunities to multiply more number of disease free plants in shortest possible time (Lin *et al.*, 2000). This shall not only ensure availability of quality planting material for growers but also open up avenues for cultivar improvement through *in vitro* mutagenesis. Therefore, current study involved standardization protocol for aseptic establishment of rhizome tips and subsequent multiplication and rooting.

Materials and Methods

Explants were washed with running tap water to remove any adhering dust and debris and cut into manageable size pieces. Afterwards the explants were put in a tween-20 surfactant solution (few drops) along with required quantity of fungicides and shaken for 30 minutes to ensure thorough cleaning. There after the surfactant along with the fungicides was washed off under running tap water followed by a final washing with single distilled water. The specimens were treated with mercuric chloride 0.1%, ethyl alcohol 70% and aseptic inoculation under laminar flow hood. Observations were recorded, percent asepsis after 4 weeks of culture and percent survival after 4 weeks of culture.

Explant surface sterilized with optimal concentration of sterilant were established on Murashige and Skoog's medium (solid, solid with activated charcoal and liquid) containing different concentrations of plant growth regulators Explants were given final 3-4 washings with sterile water before placing on the establishment medium fortified with different concentrations of 6-Benzyl amino purine, Indole-3-butyric acid, Naphthalene acetic acid, kinetin and activated charcoal. 250 ml flasks were used for conducting this experiment and observations recorded were: percent established cultures, days to rhizome sprouting and number of sprouted buds. Standardization of shoot proliferation in *Alstroemeria* was recorded in terms of percent proliferation, number of erect shoots, number of new rhizome buds, fresh weight of rhizome/shoot complex (g) and multiplication index. Whereas standardisation of rooting in *Alstroemeria* was recorded in terms of days to appearance of root, rooting (%), number of roots and root length (mm).

Statistical analysis of the data collected for different parameters was subjected to analysis of variance at 5% level of significance using Minitab for completely randomized design with four replications.

Results and Discussion

Surface sterilization of rhizome tips and rhizome sections with carbendazim 200 ppm for 30 minutes followed by mercuric chloride (0.1%) dip for 10 minutes and ethyl alcohol 70% for 1 minute resulted in highest per cent uncontaminated cultures (68.08% in case of rhizome tips and 61.63% in case of rhizome sections at 4 weeks of culture respectively).

Rhizome tips proved better explants for culture establishment. MS- liquid media proved better for culture establishment in terms of percent establishment, days to sprouting and number of sprouted buds. MS-liquid media supplemented with BAP + IBA: 1.5 + 0.2 mg l^{-1} resulted in maximum per cent establishment (89.42) along with lowest days to sprouting (9.18) and highest number of sprouted buds (4.05) (Fig. 1 and 2).

MS-solid medium supplemented with BAP + IBA + GA_3 + activated charcoal: 2.0 + 0.4 + 0.5 + 1000 mg l^{-1} resulted in highest proliferation in terms of per cent proliferation (88.85), number of erect shoots (5.75), number of new rhizome buds (3.75), rhizome fresh weight per shoot complex (6.05g) and multiplication index per cycle of (× 2.76) (Fig. 3 and 4).

In comparison to MS-solid medium, MS-liquid medium proved better in terms of rooting. Explants placed on MS-liquid medium supplemented with NAA 1.5 mg l^{-1} resulted in significantly higher per cent rooting of 54.81% (Fig. 5).

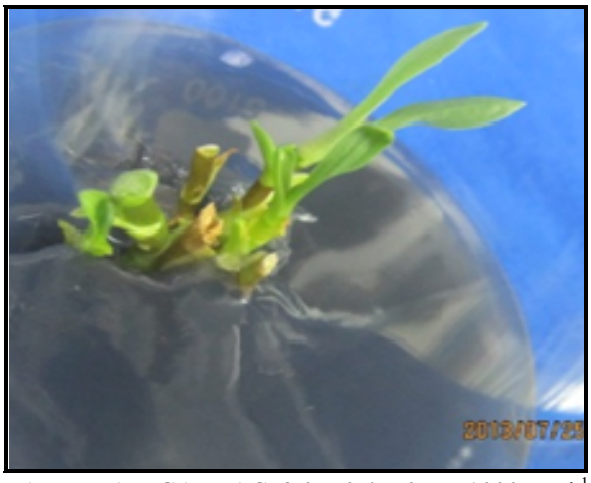
Rhizome tips taken during the vegetative growth are suitable explant for starting the culture in *Alstroemeria cv.* Pluto resulting in maximum uncontaminated growing cultures, establishment, proliferation and rooting of rhizome tip explants.

BAP + IBA: 1.5 + 0.2 mg l^{-1}

Fig. 1: Establishment of rhizome tips in liquid media

BAP + IBA: 1.5 + 0.2 mg l^{-1}

Fig. 2: Sprouted buds of rhizome tips in liquid media

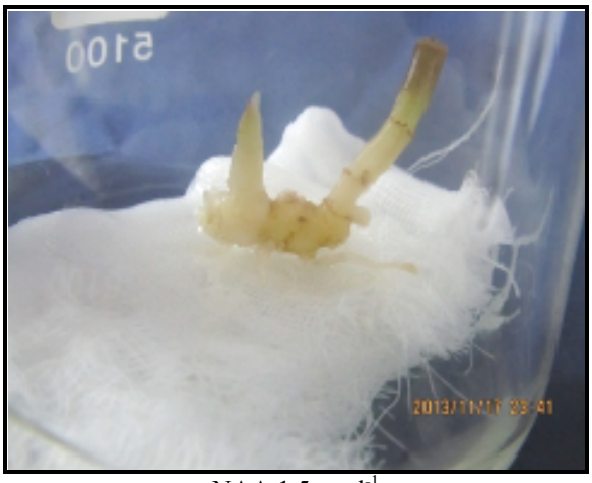


BAP + IBA + GA_3 + AC: 2.0 + 0.4 + 0.5 + 1000 mg l^{-1}

Fig. 3: Rhizome tip proliferation in media with activated charcoal

BAP + IBA + GA_3 + AC: 2.0 + 0.4 + 0.5 + 1000 mg l^{-1}

Fig. 4: Erect shoots in media with activated charcoal



NAA 1.5 mg l^{-1}

Fig. 5: Rooting in liquid media

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225.

Preferences of Agriculture Students of Punjab Agricultural University, Ludhiana for Different Occupations

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Keywords: Preferences, agricultural students, research, teaching, extension, occupation

Introduction

Students determine largely the destination of a nation. The vast potentials and talents of the students hence be explored, systematically examined and properly understood and harnessed for the constructive ends of a nation. In the modern age of psychological study of an individual, it is imperative to know the choice of an individual and to prepare them for satisfying living to avoid wastage and frustration in life. The agricultural colleges offer diversified courses of study to fit their choice and option. The agricultural students do have some plans to adopt a specific career after completing their graduation and post-graduation. They have their own liking and disliking for various occupations/job opened to them after completing their studies. So, to know preference of the agricultural students to adopt various occupations, a study was conducted at the College of Agriculture of Punjab Agricultural University, Ludhiana.

Materials and Methods

All the final year students of B.Sc. Agriculture (Hons) as well as post-graduate students of the College of Agriculture were the respondents. A total of 180 students comprising of 95 from B.Sc. Agriculture (Hons), 80 from M.Sc. and 5 from Ph.D. were selected for the study. Occupation/ job preference of students was measured in term of favourable evaluation made by students for teaching, research, extension and self-employment as first, second, third and fourth in relative terms. A score of "1" was given to fourth favourable occupation/job and a score of "4" to first favourable occupation/job. Chi-square test was applied to know the differences among the preferences regarding these occupations are significant or not

Results and Discussion

The figures in the table indicate that majority of the undergraduate students recorded their first preferences for extension followed by teaching and self-employment, whereas they gave their last preferences to research. The chi-square value of 26.65 showed that difference among the preferences regarding these occupations was significant at 1% level.

Table 1: Distribution of respondents on the basis of their preferences for various occupations/jobs

Occupations	Undergraduate students (n=95)					Postgraduate students (n=85)				
	1st	2nd	3rd	4th	χ2	1st	2nd	3rd	4th	χ2
Teaching	27	21	22	25	26.65**	24	22	18	21	64.05**
Research	13	21	23	38		34	26	10	15	
Extension	32	22	22	19		18	24	12	31	
Self-Employment	23	31	28	13		9	13	45	18	
Total	95	95	95	95		85	85	85	85	

** Significant at 1%

Similarly, the data in the table shows that majority of the post graduate students gave their first preference for research followed by teaching and extension, whereas they gave their last preferences to self-employment. The chi-square value of 64.05 showed that difference among the preferences regarding these occupations was significant at 1% level. It has been concluded that corresponding first preferences of undergraduate and post graduate student were extension and research respectively, and had significant association at 1% level of significance.

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Integrated Water Resource Management: Theoretical Proposition, False Prescription

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Keywords: Water entrepreneurs', policy recommendations

Introduction

The study has conducted to analyze the development and utilization of water resources in the existing market and governance of water use in agriculture. Contribution of irrigation structures for different minor irrigation censuses, irrigation potentiality, cropping pattern with the development of irrigation over time and the extent of use of ground water resources have included in the study. Depletion of water table, participatory water management, scope of water based entrepreneurs for efficient market and the suggestive policy measures to overcome the ill consequences have been included in the study for some selected regions of lower Gangetic basin in West Bengal.

Materials and Methods

Secondary data on water table over times has been assembled from Central Ground Water Board (Eastern Region) and area on different crops are from the official statistics published time to time by public sources. The farmers' perception and actual uses of water for different crops have also collected from the farmers and tube well owners those who are selling water to others after mitigating their own needs. Benefit-cost ratio, net present worth, financial rate of return and net return per hours of sale has used in different locations to estimate the water pricing and returns from tube well installation.

Results and Discussion

Ground water contributes more area than surface sources and water tables are gradually declining for the pressure of irrigation. Summer rice (*Oryza sativa*), a high water consuming crops purely depends on ground water sources, which needs the replacement towards less water consuming crops like wheat, pulses and oilseeds from the view point of water sustainability.

The financial rate of return from tube well investment extends up to 30-40% and the margin per hours of sale of water as high as Rs.13.76-20.92 and Rs.29.18-35.98 in two distinct locations. Therefore, the demand for new installation and thereby the density of tube wells are rapidly growing which needs good governance regarding installation as well as participation in irrigation. The users are also aware about the requirement of water for their crops because in most of the cases, they irrigate within the recommended level of water when they are paying for it that demands water-based entrepreneurs' development for the new installation and water use & selling system to economies the water use.

Table 1: Financial viability of irrigation entrepreneur in lower gangetic basin (crop year 2010-11)

Location	High value crops (% of gross cropped area)	Absolute change of Water table Pre/post Monsoon (m.bgl)	Benefit-Cost ratio	Net present worth (Rs. In lakhs)	Financial rate of return (%)	Margin /hrs. of sale (Rs.)
Low value cropping zone(Highest/lowest)	20.85 *(233)	-2.59/-1.07	1.80/1.37	29.88/12.75	29.45/18.07	20.92/13.76
High value cropping zone(Highest/lowest)	53.48 *(289)	-0.36/+0.61	2.38/1.72	37.42/25.05	38.91/34.32	35.98/29.18

*Cropping intensity (%) # Negative sign means draw down from 2005-2009.

Low water consuming crops, water based entrepreneurs', regulations in tube well installation, integrated in land & water management technologies are important for direct and the electricity charges, maintenances of river basins, consumptive use of water, imposition of resource extraction fees, modification of food trade policies and subsidies for water saving are for indirect measures. Establishment of Integrated Land and Water Resource Management Institute in all levels are prime thrust for good water governance.

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227.

Gender Roles and Decision making in Agriculture- A dimension of Natural Resource Management

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Keywords: Rural women, gender roles, decision making, natural resource management

Introduction

The growing demand for food, water, fiber and energy is disrupting agro-ecosystems, eroding biodiversity and depleting land and water. Women manage natural resources daily in their roles as farmers and household providers. To meet family needs, rural women rear animals, fetch fodder for them, walk long distances to collect fuel wood and water. Despite their reliance on natural resources, women have less access to and control over them than men. Gender inequality is most evident in access to land. Frequently women have only use rights, mediated by men, and those rights are highly precarious. Today the overuse of those resources poses a serious threat to rural livelihoods and food security.

Materials and Methods

A micro level study was conducted in the two villages of R.S. Pura block of Jammu district: Badyal Brahmna and Raipur Sajdan. The total number of respondents selected for the study was 100 (50 from each village). The data was collected with the help of questionnaire by personal interview method to know the participation of women in agriculture and women's involvement in making decisions regarding agriculture related activities.

Results and Discussion

An average of 89% of women were taking part in almost every agriculture activity, in which majority (92%) of the respondents clean their seed before sowing and 94% indulge in post harvest management and storage of produce. About 82% helps in livestock management activities namely milking (38%), fodder cutting (68%) and cleaning of animal shed (74%). Regarding involvement in productive decision, only 14% were found to provide input in almost every productive decision related to farms. About (74%) of the respondents had not participated in any training programme related to agriculture (Table 1). About 90% of women did not have autonomy in any production related decisions, 96% of the respondents did not own land or any other assets and resources. Majority (88%) of respondents did not purchase or sale of land assets and other resources. This showed that without secure land rights, women farmers had limited access to credit - and little incentive - to invest in improved management and conservation practices. Rural women are more likely to make environmentally sound land management decisions when they have secure ownership. To protect the natural resources, rural women must be empowered with secure land rights, access to credit and to participate in decisions that affect their needs and vulnerabilities. Addressing the gender dimensions of natural resources management will help policy makers formulate more effective interventions for their conservation and sustainable use.

Table 1: Working pattern and involvement of rural women in agriculture

N=100

Working pattern and involvement in activities	Yes	No
Participation in agriculture activities	89%	11%
*Cleaning of seeds	92%	08%
*Post harvest and storage of produce	94%	06%
Livestock management	82%	18%
* Milking	38%	62%
* Fodder cutting	68%	32%
*cleaning of animal shed	74%	26%
Involvement in productive decisions	14%	86%
*participated in agriculture related training	26%	74%
*autonomy in productive decisions	10%	90%
*own land or any other assets	04%	96%
*sale or purchase of land or other resources	12%	88%

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Pre Harvest Wheat Yield Prediction through Agro meteorological Models for Western Zone of Haryana

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Keywords: Multiple linear regressions, principal component analysis, Bartlett test, trend

Introduction

Agriculture has become highly input and cost intensive. Under the changed scenario, forecasting of various aspects relating to agriculture is becoming essential. Forecasting of crop production is one of the most important aspects of agricultural statistics system. Since crop yield is the culmination of many temporal plant processes and is affected by various external factors related to soil, weather and technology, parameterization of these factors and investigation of their relationship with yield are essential for crop yield modeling. Several statistical approaches are in vogue for arriving at crop forecasts. Aneja, 2007 proposed a suitable methodology for the pre-harvest estimates of cotton yield by taking biometrical characters as explanatory variables. Aneja *et al.* (2013) proposed a statistical model for pre-harvest estimation of cotton yield on the basis of growth indices

Materials and Methods

Wheat yield data for the past 32 years (1978-79 to 2009-10), published by Department of Economics and Statistical Analysis (DESA) Haryana, have been taken from Statistical Abstracts of Haryana. The daily weather data pertaining to maximum temperature, minimum temperature, rainfall, and relative humidity and sunshine hours for Hisar district for the last 32 years were collected from Department of Agricultural Meteorology, CCS, Haryana Agriculture University, Hisar.

Results and Discussion

The analysis have been carried out for developing trend-agromet models on agro-climatic zone basis for wheat yield forecasting in western zone of Haryana. Considering 45 weather parameters along with trend yield as regressors and yield as dependent variable; stepwise regression analysis was performed to develop forecast models for western zone of the state. Further, two selected zonal models (**Table 1**) were used to obtain yield forecasts of all the districts falling in the zone.

Table 1: Selected Multiple linear regression models on the basis of maximum R^2 and minimum Standard Error for district-level yield prediction

Model	Yield Forecast model	Adj -R^2	SE
1	$Y=1488.68 + 1.038TY - 34.38TMX_2 + 8.65\ TMN_3 - 13.58SSH_5 + 67.78TMN_7 - 5.22RH_8 - 66.85TMN_9 - 10.34RF_9$	0.87	257.76
2	$Y= 2358.51 + 0.94TY - 34.22TMX_2 + 18.31TMN_3 - 54.20SSH_5 + 3.04RF_7 - 4.51RH_8 - 79.69TMN_9$	0.85	283.21

Principal component analysis offers considerable improvement over least squares method in the presence of multi colinearity. Bartlett's test of sphericity has been used to test the null hypothesis that the variables in the population are uncorrelated. Principal component method has been used for extraction of factors which consists of finding the eigen values and eigen vectors. The components whose eigen values are greater than one were retained. Under this study, first fourteen eigen values of correlation matrix of explanatory (weather) variables suggested fourteen factor solution. The performance of the forecast models has been compared on the basis of different statistics namely adjusted-R^2, percent relative deviation of forecast yield from the observed yield and root mean square error. The results indicate the preference of using prediction equations based on principal component scores over the regression models using weather parameters as predictor variables. Trend yield (TY) appearing in all the models, indicated that most of the variability in yield was explained by TY, which is an indication or technological advancement, improvement in fertilizer/insecticide/ fungicide/herbicide used and increased use of high yielding varieties. The other question is the usefulness of the zonal yield model to forecast the district yields in the state. Results indicate that the district-level predictions have improved significantly using zonal yield models.

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Water Management Strategies for Sustainable Agriculture

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Keywords: Agronomic practices, Water management, Sustainable agriculture.

Introduction

India is the largest groundwater user in the world, with an estimated usage of around 230 km^3 per year. Agricultural demand for irrigation is already the single largest draw on India's water, yet estimates by the Ministry of Water Resources indicate that by the year 2050 irrigation needs will rise by 56%. From the climate change viewpoint, India's groundwater hotspots are concentrated in the seven states of Punjab, Rajasthan, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, and Tamil Nadu. Northwestern India is the country's breadbasket. The state like Punjab, having semi-arid climate and highly seasonal monsoon precipitation, with only 1.57% of the total geographical area, is contributing 27-40% rice, 55-65% wheat and 18-25% cotton to the central pool since the last three decades (Jain, 2012). But these contributions to nation's central pool mean that this lush productivity comes at a cost. The dropping water levels in this region are largely attributed to unsustainable consumption of groundwater for irrigation and other uses along with increased runoff and/or evapo-transpiration, which climate change may further exacerbate.

Materials and Methods

The studies relating to the practices followed by the farmers that deteriorate the environment and management strategies for sustainable agriculture conducted by different scientists have been consulted and analyzed thoroughly. A critical review of the same has been specified in the results and discussion.

Results and Discussion

Agriculture in the state is dependent on heavy requirement of water. The available water in Punjab is 3.48 Million hectare-meter (M ha-m) while its demand is 4.93 M ha-m. The deficit is met with the installation of tubewells. Over the last 15 years, 75-80% of the water need of Punjab agriculture has been met through tubewells (Kaur *et al* 2015).

Table 1: Source-wise irrigated area percentage in Punjab

Year	Source of irrigation			Total area (000, ha)	Irrigated area (%)
	Canals	Tubewells	Others		
1970-71	44.5	55.1	0.2	2888	74.7
1980-81	42.3	57.3	0.4	3382	85.4
1990-91	42.7	57.1	0.2	3909	94.0
2000-01	24.3	75.6	0.1	4038	96.5
2009-10	27.4	72.5	0.1	4071	97.9
2010-11	27.4	72.6	0	4070	98.0
2011-12	27.4	72.7	0.1	4086	98.3

Source: Statistical Abstracts of Punjab

To draw more groundwater for irrigation (than what is replenished back) to fulfill the irrigation needs of increasing area under rice, the number of tubewells increased from about 0.98 lakh in 1960-61 (Hira and Khera, 2000) to 13.83 lakh in 2014 in Punjab. The critical analysis of the research work done in India and abroad reported that poor land leveling, lack of pre-treatment of seed and soil before sowing, selection of high yielding varieties, lack of soil testing, early transplanting of rice, over irrigation, over-use of pesticides, rice-wheat cropping system etc. deteriorate the environment and therefore management technologies namely land leveling, transplanting of rice crop in second fortnight of June, bed planting of wheat, direct seeded rice, zero tillage, tensiometer aided irrigation, drip irrigation, sprinkler irrigation, happy seeder, mulching, water saving cropping systems, protected cultivation: poly-houses and low tunnels, ground water recharging through rain water harvesting, renovation of village ponds and recharging through abandoned wells should be adopted to save irrigation water, solve labour scarcity problem, reduces weed infestation, protect soil from evaporation etc. for sustainable agriculture.. It is essential to create awareness among the end users i.e. farming households regarding water saving technologies to mitigate the effects of climate change.

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Diminishing Water Resources a Setback to Wheat Productivity Both in Rain-fed and Command Areas of Jammu Province

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Keywords: Critical stages, water balance study, consumptive use

Introduction

Rice (*Oryza sativa*) wheat (*Triticum aestivum*) and maize (*Zea mays*) wheat are the major cropping system being followed from the time immemorial both in command areas and rain-fed areas of the Jammu province. In Jammu district, Ranbir and Ravi Tawi lift irrigation canals are two major canal system for irrigation. Both these canal system remain close from January to mid April for de-siltation and repair purpose and thus situation for both rainfed as well as command area are similar from January onward till harvesting of crop. During interaction with farming community in farmers training program in various location of Jammu province under Ministry of Agriculture, Government of India sponsored project entitled "Scaling Up of Water Productivity in Agriculture for Livelihood Through Teaching cum Demonstration, Training of Trainers and Farmers" declining in crop productivity of wheat crop was the major complaint of the farming community. According to them, this was mainly due to non availability of water at critical stages due to change in rainfall pattern.

Materials and Methods

To verify the fact, rainfall data of three decade (30 years) was analyzed for Jammu district so as to ascertain whether there is any deviation of rainfall from the normal. Month wise crop water requirement values for wheat crop was calculated through Modified Penman method and the same was compared with effective rainfall available during different decade shown in Table 1. The formula used for this is given here under: \

$Et_c = K_c \times ET_o$

where

Et_c= Crop evapo-transpiration (mm)

K_c= Crop co-efficient

ET_o= Reference crop evapo-transpiration in mm/day.

Water balance study based on crop growing period and canal closure period in command area also confirms the statement of the farmers.

Table 1: Consumptive use of wheat crop along with average effective rainfall (From 1980-81 to 2009-10 (mm) for Jammu district.)

Month	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total
Avg. Rainfall w.e.f. 1980-81 to 1989-90	23.9	41.0	56.4	67.2	101.4	48.0	337.8
Avg. Rainfall w.e.f. 1990-91 to 1999-2000	11.6	34.3	70.3	83.8	52.8	43.5	296.1
Consumptive Use for Wheat crop	8.3	12.2	16.5	35.3	56.6	40.5	169.4
Avg. Rainfall w.e.f. 2000 -2001 to 2009-10	6.4	12.9	43.0	47.6	33.5	11.3	179.2

Results and Discussion

From Table 1 it was observed that rainfall in the *rabi* season in the 1st decade was 337.8mm whereas in the 2nd decade it was only 296.1mm and 179.2 mm in the 3rd decade. From the analysis one thing is clear that rainfall distribution pattern of the Jammu district has changed in 2nd and 3rd decade by 13% and 47%, respectively as compared to data of the first decade. Thus farmers statement that changes in rainfall pattern have given set back to wheat production holds good. Further at the time of sowing of wheat crop (Nov) till crown root initiation stage (ending Dec), farmers in command area were getting sufficient water from irrigation canal as it remains close for de-siltation purpose from Jan to mid April. As crop reaches jointing and flowering i.e., January and February (when the canal system is closed) rainfall in command as well as in rain-fed areas is sufficient to meet consumptive use of the wheat crops in all the three decades but stress in later part (milky and dough stages) only in 3rd decade forced the farmers to cry regarding closure of canal system in command areas, where they have the assured system of irrigation in March and April depriving them from good yield of wheat crop. These shortages/stresses of irrigation water during March and April will defiantly affect the yield of wheat crop as the crop is at milky stage and more over the grains so produced are irregular in shape and size. Under changing scenario of rainfall, it is recommended, that at least in the command areas the de-siltation process be completed in Jan-Feb and water should be available to farmers in the beginning of March so that they can produce more crop per drop of water.

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Adoption of Recommended Wheat Production Technology among the Farmers of Jammu Region

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Keywords: Adoption, recommended wheat production technology, mean per cent score

Introduction

India has achieved an impressive growth in food production after adoption of the Green Revolution technologies which made the country self sufficient in basic foods (Chand, 2009). Wheat in India is the second most important cereal crop and occupies about 27 million ha of total arable land out of 143 million ha cultivable area and contributes about 69.32 million tonnes of food grains which is about 37.96% of the total food grain production. Wheat is the major *rabi*-cereal sown in Jammu and Kashmir (J&K) state. In J&K wheat occupies 0.029 million hectares of land and contributes 0.58 million tonnes of food grains with an average productivity of 20.00 quintals/ha per hectare (Anonymous, 2015). Crop scientists have recommended a number of improved scientific practices for wheat; however, the rate of adoption of improved practices at the farmers' level is considerably low. Higher wheat production can be attained only by increasing the productivity per unit area, which in turn is possible only by wide scale adoption of improved recommended practices by the growers.

Materials and Methods

The present study was conducted in purposively selected Rajouri district of Jammu and Kashmir. Its cultivation is pre-dominantly done in Rajouri district mostly under rainfed condition. There are 9 blocks in Rajouri district, out of which one block namely Rajouri was selected on the basis of maximum area under wheat cultivation. Out of that ten villages were selected on the basis of maximum area under wheat cultivation. From each selected village 12 tribal and 12 non-tribal wheat growers were selected randomly. Thus in all, 240 farmers (120 tribal and 120 non-tribal farmers) were included in the sample of the study. The data were collected through personally interviewing the respondents with the help of a pre-tested and structured interview. The score of "2", "1" and "0" were given to fully adopted, partially adopted and not adopted at all respectively. The total score obtained by the respondent from all the practices was the adoption score of an individual respondent. Further, to determine the extent of adoption, mean per cent score for each item was worked out and ranked accordingly. Mean per cent score was calculated by using following formula:

$$\text{Mean per cent score} = \frac{\text{Total score obtained}}{\text{Maximum obtainable score}} \times 100$$

To find out the variation or similarity in the adoption of recommended wheat production technology between tribal and non-tribal farmers; Z-test was applied. Further, correlation coefficient was worked out to find the relationship between selected independent variables and level of adoption of wheat growers.

Results and Discussion

Among the selected 12 recommended practices of wheat: respondents had high extent of adoption of field preparation (89MPS), sowing time (79MPS), seed rate (76 MPS) and manure application (62 MPS) whereas low extent of adoption was observed in plant protection measures (6MPS), water management (12MPS), seed treatment (16MPS), weed management (17 MPS) and methods of sowing (21 MPS) respectively. Further analysis of Table 1 clearly shows that the calculated value of rank order correlation (r_s) was 0.21 which is statistically non-significant at 5 percent level of significance. This leads to the conclusion that there is no correlation between the ranks assigned by the tribal and non-tribal farmers with respect to different aspects of recommended wheat cultivation technology. There is a considerable scope for enhancing the production of wheat subject to the need based training imparted to the growers so that they could reap the benefits by adopting the improved package of practices.

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Table 1: Extent of adoption of recommended wheat production technology among the respondents n=240

S. No.	Recommended practices	Tribal Farmers		Non-Tribal Farmers		Total	
		MPS	Rank	MPS	Rank	MPS	Rank
1.	High yielding varieties	40	VII	66	IV	53	VI
2.	Field preparation	88	I	90	I	89	I
3.	Sowing time	73	III	85	II	79	II
4.	Seed rate	75	II	77	III	76	III
5.	Seed treatment	06	X	26	VIII	16	X
6.	Methods of sowing	20	VIII	22	X	21	VIII
7.	Manure application	60	IV	64	V	62	IV
8.	Fertilizer application	51	V	59	VI	55	V
9.	Weed Management	10	IX	24	IX	17	IX
10.	Water management	05	XI	19	XI	12	XI
11.	Plant protection measures	03	XII	09	XII	06	XII
12.	Harvesting and post harvest-technology	43	VI	49	VII	46	VII

MPS=Mean per cent score; n= Sample size $r_s=0.21^{NS}$
NS= Non-significant; r_s= rank order correlation

232.

Weather Based Pre-harvest Forecasting of Tea Production in West Bengal

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Keywords: Factors of production, indices, modeling and forecasting

Introduction

Tea (*Camelia sinensis*) production in West Bengal is playing great role not only in world tea market but also in contributing substantially to Indian economy and in employment generation. The production of tea in West Bengal was 221.57 million kg in 2009 as compared to 233.08 million kg in 2008, a decline of 4.9%. The production also declined by 6.2% during 2008 over the period 2007. From 2001 to 2009 there is no considerable expansion in the land used for tea over a period of ten years in West Bengal (Rasaily, 2013). Tea production is influenced by various factors such as soil, climate, plant growth, pests and diseases. A report of 2011 indicates that tea industry in West Bengal facing problems of low levels of productivity, high cost of production, decline in quality of production (Anonymous, 2011). So the study of growth, trends and production scenario of tea has got greater emphasis in research arena, not only in West Bengal but also in other states.

Materials and Methods

Long term data on area, production and yield of tea from Tea Board of India was collected for last 40 years. Data on ancillary variables like weather (temperature, rainfall, relative humidity) and fertilizer consumption (nitrogen, phosphorus and potassium) for West Bengal was also collected from India meteorological Department and Fertilizer Association of India, respectively. For selection of effective variables influencing production, weather indices methodology proposed by Agarwal *et al.* (2001) was followed. We developed four types of indices/models and regressed with productivity of tea crop separately. These models were then compared using higher value of R^2, lower values of root mean square error and forecast percent error for superiority of model and forecasting was done for 2013.

Results and Discussion

West Bengal contributes around 25% of tea production in India. Table 1, denotes the regression analysis of factors influencing the productivity of tea in West Bengal. Step down regression analysis is used to find out most significantly affecting factors on tea productivity. Un-weighted and weighted fertilizer index (F0/F1/F2/F3) were significantly influencing tea productivity in West Bengal in all four methods along with maximum humidity (Z441/Z442) in case of weighted correlation and weighted path coefficient method whereas, in partial correlation method, joint effect of maximum humidity with maximum (Z143) and minimum temperature (Z243) was observed. Regression analysis of tea productivity in West Bengal has observed lower values of R^2 for un-weighted indices method as compared to other methods and weighted partial correlation method has observed with highest R^2 value followed by path coefficient and weighed correlation method in both full model and step down model. From Table 2, lower values of RMSE and error percentage were observed for weighted path correlation method. Hence this method has been selected for forecasting and it is forecasted that in 2013, productivity of tea in West Bengal would be 2340 kg per ha.

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Table 1: Regression analysis of factor influencing the productivity of tea in West Bengal

	Method	Variable	B	SE	R^2
Model I	Un-weighted indice	Intercept	1175.22**	24.99	0.72
		F0	0.53**	0.03	[0.70]
Model II	Weighted correlation method	Intercept	-272.89	607.99	0.74
		F1	3.53**	0.3	[0.70]
		Z441	13.45**	5.83	
Model III	Weighted path coefficient method	Intercept	-272.89	607.99	0.82
		F2	3.53**	0.3	[0.82]
		Z442	13.45**	5.83	
Model IV	Weighted partial correlation method	Intercept	1590.93**	61.93	0.84
		F3	15.14**	2.88	[0.83]
		Z143	-0.83**	0.28	
		Z243	1.20**	0.11	

Note: figures in parenthesis [ ] denotes $\overline{R}^2$, * = 5% level of significance, ** = 1% level of significance.

Table 2: Validation of developed regression models

	Method	Year	Actual yield	Forecast yield	Absolute forecast error (%)	RMSE
Model I	Un-weighted indice	2011	2360	2240	5.06	64.26
		2012	2427	2250	7.46	65.34
Model II	Weighted correlation method	2011	2360	2261	4.18	62.78
		2012	2427	2306	5.10	63.21
Model III	Weighted path coefficient method	2011	2360	2305	2.33	61.25
		2012	2427	2342	3.60	60.56
Model IV	Weighted partial correlation method	2011	2360	2398	-1.61	59.24
		2012	2427	2353	3.12	60.12

233.

AgBalance Study on the Ecological and Socio-Economic Impacts of Transplanted and Direct Wet-seeded Rice Cultivation in Andhra Pradesh

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Keywords: Rice, TPR, DWSR, impact

Introduction

Rice (*Oryza sativa*) is the major staple crop in Asia and of paramount importance for food security in the region. But at the same time rice cultivation is both labour, water and energy intensive and as such a constraint on these limited resources. Consequently there is a need to optimize current cultivation practices towards greater sustainability as well as assess new practices and technologies for their ability to sustainably intensify rice cultivation.

Materials and Methods

We investigated the ecological and socio-economic impacts of the traditional transplanted (TPR) and the direct wet-seeded rice cultivation (DWSR) practice by applying the AgBalance lifecycle assessment (LCA) model. In this model, up to 69 indicators are used to analyze relevant aspects of agricultural production systems and identify options for improvements The data used in this study is based on the farm survey carried out by Indian Institute of Rice Research (IIRR) experts who interviewed 200 randomly chosen farmers (100 farmers each practising TPR and DWSR respectively) in the Godavari basin of Andhra Pradesh.

Results and Discussion

The farmers applying the direct wet-seeded rice practice in East-Godavari achieved on average a yield increase of almost 8%. Together with a reduction in production costs of roughly 40% this translated into a 56% increase in farm profits and 3 times higher family disposable income. The direct wet-seeded cultivation of rice at the same time reduced water use as well as methane and CO_2 emissions. The use of zinc, nitrogenous and phosphorus fertilizer was shown to have a substantial ecological impact in both transplanted and direct-seeded rice. The study identified further improvement potential for both transplanted and direct wet-seeded rice production and an interactive farm management tool is developed to support farmers in optimizing the sustainability of either rice cultivation system. By using a holistic lifecycle assessment we could identify options to improve the socio-economic and ecological performance of rice cultivation systems. This knowledge is now used to test further cultivation practices and new technologies with the goal to sustainably intensify rice production in India.

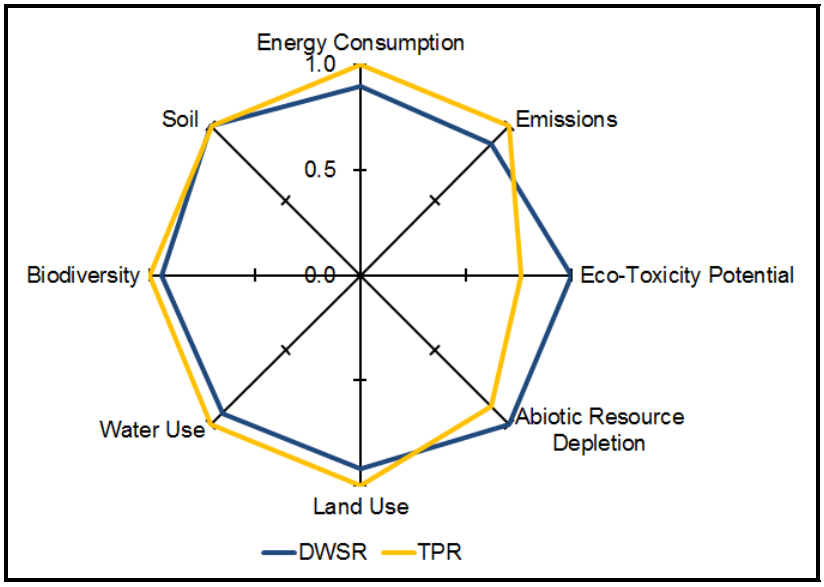

Fig. 1: AgBalance Ecological Fingerprint results for the two rice production systems (the closer each indicator is to 0 the better the score)

234.

An Innovative Method for Transfer of Technology - m-Learning Module

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Keywords: m-learning module, knowledge gain, balanced diet.

Introduction

Mobile phones no more remain just as communication devices; they are particularly useful computers that fit in one's pocket. Rural communities will benefit tremendously from m-learning as most of them possess mobiles. They are far cheaper than personal computers, easy to access and do not depend on a continuous power supply. Hence mobiles can be used as an instrument for transfer of technology to the rural masses. The learning may be through SMS, accessing internet or storing information and accessing it whenever required. The use of SMS and internet requires availability of network which is very poor in rural areas. Hence an alternative to this was thought as m-learning module. This m-learning module is any technology or lesson in audio/video format recorded on SD cards and listened/ viewed through mobiles. The present experimental study was undertaken inorder to test the effectiveness of m-learning modules.

Materials and Methods

In the present study m-learning module on "Balanced diet for rural women" was developed in audio and video format with duration of 40 minutes each. Each module was distributed to 60 rural women who had mobiles in their family in the two selected villages of Dharwad district viz., B-gudihal for video module and Kyarkoppa for audio module. Before giving them the module the women were explained about how to view/ listen to it and a pre test on their knowledge level was conducted. One month time was given to the respondents for viewing/ listening to the module and a post test was conducted on their knowledge level at the end of one month.

Results and Discussion

The pre test knowledge index was 59.84 and post test knowledge index was 70.86 resulting in 20.92 gain in knowledge index with respect to women who listened to audio module. In case of video module the pre test knowledge index was 58.64 and post test knowledge index was 86.11 which resulted in 40.89 knowledge gain. This clearly shows that m-learning module whether audio or video are effective in transfer of technology to rural women. There was significant difference between the means of knowledge gain due to audio (37.13) and video (45.46) indicating that video was more effective than audio. Even though video was more effective, there was significant difference in case of pre test and post test scores of audio module indicating that there was significant knowledge gain due to audio module. Hence audio module can be used for the rural masses who do not possess mobiles with MP3 support and video module can be used for those who possess such mobiles. Therefore m-learning modules can be used as an effective method for transfer of technology

Table 1: Knowledge gain index of the respondents on balance diet from different m-learning modules

Type of Module	Pre test knowledge index	Post test knowledge index	Knowledge gain index
Audio	59.84	70.86	20.92
Video	58.64	86.11	40.89

235.

Modeling and Forecasting of Cashew Production in India

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Keywords: ARIMA, trend, modelling, forecasting

Introduction

Cashew (*Anacardium occidentale*) is one of the important foreign exchange earners in India. As such it has got its own importance in Indian economy. 65% of the world cashew market is contributed by India and its reaches to near about 60 countries in the world including the United States of America US, the Netherlands, Japan, Spain, France, Germany, the United Kingdome UK etc. Cashew is also has its great demand in domestic market. Millions of people are directly or indirectly involved in the cashew industry, starting from its production to export through processing. Though India continues to occupy top position in processing and export, a study on the trends in cashew nut production during the past decades clearly indicate that there was only a very slow growth for cashew development in India compared to Vietnam and Nigeria, thanks to a good amount of raw nuts being imported. Padmanaban *et al.,* 2014 while analysising the trade direction in world cashew market has shown a concern about losing market in certain countries like UK, Japan etc. With this back drop the present study is an attempt analyze the trend in production behavior and forecasting of likely production scenario of major cashew producing states in India along with that of whole world.

Materials and Methods

Time series data for the 1965 - 2013 on production parameters of cashew in major five producing states have been considered in this study. On an average during the period Kerala, Karanataka, Maharashtra, Andhra Pradesh and Tamilnadu produce more than 85% of the country's total production, as such these states have been considered in the study. Different parametric trend models are used find the trend in area production and productivity during the period after due scrutiny and correction data for the existence of outliers (through Grubb's test). Data are then modeled using Box - Jenkins ARIMA modeling technique. Best fitted models, after diagnostic checks are then used for forecasting purposes.

Results and Discussion

The first information after data analysis was that though few states are having steady production scenario, the production scenario in Kerala, the most performing state, has reduced drastically during past 1-2 decades (Table 1). Trend models indicate that in most of the states the nonlinear trends are best suited to explain the production behavior. Whereas the Box-Jenkins ARIMA modeling techniques clearly justifies the use of such techniques towards modeling of production scenario in the major states as well as in India. Different types of ARIMA models starting from ARIMA (1,1,0) can be used for the forecasting purpose. Using the best fitted models, forecasting figures suggest that there would increasing trend in area production in all the major states in India, excepting the state Kerala. The study suggest that keeping mind the quality and craze of Kerala cashew in world market an efficient policy should framed and implemented to cease the deceleration in cashew production scenario of Kerala.

Table 1: Observed and predicted production(mt) of Cashew in major growing states of India and India

		ARIMA	2012		2013		2014	2015	2016	2017
	States	Model	Observed	Predicted	Observed	Predicted	Predicted	Predicted	Predicted	Predicted
Production in (mt)	Andhra Pradesh	1, 0, 0	118140	112425.8	100420	111275.5	110148.6	109044.7	107963.3	106903.9
	Karnataka	1, 1, 0	68640	62868.49	80610	66629.85	66474.82	68545.01	69350.87	70875.1
	Kerala	1, 0, 1	76960	77554.94	80120	77342.93	77131.5	76920.64	76710.36	76500.66
	Maharashtra	2, 1, 2	224640	209738	236200	221654.4	228690.3	223967.6	235451.7	241511
	Tamil Nadu	1, 0, 0	62400	59544.9	67390	59097.35	58657.2	58224.35	57798.67	57380.04
	India	1, 0, 1	751690	697705.8	753160	681549.8	666165.2	651515.2	637564.6	624280.2
	India	2, 1, 0	758.486	722.28	745.0759	736.26	751.18	769.46	772.62	773.27

236.

Assessing the Social and Economic Impact of Frontline Demonstrations on Staple Crop of Poonch

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Keywords: Front line demonstrations, social and economic impact, maize, staple

Introduction

Maize (*Zea mays*) is the staple crop of people of Poonch district and is grown on more than 80% rain-fed area of the district during the *Kharif* season. The baseline survey conducted by Krishi Vigyan Kendra Poonch revealed some gaps in adoption of maize production technologies, as recommended in the package of practices issued by the state agricultural university. Keeping in view the identified gaps and importance of crop for people of the district, Krishi Vigyan Kendra has been conducting Front Line Demonstrations (FLDs) on maize in every nook and corner of the district. The present study was conducted to assess the social and economic impact of FLD on maize conducted by Krishi Vigyan Kendra during from 2011 to 2015.

Materials and Methods

The data on yield and economics of maize crop were collected from demonstrated and nearby local plots to assess the economic impact of frontline demonstrations. Ten, twelve, eight, thirteen and sixteen beneficiaries respectively were selected through proportionate random sampling and interviewed for the year 2011, 2012, 2013, 2014 and 2015 for assessing the social impact of FLDs. The yield of demonstrated and local plots at mean level was compared using Independent sample 't' test after verifying the normalcy of collected data.

Results and Discussion

The difference in yield of demonstrated and local plots at mean level was significant in all the years for which data was collected. The standard deviation and variance of maize yield was low in demonstrated plots as compared to local plots. The maximum average yield of maize under demonstrated plots was obtained in 2015 which was 54.20 quintals/ha and corresponding average yield in local plots was 37.20 quintals/ha (Table 1). The major social impact was seen in terms of recognising the demonstrated fields by nearby farmers and further collection of queries by Krishi Vigyan Kendra regarding frontline demonstrations. The low variation in yield of demonstrated plots revealed the importance of adoption of proven technology on consistent basis for overall enhancement in productivity of maize in Poonch district of Jammu and Kashmir.

Table 1: Descriptive statistics of maize yield in demonstrated and local plots

Particulars on yield of maize	*Kharif* 2011		*Kharif* 2012		*Kharif* 2013		*Kharif* 2014		*Kharif* 2015	
	FLD plots	Local check	FLD plots	Local check	FLD plots	Local check	FLD plots	Local check	FLD plots	Local check
Area covered (ha)					10.00	-	20.00	-		
Mean	38.88	23.01	28.20	22.05	39.88	27.06	48.29	28.23	43.10	23.74
Standard Error	0.44	0.65	0.37	0.56	0.67	0.97	0.35	0.54	0.43	0.50
Standard Deviation	2.95	4.43	2.95	4.37	4.12	5.98	2.90	4.42	3.90	4.52
Sample Variance	8.73	19.61	8.71	19.13	16.96	35.86	8.38	19.57	15.24	20.43
Kurtosis	2.28	-0.82	0.12	-1.19	0.95	-1.36	-0.70	0.47	-1.06	-1.31
Skewness	-0.99	-0.09	-0.34	0.07	-0.79	-0.23	-0.10	-0.44	0.15	-0.24
Range	15.64	16.10	14.20	15.50	18.13	17.70	11.80	22.80	13.80	15.30
Minimum	28.62	14.50	20.00	14.70	29.11	17.50	42.40	14.40	36.00	15.90
Maximum	44.26	30.60	34.20	30.20	47.24	35.20	54.20	37.20	49.80	31.20
Count	46.00	46.00	62.00	62.00	38.00	38.00	67.00	67.00	81.00	81.00
C: B ratio	1.80	1.24	1.43	1.28	2.09	1.56	2.41	1.99	1.94	1.18
Difference in mean yield (Independent samples t test)	7.87***		6.11***		12.82***		12.04***		14.83***	

***Significant at 1% level of significance

Front Line Demonstrations: Hybrid maize seed; 60: 40: 20 dose of NPK; Line sowing method

Local Check: Composite mixed maize seed, imbalance dose of fertilizers, broadcast method of sowing

237.

Assessment of Postural Discomfort among Farm Workers during Wheat Production Activities: An Ergonomic Approach

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Keywords: Posture, discomfort, REBA, assessment, production.

Introduction

Wheat (*Triticum aestivum*) is the most important cereal crop for the majority of world's population as it is the most important staple food. All wheat production activities are one of the most wearisome and monotonous activity because workers requires to adopt stressful postures. The reason being prolonged use of a particular kind of posture, but they were compelled to adopt those postures during work for a long time, which is injurious to them. Keeping in view this aspect, a research study was planned with the objectives i) to analyze work postures of workers involved in wheat production system, and ii) to recommend suitable guidelines to improve working efficiency.

Materials and Methods

To analyze the work posture and discomforts of farm workers REBA (Rapid Entire Body Assessment) was used. The present study was carried out in three villages of Nainital district of Uttarakhand to explore gender participation in wheat production activities, - and to assess their work postures. A total sample size of 60 farm workers (30 males and 30 females) was taken for experimental data using purposive and random sampling without replacement technique.

Results and Discussion

The postural discomfort analysis revealed pain in different body parts among farm workers for which corrective measures in the near future are required. Due to long working hours, awkward body postures, repetitive work and physical load caused a high prevalence of postural discomforts among farm workers therefore REBA suggested action level- Investigated that required change soon to reduce discomfort. Highest Postural load factor was reported during crop cutting and load transport activities for which workers have adopted bending and semi bending postures respectively.

Wheat production activities being a physically laborious work, inevitably places farm workers at potential risk of postural discomforts and musculoskeletal disorders such as osteoarthritis (OA) of the hip and knee, low back pain (LBP), neck and upper limb complaints. There are various risk factors related to these activities which may contribute to the development of postural discomforts among farmers. Some of these occupational risk factors include static positioning, forward bending, heavy lifting and carrying. Therefore there is a need to give them training to improve their work postures.

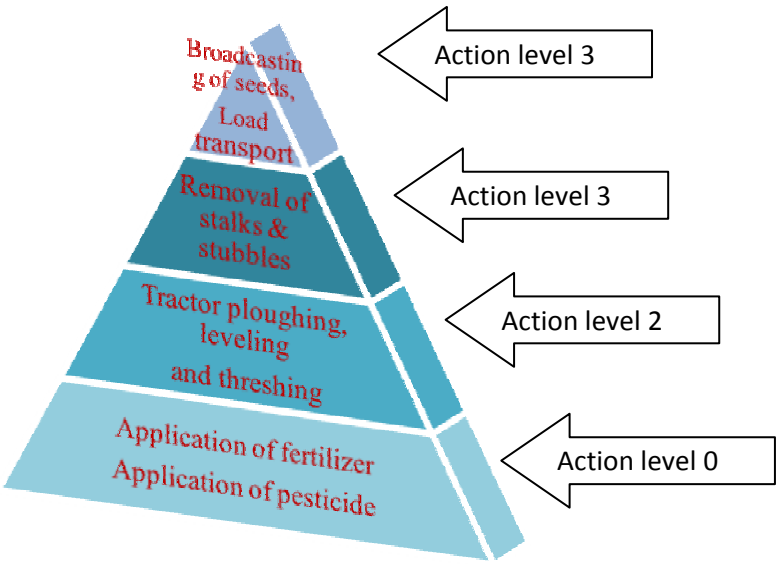

Fig. 1: Distribution of respondents according to REBA assessment (men exclusive activities)

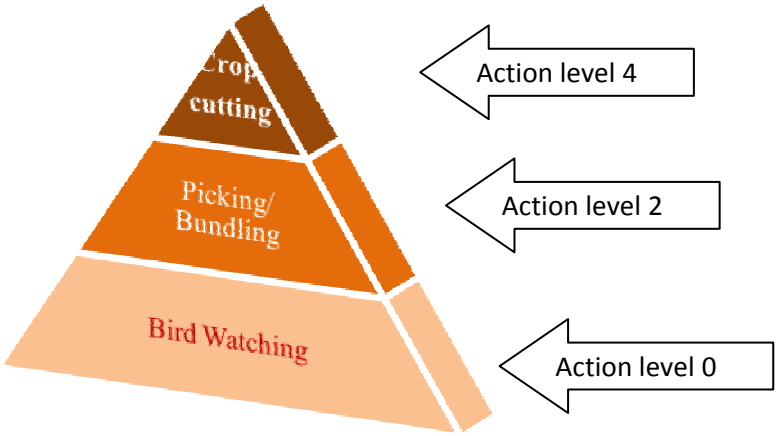

Fig. 2: Distribution of respondents according to REBA assessment (Equal Participation of men and women activities)

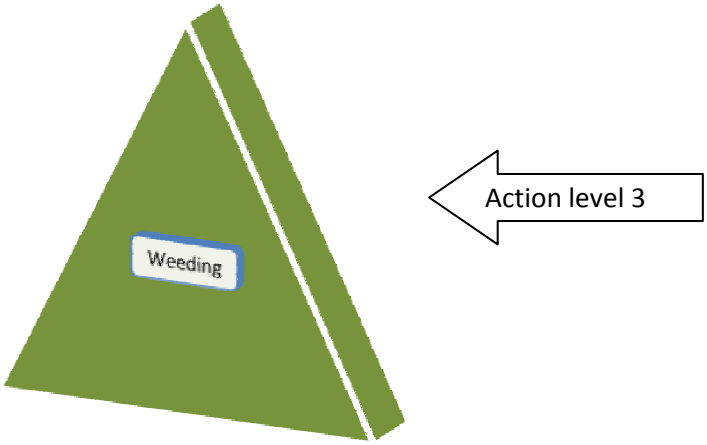

Fig. 3: Distribution of respondents according to REBA assessment (Women dominant activities)

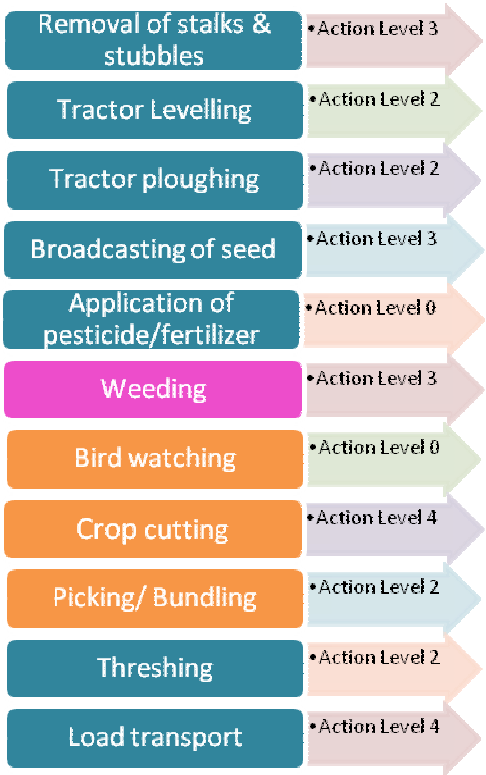

Fig. 4: Series of wheat production activities with their REBA action levels.

238.

Economic Analysis of Integrated Pest Management of Sugarcane in Haryana

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Keywords: IPM, non-IPM, Gross returns, output-input ratio, profitability, sugarcane

Introduction

Integrated pest management (IPM) is a system that in the context of the associated environment and the population dynamics of the pest species utilizes all suitable techniques and methods in as compatible manner as possible and maintains the pest populations at levels below those causing economic injury. The growers have to look at the enterprise of agriculture by the business point of view. They should get the proper benefits (returns) from their produce for which they should know the cost involved in cultivation activity. At the same time, the growers should also be able to estimate net profit or loss that would be sustained in the enterprise. In backdrop of this, the study was undertaken to analyse the economics of integrated pest management of sugarcane (*Saccharum officinarum)* in Haryana.

Materials and Methods

Karnal district was purposively selected because it has the highest area under sugarcane in the state. Two blocks were selected randomly, *i.e.*, Indri and Karnal and two villages were selected from each block. From each village, a sample of 20 farmers proportionate from their size of land holding, *viz.*, small, medium and large were selected; from each village 10 IPM and 10 Non-IPM growers were selected. Thus, in all, 80 growers were selected randomly. The primary data for the agriculture year 2012-13 were collected by survey method by conducting personal interviews of the selected farmers with the help of specially designed schedules.

Results and Discussion

The cost of cultivation for one hectare of sugarcane (Cost 'C_2') in IPM farmers' category was comparatively lower (Rs. 161831) than the non-IPM farmers category (Rs.164138). Human labour constituted the major share (19.03 and 17.85%) of the total cost of cultivation among the IPM and non-IPM farmer, respectively. The use of machine labour charges was higher, i.e., 3.71% in non-IPM as compared to 3.65% in IPM. The fertilizer use in IPM was 3.37% and in non-IPM was 3.27% of the total cost 'C_2'. Plant protection components accounted the highest share to the total cost in non-IPM farmers (3.19%) whereas, it was only (1.13%) in IPM farmers category. Total non-chemical pesticide used was 54.31% of the total cost on pest management and chemical pesticide used was 45.69% of the total cost on pest management. The per quintal cost of production on IPM sugarcane farm (Rs.190) was lower as compared to Non-IPM sugarcane farms (Rs.210), mainly due to higher productivity per hectare on IPM farms (850 q) sugarcane than the non-IPM farms (783.33 q). The gross returns on IPM and non-IPM farms were estimated to Rs. 242317 and Rs. 223399 per hectare, respectively. The output-input ratio indicates of IPM (1.50) and for Non-IPM (1.36) shows that sugarcane cultivation was more profitable on IPM farms as compared to the non-IPM sugarcane farms. The regression analysis showed that the plant protection chemicals have affected the yield of sugarcane on IPM farms significantly.

Table 6: Cost and returns of small, medium, large and overall growers from sugarcane, 2012-13 (Rs.ha^{-1})

Particular	Small growers		Medium growers		Large growers		Overall	
	IPM growers	Non-IPM growers	IPM growers	Non-IPM growers	IPM growers	Non-IPM growers	IPM growers	Non-IPM growers
Yield (q/ ha.)	800	750	875	800	875	800	850	783.33
Value of the main produce @271/quintal	216800	203250	237125	216800	237125	216800	230350	212282.43
Yield (by-product)	190	180	200	185	200	185	196.67	183.33
Value of the by-product @60/quintal	11400	10800	12000	11100	12000	11000	11966.67	11066.67
Gross returns (Rs.)	228200	214050	249125	227900	249625	228100	242316.67	223399.10
Net returns (Rs.)	71275.64	55120.89	86289.14	61894.54	83789.99	60528.04	80485.94	59261.13
Cost of cultivation at								
Cost 'A'	70910.36	73586.11	75722.86	77808.46	77127.01	80101.96	74552.73	77134.97
Cost 'B'	145910.36	148586.11	150722.86	152808.46	152127.01	155101.96	149552.73	152134.97
Cost 'C'	156924.36	158929.11	162835.86	166005.46	165835.01	167571.91	161830.73	164137.97
Returns at (Rs.)								
Cost 'A'	157289.64	140463.89	173402.14	150091.54	172497.99	147998.04	167763.94	146214.13
Cost 'B'	82289.64	65463.89	98402.14	75091.54	97497.99	72998.04	92763.94	71214.13
Cost 'C'	71275.64	55120.89	86289.14	61894.54	83789.99	60528.04	80485.94	59261.13
Cost of production (Rs./q)	196.16	211.90	186.10	207.51	189.53	209.46	190.39	209.54
Output-input ratio at cost 'C'	1.45	1.35	1.53	1.37	1.51	1.36	1.50	1.36

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Economic Contribution of Women in Chilli Cultivation

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Keywords: Chili economic contribution, man days

Introduction

Agriculture is the single largest production endeavor in India contributing about 18% of the total Gross Domestic Products. In this important sector women play a vital role performing nearly 70% of all agricultural activities including crop production, animal husbandry, horticulture, forestry, post harvest etc..

Chili (*Capscium annum*) is the "Universal Spice in India" India is the largest producer of chilies (1.1million tonnes) in the world. Karnataka is second only to Andhra Pradesh, contributing 14% to the country's production. This study was conducted to know the extent of contribution of women in chili production

Materials and Methods

The study was carried out during the year 2014-15 in Dharwad district of Karnataka. Kundgol taluk of Dharwad district was purposively selected as it is the highest chili growing area in the state. Five villages namely- Kundgol, Devanur, Kubhihal, Gudgeri and Saunshi were selected and from each village 30 land owning families cultivating chilies were selected. One woman actively involved in chili cultivation were selected from each of these families making a total of 150 farm women. An interview schedule prepared in the light of the objectives was used to personally collect the information from respondent women.

Results and Discussion

Chili is a labour intensive crop requiring labour for sowing weeding, harvesting and drying. These activities are most often carried out by women rather than men. The data depicted in Table 1 demarcates the areas where men and women dominate. While men are solely contributing in ploughing, application of organic manure, inter cultivation and use of plant protection chemicals, women dominate in weeding and harvesting. The overall man days required for cultivation of chilli/ ha are 48.15 days which translates to Rs. 8393.50. When we compare the total labour man days of men and women, women's labour contribution is higher by 1.31 man days yet when translated into money, men's labour is ₹ 4684.00 while that of female is ₹ 3709.50 with a difference of ₹ 975.50. But when converted to percentages women's labour contribution is 55.80% while economic contribution is only 44.20%. The prevailing wage rates are ₹ 150 for women and 200 for men. The disparity and the gender bias are therefore obvious; women work more but earn less. Women are not only involved in productive work on the farms but play the reproductive roles in their households. Their work at home goes unseen and unsung.

As women take on more responsibility for agricultural production, policy makers should explore how to provide services and innovations that reduces the time and work involved in domestic tasks.

Table 1: Gender wise labour contribution in chilli cultivation (N=150)

Activity	Male labour/per hectare		Female labour/ per hectare		Total	
	Man days	Labour amount received (₹)	Man days	Labour amount received (₹)	Quantity (mandays)	Amount (₹)
Ploughing	1.43	286	-	-	1.43	286
Loading, transportation and spreading organic manure	6.72	1344	-	-	6.72	1344
Seed bed preparation	1.09	218	1.1	165	2.19	383
Sowing	2.3	460	4.48	672	6.78	1132
Fertilizer application	4.09	818	-	-	4.09	818
Weeding	-	0	8.82	1323	8.82	1323
Inter cultivation	1.86	372	-	-	1.86	372
Plant protection chemicals (PPC) application	1.62	324	-	-	1.62	324
Harvesting	4.31	862	10.33	1549.5	14.64	2411.5
Total	23.42 (48.63)	4684 (55.80)	24.73 (51.36)	3709.5 (44.20)	48.15	8393.5

Note: Figures in the parenthesis indicates percentage to the total

- Wage rate of men -Rs. 200/ day
- Wage rate of women - Rs. 150/day

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Economic Evolution of Safed Musli (*Chlorophytum borivilianum*): A Studies under Malwa Region of Madhya Pradesh

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Keywords: Economic evaluation, safed musli, economic importance

Introduction

Safed musli (*Chlorophytum borivilianum* L.) is one of the important medicinal plants. It is used in all type of medicines like ayurvedic, allopathic and unani medicines. In India, it is widely distributed in Madhya Pradesh, North Gujarat and Southern Rajasthan. Due to huge demand of safed musli, plant product and profitable enterprises it must be considered in the cropping system. In this way it would generate income and employment opportunities especially in the potential areas of safed musli. So the present research work was undertaken to assess the economics of production of safed musli growers in Malwa Plateau of Madhya Pradesh.

Materials and Methods

The investigation area confined to Malwa Plateau of Madhya Pradesh, the Indore and Dhar areas were selected purposively on the basis of maximum area covered by safed musli. After that two blocks from Indore and four blocks from Dhar were selected on the basis of maximum coverage of area of safed musli. From the 12 selected villages, ten farmers were selected from each villages, thus a total 120 growers were selected by random sampling method. For the collection of required data, survey method was adopted to conduct the inquiry by personal visits and interview schedule were used to collect all the relevant information from the respondents

Results and Discussion

Average cost of cultivation (Rs. 3, 16,612.9) of safed musli was worked out and that is presented in Table 1: The major expenditure was on operational cost which accounted for 98.26% of the total cost of cultivation. Among operational cost planting material was the major item of cost which accounted 77.62%. Other important items were hired human labour, manure and interest on working capital which accounted about 19% to the total operational cost.

The average yield of safed musli was 22.58 q/ha and resulted in 4.23 lakh as a gross income from the safed musli. In earlier similar results was reported by Maiti Satyabrata, (2000). The result revealed that the average net profit of safed musli of sample farmers was estimated 75 thousand per hectare.

On an average farm business income from safed musli was 1.13 lakhs/ha and family labour income was 1.08 lakhs/ha. The cost benefit ratio was higher (1: 1.29) in case of large farmer followed by medium farmer (1: 1.25) whereas, least cost benefit ratio (1: 1.11) was found with small farmer (Table 1).

Parmar *et al.* (2007) studies economics of production and marketing of safed musli in rural areas of Vindhyan Plateau, Madhya Pradesh and reported cultivation of this wonder crop is much more profitable than any other crop and provides good returns on investment in a short gestation period of 7-8 months.

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Table 1: Break up cost of cultivation of safed musli crop.

Items	Size of farms			Average
	Small	Medium	Large	
Total operational cost	332060.52 (98.43)	305142.51 (98.23)	296169.59 (98.12)	311124.18 (98.26)
Total fixed cost	5298.15 (1.57)	5510.02 (1.77)	5679.97 (1.88)	5496.04 (1.74)
Total Cost	337356.68 (100)	310647.45 (100)	301849.6 (100)	316612.91 (100)
Cost of production (Rs/qtls.)	17316.59	14780.65	14318.47	15424.85
Gross income (Rs./ha)	414336	427107	421730	423363.76
Net farm profit	43241	85378.22	89684.47	75070.52
Cost benefit ratio	1: 1.11	1: 1.25	1: 1.29	1: 1.21

Small= <3ha land, medium=3-5ha, large=>5 ha.

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Farming System Sustainability through Front Line Demonstrations on Fodder Oats (*Avena sativa L.*)

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Keywords: Oats, front line demonstration, farmer practice, economic return

Introduction

Availability of good quality and sufficient quantity of green fodder for stall feeding during winters is a major problem in temperate areas of Jammu Division. Oats (*Avena sativa L.*) is a very useful winter fodder and could help farmers to alleviate winter fodder scarcity (Pariyar *et al.,* 1991). It has potential of providing good quality nutritious forage. Its quality protein and nutritional components are suitable for maintaining animals and milk production. In temperate areas of Doda District farmers generally practice mono cropping with maize or paddy. Low productivity of the fodder oats has been reported to be a major constraint because of use of local seed and unscientific cultivation practices. Krishi Vigyan Kendra (KVKs) through Front Line Demonstrations (FLDs) attempted to make the farming system sustainable by taking oats as fodder crop using improved varieties and recommended technology during rabi season on the land that otherwise is kept fallow.

Materials and Methods

The present investigation is based on farmers' response on 78 FLDs laid out by KVK Doda on an area of 21 ha for 5 consecutive years from *rabi* 2008-09 to *rabi* 2014-15 under rain fed conditions. Two varieties viz; sabzaar and kent were demonstrated with recommended package. Local check plots of farmers' practice were also laid along with demonstration plots. Field operations were carried out by the farmers themselves under the guidance of KVK scientists. Crop was sown in the first fortnight of November to first fortnight of December and harvested in second fortnight of May to first fortnight June. Data on total yield in demonstration plots as well as local check was recorded for the purpose of comparison. Percent increase in yield and percent increase in net returns over farmers practice due to cultivation of technology demonstrated were calculated. Besides, technology gap (TecGp), extension gap (ExtGp) and technology index (TecInx) were also calculated as suggested by Samui *et al.* (2000).

Results and Discussion

Production of green oats fodder from demonstrations plot ranged from 342.2 to 403.1 q ha^{-1} where as production from local check ranged from 238.1 to 297.5 q ha^{-1}. Average production of oats from the demonstration plots for five consecutive years was 381.9 q ha^{-1} whereas that from the farmers practice came to be 271.4 q ha^{-1}. Percent increase in yield over the farmer practice was found ranging from 34.8 to 48.7 percent with an average of 41 percent over the five years. Besides, percent increase in net return varied from 11.4 to 77.9 percent with an average of 33.3 percent (Table 1). An average Technology Gap (TecGp) of 68.1 q ha^{-1}, Extension Gap (ExtGp) of 110.5 q ha^{-1} and Technology Index (TecInx) of 18.2 percent have been observed which indicates further need for technology refinement and promotion of extension activities in the District. Though FLDs were laid out under supervision of scientists even then technology gap existed which may be due to soil fertility status and weather conditions and calls for location specific refinements of technological recommendations. Higher extension gap necessitates the need for more farmer educational programmes on recommended oats cultivation practices. Lower value of technology index indicates the feasibility of technology demonstrated with slight modifications. Farmers have found the best option in the form of oats crop that can provide some output from land that otherwise would remain fallow in winters. Besides problem of low productivity of oats due to use of local seed and non-adoption of recommended package of practices has also been overcome.

Table 1: Performance of Front Line Demonstrations on fodder oats in district Doda

Season	No of Demonstrations	Area (Ha)	Variety	Yield(q ha^{-1})		Percentage increase in yield	Percentage increase in Net Returns
				FLD	Farmers Practice		
Rabi 2010-11	19	5	Sabzaar	378.9	280.2	35.2	16.6
Rabi 2011-12	15	3	Kent	403.1	282.9	42.5	27.2
Rabi 2012-13	15	3	Kent	401.0	297.5	34.8	33.0
Rabi 2013-14	14	3	Sabzaar	384.4	258.5	48.7	11.4
Rabi 2014-15	15	3	Kent	342.2	238.1	43.7	77.9
	78	**17**		**381.9**	**271.4**	**41.0**	**33.3**

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How Policy Intervention Impacted Adoption of Mango (*Mangifera indica*) Cultivation in Subtropics of Jammu, India?

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Keywords: Adoption, subtropics, mango, HMNEH, adoption

Introduction

The Technology Mission for Integrated Development of Horticulture in North Eastern States of India including Sikkim was launched by the Government of India in 2001-2002, with the objective of improving the production and productivity of horticultural crops by harnessing the potential of the region (AFCL, 2012). The scheme was subsequently extended to the states of Jammu & Kashmir (J&K), Himachal Pradesh and Uttarakhand in 2003-2004. The scheme has since been renamed as Horticulture Mission for North East and Himalayan States (HMNEH) with four mini missions. Mini Mission-II of HMNEH constitutes the diversification and area expansion programme, which aims at increasing the total area under horticultural crops by providing incentives to farmers for the establishment of horticultural crops specific to their area. In this respect, mango (*Mangifera indica*) being an important fruit crop in the sub-tropical region of J&K, the Department of Horticulture Jammu under the area expansion programme provided incentives to farmers for the establishment of mango orchards. There is no empirical data available about the impact of government intervention under HMNEH programme for development of horticulture in Jammu region. Therefore, a study was conducted in Jammu district of J&K state to find out the impact of HMNEH programme in terms of, inputs, technical services provided, adoption of recommended practices and area expansion under mango crop.

Materials and Methods

Five blocks (Akhnoor, Khour, Marh, Dhansal and Bhalwal) from Jammu district and all the blocks of Samba district (Samba, Vijaypur, Ghagwal and Purmandal) were selected for the study. Farmers having at least fifty and above number of mango fruit bearing trees were considered for the sampling. Two sets of samples were selected for the study from the selected blocks. One set of sample was selected from the farmers who were mango orchardists before the start of HMNEH intervention in the study area. Their number in the study area as per the list provided by Department of Horticulture was 90, and out of that 25 orchardists were sampled from the selected blocks by proportionate random sampling method. Second set of sample of 50 was selected from a list of 186 beneficiaries covered under HMNEH till 2011-12 by the Department of Horticulture, Jammu. The first set of orchardists selected was from the irrigated belt and the HMNEH beneficiaries were from rain fed areas.

Results and Discussion

HMNEH programme intervention resulted in change in land use pattern of the beneficiaries residing in rain-fed areas of Jammu. Before the implementation of HMNEH in the study area, farmers used to cultivate maize in summer and wheat in winter season with an average area of 3.48 ha in both the cases. With the policy intervention under HMNEH the farmers shifted from cereal cultivation to fruit crop cultivation and the average area under maize and wheat reduced to 0.97 ha and 0.94 ha respectively. As a result of HMNEH programme average area under mango increased to 1.06 ha whereas, 0.6 ha in case of other fruit crops. As a result of HMNEH programme the area under fruit crops increased from zero to 179 ha with an increase of 100%. The number of adopters of fruit cultivation under HMNEH was 217. The survival percentage of the mango orchards established under HMNEH ranged between 6 and 100% and the overall survival percentage was 83.06%.

Table 1: Change in land use pattern

Crop	Area under different crops before HMNEH (ha)	Area under different crops after HMNEH (ha)	Average land use before HMNEH (ha)	Average land use after HMNEH (ha)	Change in area (%)
Kharief maize	174	49.80	3.48	0.996	-71.4
Rabi wheat	174	46.75	3.48	0.935	-73.1
Mango	0	53.0	0	1.06	100.0
Others fruit crops	0	30.5	0	0.61	100.0

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243.

Identifying Drudgery Prone Rice Cultivation Activities in Northern India

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Keywords: Agricultural workers, body postures, drudgery index, ergonomics, rice cultivation.

Introduction

Rice is one of the most important cereal crops in the world as it is the most important staple food. Manual uprooting and transplanting is tedious, tiresome and labor consuming, because agricultural workers has to stand in puddle field and bend for hours for putting seedling into the soil by hand. High labour demand during peak uprooting transplanting period adversely affects the timeliness of this operation, thereby reducing crop yield. Keeping this in view, the present study was planned to compare the rate of drudgery among agricultural workers, during various phases of manual uprooting and transplanting with the mechanized methods.

Materials and Methods

The ergonomical evaluation of paddy uprooting and transplanting was conducted with agricultural workers in Tarai agro-climatic zone of Udham Singh Nagar district of Uttarakhand state, India in the month of June-July. Forty agricultural workers in the age group of 20- 45 years were selected because they usually attain their highest strength level between 20-45 years. Drudgery index during various activities was calculated to assess human drudgery. An interview schedule was used to elicit information regarding personal and demographic profile of the agricultural workers.

Results and Discussion

The results revealed that more than 75 percent agricultural workers were belonged to lower middle socio economic status. It was also observed that as compared with others, manual uprooting was the maximum drudgery prone rice cultivation activity based on drudgery index. In manual transplanting activity, agricultural workers spend their maximum time i.e. 193.65 min/day in taking few seedlings by the right hand and planting them into soil and left hand (with seedlings) remained on the left thigh near the folded knee. Besides this, for the transplanting of seedling by eight row paddy transplanter only 20.68 min/day was required. It was concluded that for the significant reduction of the human drudgery, there is dire need to create awareness about the use of mechanized method of paddy transplantation, among the agricultural workers of northern India, who are usually involved in conventional and manual method of transplanting.

Table 1: Drudgery Index of Uprooting and Transplanting

Activities	Frequency Coefficient	Difficulty Coefficient	Average Time Spent Coefficient	Drudgery Index
Manual Uprooting				
1. Bending to reach the seedling on the seed bed	0.98	0.65	0.009	54.63
2. Uprooting the seedling by both the hands until those become hand full	0.98	0.96	0.009	64.96
3. Washing the bundle of rice seedling	0.91	0.74	0.017	55.56
4. Tying the bundle	0.87	0.51	0.025	46.83
5. Keeping the bundle on the ground	0.98	0.47	0.007	48.56
Manual transplanting				
1. Taking the bundle of seedling and untying it	0.57	0.87	0.008	48.26
2. Making the bundle into two halves and griping one half in one hand	0.64	0.75	0.017	46.90
3. Taking few seedlings by the right hand and planting them into soil. Left hand (with seedlings) remained on the left thigh near the folded knee	0.98	0.91	0.006	63.20
Mechanical uprooting				
1. Pick up the rice mat from ground	0.57	0.68	0.008	41.93
2. Put it on the transplanter	0.63	0.60	0.074	43.46
Mechanical Transplanting				
1. Transplanting of seedling by transplanter	0.55	0.51	0.009	35.63

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Impact of Government Policy Intervention in Procurement of Wheat in Jammu Region of Jammu and Kashmir State

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Keywords: Procurement centres, wheat, impact, rabi marketing season

Introduction

The procurement policy is part of the national commitment to make the minimum support price (MSP) policy effective. Procurement operations aim at enabling farmers to get remunerative prices for their produce and prevent distress sale. The Government policy of procurement of food grains has the broad objectives of ensuring MSP to the farmers and ensures effective market intervention thereby keeping the prices under check. The Food Corporation of India (FCI), the nodal central agency of Government of India (GOI), along with other state agencies undertake procurement of wheat, paddy (rice) and coarse grains. In the state of Jammu and Kashmir (J&K), the procurement policy was implemented in 2010-11, for the first time, to avoid distress sale of rice and wheat produced by farmers. In rabi marketing season (RMS) 2011-12, procurement of wheat was to the tune of 92500 quintals (q) was achieved through seven (7) procurement centres established by the government. In RMS 2013-14, twelve procurement centres were established but, no procurement was made at the procurement centres. A study was commissioned by Agricultural Production Department, J&K Government to find out the impact of setting of procurement centres by the government and reasons for no procurement at the procurement centres in RMS 2013-14.

Materials and Methods

The study was conducted in purposively selected Samba, Kathua, Jammu and Udhampur districts of Jammu division as wheat procurement centres were set up in these districts. Multistage sampling technique was employed for selecting the sample. The sampled farmers were divided into 3 groups, i) Group I, where wheat "Procurement Centres (PCs)" were set up in RMSs 2012-13 and 2013-14, ii) Group II, where wheat PCs were set up for the first time in RMS 2013-14, and iii) Group III, where wheat PCs were set up neither in RMS 2012-13 nor in 2013-14. Thus 74 farmers were selected from Group I, 60 farmers from group II and 91 farmers from Group III covering 70 villages. Thus the total sample size for present study was 225. Data were collected by personally interviewing the sampled farmers with the help of interview schedule. The data were collected from August to September 2013. The statistics applied were one way analysis of variance (ANOVA) to calculate mean difference in sale price of wheat crop.

Results and Discussion

The farmers who had sold their marketable surplus at PCs in RMS 2012-13, and where PCs were setup in RMS 2012-13 and RMS 2013-14, the private millers and dealers on an average purchased wheat at Rs. 1457/q thus providing on an average of Rs. 107/q higher than the MSP (Table 1). Where PCs were setup for the first time, private dealers purchased wheat at an average price of Rs.1430/q, higher than MSP per quintal, a difference of Rs 80/q. Villages where no PC was established in both the years, the private buyers purchased the wheat on average price of Rs.1388/q, which was Rs. 38/q higher than the MSP (Table 1). The indirect benefit to Group-I compared to the Group-II was to the tune of Rs. 27/q which was not statistically significant Table 4). In case of Group-I and III the difference was Rs. 42/q which was statistically significant ($p < 0.05$) (Table 1). This shows that the PCs especially in Group-I and in Group-II have benefited the farmers by having healthy competition between private players and government intervention. There were indirect benefits of the government intervention in setting twelve procurement centres. Thus, it is concluded that the setting up of PCs created healthy competition in the market, had broken the monopoly of private players, and reduced the sale of produce by famers below MSP. The government should not abandon the procurement policy and instead they should strengthen in by developing permanent PCs with all physical facilities like concrete floors storage sheds and other facilities. In case the government withdrawn this market intervention, there will be cartelization among private buyers, as prior to 2010, and the farmers may have go for distress sale of their produce.

Table 1: Impact of procurement centres on sale price of wheat crop

Year	MSP (Rs/q)	Sale price (Rs./q)			Mean difference in sale price (Rs./q)		
		Group I	Group II	Group III	Group (I-II)	Group (I-III)	Group (II-III)
RMS 2012-13	1285	1283 (1.48)	1180 (17.20)	1126	103* (17.30) P= 0.000	157* (17.04) P= 0.006	54* (19.33) P= 0.006
RMS 2013-14	1350	1457 (9.28)	1430 (13.63)	1388 (18.57)	27 (19.40)	69* (18.55) P= 0.000	42* (20.77) P= 0.047

Figures in the parentheses are mean std. error

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Improving Micronutrient Value of Habitual Indian Diet with Uncommon Plant Sources

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Keywords: Micronutrient, biodiversification, zinc-rich admix

Introduction

Food composition provides an important link for biodiversity and nutrition. Biodiversity at three levels-ecosystems, the species they contain and the genetic diversity within species-can contribute to food security and improved nutrition. There is plenty of plant sources embedded with rich nutrient potentials waiting to be explored. In India nutrient deficiency, specifically micronutrient deficiencies (MND's) are rampant and are now getting the much required attention. Micronutrients are in the forefront due to the pervasive nature in metabolic processes and innumerous biological functions. Salubrious plant based micronutrient rich sources can play crucial role in overcoming MND's. Biodiversifiation to improve the micronutrient quality seems to be natural, harmless, ecological and sustainable way out. Zinc as an essential trace element with wide public health and clinical significance has been reviewed by FAO/WHO (2002). Zinc is found in abundance in Animal source foods (ASF) but regular Indian diet is devoid of this vital mineral. With this perspective study was undertaken to identify and analyze zinc rich plant based sources suitable for vegetarians. Zinc-rich admix (ZRA) from distinguished sources was formulated and standardized for incorporation in diet to improve the dietary zinc adequacy.

Materials and Methods

For the development of zinc-rich admix, exhaustive list of edible zinc-rich sources was prepared through extensive literature survey with a standpoint of utilizing natural and vegetarian source. Categorization based on their reported mineral composition was done. From the complied list, twenty plant sources with high zinc content were identified, procured and analyzed for their zinc content. Zinc was estimated through wet ashing followed by Atomic Absorption Spectrophotometer (AAS). For the formulation of ZRA different plant sources were selected based on zinc content, organoleptic properties, acceptability and availability. Technique for development of ZRA were standardized to obtain highest zinc content in minimum amount to provide for at least one third quantity of recommended dietary allowance of zinc for adults given by ICMR.

Results and Discussion

Out of screened sources Gingelly seeds (*Sesamum indicum*), De-oiled gingelly seed meal, pumpkin seeds (*Cucurbita pepo*), lotus seeds (*Nelumbo nucifera*), brahmibuti (*Centella asiatica*), and bathua leaves (*Chenopodiu malbum*) were identified as fairly rich sources of zinc. Zinc content ranged from 4.36 to 15.46 mg/ 100 g (Table 1). ZRA was formulated by incorporating lotus seed powder, gingelly seed and fox nut powder (Fig. 1.). Gorgon nuts were added to improve the taste and color of the admix. Twenty five grams of ZRA was found to provide one third of the daily requirement for adult female *i.e.* 3.33 mg.ZRA was found to be acceptable based on sensory evaluation. Average score (7.5) on nine point hedonic scale revealed that it was liked moderately in food preparation. Therefore it can be concluded that these plant sources have the potential to become excellent inexpensive sources to contribute dietary zinc. In lower income countries, such as ours diet diversification with nutrient dense natural foods is increasingly being recognized as an effective approach to improve the micronutrient status of the population. Relative to other approaches, it is thought to be the most cost-effective means of overcoming micronutrient malnutrition. Future schemes should include food-based strategy like increasing diet diversity through promoting nutrition sensitive bio-diversification.

Fig. 1. Formulated Zinc Rich Admix with Ingredients

Table 1: Some identified and analyzed plants sources of zinc and their zinc content

Zinc rich plant sources	Botanical name	Zinc/100 gram (Dry weight basis)
Lotus seeds/nut	*Nelumbo nucifera*	14.30
Gingelly seeds	*Sesamum indicum)*	13.14
Pumpkin seeds	*Cucurbita pepo*	8.9
Brahmi Booti	*Centella asiatica*	7.9
Thua	*Chino podium album*	5.7
Gullar	*Ficusra cemosa*	4.1

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Attitude of Livestock Owners towards Dairy Farming in Muzaffarnagar, Uttar Pradesh

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Keywords: Attitude, dairy farming, livestock

Introduction

Livestock contributes nearly 7 percent towards the national economy in terms of animal's production. Livestock generates energy in several ways; the calorie intake for human being draught power for agricultural operations and fuel for rural household consumption. Although our country has an enormous population of cattle, the per capita availability of milk is woefully low i.e. 200 g/day. Within the country, milk yield varies widely. Under this circumstance, the dairy farmers should know about the use of this valuable and limited quantity of concentrate to obtain optimum production efficiency. Attitude of farmers towards dairy farming is an important factor for agriculture and dairy development. In the present study, attempt has been, therefore, made to measure attitude of farmers towards dairy farming.

Materials and Methods

The study was Charthwal, Baghra, Shahpur and Sadar/Muzaffarnagar. From each selected block four villages were selected randomly. To make the selection of respondents, a list of those farmers who had one dairy animal at the time of investigation was prepared for each selected village. From the list each village 10 livestock owners were selected randomly from different land holding category. Twenty livestock owners from urban areas i.e. each block and district headquarter were selected randomly. Thus in all, 100 urban and 160 rural respondents were interviewed to get first-hand information on attitude towards dairy farming along with basic characteristics of the livestock owners of Muzaffarnagar district.

Results and Discussion

Table 1 revealed that majority (76.25 per cent) of respondents in both rural and urban areas were belonged to middle-aged (36 to 50 years) followed young age group ranging age up to 35 years. Further, maximum respondents of urban area were educated up to intermediate level, rural respondents were educated up to high school level followed by middle school. There were about 26.67 and 15.00 percent of the farmers in urban area and rural area whose family size was up to 5 members, respectively. It was clearly enunciated from the Table 1 that majority of respondents of urban and rural area belong to medium herd size category and possessed 6 to 12 animals. In the rural areas 31.67 percent respondents reared more than 12 dairy animals, whereas only 1.67 percent respondents of rural study area reared those animals in their herd. It could be safe on the basis on herd size that respondents of urban area were kept more number of animals as compared to rural respondents in the study area. A close observation of table data clears that more then 70.00 per cent of the farmers of both urban and rural fell in medium category of milk production, (producing 12 to 41 kg per day) followed by 19.58 percent of the farmers belonged to high categories of milk production, respectively.

The data presented in the (Table 2) indicated revealed that the average of weighted score of attitude for urban, rural and pooled basis respondents was 79.58, 75.29 and 77.43 percent in the study area respectively. Further, it was observed that most of the farmers were strong favourable attitude towards the statements such as 'in dairy farming, A.I. is a good breeding practice', 'in dairy farming milch animals in dry period can be neglected in matter of their feeding', During the course of investigation it was observed that respondents commonly adopted A. I. for breeding purpose, as they want high yielding progeny in their herd. Vaccination against contagious disease asked in negative manner, on the basis of weighted score it could be concluded that respondents of the study area were showed keen interest to safe their herd by vaccinate them on proper time.

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Table 1: Socio economic profile of the respondents

Traits	Name	Urban (100)	Rural (160)	Overall
Age	Young (up to 35 Yr.)	30.00	39.17	34.59
	Middle (36 to 50 Yr.)	63.33	89.17	76.25
	Old (> 50 Yr.)	6.67	10.83	8.75
Education	Illiterate (0)	3.33	8.33	5.83
	Up to Primary (1)	10.00	10.83	10.42
	Up to middle (2)	10.00	20.00	15.00
	Up to High School(3)	28.33	23.33	25.83
	Up to intermediate (4)	30.00	18.33	24.17
	Graduate and above (5)	18.33	19.17	18.75
Family size	Small (Up to 5)	26.67	15.83	21.25
	Medium (6-10)	68.33	70.83	69.58
	Large (>10)	5.00	13.33	9.17
Herd size	Small (up to 5)	15.00	19.17	17.09
	Medium(6 to 12)	53.33	79.17	66.25
	Large(>12)	31.67	1.67	16.67
Milk Production	Low (up to 11 lt.)	8.33	5.83	7.08
	Medium (12 to 41 lt.)	60.00	86.67	73.34
	High(> 41)	31.67	7.50	19.59

Table 2: Attitude towards dairy farming

Statements	Urban	Rural	Over all
In dairy farming, A.I. is a good breeding practice	86.11	82.50	84.31
In dairy farming milch animals in dry period can be neglected in matter of their feeding	85.56	83.33	84.45
Vaccination against contagious diseases (FMD & HS) in milch animals is not regularly needed	82.22	74.72	78.47
In dairy farming crossbred cows are not better than buffaloes	73.89	76.11	75.00
Pooled	**79.58**	**75.29**	**77.44**

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Letting Information Flow: Distributing Farmer Training Videos through Existing Networks

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Keywords: DVDs, farmer learning videos, farmer experiments ICT, rural advisory services

Introduction

Access to information and communication technology (ICT) must be adaptable and flexible enough to ensure that useful knowledge is made available at the right place and time. Unless the ICT content is useful, even the best ICT tools may make little impact. For example, the "Open Knowledge Network," with nearly 200 tele centres in Africa and South Asia, failed because the content was supply-driven and did not meet demand for local content (Scarf, 2012). Most projects can distribute videos and other farmer learning material, if they pay to have it done. But if you are not a project, it is important to identify those people and organisations that are willing to do so for free.

Materials and Methods

The authors and colleagues engaged with actors in various countries, from radio stations in Benin to tea stalls in Bangladesh. We gave them free DVDs (Digital Video Disks), with farmer learning videos, and encouraged the actors to find their own ways of sharing the information. Later we went back for follow-up visits.

Results and Discussion

Experiences from five countries show the power of distributing farmer training videos through existing social networks. In Benin, radio stations broadcast sound tracks and distribute DVDs. In Uganda and Bangladesh many private and public agencies show videos. In Mali, farmers and NGOs often screen videos under difficult circumstances. Malawi has a burgeoning rural business with young "DJs" copying videos from a computer onto ordinary cell phones. In all five countries, volunteer service providers helped farmers to access training videos, because the content was relevant, of good quality and the videos were in the enlightened self-interest of the farmer and the agency.

Table 1: Video distribution mechanisms tested in East Africa, West Africa and South Asia.

Country	Number of video discs distributed	Organisation distributing videos at national level	Organisations distributing and using videos at local level	Key lessons learned
Benin	2500 VCDs	Africa Rice, an international research organisation	25 local radio stations	Radio stations use video to strengthen the agricultural knowledge of their staff and use the videos creatively to strengthen links with their communities Commercial radio stations sell videos to farmers and extension agents, whereas community radio stations distribute them for free, but could also sell video as a future source of income generation
Uganda	7500 DVDs	Farmers Media, a communication company	18 public and private sector service providers	Depositing boxes with hundreds of DVDs to an organisation may be ineffective without proper planning and monitoring Private sector value chain actors who see a direct benefit in strengthening farmers' skills play an important role in distribution and use of video
Bangladesh	1250 DVDs	The Agricultural Advisory Society, a national NGO in collaboration with Cimmyt	Over 300 tea stalls, NGOs, extensionists, community-based organisations, local government, local village shops and many others	Giving a few copies to many service providers creates a lot of local initiative to view and further share videos
Mali	10,000 DVDs	Icrisat, an international research organisation	Over 300 NGOs, ministry of agriculture, local government and extension, radio stations, cooperatives, farmer field schools and many others	Carefully planning and following up helps to ensure that organisations use the DVDs. Farmer clubs and cooperatives find ways to watch quality training videos that are relevant, even if there is no electricity

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Demographic Profile of Gujjars and Bakerwals of Jammu Division

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Keywords: Gujjars and bakerwals, demography

Introduction

The total population of scheduled tribes in India is 84.33 million out of total population of 1210 million (Census 2011). Jammu & Kashmir (J&K) has three types of unique cultural blend that differentiate it from the rest of the Country. The Socio-cultural and demographic structure of the state is comprised of three distinct parts namely Jammu, Kashmir and Ladakh. The tribal (*Gujjars* and *Bakerwals*), the third largest ethnic group in Jammu and Kashmir after Kashmiri and Ladakhi, constitute more than 20% population of the State. Out of the total nomadic *Gujjar* and *Bakerwals*, 66% population of nomad Gujjar-Bakerwals who fall under scheduled tribe groups in J&K are living below poverty line, revealed by a survey conducted by Tribal Research and Cultural Foundation (TRCF) (Koundal, 2012). With the introduction of different developmental policies and programmes, changes in the land tenure have brought certain changes in the traditional system of resource management in tribal India. Therefore, keeping in view the importance of government interventions on *Gujjars* and *Bakerwals* of Jammu division, this study was conducted with the objective to study the demographic profile of *Gujjars* and *Bakerwals* of Jammu division.

Materials and Methods

Multistage sampling plan was followed for the selection of ultimate respondents. Data regarding population of schedule tribes available in "*Digest of Statistics* of J&K state" was referred and two districts Poonch and Rajouri with highest concentration of schedule tribes population were selected. List of blocks, with maximum population of both the tribes for each selected district was prepared. Out of prepared list of blocks, two blocks were selected randomly, from each selected district. Thus four blocks were selected. From each selected blocks list of villages were prepared from where maximum population of ultimate respondents was selected. Out of the list of identified villages, two villages per selected block were selected randomly. Thus eight villages were selected out of two selected districts of Jammu division. For each selected village, 7 *Gujjars* and 7 *Bakerwals* were selected randomly. Thus, 112 respondents were selected for the study from two selected districts. The data were collected by personal interview method with the help of structured interview from July 2015 to Sept. 2015.

Results and Discussion

Mean education of the respondents *Gujjars* and *Bakerwals* was 5.80±5.17 years. Literacy rate was 63%. Majority of the respondents (62%) had marginal land holding and 20% respondents had small land holding, in case of migration status only (47.3%) were migrating. With regard to the telephone connectivity, 71 per cent of the respondents had source of telephone connectivity. 63.4 per cent of respondents had Kacha types of houses. Average no. of herd size in case of sheep was 18, 12 of Goat, 3 of Buffalo, 2 of Horse, 2, of Bullock, 1 of Cow and 1 of He Buffalo. By using correlation, it was found that among all the independent variables only education had negative and significant relationship with migration status of the respondents while Age, number of sheep, goats, buffalo, cow, and horse were had positive and significant relationship with the migration status. (Table 1).

Table 1 Relational analysis with factors affecting the migration status of the respondents (n=112)

Variable	Correlation coefficient	
	Migration Status (r value)	*p* - value
Age	0.201*	0.033
Education	-0.220*	0.020
Family size	0.136	0.152
Landholding	0.183	0.054
Job Status	-0.163	0.086
Number of sheep	0.430**	0.000
Number of goat	0.461**	0.000
Number of buffalo	0.207*	0.028
Number of cow	0.237*	0.012
Number of he buffalo	0.053	0.578
Number of horse	0.415**	0.000

*significant at p≤0.05, **significant at p≤0.01

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Youths' Perception about Farming and Extent of ICT Application for Agricultural Purposes

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Keywords: Information and Communication technology, adoption, rural youth

Introduction

Government has taken several initiatives for enhancing role and use of information and communication technology (ICT) in agriculture. The use of ICT resources, depend upon the interest of rural youths and the level of handing ICT tools by rural youths. The present study was undertaken in R.S. Pura tehsil of Jammu district of Jammu & Kashmir state to assess the extent of ICT use among rural youths, the level of interest and knowledge of rural youths on the subject of agriculture and to assess the level of ICT use by rural youths for agricultural purposes.

Materials and Methods

Two computer centres of R.S. Pura block were selected randomly to identify youth who are learning use of ICT tools. Forty five respondents from each computer centre were interviewed through convenient sampling, thus making a total of ninety respondents for the present study. The respondents were asked questions according to the pre-framed questionnaire as per the objectives of the study.

Results and Discussion

Rural youth, both male and female in large number have been learning computer application and were well versed with computer use and ICT application. The interest of rural youths in agriculture was found to be very limited when asked them for opting it as a profession. The present ICT use by rural youths for agricultural purposes was also found to be very limited (Table 1). The efforts need to be directed to create awareness among rural youths regarding ICT tools and resources available in agriculture for wider use, and adoption of latest scientific practices.

Table 1: Use of ICT for agricultural purposes (N= 90)

Agricultural information sought on internet	Male (n=56)	Female (n=34)	Overall (in %)
Seed	14	0	8
Fertilizer	2	0	1
Insect control	2	0	2
Disease control	2	0	1
Marketing	4	0	2
Any other practice	0	6	2

Decimals rounded upto the nearest whole number

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Evaluation of Bee-keeping Training Programmes Conducted by *Krishi Vigyan Kendra*-Muktsar Sahib

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Keywords: Evaluation, vocational training, beekeeping, Impact

Introduction

Beekeeping is one of such enterprise which has the potential to enhance the income of poor farmers and even the landless labourer. It provides scope for self employment among the rural youth. Rural youth adopt beekeeping for earning income. There are various other products in beekeeping that can add to income of beekeepers such as beewax, propolis, pollen and royal jelly. To improve the social, economical, psychological and health status of rural people and their family, Krishi Vigyan Kendras (KVKs) imparts skill training through theoretical as well as practical experience. In this direction KVK Muktsar Sahib also conducted vocational training on beekeeping for rural people to uplift their socio-economic status. We analyzed the impact of the training programmes in term of gain in knowledge and adoption of this enterprise.

Materials and Methods

The study was conducted in Muktsar Sahib district of Punjab. A knowledge test was prepared to measure the knowledge level of trainees of beekeeping training programme. Total 60 statements were framed under seven management practices of beekeeping. One-group pre and post evaluation research design was employed to study the knowledge gain of the trainees Gain in knowledge was measured in terms of the difference between knowledge scores of the trainees before and after training. Similarly, for evaluating long term impact of the training programmes, *ex-post-facto*, one-shot case study design was employed to study the adoption and economic benefits from these vocational training programmes conducted by KVKs prior to 2013. The adoption status was measured in terms of percentage of past trainees setting up their enterprise, continuance / discontinuance with the enterprise, and non-adoption of the enterprise. Impact evaluation or outcome was measured in terms of economic returns of the respondents who were continued adopters of bee-keeping

Results and Discussion

Mean knowledge score of the trainees before and after the training programme is given in Table 1. The trainees gained knowledge in all six practices related to bee-keeping and calculated t- value was significant at 1% level of significance. The overall mean score of trainees in pre-training was 16.30±8.86 and post training was 46.85±6.56 (t= 15.07, d.f= 29 and $p < 0.01$) this showed that there was considerable gain in the knowledge after the training programme. Pre-training mean knowledge score ranged between 0.33(in case of breeding of honey bees) to 6.66 (in case of management practices), after training a significant gain in level of knowledge was achieved.

Table 1: Gain in knowledge of trainees about different aspects bee-keeping practices

Practice	Maximum Knowledge Score (60)	Mean knowledge score of trainees		t-value
		Pre-training	Post-training	
General information about bee-keeping	13	6.16	10.16	15.43*
Breeding of honey bees	6	0.33	5.16	9.77*
Bee flora	5	1.66	3.73	5.07*
Diseases and pest	6	0.83	4.48	12.18*
Management practices	20	6.66	15.66	14.29*
Production of honey	10	0.66	7.66	12.03*
Overall		16.30±8.86	46.85±6.56	15.07*

* Significant at $p < 0.01$ with $df = 29$

The adoption status with respect to continued adopters, discontinuance and non adopters was based on a sample of 120 trainees form whom response was received. From total number of trainees before 2013 only 23% of the trainees had adopted beekeeping enterprise. Later 14% from the adopter left this enterprise. Thus, effectively 20% beekeepers were continued adopters of his enterprise.

Table 2: Status of past trainees with respect to adoption of bee-keeping enterprise

Adoption status		Total
Adopter	Non-adopter	
28(23)	92(77)	120
Present status		
Continued adopters	Discontinued adopters	
24	4	28
Status of overall adoption of bee-keeping enterprise (number of past trainees n= 120)		
Continued adopter	Non-adopter	Discontinued adopter
24(20)	92(77)	4()

Figures in parentheses are percentages

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Performance of Training and Developmental Activities of Krishi Vigyan Kendra (KVKs) in Uttarakhand: Farmers' Perception

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Keywords: Performance, perception, effectiveness, Krishi Vigyan Kendras (KVKs)

Introduction

Ever since introduction of Krishi Vigyan Kendra (KVK) as a grassroots vocational training centre, it has emerged as a focal point of technology transfer through its diverse activities like On farm trails (OFTs), Front line demonstrations (FLD), capacity building, updating knowledge & skills of extension personnel and farmers. Since the establishment of the first KVK at Pondicherry in 1974, the number of KVKs has grown to 641 plus. Studies have indicated limited success of KVKs in terms of impact on the intended beneficiaries. Thus, in view of the above fact, the present study to find out farmers' perceptions about effectiveness of KVKs as an instrument of technology transfer.

Materials and Methods

This study was conducted to assess the performance of training and developmental activities of KVKs in Uttarakhand, India. A purposive and simple random sampling technique was used to select 168 respondents (160 farmers & 8 scientists) from the two division of the state- KVK Dhakrani (Dehradun) representing the plains region of Garhwal division and Bageshwar KVK representing the hill region of Kumaon division. Data generated were analyzed using analytical.

Results and Discussion

Finding of the study revealed that, majority of the beneficiaries had favourable perceptions towards training programmes, teaching & subject matter/ quality of scientists, physical facilities and advisory services and supplies. However, they had unfavourable perceptions towards FLDs and OFTs. This study throws light on the importance of variables such as, gender, education, caste, family type, occupation, mass media exposure, information seeking behavior and social participation in determining farmer's perceptions about effectiveness of KVKs.

Table 1: Multiple regression analysis of the overall farmer's perceptions about effectiveness of KVKs with socio-personal variables

Variable	Regression coefficients(β) values	Standard error	"t" Value
Age	0.155614	0.102507	1.518085
Gender	14.07458	3.348842	4.20282**
Education	0.828603	3.137885	0.264064
Caste	-2.73179	2.625743	-1.04039
Family type	4.624478	3.010078	1.536332
Family size	0.03328	0.472912	0.070372
Annual income	0.000244	0.000252	0.971541
Occupation	-0.00484	1.932216	-0.0025
Size of land holding	0.232154	0.655157	0.354348
Media ownership	0.515547	1.742048	0.295943
Mass media exposure	-1.11018	0.418303	-2.65401**
Extension agency contact	0.331886	0.370953	0.894686
Information seeking behaviour	1.119915	0.402602	2.781693**
Social participation	-1.58886	0.61529	-2.58228*

β_o= 134.5142;R^2= 0.4029; F stat= 6.9886*; * Significant at 0.05 level of probability ** Significant at 0.01 level of probability

From Table 1 it is evident that observed 'F' value was significant at 0.05 level of probability. This indicates that the selected fourteen variables contributed significantly in farmers' overall perceptions towards effectiveness of KVKs. However, the value of coefficient of determination was 0.40 which indicates that the selected fourteen independent variables collectively contributed to the extent of 40.29%. The unexplained contribution (59.71%) towards farmers' perception of KVKs effectiveness may be due to the factors not covered in this study. The t-value shows that four variables namely gender, mass media exposure, information seeking behavior and social participation were significantly related to farmers' overall perceptions about effectiveness of KVKs. The regression co-efficient for these variables were 14.07, -1.11, 1.11 and -1.58 respectively, which indicated that one unit change in these variable would bring about 14.07, -1.11, 1.11 and -1.58 unit change in farmers' overall perceptions about effectiveness of KVKs. Performance of training programmes and FLDs of KVK Bageshwar was found to be better as compared to KVK Dhakrani, whereas performance in respect of OFTs and other extension activities of KVK Dhakrani was found to be better as compared to KVK Bageshwar.

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Developing Validating and Designing Entrepreneurial Technical Information Packages (ETIPs) for Agripreneurship Development

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Keywords: Information need, implementable farm technologies, perceived effectiveness of package

Introduction

Farmers and rural youth desirous of starting their own agri-enterprises face lack of information about the exact procedures to adopt and how much to invest. For farmers to become entrepreneurs they need to learn the skill to manage their businesses as sustainable long-term ventures. The core areas in which an entrepreneur seeks information before its establishment are not only the technical details but also the project economics. Appropriate Entrepreneurial Technical Information Packages (ETIPs) are not readily available to farmers for adoption. Due to this gap, many farmers are not able to reap benefits of good technologies developed by research institutes (Nain *et al* 2012, Singh *et al* 2015). An attempt was made to take up action research project to develop such packages including project framework defined clearly enough to permit the technical analysis to be thorough and precise in terms of projects inputs (supplies) and outputs (production). The study aims to present the strength of relevance of information and their need for consideration during designing of ETIPs for taking up implementable farm technologies as agri-enterprise.

Materials and Methods

The study considered six implementable technologies namely; protected cucumber cultivation, tomato seed production, baby corn cultivation, mushroom cultivation, vermicomposting, and bee-keeping standardized at Indian Agricultural Research Institute, New Delhi for National Capital Region(NCR) of Delhi. The strength of information need from 30 practicing farmers and ten scientist experts for each of the technology was assessed making a total sample of 180 farmers and 60 scientist expertsfrom 2010 to 2014. The data were analyzed with weighted mean score and prioritization through ranking.

Results and Discussion

The results showed that both (experts and practicing farmers) gave very high weightage to journalistic parameters like readability, use of illustration, clarity of information, practicability of information, sufficiency and accuracy of information. Technical information like diseases and pest management, economic parameters, precautions to be taken and the risk involved were rated highly relevant issues for enterprise development. However, some of the issues like subject introduction, font size and logical presentation of the information could not find higher order of their relevance. The data so received was used for designing the ETIPs on six implementable technologies in NCR of Delhi. Six ETIPs were developed and tested and modified and finally tested for their usability before publication. The ETIPs in the form of e publication available at www.http//iari.res.in/ as well as hard copy at Agricultural Technology Information Centre, Indian Agricultural Research Institute, New Delhi.

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Table 1: Perception of practitioners and experts on strength of relevance of information and their need for agri enterprise development.

Items	Strength of relevance of information (1-5 in increasing order)			
	Experts (n=60, ten in Each Enterprise)		Farmers (n=180, thirty in Each Enterprise)	
	Weighted mean score	Rank	Weighted mean score	Rank
Subject Introduction	3.7	7	3.75	10
Materials Required	4.7	4	4.95	1
Procedural Details	4.9	2	4.85	3
Technical Details regarding Diseases and Pest Management	4.9	2	4.90	2
Details regarding risks involved	4.2	6	4.50	7
Precautions to be taken	4.8	3	4.90	2
Economic Parameters (Plant &Machinery, Raw Material, Manpower, Working Capital and Overall Project Economics)	4.9	2	4.60	6
Relevancy of information	4.9	2	4.60	6
Accuracy of information	5.0	1	4.75	4
Profitability of information	4.9	2	4.60	6
Practicability of information	5.0	1	4.65	5
Quantity and sufficiency of information	4.8	3	4.60	6
Clarity of Information	4.9	2	4.85	3
Logical Presentation	4.2	6	3.95	9
Type size	4.6	5	4.00	8
Use of Illustrations	4.7	4	4.75	4
Use of Language/ Readability	5.0	1	4..95	1

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Entrepreneurship Behaviour of Dairy Farmers

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Keywords: Entrepreneurial behaviour, farmers, KVK, socio-economic and psychological characteristics

Introduction

Dairy is a major occupation for the weaker section of rural community. It was realized that income of the rural people (poor) could be improved by adopting subsidiary occupation. Dairy farming has become a commercial enterprise and it is a boon to many families to improve their economic condition. Entrepreneurial behaviour is a cumulative outcome of innovativeness and information seeking behaviour, farm decision making, leadership ability, risk taking ability, information seeking behavior, and market orientation of dairy farmers. In this context, the present study was undertaken to study the entrepreneurial behaviour of dairy farmers based on the 10 components namely risk taking, hope of success, persistence, feedback usage, -confidence, knowledge ability, persuability, manageability, innovativeness, achievement motivation.

Materials and Methods

The study was conducted in Bathinda, Muktsar and Mansa districts of Punjab. The *ex-post-facto* design was employed for the present study as the phenomenon has already occurred. Out of the list of all trained farmers who got the training on dairy farming. 20 trained farmers each were selected randomly from three Krishi Vigyan Kedras (KVKs) namely KVK Bathinda, KVK Muktsar and KVK Mansa. Hence, a total of 60 trained dairy farmers were selected for the study. Entrepreneurial behaviour was measured by self-assessment scale (Technonet Asia 1981) with minor modifications. The data were analyzed by applying correlation coefficient for finding relationship between dependent and independent variables.

Results and Discussion

A majority of the respondents (68%) were in the age group of 19-41 years, all the respondents were literate. Majority (65%) of the respondents was from rural area, with dairy as subsidiary occupation along with agriculture as their main occupation (100%) and had 2-18 years of dairy experience (58%). Majority (32%) of them belonged to semi-medium (2-4ha) to medium category (4-10ha) of land holding. Sixty five percent of the farmers had their family income up to 4 lakhs per annum. Majority of the respondents were having medium level of economic motivation, scientific orientation and market orientation. The data on coefficient of correlation of each personal characteristics variable with entrepreneurial behaviour of the dairy farmers have been given in the Table 1. It can be observed that amongst the independent variables all the eleven variables such as age, education, family size, land holding, dairy experience, annual income, economic motivation, scientific orientation, market orientation and herd size have positive and highly significant relationship except extension contact.

Table 1: Relationship between socio-economic & psychological characteristics and entrepreneurial behaviour

Characteristics	Trainees (n=60)	
	r	t-value
Age	0.164	1.2660
Education	0.075	0.5727
Family size	0.168	1.2978
Land holding	0.269	2.1268
Dairy experience	0.733	8.2058
Annual income	0.636	6.2760
Extension contact	0.031	0.2362
Economic motivation	0.826	11.1590
Scientific orientation	0.679	7.0431
Market orientation	0.809	10.4805
Herd size	0.66	6.77

$p<0.05$

The table shows r (coefficient of correlation values and calculated t values for evaluating the significance of r.

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Extent of Socio Economic Change of Tribal through Rashtriya Krishi Vikas Yojana in Banswara District of Rajasthan

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Keywords: RKVY, socio-economic, income, health, hygiene

Introduction

The Rashtriya Krishi Vikas Yojana aims at achieving 5.5% annual growth in the agriculture sector during XII plan period by ensuring a holistic development of agriculture and allied sectors. The scheme is essentially a state plan scheme that seeks to provide the states and territories of India with the autonomy to draw up plans for increased public investment in agriculture by incorporating information on local requirements, geographical/ climatic conditions, available natural resources/ technology and cropping patterns in their districts so as to significantly increase the productivity of agriculture and its allied sectors and eventually maximize the returns of farmers in agriculture and its allied sectors.

Materials and Methods

The present investigation was conducted in Banswara district of Southern Rajasthan. Banswara and Ghatol tehsil were selected due to maximum number of tribal population in this district and tehsil. Ten villages were included for the investigation based on maximum number of tribal population. One hundred tribal respondents (50 beneficiaries and 50 non-beneficiaries) were selected from all selected villages (5 beneficiaries and 5 non-beneficiaries from each village out of the total population) through random sampling technique.

Results and Discussion

Table 1 intends to depict the data related to social change of tribal beneficiary respondents through RKVY. The data evidently shows that social prestige increased to a remarkable extent as it was reported by 36% respondents. On the other hand, 50% respondents reported increase to some extent in their social prestige after becoming RKVY beneficiaries. A small number of respondents (14%) reported no change in their social prestige because of their affiliation to RKVY. As regards to economic change, the overall family income of majority of respondents (64%) has increased to remarkable extent, whereas a little lesser percentage (30%) of the respondents reported an increase to some extent in their overall family income. Only 6% beneficiaries reported no change in their family income after becoming RKVY beneficiary. Regarding improvement in standard of feeding and clothing after RKVY benefits, 22% beneficiaries reported no improvement whereas 34% respondents expressed that the standard of feeding and clothing has improved to some extent. The majority of respondents (44%) reported that their standard of feeding and clothing improved to a remarkable extent after their becoming beneficiaries of RKVY.

Table 1: Extent of social-economic change of beneficiary respondents through RKVY

Aspects	Extent of social change					
	Remarkable extent		Moderate extent		No Change	
		%		%		%
Social prestige increased	18	36	25	50	7	14
Experience and confidence increased due to interaction with fellow members and training received	30	60	12	24	8	16
Children joined non-formal (e.g. Anganwadi, Balwadi etc.) or formal institute (e.g., school, college etc.)	12	24	23	46	15	30
Interest and aptitude has increase toward work	16	32	19	38	15	30
Leadership qualities increased	13	26	27	54	10	20
Participation in socio-cultural activities increased	3	6	35	70	12	24
Health and hygienic, living environment increased	0	0	36	72	18	36
Membership in formal and informal organization increased	7	14	32	64	11	22
Illegal activities restricted	5	10	26	52	19	38
Transportation and communication facilities increased	9	18	27	54	14	28
Knowledge and awareness about other welfare programme increased	13	26	25	50	12	24
Economic Change						
Overall family income has increased	32	64	15	30	3	9
Standard of feeding and clothing improved	22	44	17	34	11	22
Family saving improved	18	36	30	60	2	4
Overall Standard of living improved	14	28	21	42	15	30
Material possession including households increased	29	58	11	22	10	20
Residential facilities improved	10	20	37	74	3	6
Loan repaying capacity improved	7	14	28	56	15	30
Get off from worries of every day employment	17	34	28	56	5	10
Purchasing power increased	13	26	25	50	12	24
New household assets developed	2	4	30	60	18	36

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Factors Affecting Productivity of Wheat Crop in Jammu Region

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Introduction

India is the second largest producer of wheat in the world (*Triticum spp.*), after China, with about 12% share in total world wheat production. In India wheat is grown in an area of about 30 million ha with a production of 95.91 million tons and the national productivity is about 3 tonnes/ha (DWR 2014). In Jammu and Kashmir (J&K) wheat is grown on an area of about 0.3 m ha with production of 0.5 m tonnes and productivity of about 15.35 kg/ha (DES, 2013). Thus the productivity of wheat in J&K is lower than the national productivity. To find the factors affecting the productivity of wheat in the Jammu region of J&K state, this study was conducted.

Materials and Methods

Jammu, Udhampur and Rajouri districts of the state were purposively selected for the study. From each district one block was selected randomly namely R.S. Pura, Ramnagar and Nowshera. Thereafter, from the selected three blocks one village from each block was selected randomly. From each village 20 farmers were selected randomly. Total sample size was 60 wheat growers. The data were collected through personal interview. The results were analyzed using SPSS 16.0 version.

Results and Discussion

The average yield of wheat crop was 17.73±5.6 quintals/hectare. The yield of wheat crop varies in the selected blocks. In R.S. Pura block the average yield of the wheat crop was 23.7±3.6 quintals/ha while in Ramnagar was 15.5±3.9 q/ha and in Nowshera was 14±3.1 q/ha. The average yield of wheat crop in irrigated conditions was 20.31 q/ha and in un-irrigated conditions the average yield was 14.78 q/ha. Step wise linear regression model was run to find out the factors affecting the productivity of wheat crop. The factors significantly impacting wheat productivity were quantity of application of MOP and quantity of urea applied as basal dose, and the number of irrigations given to wheat crop (Table 1).

Table 1: Factors affecting the productivity of wheat

ANOVA					
Model	**Sum of square**	**df**	**Mean square**	**F**	**Sig.**
1 Regression	918.197	1	918.197	58.941	0.000
Residual	903.536	58	15.578		
Total	1821.733	59			
2 Regression	1041.331	2	520.666	38.029	0.000
Residual	780.402	57	12.691		
Total	1821.733	59			

Coefficients				
Model	**B**	**Std. Error**	**T**	**Sig.**
1 (Constant)	15.148	0.611	24.801	0.000
Quantity of MOP	0.337	0.044	7.677	0.000
2 (Constant)	11.879	1.231	9.6447	0.000
Quantity of MOP	234	0.054	4.351	0.000
Quantity of basal dose of urea	0.062	0.021	2.999	0.004

R^2= 0.504 & Adjusted R^2= 0.495
R^2= 0.572 & Adjusted R^2= 0.557
Y= 11.879 + 0.062(quantity of basal dose of urea) + 234(quantity of MOP)

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Indicators Contributing to the Performance of Krishi Vigyan Kendra for Sustainable Development

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Keywords: Indicators, performance, Krihi Vigyan Kendra (KVK), sustainable development

Introduction

Study was conducted at University of Agricultural Sciences (UAS), Bangalore, India. Entitled - Evaluation of performance of Krishi Vigyan Kendra (KVK)- A log frame approach. The objective of the study was to identify the indicators contributing to the performance of KVK. The study will help to plan KVK activities for sustainable agricultural development in the country.

Materials and Methods

The study was conducted on KVKs of the operational area of Indian Council of Agricultural Research (ICAR) Zone-VIII comprising Karnataka, Kerala, Tamil Nadu, Goa and Lakshadweep. Andhra Pradesh was selected for pre testing the questionnaire. KVKs with three years of work experience were considered for the study. Sixty-five KVKs were selected for the study. Total number of KVKs responded for our request was 43. The data were computerized by using principal component analysis to identify the indicators contributing to the performance of KVK. The variability among the component means score were computed and its cumulative variance is presented in Table 1.

Results and Discussion

There were 94 variables related to the performance of KVK. After preliminary computation 62 important variables were selected. Among 62 important variables 33 were the major contributors in association with 17 important indicators. The most important indicators contributing were: a) problems addressed based on district diagnostic team suggestions, b) approach in educational activity and the least contributing indicator was total irrigated area of KVK farm. KVK activities plan and conducted based these indicators will reduce the time lag from technology generation to its adoption in farmers field. Thus enhance the performance of KVK and promotes sustainable agriculture and livestock production in the country.

Table 1: Indicators contributing to overall performance of KVK (n=43)

Indicators	Variance	Cumulative variance
Problems addressed based on district diagnostic team suggestions	9.24	9.24
Approach in educational activity	8.60	17.84
Training Impact	6.82	24.66
Training Rationale based on NGOs and line departments	6.22	30.88
O.F.T. Feed back	6.12	37.00
Training modules developed Rural youth and farmers	5.82	42.82
Functioning of SAC	4.79	47.61
Front line demonstration	4.51	52.12
Training facility in KVK	4.44	56.56
Training rationale based on farmers demand	4.43	60.99
Human resource development	4.10	65.09
Action taken on SAC decisions	4.07	69.16
Physical facilities	3.72	72.88
Status of irrigation facility to KVK farm	3.27	76.15
Training of Rural Youth	3.18	79.33
Impact of FLDs in neigh-bouring villages	2.90	82.23
Total irrigated area of KVK farm	2.42	84.65

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Integrating Action Research in Extension-Education Towards Sustainable Livelihood

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Keywords: action research, extension-education, sustainable livelihood, rural areas

Introduction

Deforestation, un-treated waste, polluted water, natural disasters are among natural resources and environmental issues faced nowadays. A well designed and implemented extension-education can positively contribute to community awareness, initiatives and concrete actions for sustainable development. This paper aims to present action research in extension-education to support community actions in environmental management. Action research according to Reason and Bradbury (2008) is "an approach used in designing studies which seek both to inform and influence practice." Research participants were community groups facing environmental problems such as deforestation and domestic waste and those who exposure to natural disaster including drought and flood.

Materials and Methods

Action research was used to develop participation from related stakeholders. The research involved community groups, local government, and environmental facilitators from six villages in Bandung and Bogor, West Java. Each community group has 10 to 15 members. The villages were Sunten Jaya, Lebak Siliwangi, Dayeuh Kolot, Petir, Cibeber, and Benteng The environmental issues faced by community groups including domestic and dairy waste, landslide, eroded land, polluted water, drought, and frequent floods. The steps of action research were modified as follows: (i) designing and planning, (ii) actions for improvement, (iii) monitoring and evaluation, and (iv) step forwards for sustainable livelihood.

Results and Discussion

Table 1 summarizes the phase of the research and community learning from the process. Community awareness to environmental issues vary according to knowledge and information about environmental issues received from various sources. Radio, television, paper, and cellular phone are communication media used by most members of community groups to gather information. Extension in the form of environmental education is still limited integrated in the program. Community initiatives and actions in managing the environment in each village vary depended on the environmental issues, capacity in water, land, and forest conservation, support from the government, leadership from local leaders, and partnership.

The use of action research is possible to facilitate the changes in the context of encourage movement and concrete actions from multi stakeholders. Ownership to the contextual issues (conservation, rehabilitation, and protection) has increased when the community groups are able to conserve the nature and environment together with running income generating activity as well as strengthening social bonding.

To conclude, there is an urgent needs for environmental-education integrated in extension services to strengthen community initiatives and actions in natural and environmental management. Action research can be integrated in extension-education services as an approach in change transformation through people participation, problem solving, and empowerment.

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Table 1: Learning and actions from integrating action research in environmental extension-education

Step of action research	Process of participation development	Learning and actions from community groups
Design and planning	Community groups are actors of the action research. The groups agree to promote the change The groups living in upstream of the watershed are committed to manage waste better, conserve the water, and plant annual crops. The groups living in downstream of watershed are interested in developing early warning system from flood. The groups living in the middle stream plan to strengthen groups for caring the river, manage the 3R (reuse, reduce, recycle)	Designing and planning is the essential part of the change that needed to be understood by all participants of the group
Actions for improvement	Cadres in each village work together with the community group, facilitated by change agents through extension education. The actions include: awareness to natural resources management and environmental issues	Actions can be executed by the community themselves, supported from external agents may be needed to accelerate the movement and strengthen community groups capacities in transforming the change
Monitoring and evaluation	The community groups check the change during the program. Participatory monitoring and evaluation is implemented following the indicators set during designing and planning phase	Monitoring and evaluation (observe) enrich the learning process toward sustainable livelihood
Step forwards	Extension-education services need to continue to address the issue on nature resources and environmental management as well as maintaining socio-economic of the rural community. The community groups continue to work on the actions towards sustainable livelihood.	Continuing change for the future needs co-operation among community members, cadres, local leaders, and government support through its policy and program addressing environmental issues in each regions, different regions have different context, needs, and potentials.

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Robust Regression Model to Study the Number of Indian Agricultural Workers

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Keywords: Outliers, leverages, robust regression, M-estimator, agricultural workers.

Introduction

About 1.3 billion workers of the total world population are engaged in agriculture. Census of India 2011 reported a bleak picture of Indian agriculture. It rings the alarm on an agrarian crisis- the number of farmers has dipped by over 8.6 million in the past decade. As per the census of 2011, 263 million people are engaged in the agriculture sector and over half of them are now agricultural labourers, a trend observed for the first time in the past 40 years. In classical multiple regression, the ordinary least squares estimation is the best method if assumptions are met to obtain regression weights when analyzing data. However, if these assumptions are not satisfied, then sample estimates and results can be misleading. Especially, outliers violate the assumption of normally distributed residuals in the least squares regression. The regression coefficients possess large standard errors and some even have the wrong sign (Gujarati). Robust regression estimator is an important estimation technique for analyzing data that are contaminated with outliers or data with non normal error term.

Materials and Methods

The secondary data for the number of Indian agricultural workers (AW) as dependent variable and the explanatory variable used are literacy rate (LR), average size of holding (ASH), number of establishments (EST), gross cropped area (GCA), net sown area (NSA), population density (DEN) and inflation rate (IR). Ordinary least square procedure has been used to fit the classical multiple linear regression model. The outlier and influential observations has been identified through the use of standardized residual, studentized residual, deleted residual, cooks distance, weighted sum of squared distance(WSSDi) and diagonal element of the hat matrix. Robust maximum likelihood estimation (M-estimation) is an extension of the maximum likelihood estimate method and robust estimation technique has been used which addresses dependent variable outliers where the value of the dependent variable.

Results and Discussion

In the present study, explanatory variables are assumed as literacy rate (LR), average size of holding(ASH), number of establishments(EST), gross cropped area(GCA), net sown area(NSA), population density(DEN) and inflation rate(IR) in order to study the dependent variable Y denotes number of Indian agricultural workers**.** From the Table 1, it can be seen that the maximum variability was seen in population density (207.59%) whereas the minimum variability (10.31%) was in literacy rate. Regression estimates of explanatory variables with respect to number of Indian agricultural workers showed that literacy rate negatively and number of establishment positively, significantly affecting the number of Indian agricultural workers. Kumar (2015) showed the outliers and influential values were 4, 11,13,22,25, and 34 in the data with their standardized residual, studentized residual, deleted residual, cooks distance, weighted sum of squared distance of i^{th} value (WSSDi) value and diagonal element of hat matrix as shown in the Table 2. M.-estimates of the data showed that literacy rate and average size of holding were negatively and number of establishments was positively, significantly affecting the number of Indian agricultural workers (Table 3). Table 4 shows the comparison of ordinary least square estimates with the robust M estimates which depicted that the presence of outliers and influential observations affects the size, sign and significance of regression estimates.

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Table 1: Coefficient of variation and regression estimates of explanatory variables with respect to number of India agricultural workers

Explanatory variables		LR	ASH	EST	GCA	NSA	DEN	IR
Coefficient of variation (%)		10.31	108.60	123.26	136.69	134.70	207.59	15.44
OLS estimates	Intercept							
	2.47E+7	-2.07E+5*	-1.94E+5	17.48E+2*	-291.63	963.52	177.18	-5.34E+5

$R^{2=}$0.872* F- Value: 26.415*=significant at 5%

Table 2: Outliers and influential observations of explanatory variables with respect to Indian agricultural workers

Outlier & influential observation	Standardized residual	Studentized residual	Deleted residual	Cooks distance	WSSDi value	Diagonal element of hat matrix
4	2.42000	2.82274	11505686.14	0.3530	1.013	0.2617
11	1.05756	1.87053	11587755.96	0.9306	16.702	0.6803
13	-1.40252	-1.76386	-7769548.50	0.2265	1.468	0.3677
22	-1.62477	-1.99831	-8608170.21	0.2559	21.563	0.3389
25	1.71411	2.46460	12411640.05	0.8102	31.389	0.5162
34	2.46114	2.64894	9985786.12	0.1389	3.238	0.4769

Table 3: M-Regression estimates of Number of Indian Agricultural workers

Variables	M estimates	P- Value
Constant	1,59,02,516.251**	0.000574
LR	-1,45,793.246**	0.001931
ASH	-8,81,251.752**	0.001810
EST	1,710.028**	0.000009
NSA	547.217	0.147517
GCA	291.762	0.298786
DEN	-4.364	0.975847
IR	-1,87,689.751	0.231624

R^2 Value=0.959* F value=76.745, *=significant at 5% **=significant at 1%

Table 4: Comparison of robust M regression coefficients with respect to ordinary least square

Variables	OLS estimates (Standard error)	M estimates
Constant	2,47,08,176.553 (8915233)	1,59,02,516.251** (40,76,167.85)
LR	-2,07,044.143* (94795.47)	-1,45,793.246** (42,447.61)
ASH	-1,93,549.176 (336871.10)	-8,81,251.752** (2,54,689.38)
EST	1,748.612* (640.62)	1,710.028** (312.62)
NSA	-291.621 (777.25)	547.217 (366.98)
GCA	963.505 (584.82)	291.762 (275.39)
DEN	177.188 (298.64)	-4.364 (142.81)
IR	-5,36,851.180 (313429.70)	-1,87,689.751 (1,53,374.34)
R^2 Value	0.872	0.959
Adjusted R^2 Value	0.840	0.950

*=significant at 5% **=significant at 1%

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Rural Women's Knowledge about Organic Farming and Foods

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Keywords: knowledge organic farming, organic foods, improved agriculture practices

Introduction

Jawaharlal Nehru, the Prime Minister of India, had highlighted the value of educating the women, saying that "In order to awaken the people, it is the women who have to be awakened, once she is on the move, the country moves and thus we build India of tomorrow". Knowledge is a key component in the development of agriculture when imparted to women. Organic farming is increasingly being propagated to mitigate the ill effects of chemical fertilizers and pesticides. Women are not only producers of food but also the preparers of food. The present study therefore focused on studying the knowledge of farm women regarding organic farming and organic foods.

Materials and Methods

The research study was conducted in Dharwad district of Karnataka state. The study was a comparative study of organic villages adopted by the University of Agricultural Sciences Dharwad in Kalaghatgi taluka and non organic villages from Kundgol taluka. Two villages were selected from each taluka. The selected villages from both groups (organic and non organic) were comparable with reference to soil type, crops grown and the socio economic profile. Sixty farm women from farming families and actively involved in farming were selected randomly from each of the four villages making a sample of 240. Data was collected by personal interview method.

Results and Discussion

The results presented in Table 1 show the comparison of knowledge of women in organic and non-organic villagers regarding improved agricultural practices, organic farming and organic foods. Although the difference between women about improved agricultural practices was not significant the difference with regard to knowledge about organic farming and organic foods in the compared villages was significant. The results also reveal that although women are aware of some aspects of organic agriculture they are totally ignorant about organic food and human health benefits.

The scientists of the university are constantly in touch with the adopted villages, they have been guiding the farmers in cultivating crops organically. Awareness programmes have been conducted and men and women have been trained on different aspects of organic farming. That all these efforts have paid off is well exhibited by the significant differences in their knowledge about organic farming and organic foods. The lack of total knowledge of women in the non organic villages would suggest for measures to be taken by way of awareness creation programmes through mass media or extension functionaries of the state department of agriculture

Table 1: Mean knowledge score of organic and non-organic villagers N= 240

Knowledge	Organic village	Non-organic village	t value
Knowledge about improved agriculture	2.37±0.709	2.26±0.542	1.35
Knowledge about organic farming	2.63±0.484	0.00	1.89
Knowledge about organic foods	2.32±0.467	0.00	1.79

df: 239; p value: @0.05

260.

Sharing of Knowledge and Skills with other Farmers of Punjab Agricultural University Kisan Club

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Keywords: Kisan club, knowledge sharing, motivation, PAU

Introduction

Punjab Agricultural University (PAU) Kisan Club is almost four decades old that was initially organized as a village club. The farmers of village Barewal formed a group that gave an idea of club, subsequently Punjab Kisan Club was established under the guidance of Dr. Sohal. Punjab Kisan Club is a non-political body of heterogeneous group under the patronage of Punjab Agricultural University (PAU), Ludhiana. A person engaged in farming and interested to acquire more technical information regarding agriculture, can become club member. Annual membership fee for farmers is Rs. 300, and for farm women fee is Rs. 200 whereas joint membership/couple membership fee is Rs 400. Monthly meetings are organized at PAU, Ludhiana. These monthly meetings are held on 1st Thursday of every month. It seems appropriate after passage of this much time to study the impact of this club in terms of knowledge sharing of the club members with other

Materials and Methods

The study was conducted at the Punjab Agricultural University, Ludhiana. A total of 200 respondents including 160 farm men and 40 farm women were selected on the basis of purposive and random sampling techniques from maximum, moderate and minimum attendance categories of members of the club. An interview schedule included items related to sharing knowledge/skill techniques with other farmers. The various activities were included for this purpose namely number of farmers motivated, shared personal experiences, organized demonstrations, and distributed literature, seed and nursery plants. The response for sharing farm experiences with other farmers was collected on three point continuum i.e. always, sometimes and never with score 3, 2 and 1 was assigned respectively. The findings pertaining to sharing of knowledge/skill techniques shows that all the respondent in maximum attendance categories shared their personal experience with other farmers followed by moderate and minimum attendance

Results and Discussion

The data in Table 1 indicate that all the respondents of maximum category shared their experience with other farmers. Seventy six per cent of respondents in moderate attendance category shared their personal experience while 48% respondents in minimum attendance category shared personal agricultural experience with other farmers. This shows learning was also taking place by means of shared agricultural experiences.

It has been concluded that the respondent farmers who regularly attended the monthly meeting were more responsible towards betterment of the fellow farmers

Table 1: Distribution of respondents according to sharing of personal agricultural experience with other farmers

Sharing of personal agricultural experience	Respondents with maximum attendance (n=100)	Respondents with moderate attendance (n=50)	Respondents with minimum attendance (n=50)
Experience Shared	100 (100)	38 (76)	24 (48)
Not Shared	0	12 (24	26 (52)

Figures in parentheses are % farmers

261.

Social Impact of Climate Resilient Technologies demonstrated by Krishi Vigyan Kendra Kathua in National Innovations on Climate Resilient Agriculture village

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Keywords: Socio-economic impact; climate change; technologies

Introduction

Climate change has become an important area of concern for India to ensure food and nutritional security for growing population. The impacts of climate change are global, but countries like India are more vulnerable in view of the high population depending on agriculture. In India, significant negative impacts have been implied with medium-term (2010-2039) climate change, predicted to reduce yields by 4.5 to 9%, depending on the magnitude and distribution of warming. Since agriculture makes up roughly 16% of India's GDP, a 4.5 to 9% negative impact on production implies a cost of climate change to be roughly up to 1.5% of GDP per year (Srinavas, 2015). The Government of India has accorded high priority on research and development to cope with climate change in agriculture sector. The Prime Minister's National Action Plan on climate change has identified agriculture as one of the eight national missions.

Materials and Methods

National Innovations on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR) launched in February, 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. The research on adaptation and mitigation covers crops, livestock, fisheries and natural resource management. The project consists of four components namely strategic research, technology demonstration, capacity building and sponsored/competitive grants.

Both short term and long terms outputs are expected from the project in terms of new and improved varieties of crops, livestock breeds, management practices that help in adaptation and mitigation and inputs for policy making to mainstream climate resilient agriculture in the developmental planning. The overall expected outcome is enhanced resilience of agricultural production to climate variability in vulnerable regions. The project is comprised of four components.

1. Strategic research on adaptation and mitigation
2. Technology demonstration on farmers' fields to cope with current climate variability
3. Sponsored and competitive research grants to fill critical research gaps
4. Capacity building of different stake holders.

Results and Discussion

All the production and protection technologies demonstrated yet and now through NICRA in imparting resilience in terms of mitigation and adaptation to climate vulnerability were studied. Improved and stress tolerant crops were demonstrated in large number of farmers' fields by the Krishi Vigyan Kendra Kathua in the NICRA villages (Said-Sohal) and the yield improvement was recorded in these crops is up to 60% over the farmers practice and the benefit cost ratio is up to 3.6 for some of the crops. The details are presented in the Table 1.

Table 1: Performance of improved varieties of crops in farmer's field in NICRA village

Crop	Variety	Area	No. of farmers	Measurable indicators of yield (q/ha)		Increase (%)	BC ratio
				Demo	Local		
Maize *Zea mays*	Dekalb double	12.0	74	37.0	22.0	68.18	2.8
Gobhi sarson *Brassica napis*	DGS-1	4.0	16	8.0	6.5	23.0	2.7
Mustard *Brassica juncea*	NPJ-113	0.8	4	7.5	6.0	25.0	2.5
Toria *Brassica rapa*	RSPT-2	3.0	15	6.5	5.0	30.0	2.2
Okra*Abelmoschus esculentus*	Varsha Uphar	7.5	15	114.0	86.0	32.5	2.7
Turmeric *Curcuma longa*	Sunganda	1.0	46	113.5	77.5	46.4	3.6

262.

Socio-economic Impacts of Don River Flood on Farmers Economy, Vijayapura District, Karnataka

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Keywords: Flood economics, small farmers, land less labours

Introduction

Floods have been a recurrent phenomenon in India and cause huge losses to lives, properties, livelihood systems, infrastructure and public utilities. Rivers bring heavy sediment load from the catchments coupled with inadequate carrying capacity of the rivers are responsible for causing floods. The principal problem after flood affect, in the river Basin is damage to agricultural land and crops. These floods result in serious reductions in agricultural production which in turn have a depressing effect on the economy (Anonymous, 1997). In 2009 Vijayapura district experienced severe flood-related losseswhich was been estimated to be up to Rs. 850.15 crore (Anonymous 2011).Hence the study has been taken up to understand the socio-economic impact of flood on farm economy.

Materials and Methods

Vijayapura district was purposively selected for the study based on the quantum of flood affected by farm economy in Don River basin of Vijayapura and Basavana Bagewadi taluks in the District. Loss in the district has been estimated to be up to Rs. 850.15 crore (Anonymous 2011). Hence in order to study the micro level impact, 240 flood affected households were interviewed in left and right bank from affected villages of river basin in the district. Among them, 80 large farmers, 80 small farmers and 80 landless labourers were selected randomly.

Results and Discussion

In the study area, public infrastructure loss due to flood was accounted for 2889.75 lakhs. Out of which majority loss occurred in case of public roads (55.85%) and least affected categories were electric transformers (2.42%) and others (1.38%). In case of infrastructure loss to the farmers, variables like dwelling house, livestock shed and irrigation pump house were considered and damages were analyzed in three different categories like severe, moderate and slight. Overall damage to the dwelling house was highest (Rs. 1,42,808) and least damage was noticed in case of irrigation pump house (Rs. 46,400). Agriculture is the prime most profession of rural families, if the agriculture crop area damaged means the whole livelihood of the farm families will be at risk. Flood affects agriculture, after infrastructure losses and is very crucial from the point of rural families. Flood value damage was analyzed using descriptive statistics and by comparing the normal season's income with damaged season's income. Among the three seasons and in perennial crops, highest loss was recognized in rabi (Rs. 1,00,820) season with loss of 85.46%, followed by summer (75.68%), kharif (74.30%) and least affected was perennial crops with loss of Rs. 3,407 (5.00%). Public infrastructures loss due to flood was crucial, dwelling house was affected more compared to other physical structure at farmers and in crop seasons, *rabi* season had highest impact of flood in the study area.

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Table 1: Infrastructure and Agriculture losses to the farmers and in the Vijayapura District

1. Public Infrastructure Loss in the District*				
Sector/ Areas	**Units**	**Amount of loss (Rs. in lakhs)**		**Percentage**
Roads	578 Km	1614		55.85
Bridges/Culverts (No)	168	454		15.71
Transformer/KPTCL Loss(No)	38/385 poles	70		2.42
Watershed and irrigation tanks (No)	550	711.75		24.63
Others	13	40		1.38
Total		**2889.75**		**100.00**
2. Infrastructure Loss to the Farmers (Rs.)				
Structures	**Severe**	**Moderate**	**Slight**	**Average**
Dwelling House	177897	129997	83244	142808
Livestock Shed	132302	84659	49267	82850
IP Pump house	68018	49250	31281	46400
3. Agriculture Loss to the farmers (Rs.)				
Seasons	**Normal**	**Affected**	**Net value loss**	**Per cent loss**
Kharif	243643	62610	181033	74.30
Rabi	117980	17160	100820	85.46
Summer	74607	18142	22172	75.68
Perennial crops	68210	64802	3407	5.00

***Source:** *Bijapur.nic.in* (Joint Director Office, Vijayapura)

263.

Ex-post-facto Impact Assessment of Frontline Demonstrations on Maize in Poonch District of Jammu & Kashmir

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Keywords: Front line demonstrations, impact assessment, maize

Introduction

Impact assessment is concerned with making judgments about the effect on beneficiaries of humanitarian interventions. Frontline demonstration (FLD) is one of the most important and powerful tools for transfer of technology. Presently the FLDs are mainly conducted through Krishi Vigyan Kendras (KVKs) all over the country. Keeping in view the low production of maize in the district Poonch, KVK Poonch conducted FLDs on scientific maize cultivation practices. This study attempts to assess the impact of these FLDs conducted on farmers' fields for finding the extent of adoption of scientific maize cultivation practices by the beneficiary farmers.

Materials and Methods

KVK Poonch had conducted 224 frontline demonstrations on scientific maize production technology from 2010-11 to 2014-15 on an area of 65.80 hectares. Out of 224 beneficiaries eighty beneficiaries were selected through proportionate random sampling which includes 12 farmers (out of 35) for the year 2010-11, seven farmers (out of 16) for the year 2011-12, 24 farmers (out of 68) for the year 2012-13, 13 farmers (out of 38) for the year 2013-14 and 24 farmers (out of 67) for the year 2014-15. The data were collected through personal interview with the help of pre-tested schedule.

Results and Discussion

The different tehsils of Poonch district have been covered under front line demonstrations to disseminate the maize cultivation technologies. In a particular year, the largest numbers of FLDs were laid in 2012-13. During the five years i.e. from 2010-11 to 2014-15, the overall adoption among major maize cultivation practices was found to be highest for 'weed management' followed by 'hybrid seed' & 'seed treatment' and then 'land preparation'. The lowest rate of adoption was found for 'sowing method' followed by 'seed rate' and 'fertiliser dose'. The most important constraint in adoption of all the demonstrated practices in maize as perceived by the beneficiaries was 'unavailability of labour' during the crucial periods of crop.

Table 1: Adoption of maize cultivation practices by beneficiaries of Front Line Demonstrations in district Poonch

Year	Area covered (ha)	No. of Beneficiaries	No. of respondents	Adoption in 2015 (% Farmers)						
				Hybrid seed	Land preparation	Seed treatment	Seed rate	Sowing method	Fertilizer dose	Weed management
2010-11	10.00	35	12	83.00	92.00	83.00	50.00	33.00	58.00	83.00
2011-12	5.80	16	07	71.00	57.00	71.00	43.00	29.00	57.00	100.00
2012-13	20.00	68	24	83.00	75.00	83.00	33.00	25.00	67.00	88.00
2013-14	10.00	38	13	85.00	77.00	85.00	31.00	23.00	69.00	85.00
2014-15	20.00	67	24	75.00	54.00	75.00	38.00	33.00	71.00	100.00
Overall	65.80	224	80	80.00	70.00	80.00	38.00	29.00	66.00	91.00

264.

Training Needs Assessment of Marigold Farmers on Production Technologies in Kathua District

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Keywords: Training needs, assessment, marigold production, growers

Introduction

Marigold is an important and commercial crop among flowers. The recommended marigold cultivation practices are complex and costly which require sufficient information on the part of the farmers. Need assessment helps to identify present problems and future challenges to be met through training and development. Training of the farmers about recommended cultivation practices can serve this purpose and help to design training module for the farmers. Looking to these facts, the present study was carried out with the objectives to ascertain the marigold growers training needs

Materials and Methods

The present study was undertaken in Kathua district of Jammu and Kashmir state. This district consists of eight blocks from which three block namely Hiranagar, Barnoti and Kathua were selected purposively, as more area under marigold crop is in these three blocks. From each block four villages were selected and from each village thirty farmers were selected randomly to serve as sample respondents. In this way list of 120 marigold growers was prepared by simple random method of sampling. The primary data were collected using a pre - tested structured interview schedule by conducting personal interview from the selected marigold growers.

Results and Discussion

Data revealed that training needs of the farmers based on overall mean score obtained was more in plant protection aspects. The respondents perceived the training need in plant protection ranked first with mean score 2.19 due to significant damage by aphids, caterpillar, red spider mite and diseases like bud rot and wilting. Training was found to be essential in the area of nursery raising and its management with mean score of 2.10 ranked II followed by fertilizer management with mean score of 2.04. Marigold farmers also expressed their training need regarding field management which includes land preparation, care and maintenance of crop etc. having mean score of 2.00 and ranked IV. The least essential training need area was identified as marketing of produce having mean score of 1.90 and was ranked VI with respect to other training need area.

To examine the relationship between selected characteristics of marigold, correlation coefficient (r) was computed. The data depicted in the table1 below indicate that among ten characteristics studied, farm size and decision making behavior were found positively and significantly correlated with training need at 0.01% level of probability, where as education, annual income, extension contact, risk orientation, market orientation were correlated positively and significantly at 0.05% level of probability. Further it was noticed that age, experience in marigold production and caste did not show any relationship with training needs.

Table 1: Correlation between selected characteristics and training need of the marigold growers.

Variable	r value
Age	1.253NS
Education	0.275*
Experience in marigold production	0.023 NS
Farm size	0.423**
Annual Income	0.184*
Caste	0.0816 NS
Extension contact	0.272*
Decision making behavior	0.288**
Risk orientation	0.176*

NS-Non significant
*and **indicate signification of value at P= 0.05 and 0.001 respectively

265.

Beekeeping: A Case Study of the Jammu Region, J & K State

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Keywords: Beekeeping, Economic benefits, Output - Input ratio

Introduction

Agriculture is the main stray of Indian economy and a major source of livelihood for Indians. After Independence, Government of India launched a massive programme of rapid industrialization with the aim to integrate it with rural development. Government developed various agro-based industries like diary, fish farming, poultry, sericulture and beekeeping. The task of development of beekeeping industry was entrusted to the newly constituted All India Khadi and Village Industries Board which was later reconstituted as Khadi and Village Industries Commission (KVIC) IN 1956 and other state and central level organizations working for the development of beekeeping. A study was conducted to evaluate whether the apiculture farming is remunerative enterprise in the Jammu region.

Materials and Methods

Four districts of Kathua, Jammu, Rajouri and Ramban were selected purposively for the study as maximum number of beekeepers (905) was registered with the Department of Agriculture from these districts. Out of the registered beekeepers, a sample of 210 beekeepers was selected from these districts by proportionate random sampling method. The data were collected with the help of a pretested interview schedule through personal interview method. The data were analyzed by using appropriate statistical tools.

Results and Discussion

Overall 60 per cent of beekeepers were small beekeepers (5-57 boxes) followed by 30 per cent and 10 per cent medium (57-120 boxes) and large beekeepers (120-800 boxes) respectively (Table 1). Therefore, majority of the sampled beekeepers were having small unit size (5 - 57 boxes). The average net income per box was Rs. 2130 in case of large beekeepers. With the decrease in size of colony, average net income also decreased. The small beekeepers (5 - 57 boxes) had net income of Rs. 766 per box/year. In the four districts, average gross income per beekeeper was Rs. 120479 per year with an average recurring expenditure of Rs. 13327/beekeeper per year. Therefore, the average net income/beekeeper per year from beekeeping enterprise was Rs. 107151. The output - input ratio per box/ year was the highest in Kathua district, followed by Ramban district, and lowest in Rajouri district. The overall output - input ratio per box per year was 9.04. Further in the four districts, average net income of beekeeper was Rs. 1482 per box/year. The output- input ration of wheat crop, mushroom crop and sericulture were reported to be 1: 1.6, 1: 4.00 and 1: 1.85 respectively. Comparatively, the input output ratio of beekeeping was reported to be 1: 9.04. Hence, the output- input ratio of apiculture is higher than that of the above stated agricultural enterprises.

Table 1: Effect of size of beekeeping unit on expenditure, gross come, net income of beekeepers and output-input ratio of beekeeping (n=210)

Category/ No. of boxes	Percentage of beekeepers	Average number of boxes	Gross income Rs. / box	Recurring expenditure Rs. / box	Net income Rs./ Box	Output / Input ratio* of beekeeping
5-57 (Small)	60	33±18.28	921±323.79	155±23.55	766±318.18	**5.94**
57-120 (Medium)	30	83±16.56	1535±592.03	157±32.29	1378±578.88	**9.78**
120-800 (Large)	10	269±223.36	2315±368.37	186±50.49	2130±380.59	**11.47**
-	-	F= 99.193 p=0.000	F=120.997 p=0.000	F=10.704 p=0.000	F=120.733 p=0.000	-

Overall Output/Input Ratio= 9.04
*Output/input ratio= Gross income/Recurring expenditure

266.

Policy Issues for Integrated Watershed Management Program of Jammu & Kashmir State

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Keywords: IWMP, SLNA

Introduction

In 2008, the Union Ministry for Rural Development and Panchayati Raj came out with comprehensive policy guidelines for the watershed development with effect from 1st April, 2008. Under the scheme, about half of the geographical area of India, that is degraded or rain fed, is to be covered and prioritized for development under various watershed development projects. The scheme is oriented towards employment generation, livelihood enhancement for marginalized farming communities and conservation of land and water resources especially in rural areas and has got to be implemented through the Rural Development Department and Panchayati Raj, Self-help groups and the Non-Governmental Organizations. At the state level, State Level Nodal Agency (SLNA) has been constituted and the committee meets twice in a year to finalize various activities to be executed well in advance for the smooth running of the project. At the district level, project officer integrated watershed management program have been appointed, assisted by district technical expert and member of watershed development team belongs to different disciplines of agriculture and allied sectors. During 3rd SLNA meeting of state, it was decided that state agricultural university especially Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, India will organize a master training programme for the staff of Integrated Watershed Management Programme (IWMP) so that the staff may be well equipped with the latest techniques on watershed program.

Materials and Methods

As per minutes of meeting, a two days training program was organized on 11-12 Jan, 2014 at Jammu and Kashmir Entrepreneurship Development Institute (JKEDI), Jammu in which participants from all the ten districts of Kashmir province and six district of Jammu province (Kathua, Samba, Jammu, Udhampur, Reasi and Doda) participated whereas there was no participation from the Ladakh region. Feed back through well structured schedule from 26 participants including state level expert (individually and collectively) was taken on various aspects of training and recorded on a five point continuum scale from, outstanding, very good, good, fair and poor with score of 5, 4, 3, 2 and 1, respectively. The learning index was calculated by the following formula:

$$\text{Learning Index} = \frac{\text{(Post training score - Pre test score)}}{\text{(100 - Pre test score)}} \times 100$$

The topic were chosen very appropriately in the light of Union Government's commitment to improve agricultural productivity per drop of water.

Results and Discussion

Hundred percent participants rated fulfillment of expectations as outstanding, knowledge has increased by participating in training program. It was a good learning experience, trainees are ready to come again for the training program with modified course content and they also agree that other officer of their department should attend this training program. Ninety-six percent reported that they have developed new skills by participating in training programme. Ninety two per cent reported that training has changed their attitude towards their job and trainers have rich knowledge of the subject. About eighty eight per cent confirmed that training has improved their job proficiency, full and best utilization of time and environment of imparting training and learning was excellent. A large percentage of eighty five reported that there was perfect balance between theory and practical (tutorial). Seventy per cent trainees responded that the duration of the training program was short and it should be bit longer. The overall learning index of the training programme was fifty seven per cent. Hundred percent participants were of the view that after the appointment in IWMP project, new appointee may be sent immediately for this training program as the knowledge gained have direct impact on the preparation of detailed project report of their watershed.

Table 1: Response of trainees on different aspects of training

Particulars	Response on 5 point scale / %				
	5	4	3	2	1
Fulfilment of expectation					
Weather your expectation fulfilled or not	26/100				
Weather there is any effect of training program on DPR	26/100				
Opinion of trainees on different aspects of training					
	Agree		**Undecided**	**Disagree**	
Knowledge has increased by participation in training	26/100				
It was a good learning experience.	26/100				
Are you ready to participate in another training with advance course content ?	26/100				
Do you think other officers of your organization should attend this training program	26/100				
Development of new skills by participation in training	25/96		01/04		
Training has changed my attitude toward my job	24/92		02/08		
Trainers have rich knowledge about subject matter	24/92		02/08		
Training has improved my job proficiency	23/88		03/12		
Full and best utilization of time	23/88		03/12		
Excellent learning environment	23/88		03/12		
Perfect balance between theory and tutorial	22/85		04/15		
Duration of training was satisfactory	09/35		13/60	04/15	
Learning Index	57%				

267.

Perceived Constraints of Contract Basmati Growers in Jammu Division

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Keywords: Contract farming, contract farmers constraints.

Introduction

A contract farming arrangement is seen as a promising alternative that typically obliges a firm to supply inputs, extension, credit etc. in exchange for a marketing agreement that fixes a price for the product and binds the farmer to follow a particular production method or input regimen. Catelo and Costale (2008) discussed contract farming as a binding arrangement between a firm (contractor) and an individual producer in the form of a 'forward agreement' with well-defined obligations and remuneration for tasks done, often with specifications on product properties such as volume, quality, and timing of delivery. It can be structured in a variety of ways depending on the crop, the objectives and resources of the sponsor and the experience of the farmers. Broadly speaking, contract farming can be categorized into three like: marketing, partial and total. Out from all the specified model of contract farming, partial contract farming is practiced in Jammu. A study was conducted to access the impact and perceived constraints of contract farming. In this extended summary we present the perceived constraints of contract farming as reported by the Basmati growers..

Materials and Methods

In order to ascertain the constraints, under contract farming, the study was carried out in Jammu division of Jammu and Kashmir state of India. In Jammu division a list of districts that grows basmati rice under contract farming was obtained from the contracting agency Sarveshwer Overseas. On the basis of the prepared list two districts Jammu and Kathua selected for the study. From the selected districts, the villages where contract farming was done, the list was prepared. Out these identified villages, 3 villages from each district having maximum number of contract farmers were selected purposively. From selected villages, the list of contract farmers was prepared and out of the prepared list, 50 contract farmers were selected randomly for the study. Equal number of non-contract farmers having similar land holding were also selected from the selected villages. In this way a sample of 100 contract farmers and 100 non-contract farmers of basmati rice in Jammu division was taken for the study.

Results and Discussion

Out from the confronted constraints the contract farmers reported that the non-adoption of the contract farming by the agriculture department was on rank first as guaranteed by 89% of the contract farmers, trailed by irregular payment (55%) was on rank second and no increment in price (46%) was put on rank third. From non-contract farmers, all respondents didn't know about the contract farming. The ones who were aware (n=26) positioned irregular payment (85%) by the firm on rank first took after by difficult norms of firm (69%) and non-adoption of contract farming by agriculture department (62%) on rank second and third separately

Table 1: Constraints of contract farming as reported by Basmati growers

Constraints	Contract farmers (n=100)	Rank	Non-contract farmers (n=26)	Rank
Non- adoption of contract farming by agriculture department	89	I	62	III
Irregular payment	55	II	85	I
No increment in price if market prices increase	46	III	20	IX
Poor technical assistance	45	IV	38	V
Low contract price	25	V	7	X
No initiative by contract personnel in decision making	20	VI	31	VII
Difficult norms of contracting firm	16	VII	69	II
Weak enforcement of contractual laws	12	VIII	46	IV
Breach of contract	10	IX	35	VI
Higher rejection of produce	9	X	26	VIII

Reference

Catelo, M.A.O. and Costales, A. 2008. Contract farming and other market institutions as mechanism for integrating small holder livestock producers in the growth and development of the livestock sector in developing countries, PPLPI working paper No.45.

268.

Pesticide Use in Cereals: An Analysis of Farmers' Perception and Knowledge in Jammu District

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Keywords: Pesticides, cereals, farmers' perception

Introduction

Pesticides become an integral part of present Indian agriculture which has shifted its course from sustenance to commercial character. This has resulted in exposing cereal crops to regular use of pesticides even in remote districts of the country. The increased use of pesticides in cereals emphasized the importance of technical knowledge that farmers must acquire to reduce the negative effects of pesticides. R.S. Pura tehsil of Jammu district is an agricultural active tehsil, chosen purposively for assessing the extent of pesticide use in cereals and for assessing the perception & knowledge of farmers regarding pesticide use.

Materials and Methods

R.S. Pura tehsil of Jammu district was purposively selected for conducted the present study. Eight villages from the selected tehsil were randomly selected and a list of 20 farmers was prepared for each village. Eight farmers out of 20 were then randomly selected from each village thus comprising a total sample size of 64 respondents. Data were collected on pre-structured schedule framed for the present study. The data collected were put to tabulation and percentages were calculated for deriving the conclusion.

Results and Discussion

Among different categories of pesticides, herbicides found to be a necessity for application in both rice as well as wheat crop. Insecticides, fungicides and storage pesticides however found to be used occasionally. Table 1 reveals the physical benefits arising out of pesticide use in cereals, as perceived by the respondents. The gain in terms of increased yield with herbicide use, as observed by farmers was reported to be 3.0q/ha, and 2.0q/ha in rice and wheat, respectively. The gain with use of insecticides was found to be 0.50 q/ha for rice crop as reported by 7.81 prcent of the sampled respondents who applied insecticide in rice crop. The gain in yield with use of fungicides was found to be 1q/ha, in case of rice and wheat, respectively as reported by 31.25 & 53.12 percent of the sampled respondents. The gain in yield with use of rodenticides was found to be.80q/ha,.50 q/ha &1.0 q/ha for Basmati rice, coarse rice and wheat respectively. The change in yield with and without use of pesticide as reported by the farmers was based on their experience of farming. A number of farmers felt health problems in course of pesticide application. The major clinical symptom observed by the respondent farmers include headache (84%) followed by skin irritation (63%). The symptoms like uneasiness, respiration problem and vomiting were also observed in 48, 31 and 16 percent of respondents, respectively. Farmers recognize pesticides as an integral part of their agricultural activities including cultivation of cereals. They were found to be well aware about ill effects of pesticides and ready to use alternatives carrying less hazards, if found equally effective.

Table 1: Effect of pesticide use on average yield of rice and wheat crops

Type of Pesticides	Crop wise average yield (q/ha)		
	Rice		Wheat
	Basmati	Non-Basmati	
Herbicides			
With use	25.00	42.00	22.00
Without use	22.00	39.00	20.00
Insecticides			
With use	25.00	42.00	Not used
Without use	24.50	41.50	
Fungicides (seed treatment and in standing crop)			
With use	25.00	42.00	22.00
Without use	24.00	41.00	21.00
Rodenticides			
With use	26.00	42.00	22.00
Without use	25.20	41.00	21.00
Storage pesticides	Not used	Not used	Save stored wheat by 5% with use of storage pesticides.

269.

Role of IPRs in Biological and Environmental Sciences

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Keywords: Intellectual Property, IP

Introduction

Increasing evidences suggest that biotechnology is going to influence the existing realms of agriculture, environment, healthcare and biodiversity and seems ready to offer promising approaches to cure diseases clean the environment and enhance agricultural produce to feed the increasing large population. In order to match the fast pace of biotechnology and deliver the biotechnology-associated products, money and rigorous efforts are needed which further demands assurance for protecting the research outcome and investment. Intellectual property rights provide this protection to research outcome and investment while augmenting the innovation ecosystem by adding new knowledge to the public domain.

Materials and Methods

Author has been environmental biologist by training and involved in patent drafting and patent arguing in the area of biology and environment. Thus, most of his understanding of the role of IP in biology and environment has been acquired through his extensive and regular engagement with IP affairs. His current engagement as scientist in the patent cell of NII also exposed him to the latest trends of interfaces between IP and biological sciences.

Results and Discussion

Neither biotechnology, in itself, a new field nor its interaction with intellectual property is new. Biotechnology-led products, for instance, famous French cheese, Roquefort, were legally protected as early as 1411. In 1865, yeast clones were protected under French IP system and a patent was granted to renowned French chemist and microbiologist, *Louis Pasteur*. For success of biotechnology and biotechnology-led economic growth, an adequate and robust protection of IP rights is required. Recent years have seen an increase use of patent metrics to evaluate innovation, technological progress and R&D performances in the Indian universities. For reaping the scientific and societal benefits of IP rights, a practical understanding of how does IP system works is required for researchers. In order to align R&D with IP system, all researchers are not needed to become patent agents or experts but their sensitization to IP will ensure that their research outcome is disseminated well and they get incentives for their efforts, intellect and investment. Understanding of what is patentable and what is not patentable in life science will help life science researchers to participate and benefited in the emerging bio-economy of India. IP will also act as critical factor in designing economic policies for modern bio-economy which is expected to emerge in the years ahead.

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Farmers Suicide in Karnataka, India: An Overview

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Keywords: Farmer, suicide, Karnataka, India, NCRB data set.

Introduction

"Jai Jawan, Jai Kisan" - Lal Bahadur Shastri, this slogan of a visionary prime minister had lost its potential over the time. As years passed, by agriculture as an industry lost its importance for policy makers of India. Every day in national newspaper invariably there is news related to farmers' suicide. In India according to National Crime Record Bureau a record of 2, 50,000 farmers have committed suicide over the last 13 years. In Karnataka the beginning of the suicides can be traced back to the year 1998, when two farmers in Bidar, who were involved in cultivating tur dal committed suicide.

Materials and Methods

For evaluating specific objectives of the study, secondary data on the number of farmers committed suicide were collected from different secondary sources.

Results and Discussion

From Table 1 it is observed that in 2000 number of farmers committed suicides in India was quite higher compare to 2001, but after 2001 it increased up to 2004 then gradually the rate was in decreasing order up to 2013. In 2014 it increased to great extent. It also has been observed that in Karnataka more than 90 farmers committed suicide from 2003 to 2015. In 2003-2004 farmers suicidal rate was high due to drought, and now up to June and July of 2015 it was 172, quite an increase. General causes of farmers suicide were chronic indebtedness and inability to pay interest, economic depression, falling prices of agricultural produce. There is an urgent need for increased public awareness among farmers regarding agricultural policies.

Table 1: Number of farmers (farming/agricultural labourers) committed suicide during 2000 - 2014 in India and selected state Karnataka

India		Karnataka	
Year	**No. of Farmers Committed Suicide**	**Year**	**No. Of farmers suicide**
2000	16603	2003-04	708
2001	16415	2004-05	271
2002	17971	2005-06	163
2003	17164	2006-07	346
2004	18241	2007-08	342
2005	17131	2008-09	337
2006	17060	2009-10	290
2007	16632	2010-11	242
2008	16196	2011-12	187
2009	17368	2012-13	100
2010	15964	2013-14	130
2011	14027	2014-15	61+131 (June & July)
2012	13754		
2013	11772		
2014	12360*		
Total	2,38,658		

*(excluding farmers whose own land (4949 suicides) and farmers on contract (701 suicides)
Source: Various issues of Accidental Deaths and Suicides in India (ADSI), National Crime Records Bureau (NCRB), Ministry of Home Affairs, Government of India & *www. indiastat.com*
Internet, NCRB, Vijay Karnataka news paper.

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Migration of Agricultural Labourers in Karnataka

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Keywords: Migration, Agricultural Laborer's.

Introduction

Our 70% population lives in the rural areas and most of them are dependent on agriculture. Labour is the single most important factor in determining national income. Poverty is the main obstacle for the development of any country but it is very grave phenomenon where a section of society is unable to fulfill the basic necessities of life. The seasonal migration of agricultural labourers is not a new phenomenon in Karnataka and India. As a result of the defective policies of agricultural development the regional disparity is increasing even after independence leading to the increase in the seasonal migration of agricultural labourers.

Materials and Methods

The study was based on secondary data of census report of 2001 and 2011 of Karnataka state. The Statistical tool used in this study was survival ratio method.

Results and Discussion

It has been observed that Migration in India was mostly influenced by social structures and pattern of development. From Table 1 it can be observed that in Karnataka the percentage of total agricultural labourers has decreased in 2011 compare to 2001 in some of the districts namely Belgaum, Bagalkote, Koppal, Gadag, Dharwad, Haveri, Davangere, Shivamogga, Udupi, Tumkur, Banglore, Mandya, Dakshina Kannada, Chamarajanagar, Gulbarga, Banglore Rural, and Ramnagar due to migration of Agricultural labourers. Highest migration was seen in Belgaum (10.27%) followed by Bellary (7.42%), Gulbarga (6.96%), Raichur (5.65%) and Tumkur (5.11%). And lowest migration was observed in the remaining districts of Karnataka. Hassan (-0.53) and Kodagu (-0.03) indicate in-migration

Table 1: Percent estimated net migration of Agricultural labourers in Karnataka by using 2001 and 2011 census data

District	Total agril. labourers in %		Total population in %		Estimated net migration%
	2001	2011	2001	2011	
Belgaum	9.43	9.14	7.97	7.82	**10.27**
Bagalkote	4.38	4.23	3.13	3.09	4.94
Bijapur	4.60	5.16	3.42	3.56	4.37
Bidar	3.36	3.93	2.84	2.78	2.12
Raichur	5.28	5.28	3.16	3.15	**5.65**
Koppal	3.77	3.61	2.26	2.28	4.53
Gadag	2.88	2.78	1.84	1.74	2.87
Dharwad	3.00	2.99	3.04	3.02	3.21
Uttarakannada	1.36	1.62	2.56	2.35	0.53
Haveri	4.68	4.46	2.72	2.61	4.96
Bellary	5.80	6.00	3.84	4.14	**7.42**
Chitradurga	3.88	3.92	2.87	2.72	3.42
Davanagere	4.35	4.29	3.39	3.18	3.98
Shimoga	3.60	3.48	3.11	2.87	3.27
Udupi	1.41	0.90	2.10	1.93	2.28
Chikmagalur	1.75	1.80	2.16	1.86	0.98
Tumkur	5.04	4.43	4.89	4.39	**5.11**
Bangalore	1.08	0.82	12.37	15.69	2.71
Mandya	3.31	2.93	3.34	2.96	3.20
Hassan	2.03	2.93	3.26	2.91	**-0.53**
Dakshina kannada	0.68	0.48	3.59	3.41	1.08
Kodagu	0.18	0.25	1.04	0.91	**-0.03**
Mysore	4.02	4.10	5.00	4.90	3.91
Chamarajanagar	3.10	3.06	1.83	1.67	2.57
Gulbarga	5.77	5.62	4.11	4.20	6.96
Yadgiri	2.90	3.22	1.81	1.92	3.01
Kolar	2.58	2.82	2.62	2.52	1.94
Chikkaballapura	2.84	3.07	2.17	2.05	2.03
Bangalore rural	1.36	1.16	1.61	1.61	1.94
Ramanagara	1.56	1.53	1.95	1.77	1.29

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272.

On the Long Term Climatology and Trends of Heat and Cold Waves over Bihar, India

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Keywords: Climatology, heat and cold wave, temperature, trend analysis.

Introduction

The amount of damage wrought by weather-related natural disasters has skyrocketed in recent decades. Episodes of extreme heat and cold can have serious societal, agricultural, economical and ecological impacts across the globe, with heat being the number one weather-related killer (National Weather Service, 2014). There is need of regional based study to quantify degree of stress due to thermal environment. We examined climatological distribution of heat and cold waves of two agro-climatic zones comprising 17 densely populated (1108 persons/sq. km) districts of Bihar state using weather (temperature) information at district level over 45 years (1969-2013). The in depth climatology and trends in the occurrence, frequency, intensification and duration of heat and cold waves were studied to generate the information at local level to address the challenge of climate change and its extremes.

Materials and Methods

The study was conducted in two agro-climatic zones namely South East Alluvial Plain (Zone-IIIA and South West Alluvial Plain (Zone-III B) located in the south of river Ganga of the state of Bihar and comprises of 17 districts with total geographical area of 44875.5 sq. km. Rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.) are principal agricultural crops growing in these two zones. We used series of daily maximum and minimum temperature data of recent 45 years (1969-2013) of six meteorological stations/substations to calculate temperature indices, from which the trend, occurrence, duration and severity of heat and cold waves were estimated.

Results and Discussion

In period of 45 years, zone-IIIA & IIIB has experienced 251/182 and 337/140 average number of heat and cold events respectively. Although the zone-IIIA on average is experiencing ≥ 8 heat and cold wave days per hot and cold weather season, but, both these high frequency temperature extremes are decreasing at the rate 0.15 and 0.17/year respectively, indicates decreases in warmer days during hot weather period and increase in warm days during cold weather period, which may cause yield loss in wheat crop of the region. Whereas, Zone-IIIB on average is experiencing ≤ 5 heat and cold days per season, but, heat waves have been found increasing at the rate 0.11/year, whereas a non-significant decreasing rate of 0.04/year was observed in cold waves. Thus the result indicates increases in warm days during hot and cold weather period, which may pose greater threat to the yields under rice-wheat system of the region. Study also inferred that heat waves of month May in zone-IIIA and of June in zone-IIIB are more frequent, hotter and longer than other months of hot weather period under study, whereas, cold waves of month January are more frequent and longer in both zones (Fig. 1). Using long term local weather data for identifying consequences of climate change like extreme weather events and its effects of local environment needs immediate attention for effective agricultural planning and its management.

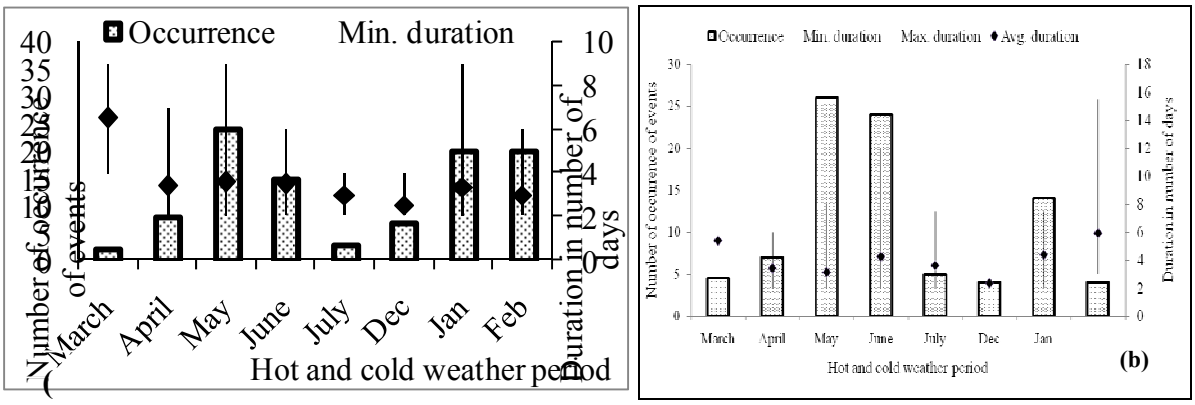

Fig. 1: Episodes and duration of heat and cold events over agro-climatic zone IIIA (a) & B (b) of Bihar

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273.

Private Sector Extension Approaches and Elements for Coherence with Public Extension Systems in India

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Keywords: Agriculture extension, private sector, coherence

Introduction

The extension system in India has evolved across the past few decades. From being mainly led by government institutions, there has been a gradual involvement of the private sector, consultancies and non-government organizations. However, the provision of extension has fallen short of expectations. The success of our extension system will entail effectively reaching out to the farming communities across challenging geographies and providing them timely and reliable information. The paper presents the key approaches adopted by various private sector entities and identifies areas for brining coherence with the public extension system.

Materials and Methods

The paper is based on review of literature, analysis of case studies and interaction with private sector companies. Based on an analysis of select case studies implemented by private sector companies, the paper identifies some key elements that enable a successful extension programme. The paper also makes an attempt to identify potential areas for convergence of public and private extension systems.

Results and Discussion

India is seeing an increased participation of the private sector in agricultural extension space. Segments of the private sector offering extension as part of their value proposition include crop science industry, seed and input companies, distributors and agro-dealers, service providers of various kinds, food processors and retailers (Ferroni, 2013). Table 1 outlines the approaches adopted by various segments within the private sector and the key elements involved in extension. One of the main reason attributed to the success of the private extension system is the direct and frequent connect with the farmers. Private sector companies have looked at an extension approach that includes information not only on technology dissemination but on the provision of range of non-technology services and supporting farmer organizations. The private sector in its approach has been able to aggregate information and services relating to not only agri-inputs but also to machinery, credit, farm advisory and field supervision services. The increasing use of Information and Communication Tools (ICT) in agri-extension by private sector has built in a dynamic system of information sharing and feedback from users.

Table 1: Private sector approaches for agri-extension

Entity	Key approaches
Agri-input companies (seeds, fertilizer, pesticides and agro-machinery)	▪ Pamphlets, wall paintings, advertisements and demonstrations mainly on respective products. ▪ Organizing seminars and soil testing (in case of fertilizer companies). ▪ Kisan Kendras providing package of inputs and services.
Agri-business initiatives	▪ Provide integrated production and marketing support. ▪ Services extend from providing high value inputs, access to credit, advice from experts and in some cases procurement of produce. ▪ Information on weather, markets, scientific farm practices through e-kiosks and mechanism for asking queries and getting their answers.
Financing companies	▪ Extension through financial services and technical assistance companies. ▪ Works in collaboration with government and non-government agencies with a string focus on capacity building activities.
Agro-processing and trading firms	▪ Extension services as part of contract farming arrangement with farmers.

While there are success stories of the private sector, there has been an argument that their presence has been towards well-endowed regions of this country, towards high value crops and mainly with large and medium farmers. It is true that for a country as diverse and big like India, collaboration between the private and public sector will be the key for success. A partnership approach that combines the public institutional framework with the innovation and marketing expertise of the private sector is the need of the hour. However, as a fundamental basic it will be essential to undertake research to understand why farmers are not accessing information in the current form and what their expectations are. This will help in designing an extension system that caters to the information needs of farmers across different agro-climatic zones, land holdings and income groups

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274.

Evaluation of On-farm Front Line Demonstrations on the Yield of Gram (*Cicer arietinum*) in Amritsar District of Punjab

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Keywords: Demonstration, FLD programme, gram

Introduction

Gram (*Cicer arietinum*) is an important food legume widely consumed in India and plays an important role in enriching the soil through biological nitrogen fixation. In Punjab, gram accounts for only 0.02% of area and 0.03% of production of the country. The average yield in Amritsar district is 12.61 q/ha, which is substantially lower.

Materials and Methods

Seventy one front line demonstrations(FLDs) were undertaken by Krishi Vigyan Kendra, Amritsar on the improved package of practices of gram for 5 consecutive years (from 2009-10 to 2013-14), across 38 villages in Amritsar district of Punjab. Prevailing farmers' practices were treated as control for comparison with recommended package of practice for gram. The economics of both control and demonstrated plot was worked out.

Results and Discussion

The yield of gram under demonstration was recorded as 10.53, 14.95, 16.8, 15.53 and 16.5 q/ha in 2009-10, 2010-11, 2011-12, 2012-13 and 2013-14, respectively(Table 1). The yield enhancement due to technological intervention was to the tune of 14.0, 18.2, 20.0, 13.7 and 15.0% over control in the same order. The cumulative effect of technological intervention over five years, revealed an average yield of 14.86 q/ha, 16.18% higher over local check. An average of Rs. 16503 was recorded as net profit under recommended practice while it was Rs. 11645 under farmers' practice. Benefit cost ratio was between 1.27 and 2.02 under demonstration, while it was 1.11 and 1.77 under control plots. This favorable benefit cost ratio of the demonstration built the relationship and confidence between farmers and scientists.

Table 1: Impact of Front line demonstrations on gram (*Cicer arietinum*) var. PBG5.

Year	No. of Demons-trations	Area (ha)	Yield (q/ha)		Change in yield (%)	Economics of demonstration (Rs/ha)				Economics of check (Rs/ha)			
			Demons-tration	Check		Cost of cultivation	Gross return	Net returns	Benefit: Cost ratio	Cost of cultivation	Gross return	Net return	Benefit: Cost ratio
2009-10	4	1	10.53	9.24	14.0	17210	21850	4640	1.27	16150	17860	1710	1.11
2010-11	7	2	14.95	12.65	18.2	23900	31395	7495	1.31	22310	26565	4255	1.19
2011-12	10	2	16.80	14.0	20.0	24230	47040	22810	1.94	22740	39200	16460	1.72
2012-13	10	2	15.53	13.65	13.7	24870	46590	21720	1.87	23300	40950	17650	1.76
2013-14	40	8	16.50	13.50	15.0	25300	51150	25850	2.02	23700	41850	18150	1.77
Average	**71**	**15**	**14.86**	**12.61**	**16.18**	**23102**	**39605**	**16503**	**1.68**	**21640**	**33285**	**11645**	**1.51**

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Seed Quality of Fenugreek (*Trigonella foenum-graecum* L.) CV. Hisar Suvarna as Influenced by Integrated Nutrient Management

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Keywords: Agricultural production, good quality seed, viable & vigorous seed.

Introduction

Seed is an important component of agricultural production and industry in India. The quality seed plays important role in the agricultural production as well as in national economy. Therefore the good quality seed is necessary to enhance the production and productivity. Availability of viable and vigorous seed at the planting time is important for achieving targets of agricultural production because good quality seed acts as a catalyst for realizing the full potential of other inputs. Since the total cultivable area is decreasing due to over growing population, the increased agricultural productivity is the only option. Good seed in good land yield abundant. Keeping in view the above background we analyzed the impact of INM on seed quality.

Materials and Methods

The sowing was done in Rabi, 2013-14 in the field research area of department of vegetable science CCS HAU, Hisar. The variety "Hisar Suvarna" of fenugreek was grown in the field research area in a Randomized Block Design (RBD) with three replications and seventeen treatments. The biofertilizers Rhizobium and PSB were used as seed treatment while FYM and Vermicompost were used @ 20t/ha and 5t/ha respectively. Recommended dose of fertilizer was taken @ 25kg N/ha and 40kg P/ha. The observations were recorded on freshly harvested seed in laboratory by using Completely Randomized Design. The data was analyzed statistically according to the method described by Panse and Sukhatme (1985)

Results and Discussion

The data revealed that all the nutrient management treatments through various sources brought significant improvement in quality parameters viz, Standard germination (%), Test weight (g), Seed density (g/cc), Dry weight (mg), Seedling length (cm) and Electrical Conductivity (µS cm-1 g-1) (Table1).Maximum improvement was noticed under the application of nitrogen and Rhizobium+PSB.The nutrient combination of Rhizobium+PSB+75% nitrogen showed significantly higher improvement over the rest of treatments (Table1) and control followed by Rhizobium+100%Nitrogen and PSB+100%Nitrogen.

The Standard germination (%) (94.33), Test weight (g) (13.65), Seed density (g/cc) (1.541), Dry weight (mg) (82) and Seedling length (cm) (29.4) were maximum in T_{15} (Rhizobium+PSB+75% Nitrogen) followed by T_5 (Rhizobium+100%Nitrogen) and T_{11} (PSB+100%Nitrogen) over T_0 (control) The Electrical Conductivity (µS cm-1 g-1) (0.187) was also recorded less in T_{15} (Rhizobium+PSB+75% nitrogen) followed by T_5 (Rhizobium+100%Nitrogen) (0.194) and T_{11} (PSB+100%Nitrogen) (0.206) over T_0 (control) (0.363). The Integrated Nutrient Management in fenugreek revealed that the slightly reduced dose of inorganic nitrogen was best when applied in combination with bio-fertilizer (Rhizobium+PSB) for improving the seed quality as compared to the rest of INM treatment combinations.

Table 1: Effect of INM on seed quality parameters of fenugreek (*Trigonella foenum-graecum* L.)

Treatments	Standard germination (%)	Seedling length (cm)	Test Weight (g)	Dry Weight (mg)	Seed Density g/cc	Electrical conductivity µS/cm/g
T0 Control	76.00	17.50	12.52	45.00	1.12	0.363
T1 Rhizobium + FYM (100%)	87.33	22.50	13.10	74.87	1.45	0.243
T2 Rhizobium + FYM (75%)	85.33	21.10	12.85	73.23	1.43	0.253
T3 Rhizobium + Vermicompost (100%)	83.00	20.63	12.75	65.10	1.16	0.285
T4 Rhizobium + Vermicompost (75%)	79.67	19.10	12.23	62.67	1.16	0.295
T5 Rhizobium + Nitrogen (100%)	91.67	28.07	13.63	80.13	1.49	0.194
T6 Rhizobium + Nitrogen (75%)	80.33	27.30	13.37	77.03	1.46	0.222
T7 PSB + FYM (100%)	87.00	21.80	13.05	72.00	1.43	0.23
T8 PSB + FYM (75%)	83.33	20.27	12.70	70.60	1.44	0.249
T9 PSB + Vermicompost (100%)	82.00	19.77	12.60	62.33	1.15	0.233
T10 PSB + Vermicompost (75%)	78.33	18.47	12.08	62.03	1.15	0.241
T11 PSB + Nitrogen (100%)	91.33	26.30	13.60	78.67	1.46	0.206
T12 PSB + Nitrogen (75%)	79.67	25.23	13.20	74.57	1.45	0.216
T13 Rhizobium + PSB + 75%FYM	89.00	24.17	13.47	70.97	1.44	0.239
T14 Rhizobium + PSB + 75%Vermicompost	84.00	23.20	13.16	60.87	1.28	0.249
T15 Rhizobium + PSB + 75% Nitrogen	94.33	29.37	13.65	81.97	1.54	0.187
T16 N:P:K	89.00	24.80	13.15	72.03	1.46	0.213
Grand Mean	84.78	22.92	13.01	69.65	1.36	0.242
S.E(m)	0.55	0.26	0.06	0.70	0.01	0.007
C.D (P=0.05)	1.59	0.76	0.16	2.02	0.029	0.021

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Genetic Diversity and Antimicrobial Action of Buffalo Cathelicidins against Challenging Pathogens

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Keywords: Antimicrobial peptide, cathelicidin, pore formation, water buffalo

Introduction

Cathelicidins are an ancient class of antimicrobial peptides (AMPs) with broad spectrum bactericidal activities. Naturally occurring AMPs have been foresighted as potential future antimicrobial agents, especially for rapidly emerging multidrug-resistant pathogens.

Materials and Methods

Novel buffalo cathelicidin genes were detected using Single Stranded Conformation Polymorphism (SSCP) Sanger and next-generation sequencing (Ion Torrent Platform). Bioactivity of peptides were detected using combination of antimicrobial assay, scanning and transmission electron microscopy and molecular dynamics (MD) simulation. Cytotoxicity of peptides was determined by haemolytic assay and flow cytometry.

Results and Conclusion

In this study, a series of new paralogs of cathelicidin4 (*CATHL4)*, previously known as indolicidin), was identified in buffalo, which are structurally diverse in the antimicrobial domain. AMPs of newly identified buffalo CATHL4s (buCATHL4s) displayed potent bactericidal activity against *S. aureus, S. typhimurium* and *P. aeruginosa* (Table 1).When added to bacterial cultures these peptides were prompt to disrupt the membrane integrity of bacteria and eliminated the test pathogens within short time. In addition, the peptides were effective against bacteria at stationary growth phase and also reduced growth of biofilms. Specific changes in bacterial cell membrane like blebing, budding and transmembranepore formations were observed after buCATHL4s exposure. Simulation studies suggested that the amphipathic design of buCATHL4 was critical for water permeation following membrane disruption. Low toxicity of buCATHL4s to fibroblast cells makes them further attractive to be explored as topical antibiotics. The study highlights buffalo cathelicidinsas a target for development of peptide antibiotics and antimicrobial peptidomimetics with potential translational applications.

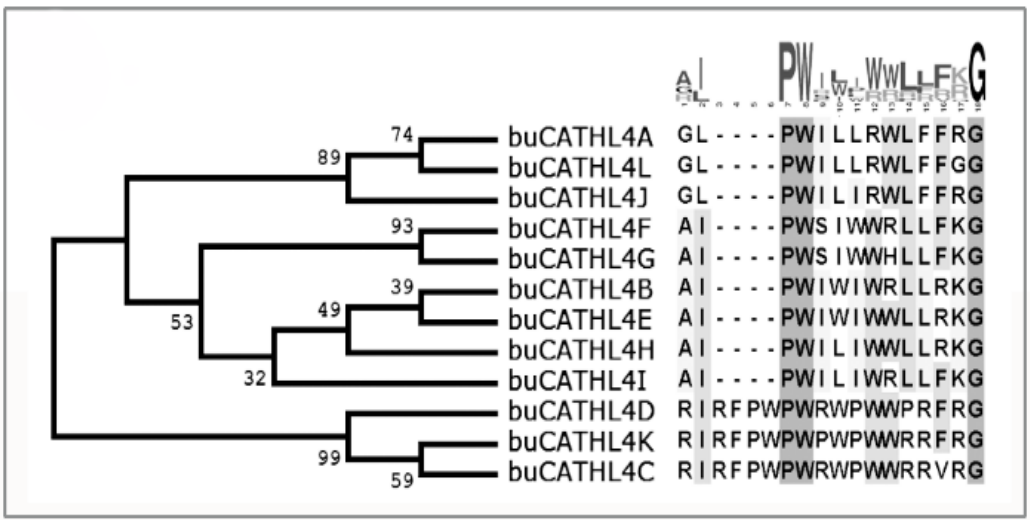

Fig. 1: Phylogenetic relationship and consensus of amino acid residues of the 12 CATHL4 AMPs. The Neighbor-joining tree construction was based on complete nucleotide sequences of the CATHL4 variants (NCBI Accession ID: KJ173930 - KJ173976).

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Integrated Aquaculture for Improving Livelihood in Bastar Region of Chhattisgarh: A Case Study

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Keywords: Integrated farming, livelihood security, polyculture, rice

Introduction

Farming of live stock *viz.,* pigs, ducks, poultry birds, cattle rearing and fish farming is common in Bastar plateau and their integration is very popular in the tribal population. Integrated farming system is uncommon in Chhattisgarh plains, wherein the Indian Magurand the common carp have been polycultured and traditionally integrated with paddy crop (Das, 2000). Fish cum livestock namely pigs and poultry/duck is popular in Bastar. However, in Bastar the integrated approach is boosting up production of agricultural yield per unit area, which is economically feasible and optimizes the utilization of farm resources. It has been proven beyond doubt that integrated livestock-fish-crops is not only technically feasible but also economically viable.

Materials and Methods

The study was done in four villages of Rajim area, Raipur, Chhattisgarh. Perimeter type of rice (*Oryza spontanea*) fish had various fish trenches (size 2x1m, 1x1m, 1.5x1m) out of which roughly 10% of the total plot area was the best fit method found out of various 05,10,15,20% area chosen for the experimentation. The mean biological and physico-chemical parameters, conductivity, alkalinity, hardness, Secchi disc turbidity, dissolved oxygen, ammonical-nitrogen, nitrate-nitrogen, nitrite-nitrogen, total nitrogen, organic-nitrogen, ortho-phosphate, total phosphate, dry matter, biochemical oxygen demand (BOD), primary productivity, zooplankton and phytoplankton counts were compared for observation of growth and health of fish during the culture period) Delmendo, 1980).

Results and Conclusion

Overall, the waste-fed ponds had higher primary productivity, more phytoplankton and zooplankton counts as compared to the control pond. Results showed that 300-350 ducks was the best carrying capacity found in one hectare of pond. Treatments incorporating chicken farming seemed to give favorable response for such kind of farming system. The integrated farming system resulted in different specific growth rates, survival rates and final bulk weights for different fish species. The zooplankton feeder, *L. rohita* benefited greatly by the higher zooplankton population in the waste-fed ponds. The possibility of the Common carp feeding on allocthonous detritus cannot be ruled out. The average growth of grass carp, common carp and magur were obtained up to 570g, 430g and 85g respectively. Increasing productivity of paddy up to 4.3 tonnes/ha that increased additional income of Rs. 38,229/- from 0.19ha plot area during the culture periods.

Rice Fish Farming	**Fish (**kg/ha)	**Paddy (**kg/ha)	**Total Income (Rs/ha)**	**Cost/Benefit ratio**
Gross yield	679	6,530	38,229	1:1.2
Duck Fish Farming		**Duck**		
Gross yield	2,600	1,200	36,000	1:2.5
Pig Fish Farming		**Pig**		
Gross yield	2,500	2,800	35,000	1:2.7

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Evaluation of Front Line Demonstration Programme on Summer Moong (*Vigna radiata*) Variety SML 668 in Moga District of Punjab

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***Keywords*:** Front line demonstrations, summer moong, technological gap

Introduction

India consumes about 30 per cent of the world's pulses yet domestic production of pulses is not in equilibrium with the growing population of the country. With the growth in demand the country has to import pulses to the tune of 2.0 to 4.0 million tones. The main reason for the shortfall in demand and supply of pulses is burgeoning population of the country and low productivity of pulses in India (694 kg/ha) which is lower than the most of the pulse producing countries. To enhance the productivity of pulses in the country, it is pertinent to educate and motivate the farmers to adopt recommended high yielding varieties of pulses and follow the recommended production technology for the crop. Krishi Vigyan Kendra, Moga has been conducting front line demonstrations on pulses i.e. summer moong, gram, mash etc. since its inception. The objectives of the present study were to identify the adoption gaps in summer moong production, to rectify those gaps through FLDs at farmer's fields, to compare the yield level of local check and FLD fields and to collect feedback for further improvement in research and extension programme.

Materials and Methods

The present study was conducted during the summer season of 2014 to 2016 in different villages in Moga district of Punjab. The farmers were selected in such a way so that they represent different socio-economic status, land holding and soil types. The yield data of the front line demonstrations was recorded from both the FLD and local check plots. To estimate the technology gap, extension gap and technology index, following formulae used by Samui et al. (2000) were used:

Technology gap = Pi (Potential yield) - Di (Demonstration yield); Extension gap = Di (Demonstration yield) - Fi (Farmer yield); Technology index $= \frac{Technology\,gap}{Potential\,yield} \times 100$

Results and Discussion

From the results it was observed that the improved summer moong variety SML 668 recorded the higher yield (11.07 q/ha) compared to the farmers' practices variety (9.13 q/ha). The increase in the demonstration yield over farmer's practices was 21.25%. The evaluation of the front line demonstration showed that there was huge extension gap which highlights the need for dissemination of technology to the farmers at a micro level.

Table 1: Evaluation of frontline demonstration on summer moong conducted in Moga district

	Front line demonstration	Farmer's practice
Average seed yield (q/ha)	11.07	9.13
Percent increase over Farmer's practice (%)	21.25	
Technology gap (q/ha)	0.18	2.12
Extension gap (q/ha)	1.94	
Technology index	1.6	

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Evaluation of On-Farm Front Lie Demonstrations on the Yield of *Gobhi sarson* (*Brassica napus* L) in Amritsar district of Punjab

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Keywords: Demonstration, FLD programme, *gobhi sarson*

Introduction

Rice-wheat is most important cropping system of Punjab but, the issue of crop diversification is nowadays, getting very popularity in Punjab as the adverse impacts of rice-wheat system are being realized not only by the scientists but also by the farmers. The oilseed crop of *Brassica* spp. is well adapted to the agro-ecological conditions of Punjab and their cultivation can play a crucial role in crop diversification. Moreover, it ensures regular utilization of farm labour because of its maturity 15 days before wheat harvesting. Its water requirement is also less as compared to *rabi* cereals. *Gobhi sarson* (*Brassica napus* L) has better adaptability on account of its peculiar growth habit and ability to sustain low temperature regime by restricting above ground plant biomass and prolonging the vegetative phase. In Punjab, Rapeseed- Mustard accounts for only 1000 ha of area and 1000 tonnes of production with productivity of 1030 kg/ha. There is considerable scope of enhancement in productivity leading to higher production exists, especially in Amritsar region.

Materials and Methods

Eighteen front line demonstrations were undertaken by Experiments on Cultivators Field (ECF) Centre, Amritsar in two blocks on the improved package of practices of *Gobhi sarson* for 2 consecutive years viz 2013-14 to 2014-2015, across six villages in Amritsar district of Punjab. Prevailing farmer's practice was treated as control for comparison with recommended package of practice for *Gobhi sarson* as improved practice. The economics and benefit cost ratio of both improved and farmers practice was worked out.

Results and Conclusion

The data revealed that under improved practice, the performance of *Gobhi sarson* was found to be substantially higher than under farmers practice during all the years (2013-14 and 2014-2015) (Table 1). The yield of *Gobhi sarson* under improved practice was recorded as 13.4q/ha and 12.5q/ha during 2013-14 and 2014-15 respectively. The yield enhancement due to technological intervention was to the tune of 12.6% and 16.3% higher over farmers practice. The cumulative effect of technological intervention over two years, revealed an average yield of 12.95q/ha, 14.45% higher over farmers practice. An average of Rs. 29757/- was recorded as net profit under improved practice while it was Rs. 23987.5/- under farmer's practice. Benefit cost ratio was 2.55 under improved practice, while it was 1.95 under farmers practice plots. This favorable benefit cost ratio of the improved practices built the relationship and confidence between farmers and scientists. It is pertinent to point over here that cultivation of *gobhi sarson* not only gives good return but it vacates the field 15 days before wheat harvesting. Thus, this will further improve the total productivity.

Table 1: Yield performance and economic indicators of front line demonstrations on *Gobhi sarson* var. GSL-1

Year	Area (ha)	Yield (q/ha)		% change in yield	*Economics of Improved Practice (Rs./ha)				*Economics of Farmers Practice (Rs./ha)			
		Improved Practice	Farmers Practice		Gross Cost	Gross Return	Net Return	** BCR	Gross Cost	Gross Return	Net Return	** BCR
2013-14	6	13.4	11.9	12.6	11743	42987	31244	2.7	12332	38080	25748	2.1
2014-15	12	12.5	10.86	16.3	11810	40080	28270	2.4	12520	34747	22227	1.8
Average	18	12.95	11.38	14.45	23553	41533.5	29757	2.55	12426	36413.5	23987.5	1.95

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Insect Pest Survey on Small Cardamom in Kerala

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Keywords: Cardamom, cardamom hills reserve, survey

Introduction

Small cardamom (*Elettaria cardamomum* L. Maton) is an economically important spice crop and known as "Queen of Spices". India is a major exporter of cardamom, with a significant number of farmers dependent on it. Cardamom is infested by many insect pests, right from the seedling stage to the cured cardamom in storage. Nearly 60 species of insect pests infest cardamom at different stages of its growth (Kumaresan and Varadarasan, 1987). The Cardamom Hills Reserve (CHR) in Idukki district of Kerala is a major source of this spice. The major cardamom variety growing in Idukki district is Njallani. Due to intensive cultivation of Njallani, invites many insect pests and pesticide usage in Idukki district also higher than Karnataka and Tamil Nadu. So experiment was conducted to study pest surveillance and outbreak of major and minor insect pests due to pesticide usage in all parts of Idukki district of Kerala.

Materials and Methods

Insect pest survey was conducted by Division of Entomology, Indian Cardamom Research Institute, Spices Board, Myladumpara, Idukki District, Kerala in the Cardamom Hills Reserve in Idukki district of Kerala from April 2013 to March 2015. A fixed plot survey was conducted in the four locations *viz*., Santhanpara, Myladumpara, Pampadumpara and Vandiperiyar covering all parts of Idukki district. Monthly observation on percentage thrips, shoot borer, panicle borer and capsule borer damage, incidence of root grub and minor pests like whitefly, lace wing bug, scales and red spider mite were recorded from four fixed plots. Pesticide usage in all locations also recorded.

Results and Discussion

Thrips damage: The highest thrips damage noticed during January 2015 in Myladumpara (58.33%) and Pampadumpara in April 2014 (49.58%). The higher damage was noticed from May 2014 to March 2015 in Myladumpara and moderate damage was noticed in Myladumpara and Pampadumpara from April 2013 to March 2014. Among all locations, least damage was noticed in Sathanpara (Fig.1.). Shoot borer damage: The higher damage was noticed in April 2013 (10.35%) in Santhanpara. Moderate incidence was noticed in all the months in Vandiperiyar. Least incidence was noticed in Pampadumpara (Fig.2). Panicle borer damage: Highest panicle borer damage was noticed in February 2014 in Myladumpara (5.66%) and April 2013 in Santhanpara (5.48%). No damage was noticed from April 2013 to February 2014 in Vandiperiyar and Pampadumpara. Capsule borer: The highest damage was noticed in April 2013 in Santhanpara (3.29%). The least damage was noticed throughout study period in all the four locations. Root grub: The highest grub incidence was noticed in Myladumpara and Vandiperiyar. Root grub incidence was noticed in all the locations from April 2014 to March 2015. Minor pests: Higher incidence of Red spider mite was noticed in Vaniperiyar. Moderate incidence of red spider mite and whitefly incidence was noticed in Pampadumpara. Highest incidence of whitefly incidence was noticed in Santhanpara. Moderate incidence of scales, red spider mite and lace wing bug were noticed in Myladumpara. From the present study, the incidence of insect pests was not similar in all cardamom grown areas and cardamom growers are spraying 9 to 12 rounds of insecticides per year for controlling cardamom insect pests which is not recommended by research institute and due to this continuous and indiscriminate usage of pesticides outbreak of major and minor pests are noticed in few areas of Idukki district, Kerala.

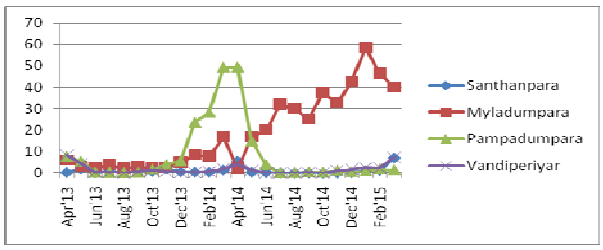

Fig. 1: Thrips damage on capsules (%)

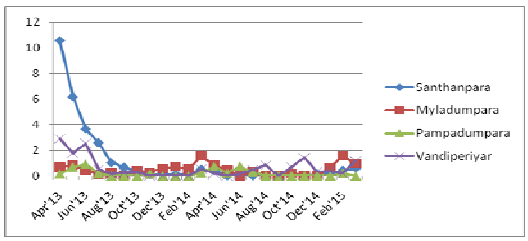

Fig.2. Shoot borer incidence (%)

Reference

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Training Needs of Women Farmers & Rural Youth in Home Science in Jammu District of J&K

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***Keywords**:* Training needs assessment, women farmers, women empowerment

Introduction

Training is a process of acquisition of new skills, attitude and knowledge in context of preparing for entering into a vocation or enhancing one's productivity in an organization or in an enterprise. Training need assessment is one of the crucial steps towards identifying the area of farmer's interests, design and development of curriculum that can best suit to the existing real conditions of farmers. Today there is a growing realization and commitment of global community to achieve more sustainable and broad agricultural growth by addressing gender related issues in agriculture through national, regional, and global initiatives. Rural women with multiple roles and responsibilities at farm and household require technologies to reduce their work stress and improve agricultural productivity, family nutrition and cash flow. Despite their high involvement in agriculture, women lack adequate knowledge and technical competency related to technological advances

Materials and Methods

The present study was conducted in 5 rural tehsils of Jammu district. From each selected tehsil, four villages were selected based on production potential and consultation with extension functionaries. Twenty farm families were randomly selected from each village. Thus a total of 100 respondents were selected for the study. Responses were collected in a 3- point continuum scale i.e. very important (V.I), important (I) not important.(N.I) by assigning scores 3, 2,and 1respectively. Results were calculated as weighted scores for each specific and relevant training need item

Results and Discussion

Training on income generating activities for empowerment of rural women and household nutritional security through kitchen gardening (50% and 45% respectively) was found as the most sought after training need in Jammu district. This was followed by training on value addition. Postharvest- training was reported by majority of farmers (44%) and most important need followed by S.H.Gs formation. Based on the findings of the study, it is recommended that both extensive and intensive hand on training should be emphasized for farm women and rural youth through proper assessment of needs in the district. Training areas such as value addition, income generating activities and formation and management of S.H.Gs should get importance while planning training course for the target groups. The concerned stakeholders should pay more emphasis on these specific needs identified by the study through their efforts.

Table: 1 Weighted scores (1-3 Scale) of training needs of women

Training needs	Score			
	VI	I	N.I	W.S
Women and child care	36	23	41	1.95
Rural Crafts	18	37	45	1.73
Value addition	38	20	42	1.96
Gender mainstreaming through S.H.Gs	22	38	40	1.82
Storage loss minimization techniques	29	32	39	1.90
Household food security by kitchen gardening	45	33	22	2.23
Income generating activities for empowerment	50	23	27	2.23
Location specific drudgery reduction technology	13	43	44	1.69
Small scale processing and value addition	23	30	47	1.76
Formation and management of S.H.Gs	43	31	26	2.17
Post harvest technology	44	15	41	2.3

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Management of Yellow Mosaic of Mungbean by Using Insecticides

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Keywords: mungbean, insecticides, yellow mosaic

Introduction

Green gram commonly known as mungbean or mung (*Vigna radiata* L.) is one of the thirteen food legumes grown in India and third most important pulse crop after chick pea and pigeon pea. It is an important short duration summer food legume in the tropical and sub tropical countries of the world. The crop is attacked by yellow mosaic disease and the incidence of disease varies from 5.0-90 percent with reduction in yield from 10-100 percent depending on the infection at different crop age. Thus keeping in view the importance of the disease study was undertaken to manage the disease by using insecticides.

Materials and Methods

The experiment was conducted during rainy season 2014 for the management of yellow mosaic of mungbean under field conditions by selecting different insecticides. Percentage of diseases index of mungbean yellow mosaic virus (MYMV) in treated and untreated plots was calculated by using 0-5 scale.

Chemical Name	Schedule and dosage
Carbofuran 3G	Soil application at the time of sowing @ 1 kg / kanal
Imadacloprid 17.8 SL	Seed treatment @ 3g/kg seed and 3 sprays at 15 days interval @ 0.5 ml lit^{-1} of water
Metasystox 25 EC	3 sprays at 15 days interval @ 1.5ml lit^{-1} of water
Profenofos 50 EC	3 sprays at 15 days interval @ 0.25ml lit^{-1} of water
Thiomethoxam 25WG	Seed treatment @ 5g/kg seed
Imidacloprid 17.8 SL + Carbofuran 3G	Seed treatment @ 3g/ kg of seed and 3 sprays at 15 days interval @ 0.5ml/L of waters + soil application @ 1 kg/kanal
Imidacloprid 17.8 SL + Carbofuran 3G+ Metasystox 25EC	Seed treatment @ 3g/kg of seed + Soil application @ 1 kg/kanal + 3 sprays at 15 days interval @ 1.5ml/L of water

Results and Discussion

From the results it was observed that all the chemicals were effective in reducing the spread of the disease by controlling the population of whiteflies which are the main vector of the virus except control plots. At 60 DAS, imidacloprid (seed treatment) + carbofuran (soil application)+ Imidacloprid (Foliar spray) (7.33%) was found stastically superior to other treatments followed by thiomethoxam (seed treatment) + carbofuran (soil application) + Profenofos (Foliar spray) (10.00%), Imidacloprid (Foliar spray) (10.66%), imidacloprid (seed treatment) (11.33%), Thiomethoxam (seed treatment) (12%) Metasystox (Foliar spray) (12.33%), Profenofos (Foliar spray) (14.00%), imidacloprid (seed treatment) + carbofuran (soil application)+ Metasystox (Foliar spray) (14.33%) and Carbofuran (soil application) (15.33%) whereas at 45 DAS imidacloprid (seed treatment) + carbofuran (soil application)+ Imidacloprid (Foliar spray) (4.66%) was found to be most effective in controlling the vector population followed by thiomethoxam (seed treatment) + carbofuran (soil application) + Profenofos (Foliar spray) (6.00%), Imidacloprid (Foliar spray) (8.00%), imidacloprid (seed treatment) (8.33%), Thiomethoxam (seed treatment) (8.66%), imidacloprid (seed treatment) + carbofuran (soil application)+ Metasystox (Foliar spray) (9.00%), Metasystox (Foliar spray) (9.66%) and Profenofos (Foliar spray) (12.33%) and carbofuran (soil application (14.00%). Similarly at 30DAS imidacloprid (seed treatment) + carbofuran (soil application)+ Imidacloprid (Foliar spray) (2.66%) was found to be most effective in controlling the vector population and checking the further spread of the disease. Field evaluation of various insecticides alone or in combination revealed that combination of imidacloprid and carbofuran recorded the lowest disease intensity and thereby indicating their usage in the absence of any suitable variety.

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Role of Integrated Nutrient Management to Partially Reclaimed Sodic Soil

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Keywords: INM, vermicompost, farm yard manure, chemical fertilizers and sodic soil

Introduction

The basic concept underlying the principal of integrated nutrient management (INM) system is the improved soil fertility for sustainable crop production on long term basis. It may be achieved through integrated use of all the possible sources of plant nutrients and their scientific management in different crops and cropping system. Fertility status of sodic soils is generally poor because of high pH, excess amount of exchangeable sodium, low organic matter and nitrogen content. Moreover, nitrogen transformations are adversely affected by high pH and sodicity. Direct and indirect effects in soil physical, biological environments and affects the plant growth in these soils.

Materials and Methods

The experiment was conducted in 2011-12 at Instructional farm of [NDUA&T], Kumarganj, Faizabad [U.P.]. The soil of experimental field was silty loam in texture with low in [OC]0.27%, available N(194.01), P_2O_5(13.86), K_2O (242.56)kg ha^{-1} and with pH 8.90 and [EC] 0.40 dSm^{-1}. The experiment was consisting of eight treatments with [RDF] + organic manures [VC or FYM]. These treatments were evaluated in [RBD] having four replications.

Results and Discussion

The result presented that soil pH declined slightly in all the treatments containing organic and inorganic treatments from initial level in 0-15 cm soil layer. The release of organic acids during decomposition of these organic manures might have resulted in slight decline in soil pH, but in the case of soil EC (dSm^{-1}) it increased in the sodic soil due to the INM approach in comparison to chemical fertilizer nutrient supply system. OC (%) content in the sodic soil increased significantly in the plots that had received organic manure plus chemical fertilizers than chemical fertilizers alone. [Increase in available nitrogen significantly with organic manures application to the available pool of the soil]. Increase in available P content of soil due to the incorporation of organic manures may be attributed to the direct addition of P as well as solubilisation of native P through release of various organic acids. Similar improvement in available P due to INM has been noticed. Significantly higher contents of available K were recorded under conjoint use of organic manures (VC or FYM) and chemical fertilizers than the sole use of chemical fertilizers alone.

Substantial improvement was recorded in residual soil fertility as the contents of organic carbon, available N, P_2O_5, and K_2O were significantly higher in case of the plots which had received either FYM or VC in combination with chemical fertilizers only.

S.No.	Treatments	pH (1:2.5)	EC (dSm^{-1})	OC (%)	Avai. N (Kg ha^{-1})	Avai. P (Kg ha^{-1})	Avai. K (Kg ha^{-1})
T_1	Control	8.87	0.38	0.29	167.49	12.90	236.87
T_2	100% RDN-F	8.85	0.36	0.31	211.49	15.14	256.54
T_3	75% RDN-F + 25%N-FYM	8.83	0.35	0.34	208.72	14.01	246.58
T_4	50% RDN-F +50% N- FYM	8.81	0.31	0.36	214.54	14.96	250.58
T_5	25% RDN-F +75% N- FYM	8.76	0.30	0.39	217.37	15.48	253.79
T_6	75% RDN-F+ 25% N-VC	8.86	0.34	0.33	209.79	14.58	247.38
T_7	50% RDN-F + 50% N-VC	8.84	0.33	0.35	215.82	15.20	257.39
T_8	25% RDN-F + 75% N-VC	8.79	0.32	0.37	220.51	15.93	260.44
	SEm±	0.04	0.015	0.01	1.05	0.09	0.50
	CD (P=0.05)	0.12	NS	0.03	3.08	0.27	1.47
	Initial value	8.90	0.40	0.27	194.01	13.86	242.56

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Phalsa Possesses *In Vitro* Cytotoxic Efficacy against Human Cancer Cells

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Keywords: Phalsa, cancer cells, SRB assay, *in vitro* cytotoxicity

Introduction

Fruits of *Grewia asiatica* are reported for their antitumor and cytotoxic activity (Kakoti *et al.* 2011). Some *Grewia* species have free radical scavenging activities which may be responsible for therapeutic action against tissue damage. *Grewia*'s extracts are also supposed to be helpful in curing hepatitis and used as herbal antidiabetic. In the present study, *in vitro* anticancer potential of phalsa has been investigated against nine human cancer cell lines (A-498, A-549, HCT-116, MCF-7, MDA-MB-435, OVCAR-5, PC-3, SF-295 and T-47D) from eight different tissues (renal, lung, colon, breast, melanoma, ovarian, prostate and CNS).

Materials and Methods

The anticancer activity was determined by the cytotoxic potential of the test material (methanolic extract from phalsa) via Sulphorhodamine blue (SRB) assay (Skehan *et al.,* 1990). Cells were allowed to grow for 24 hours on 96 - well flat bottom tissue culture plates. Cells were further allowed to grow in the presence of test material for 48 hours. Cell growth was terminated by addition of 50% (w/v) trichloro acetic acid. Cells were stained with SRB dye. Excess dye was removed by washing with 1% (v/v) acetic acid and bound dye was dissolved in Tris buffer. Optical density (OD) was taken at 540 nm. Suitable blanks (growth medium and DMSO) and positive controls (Taxol, Tamoxifen, Mitomycin-C etc.) were also included. Each test was done in triplicate and the values reported were mean values of three experiments. The growth inhibition of 70% or above was considered active while testing extracts, but in testing of active ingredients at different molar concentrations, the growth inhibition of 50% or above was the criteria of activity.

Results and Discussion

Phalsa fruit suppressed the proliferation of four human cancer cell lines from four different origins in the range of 72-80% as it exhibits 80% growth inhibition of A-498 (renal), 78% of MDA-MB-435(melanoma), 75% of A-549 (lung) and 72% of HCT-116 (colon). When evaluated at lower concentrations, phalsa, at 50 µg/ml exhibited 81% growth inhibition of lung (A-549) cancer cells (Table 1). The results obtained from our investigation confirmed the therapeutic potency of phalsa against four human cancer cells and showed that the fruit possess certain cytotoxic constituents that can be used for developing anticancer agents for cancer therapy. Moreover, it forms a good basis for the selection of this minor fruit of Jammu region for further phytochemical and pharmacological analysis and offer us new drugs from natural sources which would be less toxic and more potent for the efficient management of cancer.

Table 1: Growth inhibitory effect of phalsa along with positive controls against human cancer cells

Generic name of the fruit	Extract E Extract	Conc. (µg/ml)	Human cancer cell lines from eight different tissues								
			Breast	Breast	CNS	Colon	Lung	Melanoma	Ovarian	Prostate	Renal
			MCF-7	T-47D	SF-295	HCT-116	A-549	MDA-MB-435	OVCAR-5	PC-3	A-498
			Growth Inhibition (%)								
Grewia asiatica	Methanolic	100	55	60	60	**72**	**75**	**78**	45	41	**80**
		50	-	-	-	10	**81**	45	-	-	00
		30	-	-	-	05	60	31	-	-	00
		10	-	-	-	00	57	00	-	-	00
		1	-	-	-	00	18	09	-	-	00
Positive control (standard drugs)		Conc. (µM)									
Doxorubicin		1	-	-	71	-	-	-	-	-	-
5-Fluorouracil		20	-	-	-	65	-	-	70	-	-
Mitomycin-C		1	-	-	-	-	-	-	-	63	-
Paclitaxel		1	77	72	-	-	71	-	-	-	70
Tamoxifen		1	-	-	-	-	-	75	-	-	-

Growth inhibition of 70% or more in case of extracts has been indicated in bold numbers
Mark (-) indicates that particular human cancer cell line was not treated with that particular positive control

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6

Success Stories

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Theme Area: Eco-responsive Livestock and Fisheries Production

Aquaculture in Inland Salt Affected Water Logged Areas in Punjab

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After 'Green' and 'White' revolution, Punjab has recorded commendable growth in fish farming in the last three decades and is also moving very fast towards 'Blue Revolution'. Total fish production of the State has increased from 2,800 tonne (t) in 1980-81 to 1,14,000 t in 2013-14. Being a landlocked State, around 70% of the total fish production is coming from the aquaculture sector (from village and private ponds) and 30% from the capture sector (from river, canals, lakes/wetlands and reservoirs). Presently, about 8,500 fish farmers are culturing carp fishes in 10,687 fish ponds (14,673 ha), with an average productivity of 5.27 t ha^{-1} yr^{-1}. There is still ample scope to further expand the fisheries sector in the State, both horizontally (expansion of area under fish farming) and vertically (productivity enhancement), through an efficient need based region specific action plan.

More than 1.0 lakh ha area in south west districts (Ferozepur, Fazilka, Mukatsar, Bathinda and Faridkot) of the State, is affected with dual problems of underground water salinity and waterlogging, which have devastated agricultural productivity in the region. Water although saline, is abundantly available in these areas and hence, can be potentially utilized for horizontal expansion of aquaculture sector in the State, for additional food security through fish production and socio-economic uplifting of affected rural areas through employment and income generation.

Inland salt affected waterlogged area in village Shajrana, District Fazilka

Research cum Demonstration Aquaculture Farm at Village Shajrana

Fish harvesting from inland saline water pond

College of Fisheries (GADVASU) took up the challenge to develop salt affected waterlogged areas of the State through aquaculture and initiated its journey with a dedicated team of scientists in 2007, under a research project (2007-2010) sanctioned by the Punjab State's Farmers Commission, which later on earned the team ICAR's prestigious 'Niche Area of Excellence' programme - Inland Aquaculture in Punjab' in 2010. After rigorous R & D inputs in the form of field surveys, water testing, bioassay studies, awareness campaigns, selection and adoption of farmers and extensive off-campus research trials in village Shajrana (District Fazilka), aquaculture technologies were developed for rearing fresh water carps in low to medium saline areas and an average productivity of 4.75 t ha^{-1} yr^{-1} was achieved through technological intervention with respect to water quality, stocking density, species combinations and integration strategies over a period of 5 years (2010-2015).

The success achieved by GADVASU in developing and demonstrating aquaculture technologies for inland salt affected waterlogged waste lands in south west districts of the State, has not only motivated the villagers to take up fish farming in their zero earning waste lands, but has also earned them substantial financial assistance from the State Government for construction of aquaculture units. Area under aquaculture has increased from 20 acres in 2012-13 to 45 ½ in 2013-14 and further to 69 acres in 2014-15 in village Shajrana itself and number of beneficiaries has increased from 4 to 15.

2013 *2015*

Satellite pictures showing development of aquaculture units in village Shajrana, District Fazilka over a span of 3 years (Source: Google Maps)

Under RKVY component 'Crop Diversification', Punjab Government has selected 6 villages in district Shri Mukatsar Sahib and district Fazilka (Ratta Khera, Tappa Khera, Fethepur Mania, Gagga, Bahadur Khera and Shajrana) for developing aquaculture in 600 acres of salt affected waterlogged areas, with an investment of Rs. 800 lakh, having a provision of 90% subsidy to the farmers. Under this scheme, over 300 acres aquaculture farms were developed during 2014 and work pertaining to remaining 300 acres is under progress for completion in 2015-16. Further, under RKVY component 'National Mission for Protein Supplement', Rs. 5 crores have been released by the State Government for developing 900 acres fish farms in south west districts of the State, with 50% subsidy to the farmers.

The recent developments indicate that the said project has not only been successful in developing and demonstrating suitable aquaculture technologies for inland saline waters but also succeeded in motivating the farmers to take up aquaculture in their zero earning waste lands. It will not only add additional fish to the fish basket of the State but also elevate the socio-economic status of the destitute debt ridden rural population owning these lands, who were otherwise left with no option but to do labor work to earn their livelihood. In achieving this milestone, a significant role was played by the farmer Mr. Radhe Sham, who assisted the university in developing a 2 acre 'Research cum Demonstration Aquaculture Farm' in his salt affected waterlogged land in village Shajrana. During his consistent support for 5 years to GADVASU, he acquired fish farming skills and is presently reaping rich harvests of fish from 12 acres ponds constructed in his salt affected waterlogged land, which was otherwise nothing more than a waste land for last 30 years. Local working assistance provided to GADVASU by Mr. Sanjeey Nagpal, Director M/s Nasa Agros, Fazilka, in selection and adoption of farmer in village Shajrana and his continuous encouraging backup to the farmer, Mr. Radhe Sham is also highly acknowledged.

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Theme Area: Eco-responsive Livestock and Fisheries Production

Smt. Veda Sitaram Hegde- A Role Model for Scientific Dairying

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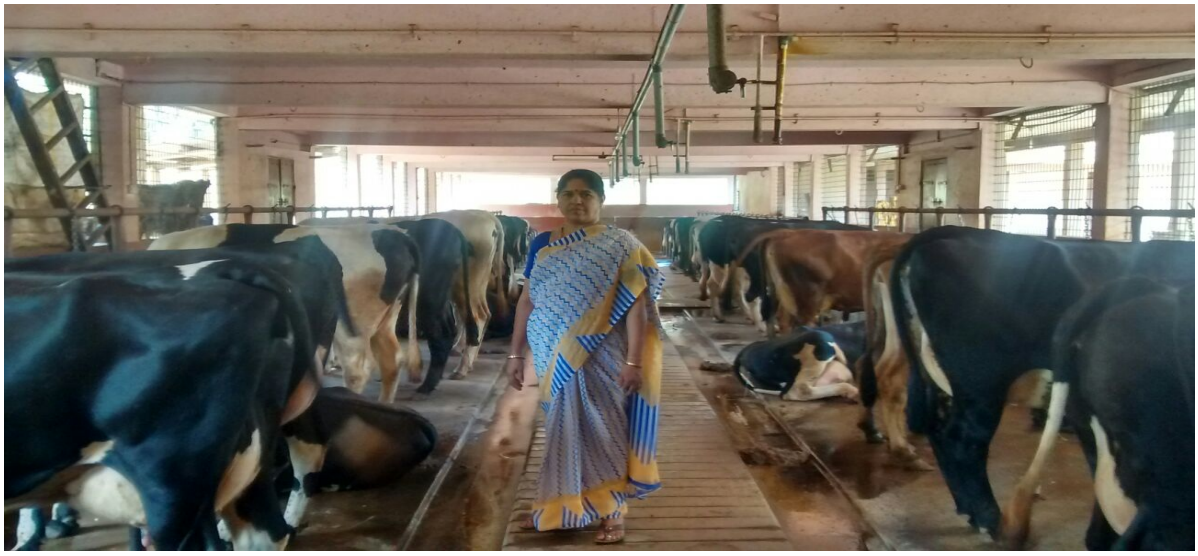

Well planned cattle shed with lime concreting and underground drainage facility

Dairying is considered as the one of the profitable ventures, if it is practiced scientifically. Samrudhi Farm at Neernalli village near Sirsi, Karnataka, provides a great example of very successful dairying due to the efforts made by Veda Hegde and Seetaram Hegde, who are practicing agriculture in their 15 hectares of land along with scientific dairy unit. Samrudhi farm is one of the largest farms in the area with arecanut (*Areca catechu*) based multi storied cropping system. Black pepper *(Piper nigrum*), nutmeg*(Myristica fragrans)*, agarwood(*Aquilaria malaccensis)* & cocoa(*Theobroma cacao)* are intercropped with the Arecanut. Banana*(Musa spp)* is grown in six hectares and coconut *(Cocos nucifera)* in two hectares. The practices adopted in the farm are more scientific and less labour dependent than those in conventional farms.

Besides growing horticultural crops, Veda Hegde, have setup well established scientific dairy unit with 70 cross bred cows and 15 heifers. The cattle shed is well planned with lime concrete flooring which facilitates easy cleaning. The urine and excess water is drained directly to the biogas plant of 1200 cft capacity through the underground drainage system. Cow dung collection is done through a modified spade with rubber strap and carried in a trolley to the biogas plant. All cows are tied with automatic chain system which is unique in itself. Washing of cows is done through 1 hp water jet spray with pressure pump for removal of ticks and dirt. No chemical pesticide is used to control ticks and pests. Milking is done with machines and power requirement for milking machine is met out from the bio gas plant.

The fodder requirement for the dairy is self reliant as they have established a fodder production unit with fodder chopper of 5 hp capacity and feed grinder and mixer unit. The green fodder hybrid napier grass and fodder maize (African Tall) varieties are grown in an area of 1 ha. Both green and dry fodder is chopped and fed to the animals along supplement mineral mixture. Due care is taken to give proper vaccination to the animals. Average milk yield per day is 350 litres and is mainly sold to Karnataka Milk Federation (KMF) and local vendors.

Apart from selling the milk, the subsidiary income generated through the dairy are selling heifers, root slips of fodder grasses, feed mixtures and manures. The monthly average expenditure incurred for the dairy unit is around Rs. 80,000 and net income is Rs. 1,25,000. The monthly gross income is around 2,05,000.

Further, the unutilized pineapple fruit residue like crown, peel and pomace from local pineapple processing industries, is used to prepare silage under the guidance of National Institute for Animal Nutrition and Physiology (NIANP), Bangalore. The silage is fed to the dairy animals along with the other feed ingredients in the form of total mixed ration, replacing green fodder in some seasons of the year.

The peculiarity of the farm is its self sufficiency in every aspect including manure production as well as electricity generated for the farm. The arecanut garden is well established with scientific underground drainage for removal of excess water and well connected with motorable road, which gives easy access to the plantation. The slurry from the biogas plant is filled in a specially designed steel tanker and moved to the garden for fertilizing the plantation crops. Scientific methods of soil, moisture, water and fertilizer management is done based on soil test reports. Natural mulching is done to the areca nut trees with cocoa leaves. Drip irrigation is provided to fodder, arecanut and coconut plantations. The water requirement is met out with one open well and 2 bore wells.

Samrudhi farm is a popular place for fellow farmers for obtaining newer technical information, first hand/practical demonstrations, purchase of cows/heifers, arecanut seeds/saplings, fodder root slips/cuttings etc. Many scientists/ researchers, progressive farmers from all over the country visit their farm for practical experience. Considering the achievements in dairy and plantation crop cultivation many awards/recognitions have been bestowed on her, significant are

1. **"*L M Patel Best Women Farmer*"** by ASPEE for the year 2007-08
2. ***"Shreshtha Krishi Mahile"*** by UAS,Dharwad during Krishi Mela 2008
3. "***Best Farm Women*"** by Bharateeya Krishika Samaj, New Delhi 2015

The key to her success is adoption of scientific practices, mechanization and innovativeness.

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Theme Area: Land and Water Resources

Ravinder Singh: An Initiator of Direct Seeded Rice Technology in Sri Muktsar Sahib District of Punjab

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Mr. Ravinder Singh Brar S/o Kanwarjeet Singh Brar resident of village Kaoni, Distt. Sri Muktsar Sahib, Punjab owns 30 ha farming land. Farmer is progressive, innovative farmer and member of Progressive Farmer Club of KVK Muktsar. He regularly attended the club meetings. Mr. Ravinder Singh started DSR trials at his field using zero till drill during *kharif* 2009, unfortunately germination of his first DSR crop was poor due to excessive seed breakage by the drill during seeding. Seed depth could not control effectively because the land had not been laser leveled. Ravinder's first DSR crop was a complete failure. Mr Ravinder didn't give up he contacted KVK as well as PAU scientists and received hands on training in production technology. KVK Muktsar has conducted on Farm Trial on cost and resource effective method of paddy cultivation during *kharif* 2010, to show the results of DSR trials, KVK, Muktsar Conducted progress farmers club meeting during *kharif* 2010 and Mr. Ravinder Singh also attended this meeting. He was highly impressed with these results. He also planted four ha of his farm with inclined plate rice seeding drill using 17.5 kg/ha of Pusa 1121 followed by irrigation. He achieved 5.0 t/ha basmati grain yield under DSR (Direct Seeded rice) as compare to 4.9 t/ha under PTR (Puddled transplanted rice). In 2011, he purchased his own rice seed drill and increased area under DSR 20.8 ha. During *kharif* 2011, KVK organized a crop seminar on DSR technology at his field. About 150 farmers participated in this programme and they were convinced about the technology. During 2012 he increased area DSR to 22.8 ha. During 2013, 2014 and 2015 he cultivated all land under DSR (25 ha). The weeds were controlled by sequence combination of pre and post emergence herbicides followed by hand pulling. Productivity of basmati rice under DSR and PTR has been similar on his farm. Mr Ravinder Singh has reported minimum of 15-20% water saving under DSR as compared to PTR. He worked as key communicator for other farmers of the vicinity and due to his motivation the area under a DSR in his village increased to more than 500 ha in 2012. In paddy sowing depth of seed is essential component for germination. DSR machine has been modified by Mr. Ravinder Singh. It has a roller before the seed drill that helps to control the depth of the seed sown which in turn increases the rate of germination. Secondly roller helps to determine the paired row distance for proper aeration and sunlight, paired row distance is 8" to 11" which helps to increase seed rate and the yield also. Muktsar district holds maximum area in Punjab under DSR technique.

Happy seeder machine has been developed for sowing of wheat in combine harvested paddy fields to develop crop residue recycling technologies. Crop residue is good source of essential plant nutrients. He has been using happy seeder for sowing of wheat from last 3 years. Using happy seeder for sowing also saves time and decreases the cultivation cost. Usually after basmati harvesting, sowing of wheat gets late. By using happy seeder technique, we can get variety of benefits such as 60%-70% less weed growth, water saving, improved soil health. Mulching of straw also prevents environment pollution as if we will not mulch, straw burning becomes necessary before cultivation, which causes complete loss of nitrogen, sulphur and it adversely affects the soil health.

With the aim to supply quality seed to the farmers, he started seed production in 2011, before that he used to produce seed on contract basis for *Harayali* (a subsidiary of Sriram group). After attending seminar on "Farmer's Produce & Marketing" at PAU Ludhiana, he planned to market his produce directly to the other farmers after which he got registered under M/s Ik Onkar Seed Farm. M/s Ik Onkar seed farm produces foundation & certified seeds of high yielding varieties of wheat, paddy, basmati and moong. M/s Ik onkar seed farm holds membership with I.A.R.I, New Delhi and Seed producing farmers society.

Ravinder's efforts in conservation agriculture have been recognized with several awards from different organization. Some of these awards include Krishak Samrat Sanman 2012- A Mahindra Samridhi India Agri Award (north zone) for diversified farming. Innovative farmer award 2012 from Indian council of Agricultural Research Award, new Delhi, Progressive farmer Award 2013 for quality seed production at Vibrant Gujrat Agri Summit, Progressive farmer Award 2014 at Progressive Punjab Summit, Mohali, Chief Minister Award 2015 from PAU, Ludhiana, State Award in Agriculture 2015 from Govt. of Punjab at 68th independence day.

Progressive farmer Award 2014 at Progressive Punjab Summit, Mohali

Progressive farmer award at Vibrant Gujarat Summit -2013

Krishak Samrat Sanman 2012

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Theme Area: Land and Water Resources

Efficient on Farm and Off-farm Resource Management by Naik Couple

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Promoting sustainable agriculture is one of the major thrusts of India. It begins with the farming community to adopt affordable alternative farming practices in terms of on- farm Natural Resource Management along with appropriate crop mechanism technologies. Further it involves rebuilding the environmental support to farming in an adequate measure, through better management of off-farm natural resources. Here is a story of a couple, Mrs. Asha Naik and Mr. Tejaswi Naik, practising agriculture at Modaga village of Belgaum Talluk of Belgaum district by using on-farm and off-farm natural resources. The Naik couple own 12 acres of land growing mulberry as their main crop. The V-I variety of mulberry is grown which produces 50 tons of leaves/ha. They are into silk worm rearing producing on an average 75-80 Kgs of cocoons from 100 disease free laying. For the production of quality cocoons the ASPEE foundation awarded them as innovative farmers. They have also started a Chawki rearing centre and is supplying young worms to other rearers. Other crops grown are vegetables and flowers. Belgaum area is known for growing vegetables especially winter crops which include cole crops, peas, carrots and beetroot. The flowers grown are Zerbera, Carnations, Gladiolus, Daizies and Golden rods.

On - farm rain water management.

Two km away from their farm is a hill. The water flowing from this hill carried away soil and deposited it on the road. This caused problems to motorists while it was wet as well as when it dried up. The Naik couple decided to harvest this water which was otherwise being wasted. They created a diversion so that water began to flow into their farm. In the farm they dug up a tank to catch this water. The water collected on their farm is used for farming during summer and also has helped to recharge the bore wells. They water from the pond. The pond water is filtered and used for drip irrigation of mulberry. They are also practicing roof rain water harvesting. The Naik couple have thus made best use of rain water to recharge their bore wells and to solve water scarcity during summer.

Improving soil fertility

To improve organic matter and improve soil fertility, the family use about 30 tons of vermicompost/ year. The vermicompost is produced on their own farm by using agriculture and horticulture waste they also used 50 tons of Farm Yard Manure to grow mulberry produced on farm. They also use sugarcane trash which is normally burnt by other farmers. They thus use all the organic wastes from their own farm.

Organic cropping practices

The main crop being mulberry, soybean and cole crops are grown between the rows. Cauliflower is a vegetable that requires heavy pesticide, the use of which also affected the mulberry crop which is turn affected the worms. They have now given up using chemicals and adopted organic production. Their bunds are planted with Gricidia and Sesbania which are used as green manure as well as mulch crops for moisture conservation.

Value Addition

The flowers grown on the farm are not sold in bulk. Asha Naik has networked with florists and takes online orders for supply of boquets. She also takes up floral decorations for functions and marriages.

Homa farming

Another practice for which the Naik couple have become popular is the practising of Homa farming. Every day at sunrise and sunset Agnihotra is performed on their farm. They have got a special shed constructed for this purpose. According to the couple due to Agnihotra they feel a positive energy on the farm which has created ideal crop growing conditions. They feel that the number of bees birds and butterflies on the farm have increased while harmful insects pests and disease causing organisms have decreased. They feel that the

biological balance is well maintained on their farm. Homa farming is supposed to have improved the micro climate of their farm as well as those of the neighbouring farms.

The Naik couple are open to innovative ideas and are ready to experiment. They have maintained contacts with progressive farmers, staff of the agricultural departments and scientists of Agricultural University. They have attended many seminars and workshops organised by different institutions. Agricultural University Dharwad has also awarded Asha as "Shreshtha Krushi Mahile".

Achievements

1. Diversion channel for rain water collection in a pond. This was used for irrigating crops as well as increased the ground water table.
2. Produce of vermi compost for use on own farm
3. Reduce 50 per cent of expenditure by not using chemical fertilisers and pesticides
4. Utilise the biomass on the farm for vermi compost preparation
5. Use crop wastes from the farm for mulching.
6. Discuss and exchange their experiences with others, there by learning from others as well as motivating others.
7. Maintain contact with progressive farmers, institutions and development departments to update their knowledge.
8. Practice homa farming to keep farm cool as well as spread positive energy all around.

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Theme Area: Land and Water resources

'Achievements' Have No Age Limits

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Shri Kashappagouda Sankangoudar an active farmer even at the age of 77 hails from Naregal village, Ron taluk of Gadag district. Gadag district is largely a dry district with an average rainfall of 550-600 mm which has further declined in the past few years. Due to low rainfall during Kharif season, farmers of this taluk depend more on Rabi crops rather than Kharif crops. The main crops grown during Kharif are green gram (*Vigna radiata*) and cotton (*Gossypium hirsutum*), while rabi crops are safflower (*Carthamus tinctorius*), Bengal gram (*Cicer arietinum*), rabi sorghum (*Sorghum bicolor*) and wheat (*Triticum aestivum*).

Kashappagouda has always been a man open to new ideas and experimentation. Being the owner of 40 acres of land, he is also in a position to take risks to try out new crops and method of farming. He has also had his share of failures, but, failures have not detered him. He is always a volunteer to try out new technologies released by the University of Agricultural Sciences, Dharwad. With the help of the university scientists and the staff of State Department of Agriculture he adopted many new technologies and became a role model to farmers in and around his own village.

Sand Mulch

A unique idea of his that became recognized as a farmer's technology is the use of sand mulch which he tried out on 5 acres of black soil. He used eight tractors of sand, which he spread uniformly on the soil. The sand allowed the rain water to seep inside and maintain moisture. This also helped to prevent cracks in the soil which is a common feature in black soil. Initially when he tried this technique none were interested. But one summer was all that was required for the results to be visible. While all neighbouring fields were dry during summer, his was the only farm that was green. The next year was followed by drought and when other people were not able to grow anything on their fields, he was able to grow at least something and earn 20,00-25,000 on this five acres. He was keen to share the success with neighbor farmers and wanted to prove to the scientists the feasibility and advantage of this technique. After discussions with scientist, the state agriculture department staff and local bank officials, he got approved his idea not only for loan facility but also subsidy. All that had costed him was Rs. 800 for the sand. The advantages of soil mulching were four fold

1. Increase in water infilteration
2. Drastic reduction in evaporation
3. Reduction of weeds
4. Prevention of soil degradation

Farm Pond and Drip irrigation

During summers the open well in his farm and the bore well used to dry up, so he got constructed a farm pond. This helped him to collect rain water and recharge the well and bore well which used to dry up. Although cotton seed production was his main activity due to labour problem he shifted to horticulture crops namely mango (*Mangifera indica*), sapota (*Manilkara zapota*), guava (*Psidium guajava*), grapes (*Vitis vinifera*), lime (*Citrus aurantifolia*) and fig (*Ficua carica*) by using drip irrigation.

Mixed Cropping

He continued to use the best of both, traditional and modern method of farming. He used traditional methods like summer ploughing, sowing across the slope, inter cultivation and bund management. By mixed crop of Cotton (DDHC-II, *Gossypium hirsutum*) + Chilli (Dyavnur variety, *Capsicum annuum*)+ Onion (local, *Allium cepa*) he got the maximum profit of RS. 24000/acre. Even if one crop failed he could be able to salvage something out of the other two.

According to Kashappagouda, nature is the best school and even at this age he says he is learning from nature. He has visited many innovative farmers fields and discussed about innovations in agriculture and adopted agricultural technologies which are suited to his field conditions. His ventures in agriculture have not been without failures. Tissue culture banana and ginger were two crops which he lost completely. Gaillardia (*Gaillardia sps*) flower cultivation was also loss making due to marketing problems.

In addition to his farming feats he has been a good samaritan and philanthropist, paying school fees of poor children and donating grains to mass feeding centers.

He is regularly in touch with the scientist of UAS, staff of the state department of agriculture and progressive farmers. He regularly attends the Krishi mela of UAS and has been awarded the "*Shrestha Krushika*" award by the university. Students of UAS regularly visit his field for practical learning. Kashappagouda never tires to explain to the students of his experiments.

This man though old in age is young in mind and soul. He is a man worth emulating by the present generation young farmers.

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Theme Area: Land and Water Resources

Sustainable Agriculture through Integrated Farming System- Success story of a young farmer Prasad Rama Hegde

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Prasad Rama Hegde a young progressive farmer has set an example for the youths who are migrating towards the cities in search of jobs leaving their potential lands barren. He has shown that, agriculture is a profitable venture if it is taken as worship. Prasad Hegde, hails from an agriculture family graduated in BA degree and studied law; during his student life also he never missed the seasonal agricultural operations along with his parents. He is resident of Kanakodlu, a remote village which gets cut off during rainy season as the small rivulet swells. He has a great passion towards collection and maintenance of diversified crops such as arecanut (*Areca catechu*), coconut (*Cocos nucifera*), jackfruit (*Artocarpus heterophyllus*), mango (*Mangifera indica*), banana (*Musa* spp), black pepper (*Piper nigrum*), cocoa (*Theobroma cacao*), medicinal plants and the list goes on to reach 1000 different species in his 1.77 hectares of farm land.

Harvesting of black pepper berries

He has successfully harvested the rain water by digging 40 percolation pits in the slope of betta land (The strips or patches of tree land on the hill slopes adjoining the areca orchards that were traditionally lopped by the areca cultivators for mulch, animal bedding, manure and fuel wood). Since then, he never faced the water scarcity during summer as his farm pond is ever ready to irrigate.

He practices arecanut based multi cropping system with Banana (*Musa* spp), Black pepper (*Piper nigrum*), Coconut (*Cocos nucifera*), Cardamom (*Elettaria cardamomum*), Vanilla (*Vanilla planifolia*), Nutmeg (*Myristica fragrans*). He has effectively utilized the land by planting mango (*Mangifera indica*), cashew (*Anacardium occidentale*), kokum (Garcinia indica), jackfruit (*Artocarpus heterophyllus*), sapota (*Manilkara zapota*), bamboo (*Bambusa* spp) on bunds around the garden. He is also involved in conservation of 20 different traditional mango varieties, 12 local blackpepper (*Piper nigrum*) varieties, 6 banana (*Musa* spp) varieties, 3 jackfruit (*Artocarpus heterophyllus*) varieties etc.,. He has planted nearly 40 types of medicinal plants and also local vegetables for home consumption. In 0.4 hectare of land, he has developed cinnamon (*C. verum*) orchard which is unique, with 400 plants of 4 different varieties. He has keen interest in introduction of new crops to his farm and has planted nearly 100 agarwood (*Aquilaria malaccensis*) plants in the garden. He cultivates traditional rice (*Oryza sativa*) crop in SRI (System of Rice Intensification) method for his home consumption. His farm is live museum of crops for students, fellow farmers, agriculture scientists and many others.

He is practicing bee keeping with 40 bee boxes of *Apis cerena indica* along with *Trigona* colonies. Mainly he follows organic farming and organic needs are fulfilled by the dairy with 7 animals, a vermicompost unit and slurry from the bio gas plant.

He is successful in his venture by following the traditional practices with scientific touch. He gets technical backstopping from different institutions like Agricultural Universities, Krishi Vigyan Kendra, Uttara Kannada and different line departments, Horticulture Research Stations, College of Forestry Sirsi and other agri based agencies. He is very eager to learn the new innovations, improved techniques in the field of agriculture, hence he participates regularly in Agriculture Fairs organized by Agriculture Universities, Departments and other organizations.

To overcome the labour scarcity, he has adopted mechanization in his farm. He owns a dozen of implements viz. diggers, blowers, honey extractor, sprayers, weeders etc., to carry out different farm operations.

Mr. Prasad Hegde believes that, getting good returns from the farming activity is the key to the sustainability. His dedication towards farming has shown agriculture is a profitable venture. The following table shows his successful journey towards the sustainability.

Economics:

Year	Expenditure (Rs.)	Gross income (Rs.)	Net profit (Rs.)
2009-10	1,01,800	2,98,900	1,97,100
2010-11	1,10,500	3,84,000	2,73,500
2011-12	1,75,700	7,92,200	6,16,500
2012-13	1,76,800	7,61,800	5,85,000
2013-14	3,45,000	12,99,400	9,54,400
2014-15	4,12,500	15,17,800	11,05,300

Several awards/ honours have come in search of Prasad Rama Hegde, to mention a few,

- "**KRISHI SADHAKA-2012**" award by ***Sonda Swarnavalli Krishi Pratishthana*** of Sirsi taluk of Uttara Kannada district, Karnataka
- "**SHRESHTHA KRISHIKA OF THE DISTRICT FOR THE YEAR -2013-14**" by ***University of Agricultural Sciences***, ***Dharwad,*** Karnataka
- Awrad in national agriculture fair conducted by ***University of Agricultural Sciences***, ***Bangaluru, Karnataka.***
- "**HALASU SIRI-2006**" award in Jack Fruit Fair organised by ***Kadamba Marketing Co-operative Society, Sirsi, Karnataka***
- **Certificate of appreciation for conservation** efforts of the indigenous mango varieties at the "Mango Diversity Fair & Stake Holders Meet on Conservation Efforts" by ***Indian Institute of Horticultural Research and National Project Management Unit, India during 2014-15***
- **Faliciation by KVK, Uttara Kannada** for his efforts on conservation of traditional varieties of mango, jackfruit and local medicinal plants during **PPVFRA Awareness Programme** at his farm on 02.11.2014.
- **Certificate of appreciation from Gaonkar Memorial Foundation, Ankola** for best utilization of land and other resources during 2014-15

Many farmers / extension personal regularly visit his field to gain knowledge on different IFS components. He provides information to the fellow farmers on conservation of local varieties and motivate them by distributing the saplings. He also visits local schools to educate the students on local varieties.

Prasad Rama Hegde's hard work, dedication and commitment has proven Agriculture as a profitable venture.

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Theme Area: Crop Environment Interactions

Medicinal Plant Growers of Gadag District: Success Stories

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Keywords: Medicinal plants, Ashwganda, Rosemary, Contract farming.

Gadag district situated in Northern Karnataka is largely a drought prone area with having erratic rainfall. The farmers are also of traditional mind set and continue to grow traditional crops with traditional farming methods. Most of the area is under salinity of groundwater with fluoride problem. The soils are red, black, sandy, clayey and not very fertile. With these major problems people are reluctant to venture into new crops for fear of losing the traditional assured crops.

However in this hard land there are some shining examples of farmers who have taken the bold step to tread into paths not taken before. They have taken up medicinal plant cultivation through contract farming. This is an agreement between a farmer and a business company in which the farmer grows and supplies high value farm products to the latter. Contract farming is now emerging in India as a panacea for a number of production and marketing problems faced by farmers. It is a win-win situation to pre-determined stable price for the producer which is supposed to be higher than what he gets in the open market, the company buying the produce benefits by way of assured supply of the produce of an acceptable quality.

Medicinal and Aromatic plants form a numerically large group of economically important plants which provide basic raw materials for medicines, perfumes, flavors and cosmetics. These plants and their products not only serve as valuable source of income for small holders and entrepreneurs but also help the country to earn valuable foreign exchange by way of export.

India is one of the few countries where almost all the known medicinal plants can be cultivated in some part of the country or the other. Among various plants there is great demand in the country and abroad are as opium poppy, tropane alkaloid bearing plants, sapogenin bearing yams, senna, cinchona and ipecae. The ancient Indian system of medicine is mainly plant based matesia medica making use of most of our native plants. It caters the needs of rural population of our country. India has about 2,000 species of medicinal plants and a vast geographical area with high production potential and varied agro-climatical conditions. India is already a major exporter of medicinal plants. It is estimated that Rs 86 crores worth of raw materials and drug from medicinal plants are exported from India.

Some of the successful farmers growing medicinal plants in Gadag district through contract farming are

Sri Rajendra Shirol growing Ashwaghandh- A drought prone crop

Place: Belavanki Tq: Ron District: Gadag State: Karnataka M: 9448934730

Ashwaghandh is known as “reliever of sickness”. It is used in the treatment of many diseases especially nerve related problems. It is suitable crop for drought prone areas. Sri Rajendra Shirol of Belavanki village of Ron Tq. of Gadag district is a progressive farmer owning a 40 acre of dry land. Facing drought in Gadag for four years, he was looking out for alternative crops. In this pursuit he and his fellow farmers visited the different parts of the country. On one such tour they came across farmers in Madhya Pradesh growing Ashwaghandh. They found that the variety Jawahar-21 would be very much suited for drought conditions of Gadag district. He converted all his 40acres of land to grow Ashwaghandh. Simultaneously he made contracts with medicinal plant purchasing companies. Once he drew up the contract with the companies and released that there was assured sales of the crops, he motivated other farmers to sign up for the contract. Presently this crop being gowned 5 acres of land. This crop comes maturity within 3.5 to 4months. Therefore farmers grow 2 crops per year earning an annual income of 90,000 to 1 lakh per year.

Sri. Balawant Patil- Herb N Medicines

Manufactures of Harbal products, Zoo cross, Hubballi Road, Gadag-582 103, Karanataka; Ph.9902187060 web: www.herbnhealth.in Marketing office: Kinny’s corner, Holy cross road, I.C. Colony, Borivali(W) Mumbai; Email: info@herbhealth.in

Mr and Mrs. Balwant Patil a couple from Kurthkoti village of Gadag district own 100 acres of land of which 25 acres are irrigated and 75 acres dry. On the 25 acres of irrigated land they are themselves cultivating medicinal plants namely Tulasi, Aloe vera, Nelabevu, ginger, amla, turmeric and lemongrass. In addition to the plants grown on their lands they have motivated other small and marginal farmers to cultivate these plant. They purchase these plants to prepare their own products under the brand name "Herb n medicines" preparing medicines and cosmetics like Aloe vera juice, Aloe vera jell, Herbal tea, Ashwagandh podwer, Amla powder, Amla candy, Herbal hairwash, Face wash, Face pack, Anti pimple cream, Hair growth promoter, Herbal hair dyes and some others. The formulae for the preparation of these products are family held secrets. These products are marketed locally in Gadag and sent to other parts of the country. Herbal products are much in demand these days and the Patil family seems to be making good money.

Sri. Balawant Patil

Rosemary- A spice herb, Mahadev Pawar Place: Kalasapur Tq: Gadag District: Gadag, Karanataka-state M: 9916890225

Mahadev Pawar a graduate from Agricultural University, Dhawad was working in a private firm but was not too happy with working for some else. He wanted to go into farming although he did not own land. He took two acres of land on lease. This land was left fallow by the owner as it was stony, slopy and unfertile. He realized that this land was most appropriate to grow rosemary which is a highly drought tolerant crop. Rosemary is a flovouring agent especially in Italian cooking for flouring roasted vegetables and meat. Rosemary oil is used in aroma therapy. The plant is therefore in much demand both in the food and the cosmetic industry. He has been able to draw up contracts with purchasers and is not too sure about where the product goes although some of it reaches the southern ports of the country for export. On an average he gets 2300- 2500kg yield/ac and sells it at the rate Rs. 60-80 / kg which works out to nearly Rs 2 lakhs per acre. He has since expanded his cultivation and has further leased 25 more acres of land. All this he has been doing on leased land and hopes to soon purchase his own land.

All these successful growers are role models for medicinal plant growers in Gadag area. In recognition of their innovativeness and the University of Agricultural Sciences has honoured them as Innovative farmers during the annual Krishi mela. Being experts in the field they are being used as master trainers for training other farmers during training programmes organized by the University.

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Theme Area: Policies for Sustainable Development of Agriculture

Earning through Bee Keeping: A Success Story

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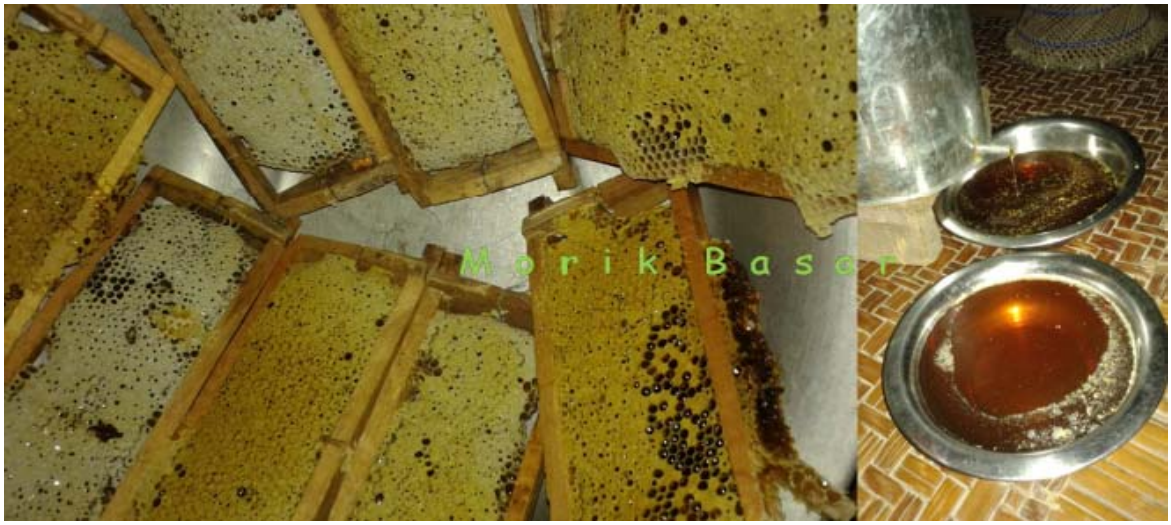
Frames full of honey and its harvesting done by Sh. Morik Basar Morik Basar, a 31 year old farmer of Gori village, Basar, West Siang district, Arunachal Pradesh, was hesitate to come near bee colonies, now shows keen interest and started earning his livelihood through it. He attended a 3-day Training cum Exposure visit programme on "Commercial Honey Production" in February 2010 sponsored by National Bank for Agriculture and Rural Development (NABARD) and organized by Indian Council of Agricultural Research (ICAR), Basar, a two-day Exposure Visit cum Training on Bee-keeping" at Assam Agricultural University, Jorhat, organized by ICAR Basar under National Agricultural Innovation Project (NAIP), "Training on Bee keeping" under Tribal Sub Plan in 2014. He started bee keeping with only three boxes of *Apis cerana* colonies and bee keeping accessories received from ICAR Research Complex for North Eastern Hill Region, Arunachal Pradesh Centre, Basar under the Tribal Sub Plan Programme in 2014 and within a short span of one year, he increased the number to thirty six by dividing the colonies and by collecting the colonies from nearby forest areas. According to him, August to initial weeks of October is the peak swarming season and more numbers of local colonies can be captured which are more stable, strong and disease resistant than the one we are procuring from distant places. Morik Basar told that he was harvesting honey five times in a year and in one harvest he was getting around two kg of honey from one box. By harvesting ten kg of honey in a year from one box, his total production is around 360 kg which he sells for Rs. 500 per kg, thereby, making an income of Rs. 1,80,000 in a year. It is worth to appreciate his earnings in the initial year of establishment. He is eager to expand his bee keeping with a target of minimum 100 boxes which may yield nearly 1000 kg of honey worth Rs. 5 lakhs in a year. Apart from honey production, he is making bee boxes also based on the measurements of a standard box mitigating the scarcity of its availability in the village and supplying to other interested farmers in the village. Now, at this stage, Morik Basar is capable enough to train his neighbours and other farmers in all aspects of bee keeping and definitely a source of inspiration for others.



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Theme Area: Policies for Sustainable Development of Agriculture

Farmer Led Innovations: A Case Study of Innovative Farmer

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Mr. Subash Chander Mishra VPO Alawalpur, Distt. Jalandhar 09357294742

Mr. Subash Chander Mishra a progressive farmer of village Alawalpur district Jalandhar, Punjab has 50 year experience of farming. Since childhood he helped his father in agriculture and after doing graduation got himself fully in agriculture. He diversified his farm by putting his 30 acre land under field crops and horticulture crops. He started growing rice, basmati, maize, potato, pulses, and put 6 ha lands under horticulture crops like mango and pear. He follows all the recommended package of practices for the enhancement of productivity of various crops. For conservation of natural resources he adopted various technologies like installation of underground pipe line system, micro irrigation system, bed planting of crops, need based application of fertilizers and pesticides, laser leveling, green manuring and application of Farm Yard Manures. He is well aware about the cultural practices for sustainable agriculture and changes his crop rotation sequence every year to tackle the major problems of insect pest, diseases and weeds etc. He has planted hedges, fruit plants like Jamun- Syzygium cumini and thorny plants like desi rose around the boundary of the farm to protect it from stray animals and hail storm. He has acquired honey bee and mushroom training from Punjab Agricultural University (PAU), Ludhiana and attended the training programme on Modern Technology & Agronomic Practices for Intensive Growth of Fruit Orchards conducted by Israel's Agency for International Development Cooperation, from 9-20, November; 1998. He has kept 10 honey bees boxes to improve the pollination in fruit plants.

Mr. S.C. Misra Showing pear orchard

Mr. S.C. Mishra with Director Horticulture Punjab (Mr. L. S. Brar)

He developed various innovations like intercropping of mango and pear and introduction of new semi soft pear variety Red Bartlet. In this innovation of intercropping, mango is planted at row to row and plant to plant spacing of 20 foot and pear is planted in-between mango. He got average fruit yield of about 25 q/ha and 30 q/ha from mango and pear respectively. Because mango has the character of alternate bearing. So in that lean period a handsome income from the pear can be obtained yielding a sort of regular income from the mango. In the second innovation he has introduced a new variety of Semi Soft Pear Red Bartlett through selection in the area. This variety is a high yielding and giving a double yield than the other recommended varieties of Semi Soft Pear and comparable with hard pear. During the last 45 years he is associated with PAU and attended all the Kisan Melas organized at PAU. He is regularly visiting Krishi Vigyan Kendra, Jalandhar and PAU, Ludhiana for seeking latest knowledge and technology besides attending training camps and extension activities organized by KVK, Jalandhar. He has delivered various radio and TV talks, published press releases and articles depicting various issues of Punjab agriculture. Many dignitaries like financial commissioner, chief secretary and election commissioner Punjab, vice chancellors and directors of extension education PAU Ludhiana, director horticulture Punjab and deputy commissioner and additional deputy commissioner of Jalandhar etc. visited his farm. He received various awards like State Level Parwasi Bharti Award (self cultivating farmers engaged in diversified farming system) for the year 2011, from PAU, state awardee in agriculture in 1993, awarded a special honour by Governor, Punjab in 1995, appreciation letter from Satish Chandra, Secretary Department of Planning, Government of Punjab, special honour in the field of agriculture and horticulture on the Republic Day, 2009, certificate of merit on Republic Day celebration in 2009 by district administration in the field of

innovative farming and district level award under Agricultural Technology Management Agency (District Jalandhar) scheme for his excellent contributions during 2010. He is also member of various societies related to agriculture like member of State Fruit and Vegetable Production Committee, member of PAU state farmers committee, member of ATMA governing committee and district agriculture production committee etc. He is socially active person and has written the issues of Punjab agriculture to the president of India, prime minister of India and agriculture minister of India from time to time. Countless farmers, self-help groups visited his farm to refresh their knowledge in the field of agriculture and horticulture. Many of them got motivated and adopted the practices led by him.

Mr S.C. Misra receiving Plant Genome Saviour Farmer Recognition

Mr. S.C. Misra showing mango crop to Dr. Kuldeep Singh (Associate Director, KVK Jalandhar) along with scientists of FASS Jalandhar

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Theme Area: Policies for Sustainable Development of Agriculture

Success Story of Diversification

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Mr. Sandeep Sharma, VPO Batura, Distt. Jalandhar. Mobile: 09872848989

Sandeep Sharma S/o Joginder Pal Sharma, village Batura, district Jalandhar owns 20 ha of land with 20 year farming experience. Traditionally he cultivated rice (*Oryza sativa*) and wheat (*Triticum spp.*). His innovative mind always envisioned about diversification. In 2012, he came in contact with Krishi Vigyan Kendra(KVK), Jalandhar and Punjab Department of Horticulture and decided cultivate vegetable crops on one portion of his farm. After getting training on protected cultivation of vegetable crops and exposure visits to other farmers field, he installed a net-house of size 1000 m^2 with the assistance from the state Horticulture Department and guidance from Krishi Vighan Kendra Jalandhar. He started with cultivation of capsicum (*Capsicum annuum*) and cucumber (*Cucumis sativus)* in net house. He had a fruitful experience with vegetable cultivation as it generated an income of Rs. 1-1.25 lakh from cucumber and capsicum cultivation. He is always guided by KVK scientists about scientific vegetables cultivation. His annual income increased many folds with the adoption of this technology. In 2014-15 he installed two poly net houses of 1000 m^2 and 2000 m^2 for offseason vegetables cultivation and earned good income from this. In these protected structures he cultivates capsicum, tomato (*Solanum lycopersicum*), cucumber (*Cucumis sativus)* and chilli (*capsicum annuum)*.He is knowledgeable about recommended package of practices for cultivation of these crops, specially training and pruning in these crops.

He installed drip irrigation system on 1.2 ha of land for efficient use of water. He is applying water as well as fertilizer according to needs of a crop which not only decreased input cost but also helped in conservation of natural resources. He also did intercropping of vegetables like garlic (*Allium sativum*), onion(*Allium cepa*), cauliflower (*Brassica oleracea* var. *botrytis*), peas(*Pisum sativum*) and pulses in sugarcane (*Saccharum officinarum*) for proper utilization of resources from which he got additional income and increased his farm income many folds. He stored the onion and garlic under optimum storage condition and sold his produce when the market price was high. He sold his produce like pulses after cleaning, sorting and grading which is basic requirement to fetch good price in the market. To conserve water and control of weeds he used to black mulching in vegetables specially in cucurbits (zucchini) from which he earned Rs 15- 35 per kg as his produce was of very good quality and came early in the market. He also practiced straw mulching in different vegetable crops. He has not only diversified their farm by protected cultivation of vegetables but also cultivates vegetables in open conditions.

Sh. Sandeep Sharma with his net house

Dr. Kuldeep Singh, Associate Director(KVK Jalandhar) with Sh. Sandeep Sharma in field of Direct Seeded Rice

He cultivates tomato(*Solanum lycopersicum*), chilli(*capsicum annuum)*, bhindi (*Abelmoschus esculentus*), bolltle guard (*Lagenaria siceraria*), broccoli (*Brassica oleracea* var. *italic*) and lettuce (*Lactuca sativa*) in open field. He cultivates these open crops systematically keeping in the mind earliness and lateness which helped him to fetch better price in lean season. The main thing in this case is self marketing of his produce for which he survey the market of all adjoining cities and send his produce where it can fetch better price. He had experiential learning in marketing and uses this learning for better marketing. He also raised healthy and diseased free nursery of vegetable crops by following all practices of scientific nursery raising.

Apart from diversification he also adopted direct seeded rice technology on an area of 0.4 ha and had a good experience, and decided to increased area under this technology as transplanting of rice is very labour intensive. In case of subsidiary occupation he started mushroom cultivation from 800 bags and has decided to increased this in next year by making his own compost.He is also very much interested in bee keeping and well aware about importance of bees in increasing yield of cross pollinated crops. He will start bee keeping unit next year.

In initial year of diversification he faced the problem of availability of labour as vegetable cultivation is labour intensive but now he has permanent and skilled labour for doing all the operations.He is regularly in touch with KVK, Jalandhar for seeking latest knowledge in field of agriculture. He diversified about 10 acre of land from total 40 acre of his land.but journey goes on and in coming years he has many plans in his mind to execute.

Scientists from KVK Jalandhar visiting Mushroom Cultivation Unit of Sh. Sandeep Sharma

Sh. Sandeep Sharma showing capsicum crop grown at his field

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Theme Area: Policies for Sustainable Development of Agriculture

Success Story of Bhutti Weavers Co-operative Society Ltd. in Kullu District of Himachal Pradesh

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Shawls on display at the Bhuttico showroom in Bhuntar, Himachal Pradesh

Bhutti Weavers Co-operative Society (Bhuttico) is the most reputed name in the hand-woven woollen shawl industry in Kullu. The Bhutti Weavers Co-operative Society was established in true sense by the Father of the Co-operative Movement in Kullu-Manali (H.P) - Thakur Ved Ram on December 18, 1944. It was on this auspicious day that only 12 poor weavers combined together to form a co-operative society with a working capital of only Rs. 24 in a tiny, backward and interior village Bhutti of Lug valley now shifted to Shamshi, 7 km ahead of Kullu. At that time, weaving was done at home and there was no sales depot or shop. The lack of funds severely curtailed the progress and functioning of the co-operative till 1952. The modern equipment started gathering only too late with the help of a loan from the All India Handloom Board during 1952. Thereafter, the government and leadership of free India started to lay more emphasis on the development and progress of co-operative movement and provision of all type of assistance was continuously made in each of the Five Year Plans prepared for the development of the country. Hence, the financial loans and grants have been continuously available over the years to the co-operative under various development schemes and projects to make and to register progress by leaps and bounds over time. Since 1944, Bhutti Weavers has been keeping alive the Himalayan traditions in step with the latest trends. The handlooms and handicrafts are integral part of cultural traditions of Himachal Pradesh. The Himalayan handlooms are now globally recognised for their purity, quality, durability and designs meeting out changing fashion needs. Since 1993-94 Bhuttico proved itself the best in the business of handloom shawls by winning the following awards:

Name of the award	Institution conferring award	Year
National Awards First Prize (Gold)	Ministry of Textiles, Govt. of India	1993-94
Udyog Ratan Award	PHD Chamber of Commerce and Industry	2005
Co-operative Excellence Award	National Co-operative Development Corporation, Ministry of Agriculture, Govt. of India	2008

Among various items of Bhutti Weavers; namely Caps, Patoos, Shawls, Loies, Stole, Mufflers, Jackets, Suits Kullu shawls occupy a place of pride among the native handloom producers and is registered under the "Geographical Indication (GI) of Goods Act 1999. It has also received ISO 9001-2008 mark. Hence, it proves that Bhutti Weavers Co-operative Society is the biggest and well established name in the hand woven shawl industry. Today, Bhutti Weavers has not only become a National name but also received appreciation from its customers in terms of increasing sale.

With this background the present study was conducted in 2013-14 in Kullu district. The objectives of the study were to analyze the growth pattern of Bhutti Weavers Co-operative Society Ltd., to know about the end products of Bhutti Weavers Co-operative Society Ltd. and to know about the factors responsible for the success of the co-operative society. The entire study was based on both primary and secondary data. Data collected were analyzed using appropriate econometric and statistical tools such as compound growth rate (CGR).

Results of the case study

Table 1: Growth of society over time 1960-2013

Growth rate (%)	Membership (No.)	Paid up share (Rs. In lakhs)	Working Capital (Rs. In lakhs)	Land and building	Sale (Rs.in lakhs)	Reserve fund (Rs. In lakhs)
Growth rate (1960-1980)	0.42	5.86	4.83	0.73	8.27	9.46
Growth rate (1981-2000)	3.22	3.87	8.99	12.75	8.94	9.98
Growth rate (2001-13)	1.29	7.29	7.32	-2.16	8.97	17.46
Growth rate (1960-2013)	3.53	10.28	13.62	11.51	15.49	15.65

The study revealed that membership of the society grew at the rate of 3.53% per annum; the share capital and working capital were found to be growing at the rate of 10.28% and 13.62% respectively. As far as sale proceeds of the society are concerned it was found to be growing at the rate of 15.49% per annum over a period of 53 years (1960-2013).

- **Creation of employment opportunities to weavers**

Bhutti Weavers Co-operative Society Ltd. popularly known as Bhuttico was found to providing whole time and part time employment to 131 personnel in its head office as well as in its own showrooms and more than 900 weavers engaged in weaving at factory of the society and in their uses during the year 2013-14.

- **Exploring foreign markets for its products**

The products of this society are not only popular with Indian customers but it is gratifying to note that our products are also popular with foreign customers. They have the privilege to export their products to United Kingdom, U.S.A, Canada Spain, France, Israel, Italy, Norway, Denmark, Russia and Japan since the year 1980 onwards. Officials of the society visited U.K. West Germany, Canada, U.S.A, France, Denmark and Sweden to explore new markets for its products.

- **Infrastructure of Bhuttico**

The society has its sale complex at Bhutti Colony, Community Hall, Orchards; five works sheds looms and accessories. The society has its weavers housing colony where 100 residential quarters have been allotted to the weavers. The society has 32 Bighas own purchased land. There are total 28 showrooms of Bhuttico in India.

Factors responsible for the success of Bhuttico

1. **Social Principles:** Bhutti Weavers Co-operative Society safeguards the interest of weaker section of the society. Improving the socio-economic conditions of the members is the primary objective of this co-operative. The principles and the values of co-operation guide the co-operative in the right direction.
2. **Wide Network:** The Co-operative Movement in India covers 100% of the villages and 71% of rural households with a network of more than 5 lakhs co-operatives of different kinds. Bhuttico easily gets funds from Co-operative banks like loans taken from Kangra Co-operative bank. It also gets the advantage of getting loan from NABARD as in past they took 1.9 crore out of which as benefit 10 lakhs was the subsidy along with relative low interest rate. Also, NHDC provides wool at 10% subsidy.
3. **Democratic Control:** The members of this co-operative society like others co-operatives enjoy equal rights of voting and participation in the administration of the society.
4. **Mutuality:** "Each for all and all for each" is the essence of co-operation. Through mutual help, the common goal is achieved.
5. **People's Support:** The co-operative have got a large membership. Presently 1000 families are directly impacted by this organization. In co-operatives the members are the beneficiaries. They support the co-operatives; in turn the co-operatives support them.
6. **Leadership:** In co-operatives the leaders emerge from among the members with leadership qualities. They guide the societies in right paths in the fulfillment of the objectives. Crucial component of members consent is fulfilled here.

Reference

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Theme Area: Policies for Sustainable Development of Agriculture

Family Farming- A Panacea to the Growing Agricultural Crisis

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Three Generations of a Farming Family

The Amminbhavi family from Marewad village of Dharwad taluka has been into farming since many generations. Somappa aged 73 and Sharabasappa aged 47 the father and son duo are together farming their 19 acres of land. Sharanabasappa, the only male child to his parents on completion of BSc degree had no other plans than to join his father in farming. He is now in the driver's seat with Somappa taking the back seat. The generation next Amminabhavi, master Rajendra is also the only male child having two sisters. He is presently studying II of the Pre-University Course year in with plans to study BSc agriculture and continue the farming profession.

Sharanabasappa, having been better exposed than his father, is in touch with the University of Agricultural Sciences and institutes like International Crop Research Centre for Semi Arid Tropics (ICRISAT). With an innovative bent of mind he has adopted many new and improved practices. He is presently growing ICRISAT chick pea (*Cicer arietinum*) varieties for on-farm-testing. He with his own native knowledge and the guidance of his father grew green gram with a spacing of 24" x 24" from plant x plant while the spacing recommended by the agriculture university was only 12"x12". This spacing method increased his yields by 20 per cent. In recognition of his achievement the American Spring & Pressing Works Pvt. Ltd. ASPEE Agricultural Research and Development Foundation of Mumbai in 2014 awarded him with a citation and one lakh cash. He has been invited by farmers groups in different parts of the country like Chhattisgarh to share his farming experiences. Sharanabasappa is now practicing integrated pest management and integrated nutrient management so as to minimize the use of chemicals. He is gradually shifting to organic agriculture and hopes to go 100 per cent organic in the near future.

The family owns 19ha of land of which 10 acres are irrigated. The family grows a variety of crops which include cereals - jowar*(Sorghum bicolor)* and wheat*(Triticum aestivum)*; Pulses - chick pea (*Cicer arietinum*), green gram *(Vigna radiata)* and black gram; Oil seeds - ground nut*(Arachis hupogaea)*, sunflower(*Helianthus annus*) and niger(*Guizotia abyssincia*) as well as a cash crop - cotton(*Gossypium hirsutum*). The family is maintaining four cows and sells 15-20 litres of milk/day. The family used to grow vegetables on 2.4ha of land for sale, but has given it up since two years due to labour problems. They now grow vegetables for their own family consumption without the use of any chemicals. With such diversity in cropping pattern the family is sure to have good nutrition

The Amminabhavi family of grandparents, parents and grand children all live under the same roof where the women of the family take care of the school going children and farm going men. At the same time the women involve themselves on the farms in supervising and managing farm labour while at home they take care of grain storage,value addition to crops grown on the farm and fruit and vegetable preservation. Seeds are stored for future use by eco-friendly storage methods. Some indigenous methods used are using neem leaves (Azdirachta indica, ash (Fraxinus Americana), castor seeds (Ricinus communis and chili seeds.(Capsicum annuum Since all of them live together the older generation; the treasure troves of family history narrate to the children the trials and tribulations of farming in the family. They thereby pass valuable farming information to the next generation. Another important feature is that during crisis and natural calamities, the family members support one another. Emotional and psychological support keeps the family stable and prevents family members from taking drastic steps.

Food and Agricultural Organization (FAO) declared 2014 as the year of "Family Farming". The case presented here though of a large landholding farmer, possesses all the characteristics of "Family Farming" as elaborated hereunder:

Family farms maintain balance between farm and families

The family has control over the all the resources to produce whatever they wish without any external exploitation. Family farming strengthens family bonds making life stressful and healthier.

Family farms link the past present and future

Family elders guide and counsel the younger generations. Joint families link past, present and future generations passing on memories to the next generation. Traditional knowledge accumulated over long years are handed over to the next generation.

Family farms are tied to the environment

Family farms maintain the indigenous culture of their families and villages. They conserve bio resources of local varieties and land races. Eco sensitive farming methods are employed by small farmers. They recycle the farm wastes and follow traditional methods of cropping

Family farms provide Food and Nutritional Security

Fresh and pesticide free foods are available on the farm to meet food and nutritional requirement.

Family farming has an important role to play in eradicating hunger and poverty, providing food and nutritional security, managing natural resources, protecting the environment and achieving sustainable development. The Amminabhavi family is a good example for family farming

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Theme Area: Policies for Sustainable Development of Agriculture

Rural BPOs to Retain Rural Youth in Agriculture- A Case Study

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Most farmers are on the verge of quitting agriculture for various reasons, the most important being the unpredictability of assured income. In order to sustain food security in the country it is necessary that our farmers continue with agriculture. The lure of the city life and the assured monthly incomes earned as wages are driving the youth towards cities. It is a challenging task to retain youth from farming families to stay back on their lands and continue the family profession. They are disillusioned with agriculture especially the profitability in agricultural pursuits. It is important to reorient agricultural practices so that agriculture becomes intellectually satisfying and economically rewarding for the youth. Youth need job opportunities by way of industries in their villages where they can earn a decent amount. For industries to come up, huge investments would be required in addition to other issues of land, infrastructure, transport, government clearance etc. Overcoming these barriers could be the setting up of BPO (Business Processing Outsourcing) in rural areas. BPOs are transfer of an organization's noncore but critical business functions to an external vendor who uses an information technology based (IT) service delivery. Since delivery is IT based, BPO is also referred to as IT enabled services (ITES).

The BPO sector is one of the fastest growing sectors of India with a contribution of 8.1% to country's GDP. The sector is witnessing both geographical and vertical expansion. Central government's focus on Digital India and Make in India is thrusting the sector further.

India is now the hub of *BPO*s in the world and the important reasons why it has become so are:

- Large population in the working age group
- Large English speaking population
- Widespread computer literacy
- Lower personal expenses
- Strategically favourable time zone
- High quality of work
- Enabling government policies

Urban BPOs are increasingly facing the challenges of high attrition rate, rising cost of labour and escalating margin pressure. This shows there is a clear business opportunity for urban BPOs to expand in rural India. By expanding in rural India, the workforce environment will be balanced giving equal opportunities to rural and urban workforce within their respective areas. The major challenge to set up BPOs in rural India is to create industry-ready rural workforce. The following table would demonstrate the advantage of setting up rural BPOs.

Components	Urban	Rural
Cost of 50 PC BPO	Rs.30 lakhs	Rs.3 lakhs
Salary	Rs.9000	Rs.3500
Attrition	30-40%	5%
Costs of recruitment, training, transport, food and real estate	High	Minimal
Absenteeism	High	Low
Productivity	Lower	Higher
Loyalty	Low	High
Data stealing	Occasionally	Nil

The prominent rural BPO players in India are

- Source Pilani
- Desi Crew
- Sai Seva Business Solutions
- Drishtee
- Comat Technologies
- Datamation Foundation
- Bhilwara Scribe
- Jai Jui Foundation
- Otra technologies
- J Soft Solutions

A Case of a rural BPO

Outsourcing through Rural Arena (OTRA) is a BPO in Rural Sankeshwer of Belgaum district started during 2010 with 30 computers. The BPO caters to clients of various countries taking up both online and off line work. Due to lack of fluency in the English language most of the works taken by OTRA are non-voice based. They take up data feeding, data processing, image capturing, tagging, form filing among others. It is heartening to note that a high percent of girls work in this BPO. The percentage is in the ratio of 80: 20, girls: boys.

OTRA has become a boon to rural educated youth of Hukkeri, Nippani and Sankeshwer taluks. They work from 9.30am to 6.00pm. Since most of the youth come from agriculture background they are also able to supervise the farm works. For girls it is a safe place without having to travel too far to work. The remuneration they receive is also high by rural standards. Wages are paid by hours at the rate Rs 300/hour. On any given day one boy/girl earns around Rs 1500/day. Work is available for 12-15 days in a month. This works out to Rs 18000-22000/month.

Rural BPOs are a win win situation for BPO owners who face less infrastructural costs and attrition while youth can carry on their family traditions of farming and earn assured incomes.

Prospects of Rural BPOs

Government of India has teamed up with private bodies to ensure availability of education facilities and adequate infrastructure to people in rural areas. To give rural BPOs a major boost, the Government of Karnataka plans to set up 100 rural BPO centres and create 1 lakh jobs in the next five years. It is said that there are 7.5 million graduates in rural India and that the rural BPO industry will be in a position to employ at least one million of them over the next five years.

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Theme Area: Policies for Sustainable Development of Agriculture

Self Help Group Approach for Natural Resource Management- A Case Study

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Name of the Self Help Group: Saraswathi Stree Shakti Sanga

Address: Chikkammanahalli village, Hosadurga taluk, Chitradurga district

Group Leader: Suvarnamma, **Contact Number:** 9731556199

Group members with product: Coconut leaf broom

Self Help Groups (SHGs) are formed with the objective of empowering women in various aspects like social, legal, political, psychological and economic. Among these aspects economic empowerment is the most important one as it forms the basis for all other types of empowerment. With the poor educational background of rural women economic empowerment is not very easy. It is easy to make women learn skills and produce things but for them fetching raw materials and finding markets is a difficult job. When women depend on locally available natural resources and market it is easy for them to sustain. Example of one such economic empowerment is the success story given here.

Saraswathi Stree Shakti Sanga is a SHG formed by the Department of Women and Child Welfare in the village Chikkammanahalli of Hosadurga Taluk, Chitradurga district of Karnataka state. The group was formed with 15 members in the year 2001. Among these 15 members two members have studied up to Pre University Course, four members have studied up to high school, seven members have middle school education and two members only primary education. The group started saving Rs.10/week by each member in the month of August 2001. Suvarnamma is the leader of this group who has studied up to PUC. The group with the help of anganwadi worker of the village thought of starting some group income generating activity. Looking into the skills of the members and the available local resources the group felt that coconut leaf broom making would be an ideal activity as it is a coconut growing district.

The group members planned together and took a house for rent for their group activity. In order to start their activity they took a loan of Rs. 1,00,000 from the State Bank of India, which was given by the Government as a subsidy. Under this activity the group planned to purchase raw coconut leaf sticks and convert it into brooms and sell them. As there are 15 members in the group, they have distributed the work among themselves. In order to prepare brooms they have to go in search of raw sticks from one field to another. Among the 15 members, Suvarnamma, the group leader maintains all the account and she is not involved much in manual work. Other 14 members are divided into two groups with seven members in each group. Among these two groups one group goes for fetching raw material and other group gather in their rented house and involve in the production of brooms. The group activity changes every week so that all the members are involved both in gathering and production. Every day the group members exclusively work for this activity around 3-4 hours. They start their work at 11.00 am and wind up between 2.00 and 3.00 p.m. based on their production. In a year the group will

have maximum production around 7-8 months that is from November to June. In the rainy season as the availability of raw materials is less their production also decreases.

During the peak production time the group produces around 150-200 brooms/day where as in the off season they produce only 80-100 brooms/day. Every week they sell their produce to the local wholesalers at Rs. 2000/quintal. In the profit earned, they distribute some amount of profit as daily wages among the members and put the remaining amount into their group account. On the basis of daily wages they earn Rs. 600-700/week during the peak season and Rs. 250-300/week in the off season. The accumulated profit in their group account is distributed among the members once in five years. In this way till now they have distributed their profit 3 times in 15 years as given below.

Year	Amount/members (Rs)
2005	15,000
2010	20,000
2015	24,000

Estimate of profit /week in peak season

Purchase of raw material	16 quintals
Cost of raw material	Rs.800/ q= Rs.12,800
Transportation & other expenditure	Rs. 3000
Production of brooms	200/day
Production of brooms per week	200x7=1400
Selling price of brooms	Rs. 2000/quintal
Number of quintals produced	1400/100=14 quintals
Gross Profit	Rs.28,000
Total cost incurred	Rs.15,800
Net profit	Rs.12,200/week

Estimate of profit /week in off season

Purchase of raw material	8 quintals
Cost of raw material	Rs.800/quintal= Rs.6400/-
Transportation & other expenditure	Rs.1500
Production of brooms	100/day
Production of brooms per week	100x7=700
Selling price of brooms	Rs.2000/quintal
Number of quintals produced	700/100= 7 quintal
Gross Profit	Rs.14,000
Total cost incurred	Rs.7,900
Net profit	Rs.6,100

As the group is relying on locally available raw material and market, it has not faced any problem in fetching raw material and sales. Due to the distribution of work they have unity in their group and has sustained its activity with increasing profits year by year based on the market price. The group is also making use of natural resources and avoiding use of plastics. Such use of natural resources not only helps in earning profits but also helps in best utilization of natural resources and sustainability of the groups.

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Theme Area: Policies for Sustainable Development of Agriculture

The Return of Ecological Security and Arrival of Socio-economic Prosperity through Rain Water Harvesting Involving Local People in Shiwalik Hills of Haryana

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Jal Hi Jiwan Hai (water is life) and Jal Nahin To Kal Nahin (no water no tomorrow) are the facts. It is Amrit (elixir) of life. Life as we know would not have been possible without water. But the cause of worry is that water is becoming a scarce resource day by day as the world is getting crowded. Fresh water sources like rivers, rivulets, streams, and lakes are drying and dying. We have to understand that water can't be manufactured in factories. We have to resort to age old method of rain water harvesting. Our forefathers who lived in drier parts, practiced rainwater harvesting. Rain water falling on the roofs of their homes was drained into an underground tank. In Himachal Shiwaliks, the practice of storing water in Khatis (rain water storage structures in rocks) was very common. Young sandstone rock absorbs plenty of water during monsoon and upon saturation, releases it drop by drop. It is fine filtered water fit for human consumption. Sandstone rock is dug into an oval shape by artisans in such a way that it gets filled with filtered water only. Such water is used for drinking for both humans and animals when natural water sources dry up. This tradition is vanishing.

Sukhomajri village today. From rag to riches.

Natural resource conservation through rainwater harvesting, regenerating degraded forests and reducing soil erosion is the first step to reverse the vicious circle of poverty and land degradation. In the context of Haryana, till mid 1970, almost all Shiwalik areas were denuded. The erosion was severe and people of the area faced acute shortage of water during summer months. The people had to migrate during summer months for feeding their livestock. Forest department officials used danda (force) for the protection and the people cut the trees and grazed their animals against the conservation regulations of the forests. But then Forest Department officials decided to shift from danda to funda (from stick to dialogue) for managing the forests. It all started in late 1970s in a village called Sukhomajri in district Ambala (now Panchkula).

After a series of dialogues between forest department and local communities, it was concluded that problem lies in the village and not in the forest. And that is the poverty. Water was identified as the catalytic agent for bringing ecological and socio-economic change and accordingly forest department constructed four earthen rain-water harvesting dams in the village. This water was utilized for growing food and fodder crops and even for drinking purpose. To ensure the participation of everyone, it was ensured that even landless has share in water who could sell his share of water to others if he does not need it. People sold goats, started rearing buffaloes and resorted to stall feeding.

Hill Resource Management Society (HRMC) comprising of all sections ensuring inclusion of 1/3rd women members was constituted for management of hill resources. Instead of selling MFP like Sabai (*E. banata*) to industries, it was given to HRMS at reasonable rates. They sold it and used profit for the development of village. The people in turn got the feeling that forests belong to them and started protecting them. Forest department also acted as facilitator between villagers and other development departments.

Historical earthen water harvesting dam of Sukhomajri whose water led to world famous joint forest management approach.

Water brought prosperity to the village. Temporary migrations stopped and people started protecting forests and watershed. Soil erosion was reduced considerably and quality of forests was improved as a result of improved soil moisture regime. Today thatched houses have been replaced by pucca ones. People have shifted to cash crops due to availability of water year around. Sukhomajri today sells 50,000 litres of milk daily.

Happy villagers of Rampur Gainda pose for picture in front of the dam

People have adopted agroforestry

Earthen dam of Rampur Gainda village which transformed lives of people of this village. Once badly denuded, the greenery has returned to its catchment area.

Water harvesting dam of Paniwala which led to ecological security and socio-economic prosperity in the village.

Very soon, Sukhomajri approach became a worldwide fame and this model was adopted throughout Haryana Shiwaliks. Over 200 such earthen dams have been constructed. The case of 2 namely Rampur Gainda & Panniwala (both in Yamunanagar district) is being mentioned here. In the case of Rampur Gainda, hill slopes on the catchment areas of the stream were completely denuded due to heavy grazing and trampling by goats.

After construction of the earthen dam by forest department in 2006, which irrigates 60 hectares, people grow fodder in their fields as water is available and bought quality buffaloes. Forest Department also constituted village Resource management committee (VRMC) for the management of village natural resources. VRMC was made capable for natural resource management by providing necessary training. The participation of all sections of society and one third of women in the VRMC was ensured. Self Help Groups (SHG) for women were constituted, trained and nurtured by forest department who now earn money by making and selling mainly vermicompost.

The event change is similar to Sukhomajri watershed. All kachcha houses have been replaced by pucca ones as a result of income from crops like sugarcane and wheat. Villagers are selling milk besides meeting their own requirement. The whole catchment area has been rehabilitated and silt load has been reduced considerably. Water table has increased from 21m to 10.6m. People have adopted agro forestry. There are about 2500 trees mainly of poplar against none before 2006.

Similarly, in village Paniwala after construction of one earthen dam in 2006, which irrigates 58 hectares, except four kachcha houses, all houses have been replaced by pucca ones, reflecting the prosperity in the area. They have resorted to stall feeding. VRMC is functioning here as well.

The catchment area has been rehabilitated. Water table has increased from 18m to 10 m. People have adopted agroforestry for enhanced on farm economy. There are about 3000 poplar trees against none before 2006.

It was concluded that water acts as a catalyst in bringing ecological and socio-economic prosperity. Constant dialogue with people bridges the gap between forest department and people, and people in return protect forests, biodiversity and watershed.

The children of Paniwala happily go to public school now.

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Theme Area: Policies for Sustainable Development of Agriculture

A Successful Bee Keeping Entrepreneur: Ashwani Kumar Shukla

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Rupnagar is situated in the eastern part of Punjab adjoining Himachal Pradesh. More than 60% of its population lives in rural areas, where majority of the population depend on agriculture. Most of the rural youths are not considering agriculture as a remunerative enterprise and getting alienated from this sector owing to lower farm income. Ashwani Kumar Shukla of village Jandla in historic block of district Roopnagar holds the technical diploma from Industrial Training Institute. He has strong affinity towards agriculture and desperately looking for some high value enterprise that can improve his economic status.

Intervention

In 2006, he made up his mind to increase his farm income from his meagre land of 1.6 ha. He got himself trained in apiculture from the state department of agriculture and Punjab Agricultural University, Ludhiana. He was highly impressed by seeing the Apiculture Demonstration unit at PAU. He was convinced that bee-keeping can be a profitable enterprise which neither demand for additional space and input nor require heavy investment to start with rather it supplement the farm income by increasing the crop productivity through pollination benefit. He started with just 10 boxes in 2006 and with his hard work and sincerity now he holds 1500 honey colonies.

Outcome

With consistent hardworking, zeal to success coupled with advanced training from PAU he had build up the empire in just fifteen years. He has established his farm as 'SHUKLA HONEY BEE FARM'. His annual gross profit is worth Rs. 20 lakhs generated through the assets of about 1500 honey bee colonies. The major part of his income (about 15 lakhs) is from sale of flavoured honey, comb honey and frozen honey branded "AMRIT" Honey with certification from Agricultural Marketing.

He had trained dozen of local youths in the bee keeping profession with the help of technical guidance of Krishi Vigyan Kendra, Ropar who are reaping great benefits from the same.

Recently he had made a self help group AMRIT to include local women and youth for value addition of honey like preparation of honey marmalades *Phyllanthus emblica, Zingiber officinale, Allium sativum and Daucus carota* based in honey etc. which are sold at a premium rate of even Rs. 400 per kg. The beauty of his business/profession lies in adoption of latest techniques in bee management like queen rearing through cell grafting, maintaining healthy and disease free colonies and seasonal migration even to remote areas of Himachal Pradesh and Rajasthan. Bulk quantity of the honey produced by him is extracted from the super chambers only. Other products like bee frames, bee boxes, queen bees sold by him fetches premium price as compared with other selling the same. He involves his family in grading packing and selling of honey. He rarely uses chemicals but uses *Allium sativum and Trachyspermum ammi* garlic extract to control varoa mite and prepare organic honey in the Himachal Pradesh area. The honey prepared in this area tastes batter and he sells it as "pure honey of Kullu Vally" and fetches premium in the market. The honey extracted from honey bee colonies in the Lahul and Spiti area has transparent colour which is sold at Rs. 1000 per kg.

The honey collected from colonies settled in Himachal Pradesh fetches high price even up to 1000 per kg. He had setup sale point at Manali (HP). He has been allotted 'Farmers School' under Agricultural technology management agency scheme, Rupnagar. His honey and its by products are being marketed sold through ATMA Kisan Hut Rupnagar.

Impact

Mr. Ashwani Shukla is now a much known face for the honey growers of the district. He is assisting the farmers of his village and nearby villages in identification and collection of suitable bee colonies. Besides, KVK Rupnagar has encouraged him from time to time on scientific bee-keeping.

He is a member of National Bee Board and executive committee member of Progressive Bee Keeper Association. He has been honoured by Chief Minister of Punjab at progressive Punjab agriculture summit 2014 held at Chapper Chiri. In his words, he aims to produce honey for all age groups i. e. from new born babies to

elderly persons from honey candy to big bottles. The scientific practices adopted by Mr. Ashwani are setting trend for the small farmers to follow.

Conclusion

As there is a lot of scope of bee-keeping in Rupnagar district, unemployed rural youth and farmers can take up this enterprise and improve their economic condition. Besides, the role of pollination in crop productivity is being increasingly realized in the recent years and therefore, beekeeping can supplement the farm income by increasing the crop productivity. The species *Apis mellifera* is highly adaptable to the local climatic condition and is a good honey gatherer. Therefore, the path shown by Mr. Ashwani Kumar Shukla will be a source of inspiration for other small farmers.

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Theme Area: Policies for Sustainable Development of Agriculture

Gursewak Singh: An Innovative Farmer of Direct Seeded Rice Technology in Sri Muktsar Sahib, Punjab

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S. Gursewak Singh S/o S. Thana Singh Sekhon, resident of village Kothe Dashmesh Nagar of Sri Muktsar Sahib district, Punjab owns 14 ha farming land. He is a dynamic progressive, innovative farmer. He is a member of Progressive Farmer Club of Krishi Vigyan Kendra, Sri Muktsar Sahib and Punjab Agricultural University Kisan Club. He regularly attends the club meetings. Gursewak Singh started farming since 2 decades. In Punjab, there has been a concern related to shortage of labour, which raises the cost and delay the planting of the rice crop. Due to receding water table, rising costs of labour for transplanting of paddy and the adverse effects of puddling on soil health, KVK Muktsar conducted on farm trial on cost and resource effective method of paddy cultivation during *kharif* 2010 at Gursewak Singh field and KVK farm. To show the results of direct seeded rice trials, KVK, Muktsar conducted progressive farmers meetings during *kharif* 2010 and Gursewak Singh also attended these meetings. He was highly impressed with these results as this technology saves 20-30% irrigation water. Moreover, the ground water was not fit for irrigation in his field. Keeping in mind all the above points, he used canal water for bringing more area under cultivation of rice (*Orza sativa*) by DSR. He started cultivation of rice crop by adopting DSR technology on 1 ha. But he experienced serious weed problem by adopting this technology. This prompted him to solve this problem. During *kharif* 2011, KVK organized a crop seminar on DSR technology at Kauni village and he attended the same. During the seminar he inquired about the various technical aspects especially on weed management.

Development of Innovative farm Machinery for spraying in DSR

Weed infestation is a major bottleneck in cultivation of DSR. It is more difficult to control weed with the help of ordinary sprayer. In DSR uniform application of herbicide is needed and it requires lot of skilled labour. To overcome this problem Gursewak Singh decided to develop/modify his tractor operated cotton spray drum for application of pre-emergence, post emergence herbicide during kharif 2012 under the technical guidance of scientists of KVK. This made the adjustment of water very easy by adjusting tractor gear. This machine has benefits of labour saving, less cost, uniform and effective spray (Fig. 1). In DSR, 2-3 sprays are required in initial stage of growth. About 500-700 liter of water/ha is required for effective control. In Punjab farmers generally use knapsack sprayer (15 liter capacity), which again is labour intensive. He modified his tractor operated spray drum for application of different of agrochemicals. It encouraged him to increase the area under DSR to 4 ha in 2013. During 2014 and 2015 he cultivated all the land under DSR (8 ha). Resulting this, Gursewak Singh was awarded as a 'Udami Kisan Award" at Progressive Punjab Summit 2014 at Mohali by the chief Minister of Punjab (Fig. 3). He is now acting as a key communicator for other farmers for adopting DSR in the vicinity. Now a days, district Sri Muktsar Sahib ranks first in adopting DSR technology. During k*harif* 2014, the direct seeded rice/ basmati was cultivated on 1, 12,000 hectares in the Punjab state. Out of this 28,000 ha was only in Sri Muktsar sahib district that is 25% of total area under DRS. His modified tractor operated sprayer become popular among the farmers in the area. Now a number of farmers modified their cotton sprayer to this type

Apart from this he is adopting innovative ideas for diversification through cultivation of vegetable and fruit with the technical guidance of Horticulture Department and KVK. He owns a kinnow (*Citrus reticulata*) orchard in 2.5 ha and using all new techniques and methods he got a highest yield of 27 tonnes/ha of best quality kinnow fruits. He is practicing new technologies like protected cultivation, low tunnel, mulching and intercropping of vegetable on ha. To save water he installed drip irrigation system with water storage tank using solar system based electric motors (Fig. 4). He does marketing of his produce with his own efforts. He got first prize in quality fruit production of kinnow at state level regional Kisan Mela of Bathinda in September 2011 and March 2012 (Fig. 2).

Fig. 1: Power sprayer modified by Gursewak Singh

Fig. 2: Honored by Vice Chancellor PAU, Ludhiana at Regional Kisan Mela, Bathinda

Fig. 3: Progressive farmers' Award given by Chief Minister Punjab at Progressive Punjab Summit 2014, Mohali

Fig. 4: Solar based drip irrigation system

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Theme Area: Policies for Sustainable Development of Agriculture

Beekeeping: A Prime Source of Income

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Gurjant Singh with Bee Boxes

Sh. Gurjant Singh is a small farmer who belongs to a schedule caste family having only 0.1ha (2 kanal) of land. Before adopting beekeeping, he was earning his livelihood from farming (cotton-wheat) and as labourer in private Balkar Combine manufacturing unit at Handiaya district Barnala. The income from traditional farming system was insufficient. Though he had all the eagerness to undertake some productive work but his financial conditions and lack of technical skill was obstructing him in fulfilling his aspiration.

Initially he started beekeeping in 2007 with 5 boxes. Gradually as his profit from this activity increased, he invested back major part of the profit towards increasing the number of bee units and boxes. Today in a span of 9 years, he has raised the number of bee boxes from 5 to 260. By this process he has not only been able to earn from single activity i.e. honey but also from the sale of bees and bee boxes. He has earned net profit more than Rs. 9.6 lakh by selling honey to local vendor at Rs 130 per kg during last year which is several times more than his conventional farming.

Initially when he had limited number (10-15) of boxes, he use to place these near the canal in the summer season. As the number grew beyond 30, he shifted them to cooler places like the foot hill of Himalaya. Migration is a key factor in beekeeping activity because in Barnala district, availability of flora prevails only for the 2-3 months and for the rest of the year he migrates bee colonies to other places for flora. Also, during summer the temperature in South-West Punjab gets unbearable hot (47°C) for bee colonies. During winter he migrates the bee colonies in mustard fields at Shri Ganganagra, Kota, Rivari area of adjoining Rajasthan state. Sh Gurjant Singh has good relation with farmers of other state who provides space for bee boxes because it enhances the productivity of the mustard crop due to cross pollination.

Gurjant Singh enterprising passion has resulted in changing his life style. Now he has a two wheeler and a mobile phone for business and personal purposes. Gurjant Singh an unemployed youth till the year, 2006, has now become an idol for contemporary rural youth. Seeing the success of Gurjant Singh which was beyond the expectation of majority of the youth in his and adjoining villages. Two Rural youth of his village have also start beekeeping work successfully with him and earn of Rs 70,000 per annum. He now educates and inspires to other young people of his area by stating, that the work done with skill and honesty always succeeds.

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Theme Area: Policies for Sustainable Development of Agriculture

Success Story of Kundan Singh: A Dairy Entrepreneur

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Mr Kundan Singh Distt. Samba (Jammu and Kashmir), Samba, Mandi Kaili, Mob no. 9697040107

Mr Kundan Singh is a matriculate. He is the youngest among his siblings. He got dairying as legacy from his grandparents. After completing his schooling he decided to stay with and help his aged parents in a joint family. It was a tradition in his ancestral family to raise at least one or two milch animals mostly cows. He has no formal training in dairying.

Due to his enthusiastic nature he wanted to take an initiative to become a very successful dairy entrepreneur by producing quality milk and maintaining a farm with all the modern amenities. Further he wanted to have some handsome earnings to sustain his family. He owns 14 Holstein Friesian cows without any fodder production activity in the rainfed area.

Is there any scope to expand?

Yes, there is scope and he is interested to do so. He aims at enhancing his herd size to 150 cows within next few years. He has plans to purchase some irrigated land elsewhere. He plans to cultivate his own fodder in order to decrease production costs.

Brief economics of the farm / enterprise:

Name of the enterprise	No. of animals	Total cost of production (in Rs)	Returns (in Rs)	Net income (in Rs)
Dairying	14	90000	170000	80000

Income level before adopting dairy farming:

Name of the enterprise	No. of animals	Total cost of production (in Rs)	Returns (in Rs)	Net income (in Rs)
Dairying	2 local cows	4600	7800	3200

Future plans:

Targeted production capacity : **150 cows**
1800 liter milk per day
15 KW Biogas power plant
1200 kg of organic manure per day
1 acre of organic farming for vegetables.

Is there any scope to replicate to or promote the success to other areas?

Yes definitely. It is a good project and a viable one also. In fact, after being inspired by the success, two local youth have started to replicate the entrepreneurship. He motivates other farmers to make such initiatives.

What other support is needed for sustainability?

Exposure visits and training to places both inside and outside state regarding dairy keeping, dairy processing, fodder cultivation, preparation of balanced and cheap feeds. He wanted to be trained regarding modern management practices and value addition of milk to get maximum returns from his produce.

Additional important information

He looks forward and is hopeful of obtaining some subsidized financial assistance from the state government to further expand his business. In fact he is of the view that government should always come forward and encourage the youth for dairy entrepreneurship particularly in the rainfed areas. The prices for the milk are supposed to rise in the future. He is encouraged by the ever rising demand for milk. He says that he does not need to go to the market for sale of his produce. Customers come to his farm to collect milk and he remembers no day when his milk is not sold.

Is there any social or economical change in the farmer after adopting the dairy activity?

Yes, the change is remarkable. Now he has added substantially to his family income. He has plans to install milking machine very shortly at his farm to produce clean milk. He is directly providing employment to 2 locals by engaging them at his farm for different activities. Recently Secretary to Government along with Director Animal Husbandry, Jammu and Chief Animal Husbandry Officer, samba paid a visit to his farm and appreciated his efforts.

As a whole he believes that the income he is generating from the sale proceedings of his produce is helping him to maintain a good social life as well as adding some savings for future. Further he believes that dairying has uplifted his socioeconomic status. He can be a role model for the young entrepreneurs and can make them understand the true meaning of dairy entrepreneurship.

304.

Theme Area: Policies for Sustainable Development of Agriculture

Impact of Small Scale Irrigation Project - A Case study of Chikkapadasalgi Barriage in Karnataka

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Irrigation affects world economy tremendously through its impact on agriculture. It enables improvements in agrarian economy through its area and yield effects. Irrigation confers on the society innumerable tangible and intangible benefits. Keeping this in mind, the Government of India spent huge amounts of money on development of irrigation in the country and gave a big boost to the multipurpose mega projects. But, unfortunately, these projects are losing their sustainability due to the long gestation periods, huge cost escalation due to the delay in project execution, increasing irrigation inefficiency and environmental problems. In view of these facts, small scale community managed irrigation systems are thought of as alternatives to the huge multipurpose projects. Favorable inclination towards such schemes is already observed in recent years.

Chikkapadasalagi barrage is built across river Krishna in Hirepadasaalgi of erstwhile Bijapur district. Bijapur district in Karnataka State is one of the famous historical centers with a variety of rich cultural heritage. But, it is a paradox that Bijapur district is one of the typical drought prone areas of the country. To put an end to the problems, people of the area made representations to the Government of Karnataka to take up construction of a barrage across Krishna near Chikkapadasalagi village in Jamakhandi taluk. The apathy of the state towards problems of the farmers and the need and zeal of the farmers brought them together under the leadership of a local farmer cum social worker **Siddu Nyamagouda**, who is hailed as the real architect of the project. This led to formation of a farmers' co-operative society named "**Krishna Theera Ryot Sangha - KTRS** (Krisha Basin Farmers' Association) which came forward to construct the barrage.

The barrage created a storage capacity of 2.8 thousand million cubic feet (TMC). The project was completed within a short period of 11 months at a cost of about Rs. less than one crore. The main sources of contributions were farmer-beneficiaries (40%), machinery and human labour contribution by the beneficiaries (13.22%), contribution from CAPART, New Delhi (35.11%) and donations from public associations (10.58%). Apart from this people contributed their own materials required for the project work like wood, stone, cement, transport facilities, etc. In view of this large scale enthusiastic and voluntary participation of people, the project is rightly identified as "**Peoples' Project**".

The total command area of the barrage which was 10,699 ha in 1989 increased to 31,179 has in 1997. The barrage reservoir caters to the irrigation and drinking water needs of 31 villages and Jamakhandi town.Many crops like green gram (*Vigna radiata*)disappeared from the region, and some new crops like fodder crops, maize (*Zea mays*) have been introduced in the region. Area under cash crops like grape (*Vitis vinifera*) and sugarcane (*Saccharum officinarum*) has increased over these 25 years.

The area under groundnut (*Arachis hypogaea*) and maize (*Zea mays*) in *kharif* has increased substantially. In *rabi,* the area under rabi sorghum (*Sorgum bicolor,*-20%) and Bengal gram (*Cicer arietinum,*-75%) has drastically reduced over the years. There is a substantial increase in the perennial crops like grape(*Vitis vinifera*), banana (*Musa sps*)and fodder. The area under sugarcane(*Saccharum officinarum*) has shown about 698%increase during this period. The net returns observed a positive change in 2015 since 1989. Per hectare returns in 1989 and 2015 were calculated for both irrigated and non-irrigated areas. In 1989 net returns in irrigated regions were Rs. 41,218/ha and it increased to Rs. 9,16,482/ha, whereas in un-irrigated region income was Rs. 11,012/hain 1989 and reached to Rs. 2,61,572/ha.

Some other selected indicators were analyzed to show the impact of barrage in the command area by comparing the initial and present situation. The selected indicators were land value, wage rates and sugarcane yield which are main commercial crop of the command area. Land value jumped from Rs. 2,50,000/ha - Rs. 3, 00,000/ha in 1989 to Rs. 15,00,000/ha - Rs. 25,00,000/ha in 2015. Wage rates which were Rs.25 for women labour in 1989 increased to Rs.197 per day. Wage rates for men also increased from Rs.50 during 1989 to Rs. 339.

The construction of Chikkapadasalagi barrage has brought in remarkable changes in life of farmers around the barrage. The socio-economic conditions of farmers have witnessed a sea change during the 25 years after construction of the barrage. The outstanding feature of the organization was that it was founded by the farmers on their own initiative without the state support.In view of these findings it can be concluded that there is a need to encourage user participation in management of small scale irrigation projects.

1 & 2 Barrage Construction days. 3. Flow of Alamatti Back water to the Barrage. 4. Panoram eye view of Barrage. 5. KTRS Chairman Addressing farmers gathering. 5. Barrage view in Summer. 6. Pumps Lifting water from Alamatti Dam to Barrage.

305.

Theme Area: Policies for Sustainable Development of Agriculture

Integrated Organic Farming System (IOFS) for Improving On-farm Organic Inputs Availability and Profit

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Emerging from 42,000 ha under certified organic farming in 2003-04, the organic agriculture has grown many folds and by March 2014, country brought more than 4.71 m ha area under organic certification process. Out of this cultivated area accounts for 0.72 m ha (15.2%) while remaining 3.99 m ha (84.8%) is wild forest harvest collection area. Presently only 0.51% of total area (including wild collection) is under the process of certification. Sikkim has the highest percentage of net sown area (99%) under organic certification while Madhya Pradesh is having largest area (232887 ha) under organic production system. In several regions of India, agriculture is not very intensive as regards to use of agro-chemicals. Especially in mountain areas and tribal areas, use of agro-chemicals is rather low, which easily facilitates conversion to organic production. On these marginal soils, organic production techniques have proved to achieve comparable or in some cases (especially in the humid tropics) even higher yields than conventional farming. Continuous practice of raising the crops organically has good potential to sequester the C (63% higher C stock in a span of 10 years) in the soil to offset the C emissions in the atmosphere. The major limitation in promotion of organic farming is increase in cost of production by 13%, if organic inputs from outside the farm are purchased and utilized. Therefore, organic agriculture should naturally depend on on-farm generation of inputs including mixed cropping, crop rotation, residue recycling etc. Integrated Organic Farming System (IOFS) models were evaluated at Umiam (Meghalaya) and Coimbatore (Tamil Nadu) through Network Project on Organic Farming (NPOF) with a view to reduce the cost of market dependency for organic inputs especially for meeting the nutrients. The IOFS model comprised of cropping systems involving cereals, pulses, oilseeds, fruits & fodder) + dairy (1 cow & 1 calf) + fishery + vermicompost components in 0.43 ha at Umiam and cropping systems (okra, cotton, desmanthus) + livestock (1 cow, 1 heifer and 1 bull calf) + vermicompost + boundary plantation with Gliricidia sp in 0.40 ha at Combatore resulted in net return of Rs 70,951 and 74,316 respectively which is higher than existing system of rice-fallow (Rs 8618) and rice-vegetables (Rs 24518) in Umiam and fingermillet-cotton-sorghum (Rs 27200) in Coimbatore. Organic inputs to meet the nutrient requirement (80-90%) of cropping systems was generated within the model resulted in reducing the market dependency for organic inputs. Besides, these, organic seed materials and fodder requirement for livestock was also generated within the model.

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Theme Area: Policies for Sustainable Development of Agriculture

Integrated Farming System: A Profit Oriented and Sustainable Approach to Enhance Farmers' Income

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Keywords: Integrated farming system, Punjab agriculture, profitability

Background Information

The state of Punjab in India, been one of the world's most remarkable examples of agricultural growth. The growth in Punjab has been closely associated with the well-known Green Revolution, which saw the development and adoption of high-yielding varieties (HYV's) of wheat and rice crops (Dhawan and Singh, 2015). The Punjab agricultural sector has reached a point where it must make significant changes if it wants to move forward and regain its leadership role. Conversely, if the state does not rationalize incentives, create new institutions and reinvigorate old ones, and increase investments significantly, it will suffer declining income and employment and irreversible environmental degradation. This prospect gives rise to a number of questions: How can the Punjabi farmer again become a role model? So, keeping in view the above said points, the following story of a Punjabi farmer has been presented in an effective manner.

Activities

The paper covers the story of a farmer role model Amarjeet Singh S/o Chanan Singh residing in Village Sujo Kalia, block Sultanpur of District Kapurthala (Contact No. 097797-24546). The farmer owned 20 acres of land. In which he has grown wheat and paddy on 16 acres each in different seasons, garlic on ¼ acres, barseem on ½ acres, gobhi sarson on ½ acre and rye grass on other ½ acre. Chick pea and mash were grown on 1/8 acres each, vegetables on 1/8 acres, cucumber on 1.0 acre and fruits such as kinnow, guava, pomegranate and grape vine on 1/8 acres of land. In addition to this, eight buffaloes, four cows and eight calves were also the part of the system. The economics of various enterprises were calculated using the costs incurred and the gross returns from various crops and other agricultural allied activities for which simple mathematical and statistical calculations were used.

Success of Those Activities

The study showed that wheat grown on 16 acres of land carried net returns of Rs. 298832 to the farmer with garlic on ¼ acres of land adding Rs. 14934 of net returns to the total income. From barseem and *gobhi sarson*, the gross returns received were Rs. 31025 with costs incurred of Rs. 10871 resulting with the net returns of Rs. 21554. The crops such as rye grass, chickpea and mash which were grown on an area of 0.625 acre collectively yielded net returns of Rs. 10392. The vegetable crops added a good share to the farmer's income by providing net returns of Rs. 1617. During Kharif season, paddy which has been grown on an area of 16 acres gave net returns of Rs. 1319830 and fruits such as kinnow, guava, etc were also grown resulting in net returns of Rs. 10000. Cucumber was also grown on one acre of land resulting in gross returns of Rs. 65075 with variable costs of Rs. 22669 which resulted in net returns of Rs. 42406. The dairy component of the farm added highest returns to the farmer's income with gross returns of Rs. 1056848, variable costs of Rs. 523561 and net returns of Rs. 533287. The gross returns, input costs and net returns from both seasons and dairy enterprise were Rs. 2401347, Rs. 1081517 and Rs. 1319830, respectively. The net returns per acre were Rs. 82489.38 and the profitability per acre per day was Rs. 231.71. Thus, it is evident from the study that the addition of other crops has made the farming more remunerative and dairy component alone has covered above 40 per cent of the total net returns. So, it is more remunerative to adopt integrated farming system model for enhancing farmer's income and to get rid of stagnation in Punjab agriculture.

Conclusion

Integrated farming system can be a way out for farmers' in Punjab to enhance their income and also for the sustainability of Punjab agriculture.

Reference

Dhawan, V. and Singh, J.M. 2015. Role of farm inputs in sustaining Punjab agriculture. *Indian Journal of Economics and Development* **11**(1): 325-332.

307.

Theme Area: Policies for Sustainable Development of Agriculture

Diversification in Punjab Agriculture towards High-value Crops

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Keywords: Diversification, green revolution, sustainability

Background Information

Punjab agriculture has been undergoing spectacular changes in recent period. Undoubtedly, the Green Revolution helped the Punjab convert into one of the most highly mechanized agricultural states of India. However, it can be viewed as a mixed blessing for Punjab because it led to the establishment of wheat (*Triticum aestivum*)-rice (*Oryza sativa*) cropping-pattern (WRCP) as a main cropping pattern in many parts of Punjab by eliminating all the other available cropping patterns during the pre- Green Revolution period. The rice- wheat crop rotation became predominant at the cost of maize, other cereals, oilseed and pulses in the state (Dhawan *et al.* 2015). But now is the time to diversify the Punjab agriculture for the sustainability and betterment of socio- economic status of farmer's in Punjab.

Activities

The story covered the story of a farmer named Rajendra Singh S/o Arjinder Singh residing in Village Barendpur of District Kapurthala (098721-40076). The farmer owned 50 acres of land and leased in 50 acres of land. During Rabi season he had grown potato on 95 acres with wheat on 2 acre. Barseem on 0.50 acre, Gobhi Sarson and peas on 0.50 acre, Gram and other vegetables on 0.125 acre each. During February-March, he had grown watermelon on 60 acres, melon on 25 acre and cucumber on 2 acres of land. During Rabi season, he had grown paddy on 96 acres and rye grass on 2 acres. Kinnow, peach, chikoo were used to grown on 0.125 acres, sugarcane on 0.125 acres for which he has made sugarcane crusher in an area of 0.50 acres. In addition to this, four buffaloes, three cows and five calves were also the part of the system. Two vermi-compost units for additional income were also running along with all this. The economics of various enterprises were calculated using the costs incurred and the gross returns from various crops and other agricultural allied activities for which simple mathematical and statistical calculations were used.

Success of Those Activities

The study showed that potato grown on 95 acres of land carried net returns of Rs 1481240 to the farmer with wheat on 2 acres of land adding Rs. 37354 of net returns to the total income. From barseem and gobhi sarson, the gross returns received were Rs. 25513 with costs incurred of Rs. 7935 resulting with the net returns of Rs. 17578. The crops such as peas, gram and other vegetables which were grown on an area of 0.625 acre yielded net returns of Rs. 5012. The vegetable crops such as watermelon, melon and cucumber collectively added a huge share to the farmer's income Rs. 5861840 of gross returns and costs incurred were Rs 1949188 resulting into net returns of Rs. 3912652. During Kharif season, paddy which has been grown on an area of 96 acres gave net returns of Rs. 2329248 with rye grass on 2 acres gave net returns of Rs. 35000. In addition to this, fruits such as kinnow, chikoo and peach were also grown resulting in net returns of Rs. 13000. Sugarcane was also grown on the farm with its crusher resulting in gross returns of Rs. 30709 with incurring costs of Rs. 13247 which resulted with net returns of Rs. 17462. The dairy component of the farm also added good returns to the farmer's income with gross returns of Rs. 767500, variable costs of Rs. 420882 and net returns of Rs. 346618. Two vermi-compost units have also been constructed to explore the income from dairy unit which gave the net returns of Rs. 35000. The gross returns, input costs and net returns from both seasons and dairy enterprise were Rs. 17169908, Rs. 8939744 and Rs. 8230164, respectively. The net returns per acre were Rs. 82301.64 and the profitability per acre per day was Rs. 231.18. If we assume that on the whole 100 acres, rice and wheat were grown, the net returns per acre would have been Rs. 42940 and the profitability per acre per day would have been Rs. 120.61. It is quite evident that profitability /acre/day was 1.92 times more in these crops over rice wheat cropping system thereby highlighting the importance of diversification and also providing an alternative cropping system providing high returns and sustainability to Punjab agriculture.

Conclusion

The study concluded that the vegetable based cropping system can be more remunerative and will fetch good prices to farmers as compared to prevailing wheat-rice cropping pattern.

Reference

Dhawan, V., Singh, J.M. and Kashish. 2015. Commercialization to specialization: A scenario of Punjab Agriculture. *Economic Affairs* **60** (3): 433-437.

308.

Theme Area: Land and Water Resources

Amelioration of Degraded Irrigation Lands- A Success Story of Margur Village, Karnataka

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Irrigation has been the driving force behind economic growth of countries in the world. However, alongside it has created negative externalities. The twin problems of water logging and salinity have severely damaged the land productivity and posed threats to sustainability of irrigated agriculture and livelihood of the farmers in the irrigated command area. Many irrigation projects in India and Karnataka are suffering from serious problems of water logging and soil salinity. Canal commands in Karnataka have developed alarming levels of land degradation in varied degree of severity which include soil acidity (87,549 ha), soil sodicity (1,21,814 ha), saline soils (1,48,462 ha) and water logging (65,154 ha). In Upper Krishna Project (UKP) command area in north Karnataka the extent of degraded land, in various degrees, is estimated to be around 0.50 lakh ha. Command Area Development Authority (CADA-UKP), Bheemarayan Gudi which is a statutory body to ensure overall development of irrigated commands initiated measures to ameliorate the conditions. University of Agricultural Sciences Dharwad team of scientists consisting of Rajendra Poddar, M.S. Shirahatti, S.Y. Wali and I.M. Sarwad was entrusted with the responsibility of preparation of detailed project reports (DPRs) in consultation with CADA officials for reclamation of saline and water logged soils in the command areas of Upper Krishna Project to get funds from Government of India and execute the project.

On an experimental basis the team proposed to the CADA a reclamation project for Maragur village in Indi taluk of Vijayapura district. Maragur village, with a population of about 3,000 peoples and exist at three km interior to the National High Way 13 on the banks of river Bhima. Village is mostly agrarian with some petty businesses. Before the beginning of canal irrigation, in spite of presence of the river adjacent tothe village farmers practiced mostly dry land farming with a few *kharif* crops like green gram (*Vignaradiata*), bajra (*Pennisetum glaucum*),*rabi* sorghum (*Sorghum bicolor*), wheat (*Triticum aestivum*) and bengal gram (*Cicer arietinum*).Upon rapid appraisal of the situation it was approximated that a minimum of about 200 ha.land of about 62 land holders out of the total cultivated land (about 880 ha)was severely damaged. Water was let in to the lands during 2002 *kharif* season and farmers could take up good crops during the first two years i.e. 2003 and 2004. Since 2005, lands have been affected and crop yield begins to decrease. Without advance preparations and capacity building for irrigated farming, the lands have developed salinity and water logging in a short period.

The main canal (D-36) of Indi Branch Canal (IBC) and laterals in the village pass through rugged, rocky and undulating terrain. Many ducts aqua and embankments have been constructed by the Krishna Bhagya Jala Nigam Ltd (KBJNL) to suit the landscape. But, due to breaches there was continuous leakage and seepage of water from these points when water flowed in the canal. The lands have been affected with severe salinity, water logging and turned uncultivable with growth of thick jungle, typha grass and unwanted weeds. Thick encrustation of white salts has made lands unproductive. The team of scientists, engineers, members of Gram Panchayat and Non-Government Organization representatives carried several field visits to prepare design and estimates for the reclamation project. Conveniently there are a few natural stream draining into the river Bhima, which flows hardly a few meters away from the affected area. Effective drainage was easily achieved. In the post reclamation period the degraded lands have been restored to normal conditions. The soil salinity levels, soil pH and water table have been brought down to normal levels. *Typha orientalis, Prosopis juliflora* and other weeds have been removed and water logging has been reduced. Presently farmers grow sugarcane on about 120ha of recovered land with yields of 100-125tonnes/ha. This has substantially improved economic condition of farmers and many who had left village have since been referring cultivation their lands. The message went far and wide and these measures spread to neighboring villages of Dhulakhed, Sirnal, Chanegaon and Sirgur. Farmers who had no idea how to tackle this common problem came forward and invited University of Agricultural Science Scientists and the Command Area Development Authority (CADA) officials to take up amelioration measures. About 200ha of valuable land which had gone out of cultivation in these villages has been retrieved and restored to normal health. The role played by the Swamy Vivekanand Yuva Shakti Kendra, Dhulakhed, an NGO, conflict resolution and community mobilization was very critical input in the programme.

Large area of degraded lands has been restored to normal health within a span of 3 years. Rajendra Poddar, who led the UASD team, opines that it is like treating a disease after it has aggravated. Instead, it has to be prevented which is possible through participatory Irrigation management (PIM) for water management. Further, these villages could be adopted by the nearby farm science centers (KVK) of Agricultural University, Dharwad for follow on scientific crop production. Local communities need to be trained in scientific crop, land and water management.

1. Field affected with Prosopis julifera. 2. Saline affected field 3.Field affected with Typha orientalis 4. Scientists and farmers' interaction in the affected field 5. Reclamation work under process 6.Water draining out of the fields 7&8 crops cultivated in the field after soil reclamation measures 9. Scientists and farmers in a successfully reclaimed field.

Panel Discussion

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Promoting Resource Efficient Agriculture System through Public- Private Partnerships WWF India and Centre for International Projects Trust (CIPT)

Panellists:

- **Dr. Birgit Wilhelm**, WWF, Germany
- **Pioneer India**
- **Mr. V. Vijay Vardhan**, ITC Limited
- **Mr. Premprakash Saboo**, RML
- **Mr. Jagmeet Bal**, BASF
- **Dr. Anil Kakkar**, Excel Crop Care Ltd.

India accounts for only about 2.4 per cent of the world's geographical area and 4 percent of the global water resources, but has to support about 17 per cent of the world's human population and 15 per cent of the livestock. Agriculture remains the mainstay of Indian economy; contributing 14 per cent of Gross Domestic Product (GDP) and with its allied sectors like forestry and fisheries employing nearly 50 per cent of the country's workforce. However, the growth rate of the agriculture sector has been fluctuating over the last few years.

In India, the success of green revolution has led to increase in food grain production and helped achieve the goal of self-sufficiency in food grains. However, widespread problems of resource degradation have also emerged across the past few decades. The major reason for these problems mainly relate to excessive use of chemical fertilizers, agro-chemicals, over-extraction of groundwater resources and faulty cropping patterns. Several studies have indicated that intensive agriculture practices or overuse of inputs have affected the sustainability of agricultural systems in the country. The key indicators listed by them include soil erosion, decline in soil organic matter, water and wind erosion, reduced water infiltration rates.

The agriculture sector has therefore had its share of problems and challenges. There have been minor improvements in agriculture infrastructure, land holdings continue to remain fragmented, and risk mitigation options have not improved. The yield of several crops in India are not at par with other agriculture developed countries and in some instances, not even one third to half of the world average. India's spending on agriculture research and development (R&D), though among the best in South Asia, is still below those of its competitors such as Brazil and China.

In addition to these, new challenges attributed to climate change have had an impact on agricultural production. A paradigm shift is required for achieving sustainable resource use. Several steps have been taken by the government by introducing conservation agricultural practices on large scale such as laser land levelling, direct seeding rice, soil health card etc for enhancing the resource base within the country.

The private sector has increased their engagement with farmers in terms of contract farming and direct procurement. Private sector operations in agriculture currently span across a variety of crops, regions and are being implemented by both small & medium and large players. These initiatives have brought about significant improvements in productivity, increased farmers' returns, aided in agriculture extension, R&D and at the same time, contributed to increasing local employment base. However, there is a need to mainstream such efforts and approaches into the current system for wider adoption and scale.

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