

International Web-Conference

on

**Food Security through Sustainable Agriculture
(FSSA)**

VAKSANA-2020

SOUVENIR

21-22 September, 2020

Venue

By online mode (Zoom Video Conferencing App)

Organized by

Shri Vaishnav Vidyapeeth Vishwavidyalaya
Shri Vaishnav Institute of Agriculture, Indore (M.P.), India



Proceedings of International Web-Conference

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Message from the desk of Vice Chancellor

The agricultural scenario in the post Green Revolution era has changed Indian agriculture from the subsistence farming to a commercial enterprise. Signing of World Trade agreement by India has exposed Indian farmers to the global competition. This demands rapid modernization of Indian agriculture so that our farm produce meets not only national but international quality standards, is produced at internationally competitive price and is sustainable. With the liberalization of global agricultural trade and the WTO regulations which facilitate the trade of agricultural commodities; the demand for improvement in the qualitative traits of agricultural produce/seed has contributed to the importance of crop improvement and seed production technology.

This, therefore calls for developing and imparting proper training to the farmers, which is possible only if the trainers which are produced by the agricultural universities are themselves properly educated in the advances in science of agriculture particularly at the post-graduate level where they have not only to learn the recent advances in their subject but have also to be trained in the modern and latest techniques in their disciplines so that they can participate and contribute in the development and advancement of agricultural science in India.

Shri Vaishnav institute of agriculture is holding two days International webinar on theme 'Food security through sustainable agriculture'. I hope the deliberations will come up with research results that are helpful in sustaining the production of agriculture crops even in known uncertainties. Hope, they will come up with the solutions for sustaining crop production and its quality ensuring food security to ever increasing human and animal population under the scenario of climatic changes, etc. Best utilization of diminishing resources like irrigation water and land for cultivation will be addressed. Scope for application of digital agriculture, precision agriculture with introduction of AI and remote sensing will be researched.

Dr. Upinder Dhar
Vice Chancellor, SVVV, Indore



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MESSAGE

It is my pleasure to participate in the International Web-Conference on “Food Security through Sustainable Agriculture” organized by Shri Vaishnav Institute of Agriculture. Agriculture forms the backbone of the economy of any country, more so in India where nearly 70% population is occupied in agriculture. Agriculture is a natural industry run by the forces of nature ‘sun’, ‘water’ and ‘soil’ and it supports the rest of the industries. In our endeavor to enhance production in agriculture we are often disturbing the nature and that has necessitated a change in our approach to practice ‘sustainable agriculture’. I am sure deliberations in this webinar will give insights into innovations needed for sustainable agriculture.

Dr. K. N. Guruprasad
Organizing Chairperson, FSSA, VAKSANA-2020



Prof. Vinod Dhar
Convener, FSSA, VAKSANA-2020

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MESSAGE

Shri Vaishnav Institute of Agriculture, Indore under the aegis of Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore has been regular in organizing and conducting its annual feature of conferences/seminars under VAKSANA, which is its conference/seminar logo. This year a two days conference is being held on 21-22 September, 2020. Because of the present pandemic COVID-19 situation, this year's event is being conducted in virtual platform observing the guidelines prescribed by Government of India. Theme of this year's conference is 'Food Security through Sustainable Agriculture (FSSA)' – an International Web-Conference in nature, as we have reached out to global researchers online to deliberate on issue. There are about 15 sub themes, under which the oral and poster presentations will be discussed.

Well, notwithstanding rainbow revolution, India is still home to one-fourth of the world's undernourished and poor people. Further, while the food demand is likely to double by 2050, serious yield and total factor productivity gaps exist in our food and agriculture system. Studies reveal that, with the business as usual, in face of the declining land, water and biodiversity resources and the intensifying volatilities of climate change and markets, by the year 2030, only 59 percent of India's total demand for food and agricultural products will be met. Thus, the challenge is to sustainably produce more from less for more (MLM).

With the above backdrop, the urgency for strengthening our educational standard, graduates employability, and research and extension outcomes are of paramount importance. The thrust on creating trained quality human resources in the Agriculture Sector through the countrywide establishment of State Agricultural Universities (SAUs) under 'The National Agricultural Research, Education and Extension (NAREE) has generated the needed scientists, teachers, researchers, technologists, technologies and technology transfer systems to transform India from Ship-to-Mouth situation to the Right-to-Food status. It is, endeavor of our institute to teach and train our students in this stride.

I wish organizing secretary, coordinators of VAKSANA-2020 and the team all success for this international conference and hope the researchers/delegates will come up with viable solutions in sustaining the crop production along with maintaining quality and resistance to pest parameters.

(Prof. Vinod Dhar)
Convener, FSSA, VAKSANA-2020



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MESSAGE

I heartily welcome all delegates and participants on this auspicious occasion of International Web-conference on **Food Security through Sustainable Agriculture (FSSA), VAKSANA-2020** which is being organized by Shri Vaishnav Institute of Agriculture, Indore, Madhya Pradesh via Zoom Video Conferencing app and Youtube live during September 21-22, 2020.

During COVID-19, this mega event will provide us an opportunity to assemble the learned delegates coming from different parts of our country and abroad via virtual mode and sharing their ideas. Although the conferences are very broad but main focus of this conference is how to overcome the problems that are arising for the development of sustainable agriculture with low expenditure.

I am very thankful to our Chief Patron Shri. Purushottamdas Pasari, Honb'le Chancellor, Patron Prof. Dr. Upinder Dhar, Honb'le Vice-Chancellor, SVVV, Indore, Madhya Pradesh and other committee members of this conference for their valuable support and cooperation during this event.

I am highly grateful to Organizing Chairperson Dr. K. N. Guruprasad, Coordinator, SVIAG, SVVV, Indore, and Convener Prof. Vinod Dhar, Head- Centre for Vocational Studies, SVIAG, SVVV, Indore, M.P. India for their guidance.

I am once again thankful to all esteemed delegates and participants for taking part and enhancing the dignity of this conference and sharing their views on different themes of agriculture, environmental and life sciences for the grand success of this International Web-conference.

(Dr. Yuvraj Arjun Shinde)
Organizing Secretary, FSSA, VAKSANA-2020



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MESSAGE

I am pleased welcome you all for the International Web Conference on theme “Food Security through Sustainable Agriculture” (FSSA) VAKSANA -2020 which is being organized by Shri Vaishnav Institute of Agriculture, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, Madhya Pradesh, India.

The events of conference are targeted towards researchers, professionals, educators and students to share their experience, innovative ideas, issues, recent trends and future directions of sustainable agriculture for food security.

This web conference is unique forum for exchange of innovative ideas on the important theme. It includes keynote address from reputed scientists, paperpresentations by research professionals, academicians, research scholars and poster presentations by students.

The conference has been designed for innovative ideas for sustainable agriculture and we are fortunate to have leading speakers to share their experience and perspectives to achieve smart solution through their innovative ideas

I would like thank special guest, keynote speakers and authors for their support and co-operation.

I would like to thank to our Chief Patron Shri Purushottamdas Pasari Hon`ble Chancellor and Patron Prof. Dr. Upinder Dhar, Hon`ble Vice Chancellor, SVVV, Indore, M.P. and committee members of this conference for their support and cooperation during this event.

I am thankful to Organizing Chairperson Dr. K. N. Guruprasad Coordinator of Shri Vaishnav Institute of Agriculture and Convener Prof. Vinod Dhar , Head –Centre of Vocational Studies Shri Vaishnav Institute of Agriculture, SVVV, Indore, M.P. for their guidance and support to make this conference successful.

I hope that this conference would provide valuable, useful and informative ideas to the participant students, researchers and other experts.

I wish VAKSANA 2020 a grand success.

Chhavi Tiwari

(Dr. Chhavi Tiwari)
Coordinator, FSSA, VAKSANA-2020



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MESSAGE

I am happy to inform that Shri Vaishnav Institute of Agriculture, Shri Vaishnav Vidyapeeth Vishwavidyalaya is organising an International Web-Conference, Vakshna-2020 on theme entitled “Food Security through Sustainable Agriculture (FSSA)”.

Current food production systems that include intensive food products, emission of greenhouse gases continue to exploit and decline natural resources and pollute ecosystems in unsustainable way will affect the capacity of India to produce food for future generations. The situations will be worse for nation when we consider that in future more pressures will be increase due to decreasing natural resources, climate change, growing population, urbanization. So, overcome from these challenges, new approaches and research related to food security is urgent need of an hour to adopt a much broader perspective than food productivity alone without to compromise biodiversity and ecosystem services for future generations.

I hope this International Web-Conference will provide platform for researchers, students and scholars to discuss, make strategy and further implementation to achieve target of food security issues through sustainable way.

I extend my sincere thanks and gratitude to Honourable Vice-Chancellor, Chancellor, Director and Head of Department who promoted and inspired us to organise this program.

I welcome all delegates for being part of conference.

(Dr. Sheshnath Mishra)
Co-coordinator, FSSA, VAKSANA-2020

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Invited / Lead Lecture

Agroforestry towards sustainability: Some Global Examples

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Agroforestry is integration of trees into agriculturally productive landscapes. It is one of the most effective and time-tested ways to compensate the loss of forest/ tree covers. Agroforestry provides products that otherwise will be obtained from already over-exploited forests; increases environmental sustainability; enhances the production of food, fodder, fuelwood, and timber; reduces soil erosion and degradation; supports rehabilitation of degraded lands; enhances soil organic matter; removes atmospheric carbon through sequestration; support biodiversity; and provides many other social, religious, and aesthetic benefits. In fact, role of trees is well recognized to significantly reduce the risk of climate change and make the environment more conducive and sustainable to humans, livestock, and to agriculture. As per Food and Agriculture Organization (FAO 2013) the role of agroforestry in contributing to sustainable development has been recognized globally and is considered as an important component of national adaptation plans of action and nationally appropriate mitigation actions. Further, United Nations Framework Convention on Climate Change (UNFCCC) acknowledges agroforestry as a key mitigation method within the agricultural sector (Smith 2008). Agroforestry is recognized as an effective tool to enhance the resilience to climate change and reduce the carbon footprint of the fast pace development. To achieve their Intended Nationally Determined Contributions (INDCs), 23 countries have recognized agroforestry as priority for mitigation, and 29 for adaptation (<https://ccafs.cgiar.org/agricultures-prominence-indcs-data-and-maps#.Wfa1uohx200>).

On economic front, trees contribute over 10% of the US \$3.1 trillion worth of global GDP created by the agricultural sector (*Annual Report 2016-2017: Harnessing the multiple benefits of trees on farms. World Agroforestry Centre*).

Introduction of compatible trees in the agricultural landscape (on the field boundaries, inter cropping with crops, and on community lands) provide additional and diverse food with less inputs. Compared to trees, annual crops are more susceptible to climate extremes. Thus, intercropping of multipurpose trees with crops reduces farmers' risks against crop failure. A tree can also be sold to arrange anytime cash during any emergency in the form of fuelwood or timber, thus serving as a 'biological ATM'.

A global quantification of the area under agroforestry indicates significant increase both in extent and in number of people involved. Agroforestry is currently practiced on about more than 43% of all agricultural land globally (about over a billion hectares) supporting about 30% of rural population (more than 900 million). Globally, the amount of tree cover on agricultural land has increased substantially. South Asia as well has recorded an increase of 6.7% in trees outside forest.

Success stories from Africa: The Drylands Development Programme (DryDev)

Complementary research has been conducted by ICRAF through Regreening Africa project, which aims to restore 1 million hectares in eight countries: Ethiopia, Kenya, Mali, Niger, Rwanda and Somalia. It is a Farmer-led Program to Enhance Water Management, Food Security, and Rural Economic Development in the Drylands of Burkina Faso, Ethiopia, Kenya, Mali and Niger. It involves above 158,800 farmers (about 40% women) in rehabilitation of more than 87,000 hectares using various watershed treatments, planting of grasses and about 2 million trees. Check dams on streams, sand dams, infiltration trenches/pits, and half-moon micro-catchments were promoted to manage siltation and store underground water.

In Kenya, smallholders in the eastern drylands have been benefiting from innovative approaches to expand farmer-centred restoration options, including introducing new farming techniques initially tested in collaboration with ICRAF and Government partners. The project is just one among many international restoration activities that are underway as part of efforts to meet Goal 15, 'Life on Land' of the Sustainable Development Goals which is aimed at promoting the sustainable use of terrestrial ecosystems, sustainably managing forests, combating desertification, halting and reversing land degradation and biodiversity loss. New agroforestry and crop-diversification techniques have resulted in planting and survival of 30,000 trees across the three counties and farmers continue to embrace the techniques as an effective way to increase food security. The project increased tree survival on farmer's fields from 30 percent to over 80 percent. The challenge to increase tree cover in arid climates was low seedling survival, however, this project has overcome the challenge. The project not only supports the Goals but also feeds into Kenya's aims to restore 5.1 million hectares of land by 2030 under the African Forest Landscape Restoration Initiative (AFR100), which fuels the Bonn Challenge, an international commitment by countries to restore 350 million hectares of the world's deforested and degraded land by 2030.

This success story is spreading by word of mouth throughout Eastern Kenya, Mali, Niger and Ethiopia. Smallholders are benefiting from the approach in which they test various options on their farms, adopting a new way of thinking about farming, adapting the suite of technologies to work best for their particular context and helping them meet challenges as they arise.

Agroforestry contributing significantly in land use and farm income diversification in India

ICRAF with Government of Odisha is implementing "Enabling small holders in Odisha to produce and consume more nutritious food through Agroforestry System" project in Bolangir and Nuapada districts of Odisha. The project area is drought prone and represented by resource-poor small & marginal farmers, with a problem of distress migration and food & nutritional insecurity. The project involves 9,000 farmers with coverage of 5,000 ha area in 149 villages. The Project implementation is in a "System Mode" – through bund plantation,

crop demonstration with agroforestry, nutri-garden, backyard garden, nursery establishment with adequate capacity development and exposure visits. The major interventions are improved package & practices of crops as well fruit plants; introduction of biofortified varieties and short duration legumes in *rabi* season to capture fallow; capacity development of trainers and farmers (both at village and district level); and introduction of hydrogel and sub-surface irrigation; natural resource management based agroforestry practices. In lowland area: Rice based Agroforestry and in Upland Areas: Green gram/Black Gram/Groundnut/Cotton based agroforestry is being demonstrated and upscaled at farm level. About 90,000 saplings have been planted with hydrogel which helps plants to sustain better during hard summer season and reduces water requirement. Despite high rainfall (1200-1600 mm), poor availability of sub-surface water for *Rabi* cultivation is one of the major causes of migration in Odisha. Introduction of agroforestry based NRM practices are providing a solution leading to reduction in migration.

Some agroforestry success stories

During 2014, India took lead in formulation and implementation of the world's first National Agroforestry Policy. South Asia Regional Program (SARP) of ICRAF played important role as a technical partner in its development; and now is involved in its implementation. (<http://www.indiaenvironmentportal.org.in/files/file/Agroforestry%20policy%202014.pdf>/<http://www.worldagroforestry.org/publication/national-agroforestry-policy-india-experiential-learning-development-and-delivery-phases>). ICRAF is one of the members of the Inter-ministerial Committee which supervises implementation of the policy; and is also a member of the Technical Group that supports Sub-Mission on Agroforestry.

Tremendous success of India's agroforestry policy in increasing awareness about the benefit and potential of agroforestry; removal of legal hurdles in planting, felling and transporting agroforestry products (mainly timber and wood); and in channelizing huge resources to mainstream agroforestry in the national agenda has caused ripple effect in the South Asia region and beyond. Recently, ICRAF worked with the Ministry of Agriculture Development, and with the Ministry of Forest and Environment of Nepal to develop the National Agroforestry Policy of the country, which was approved and launched by the Minister of Agriculture during July 2019. ICRAF has also worked with South East Asian countries (ASEAN) to develop their AF Strategy. (<http://www.worldagroforestry.org/region/sea/publications/detail?pubID=4392>).

In India, annual production of timber from trees outside forests (TOF) is about 74.5 million cum (FSI, 2017), and bulk of it comes from agroforestry. Major raw materials to about 26,500 wood based industries in the country are also provided by agroforestry. One of the best examples of timber-based agroforestry success comes from Haryana. The Yamunanagar city in Haryana has emerged as the biggest market of farm-grown wood in the country with 205 plywood industrial units manufacturing wood products worth INR 5,000-6,000 crore annually providing direct and indirect employment to about 1 lakh people. The district alone produces about 45% plywood of the country which has helped it earning the

title of country's 'plywood capital' (A booster dose needed in agroforestry, Haryana Tribune, 18.01.2020, Chandigarh).

Agroforestry is contributing significantly in land use and farm income diversification helping both, the farmers and industries. One of the most important successes of agroforestry in India is the fact that the country currently fulfils about 70% of its timber needs through agroforestry which is valued at about more than Rs. 14,000 crores annually (SoujanyaShrivastava and Ajay Kumar Saxena 2017). Agroforestry has contributed to increase the green cover of India (ISFR, 2017) which in turn provides several environmental benefits (addition of oxygen and removal of carbon from the atmosphere). Both are priceless and hard to put a Rupee value on these. Based on an assessment, the average rate of return on investment in agroforestry in terms of Cost: Benefit ratio varies from 1: 2.4 to 4.17 which is high (Planning Commission, Govt. of India, 2001).

The way forward

Adopting agroforestry by the farmers is a sensible solution for achieving sustainability by optimizing the farmland diversification for meeting the demand of food, nutrition, energy, employment, wood, pulp and other industrial products. This can be achieved by focusing on following areas,

- Utilization of abandoned agriculture land for agroforestry
- Targeting increasing livelihood, reducing poverty, creating local employment, increasing income for women and youth and reducing migration,
- Empowering women through agroforestry interventions, changing role of women from 'employee' to "employers", and reducing drudgery for women and children,
- Promoting small businesses, value chains, and sustainable development through agroforestry,
- Creating awareness and monetizing ecosystem services, increased green cover, climate resilience, improved quality of life,

To realize the full potential and benefits of agroforestry, there is an urgent need and demand to sensitize the policy makers and other stakeholders and strengthen their capacities for mainstreaming agroforestry in the country's development agenda.

Biofortified wheat for achieving food and nutrition security in South Asia



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Abstract

The current and future trends in population growth and consumption continue to increase the demand for wheat, a key cereal for global food security. Wheat products are an important source of essential macro- and micro-nutrients in human diet. About 2 billion people are deficient in some essential micronutrients including zinc (Zn) and iron (Fe); the magnitude is particularly severe among children, pregnant, and lactating women. Wheat is the second largest produced cereal in India with over 107 million tons during 2019-20 season. It is a primary food staple consumed in India, although consumption varies widely by State. Therefore, biofortified wheat is potentially an ideal vehicle for delivering increased quantities of Zn to young children and their mothers in those States where wheat is a primary staple. The conventional breeding strategies have been successful in introduction of novel alleles for grain Zn that led to release of competitive Zn enriched wheat varieties in South Asia. The major challenge over the next few decades will be to maintain the rates of genetic gains for grain yield along with increased grain Zn concentration to meet the food and nutritional security challenges. Therefore, to remain competitive, the performance of Zn-enhanced lines/varieties must be equal or superior to that of current non-biofortified elite lines/varieties. Since both yield and Zn content are invisible and quantitatively inherited traits except few intermediate effect QTL regions identified for grain Zn, increased breeding efforts and new approaches are required to combine them at high frequency in CIMMYT's elite germplasm, ensuring that Zn levels are steadily increased to the required levels across the CIMMYT breeding pipeline. The addition of Zn as a core trait will require a significant acceleration in the breeding cycle, expanding population sizes, extensive phenotyping for Zn, yield testing, phenotyping for biotic and abiotic stresses, genotyping, molecular-assisted selection and genomic selection. While continuing to increase agronomic performance, high Zn alleles will be added as a core trait and the Zn content will be increased in breeding lines annually along with the frequency of elite lines with high Zn with potential to be released by partners.

Keywords: Wheat, genetic diversity, yield gain, genomic selection, nutritional quality

Micronutrient deficiency or “hidden hunger” affects more than two billion people globally and is particularly prevalent in the poorest rural communities in developing countries, where people do not have access to and/or cannot afford a more nutritious diversified diet. Grain zinc (Zn) and iron (Fe) are essential micronutrients, which supplied through wheat can reduce the urgent issue of micronutrient deficiency for about 2 billion people (WHO, 2018). The magnitude of Fe and Zn deficiency is particularly severe among children and pregnant and

lactating women (Black et al. 2013). Biofortified wheat with increased grain Zn and Fe has several potential advantages as a delivery vehicle of Zn and partially for Fe through wheat in South Asia, and the Zn enriched wheat can provide upto 50% of daily recommended allowance for humans (Sazawal et al. 2018). Most of the wheat produced in the targeted regions is milled locally, and the use of whole grain wheat flour in food products allows retaining most of the zinc in the grain as these minerals are concentrated in the outer layer of the grain. The consumers in South Asia and Ethiopia prefer flatbreads, such as *chapatti*, *roti*, *nan*, and other whole grain products including porridge.

Wheat (*Triticum aestivum* L.) is the world's most important crop species, grown on an area of over 225 million hectares and now yielding almost 740 million tonnes annually (FAO, 2019). Importantly, there has been a steady and highly significant increase in wheat yields, largely due to the release of new improved varieties. Since the early 1960s there has been little increase in the area sown to wheat, but over the same period, yields have increased almost 3-fold. While much of this increase has been through improved agricultural practice, the breeding of new varieties has been crucial. The major challenge over the next few decades will be to maintain these rates of improvement, and the application of the remarkable advances made in molecular genetics and biotechnology over the last decade to wheat improvement is clearly a key strategy in achieving this.

In recent years, changes in population trends, eating habits, and economic and socio-economic conditions, especially in Africa and Asia have resulted in an increased demand for nutritious healthy diets. Therefore, biofortified wheat with enhanced Zn and Fe concentration could supply essential micronutrients such as Zn, Fe, Mn, Mg, Ca and vitamin B and E. In addition, continuous yield gain is paramount to feed the growing global population along with tolerance to climate changes and disease resistance combined with good agronomy can potentially improve the productivity to meet the future demands. The wheat biofortification breeding program at CIMMYT has made significant progress over the past 10 years focusing on improving grain Zn and Fe concentrations along with reducing phytic acid content for improved bioavailability in humans (Velu et al., 2014). Wheat is probably the crop with more genetic resources available in its secondary and tertiary gene pools. Among these genetic resources there are landraces, the old local varieties and recreated synthetic hexaploid wheats are among the potential source for high Zn and Fe.

Large-scale screening of diverse genetic resources from CIMMYT germplasm bank and other sources have shown that there is significant genetic variability for Zn and Fe content in some wheat gene pools from primitive wheats, wild relatives and landraces, indicating that Zn content is amenable to rapid breeding progress. Landraces and wild relatives of common wheat such as *Triticum spelta*, *T. dicoccon* and *T. turgidum* based synthetics that had the highest levels of Zn and Fe were used by us in targeted transfer using limited backcrossing into elite breeding lines (Ortiz-Monasterio et al. 2007).

Significant progress has been made in the past decade in transferring high-zinc alleles from these sources into elite breeding lines through selection in relatively large segregating populations grown in Toluca and Ciudad Obregon environments in Mexico. Elite high Zn lines combining high Zn (and Fe), comparable yield potential, disease resistance, stress tolerance and quality were identified; some released in India, Pakistan, Bangladesh, Mexico and Bolivia already.

Genetic diversity and targeted breeding:

Large-scale screening of diverse genetic resources from CIMMYT germplasm bank and other sources have shown that there is significant genetic variability for Zn and Fe content in some wheat gene pools from primitive wheats, wild relatives and landraces, indicating that Zn content is amenable to rapid breeding progress. Landraces and wild relatives of common wheat such as *Triticum Spelta*, *T. dicoccon* and *T. turgidum* based synthetic that had the highest levels of Zn and Fe were used by us in targeted transfer using limited backcrossing into elite breeding lines (Velu et al., 2014; 2019).

Current breeding approach:

Significant progress has been made in the past decade in transferring high-zinc alleles from these sources into elite breeding lines through selection in relatively large segregating populations grown in Toluca and Ciudad Obregon environments in Mexico. Elite high Zn lines combining high Zn (and Fe), comparable yield potential, disease resistance, stress tolerance and quality were identified; some released in India, Pakistan, Bangladesh and Bolivia already (Singh and Govindan, 2017).

The targeted breeding focused on simultaneous enhancement of high yield and enhanced Zn concentration has become the key objective after achieving success from the proof-of-concept approach. Each year about 400-500 simple crosses are made between elite high/moderate Zn lines, and between elite high Zn lines and best lines with normal Zn. Three-way crosses, or single back-crosses (BC1), are also made with a high yielding parent. The BC1/F1 Top and other segregating populations are shuttled between Obregon and Toluca field sites as described in breeding pipelines. In all generations, plants are selected for agronomic traits and disease resistance (all three rusts, Septoria tritici blight), 1-2 spikes from selected plants harvested as bulk, plump bold grains retained for advancing to next generation. Selected plants in the F4/F5 generations are harvested individually, selected for grain traits and grown as F5/F6 small plots for phenotyping. Lines retained for agronomic traits and disease resistance are harvested, selected for grain characteristics and grain Zn and Fe concentration determined using XRF machine. High Zn carrying F5/F6 lines are advanced to stage 1 replicated yield trials at Obregon in the Zn-homogenized fields, which has shown good prediction of grain Zn in South Asia and other TPEs. Lines that yield similar or better than the checks in stage 1 yield trials are analyzed for grain Zn and Fe, and selected lines analyzed for end-use processing quality. Line in stage 1 yield trials are also simultaneously phenotyped for resistance to Ug99 and yellow rust at Njoro, Kenya-off season, and the lines

retained from Obregon trial again in the main-season. Seed multiplication of retained lines then conducted in El Batan while they are also phenotyped for rusts and other diseases.

The competitive high Zn lines combined with key agronomic traits are distributed to NARS partners in South Asia and other TPEs. This led to identification and release of competitive high Zn varieties in TPEs. There are quite a few high Zn wheat varieties released in target countries of South Asia and beyond and adapted by >0.5 million smallholder farmers.

Challenges and opportunities:

The major challenge over the next few decades will be to maintain the rates of genetic gains for grain yield along with increased grain Zn concentration as well as to close the yield gap of 4-6% between non-biofortified vs biofortified lines. Therefore, to remain competitive, the performance of Zn-enhanced lines/varieties must be equal or superior to that of current non-biofortified elite lines/varieties, to ensure that smallholders will adopt them. Since both yield and Zn content are invisible and quantitatively inherited traits except few intermediate effect QTL regions identified for grain Zn, increased breeding efforts and new approaches are required to combine them at high frequency in CIMMYT's elite germplasm, ensuring that Zn levels are steadily increased to the required levels across the CIMMYT breeding pipeline.

The addition of Zn as a core trait will require a significant acceleration in the breeding cycle, expanding population sizes, phenotyping for Zn, yield testing and expanded land use, phenotyping for biotic and abiotic stresses, genotyping, molecular-assisted selection and genomic selection. While continuing to increase agronomic performance, high Zn alleles will be added as a core trait and the Zn content will be increased in breeding lines annually along with the frequency of elite lines with high Zn with potential to be released by partners.

In addition, heterogeneity within experimental plots for available soil Zn remains bigger challenge. At our experimental fields at Ciudad Obregon has been optimized using soil application of Zn fertilizers over the years. Similar approaches will be followed in key sites in TPEs to optimize and improve the homogeneity for available soil Zn, which in turn helps in identification of lines with better genetic potential to accumulate more Zn in grain.

Gene discovery and marker development:

Several genetic and QTL mapping experiments at CIMMYT and other published research have shown that inheritance of grain Zn (and Fe) is governed by small-to-intermediate-effect QTL of additive effects. The additive and additive x additive gene actions for the selection traits will allow the continuous addition of high grain Zn in high-yielding backgrounds by crossing the best elite lines from the current high Zn breeding lineage with the best elite high-yielding lines. Previous studies by CIMMYT and NARS partners have identified promising larger-effect QTL regions for increased grain Zn on chromosomes 2B, 3A, 4B, 5B, 6B and 7B; and some QTL regions have a pleiotropic effect for grain Fe. Moreover, 2B and 4B QTL had a pleiotropic effect for increased thousand-kernel weight (TKW), suggesting that a simultaneous improvement of grain Zn and seed size is possible.

Based on our previous and ongoing studies, four promising QTL have been identified that have the potential to be used in forward breeding. These QTL showed significant effect for grain Zn when combined in adequate genetic backgrounds. Further progress is possible by accumulating the additive effect QTL dispersed across lines into elite germplasm through marker-assisted breeding. We will implement forward breeding by taking advantage of the rapid cycling pipeline to simultaneously introgress *QGzncpk.cimmyt-3AL* and *QZn.Across_4BS* in high Zn and normal zinc elite lines, further increasing Zn concentrations. This will aid the development of new parental sources for the RCRS pipeline to close the observed yield gap between high Zn and normal elite lines. Once the QTL have been introgressed, the developed markers associated to them can be included in the genomic prediction models as fixed effects, and the rest of the markers as random effects.

Future breeding approach: Novel approaches for mainstreaming:

The moderately high heritability and significant positive association between environments for grain Zn concentrations under diverse target environments, the lack of associations between grain yield and grain Zn, combined with favorable associations between grain Fe and Zn densities, should permit efficient breeding for nutritious and high-yielding wheat varieties. Since both yield and Zn content are polygenic traits, increased breeding effort and new approaches are required to combine them at high frequency in CIMMYT's elite germplasm, ensuring that Zn levels are steadily increased across the CIMMYT breeding pipeline. This will be achieved by implementing increased population size, Zn screening across the program and reducing breeding cycle times allowing simultaneous gains for Zn and grain yield together. This will allow all CIMMYT breeding lines distributed globally will exceed the yield level of current varieties and meet the Zn biofortification target of 36 ppm, about 40% above current levels, within 10 years.

The proposed approaches to mainstream grain Zn in wheat breeding involves:

- Increase the number of crosses and population size from crosses generated with high Zn elite parent with best elite parent and identify transgressive segregants for high yield and high Zn using traditional shuttle breeding pipeline (4 years scheme)
- Selection of best recipient elite parent for high yield with known 'Identity by Decent (IBD)' segments or haplotypes for yield and Zn and then cross with best high Zn elite parent advance through Rapid Bulk Generation advancement (RBGA) using greenhouse and field facility (3 years scheme) and look for best transgressive segregants with high yield and high Zn.
- Rapid cycle recurrent selection (RCRS) approach of high Zn elite x best elite crosses advanced in the greenhouse and GEBV's calculated for the progenies and progeny lines with highest GEBV for Zn and yield will be recycled as a population improvement approach (2 years recycling time). Though the mean levels of Zn and yield potential among the populations increased over 2-3 cycles of a recurrent selection scheme, the resulting progenies will have to be fixed for disease resistance and processing quality to ensure release in targeted countries.

In order to achieve above mentioned breeding schemas we are in the process of generating genotypic data for high Zn wheat lines and training populations specific for biofortification breeding will be generated within next 2-3 years. Prediction models developed using novel statistical genetic models (ex. GBLUP) incorporating all the available genomic and phenomic information, will be validated and utilized in the RCRS breeding pipeline for selection of potential parents and progenies with high breeding values for Zn and grain yield, to accelerate higher genetic gains for grain Zn and grain yield simultaneously. For instance, genomic predictions for Zn and Fe were moderately high ($r= 0.4$ to 0.6) across locations in Mexico and India using the association mapping panel from biofortification program (Velu et al. 2016). Therefore,GS models for these traits could also be built for selecting parents; however, it could slow down the progress for yield and high Zn.

The options are to a) use the trait pipeline to introgress disease resistance genes in high value elite lines/parents, b) go through a breeding cycle using the rapid bulk generation advancement scheme (RBGA), or c) use CIMMYT's current shuttle breeding pipeline. In addition, to accommodate increased number of lines for high Zn pipeline, large area is being optimization of available soil Zn at the Ciudad Obregon site is underway.

In addition, Wheat biofortification program requires fast, accurate and inexpensive methods of identifying nutrient dense genotypes. The energy-dispersive X-ray fluorescence spectrometry (EDXRF) has been standardized to screen Zn and Fe concentrations in whole grain wheat samples. The capacity for EDXRF analysis will be doubled with additional EDXRF equipment in Obregon.

Pollination crisis-A threat to global food security

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Abstract

Pollination is one of the most essential components in the pollination of field /fruit crops and natural ecosystems. About one third of human diet directly or indirectly depends upon pollinators services which are essential for orchard, horticultural and forage production. The first step in getting a fruit/field crop is having sufficient pollination. Without pollen transfer all other management practices are meaningless. Adequate and sustained pollination helps stabilize fruit set from year to year. A number of fruit, vegetable, fodder, oilseed and other commercial crops differ greatly in their pollination requirements. Birds, bees, bats and other species that pollinate plants life are declining at alarming rate which has threatened the existence of plant life and this downward trend could damage dozens of commercially important crops. A decline in pollinator populations is one form of global change that actually has credible potential to alter the shape and structure of terrestrial ecosystems. The decline in pollinator population and diversity presents a serious threat to agricultural production and conservation and maintenance of biodiversity in many parts of the world. One indicator of the decline in natural insect pollinators is decreasing crop yields and quality despite necessary agronomic inputs. This paper discusses the world scenario on the causes of pollinator decline and future strategies to overcome the impending crisis.

Conservation agriculture for sustainable food security in India

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The population explosion post 1970s was primarily driven by the agriculture development coupled with good health care facilities. The health care facilities reduced the mortality rate while increased population was well fed to remain alive and contributed towards societal development. The food grain production in the country increased continuously due to introduction of high yielding varieties, plant protection chemicals, fertilizer and expansion of irrigation facilities. This made our farmers prosperous and food security of poor people ensured at affordable prices. At the same time, this have created a great pressure on the natural resources as the many of faulty agricultural practise and deployment of the crops in non-traditional areas with our proper planning raised serious environmental concerns. However the glory of the past is likely to be unstable in the scenario of declining water table in some of the high productive areas of western Indo-Gangetic Plains (IGP) and peninsular India is alarming and lead to creation of dark zones. This has become matter of concern for the present rice-wheat in IGP and rice-rice in peninsular India. The soil sickness, fading organic carbon, multiple nutrient deficiency, build up of insect-pest and disease which lead to decrease in input use efficiency and are the major challenges for the sustainability of modern agriculture. It is further aggravated by the fast-changing climatic conditions having aberrant weather conditions, which pose a serious threat to the sustainability farming in the world and India in particular. The excessive tillage operation enhances the production cost and carbon oxidation and thus causes economic and soil health losses. The increased area and production may have a threat to nutrient mining due to high nutrient removal with biomass and thus may make the future maize farming under threat. The reduction of the diesel consumption in agriculture and enhancement of soil carbon in soil could arrest the escalating burden of the environmental footprints and sustainability.

For meeting the future food with sustainable natural resources the practices for food production also to be sustainable. The growing of the crop must keep our soil healthy and environment clean. The present practise of excessive tillage and residue burning or removal can be preplaced with sustainable crop production practices. Thus, there is need to have best bet crop production practices involving conservation agriculture (CA) which involves best residue management strategy and could be a solution for sustainable crop production.

The key elements of CA have direct and indirect bearing on the nutrient supplying/availability of soil that are described as below:

A. Minimal mechanical soil disturbance: The mechanical disturbance of the soil is completely avoided expect for sowing purposes and sowing implement or process also must

open soil minimally. The mechanical weeding also to be avoided in CA and uprooting to be practiced. The key benefit of this practice are as follows:

- It allows the residue to be remain over soil surface which is a key for success of CA.
- Moderates/decreases organic-matter oxidation and enhanced soil carbon sequestration.
- Limits re-exposure of weed seeds and their germination.
- Optimum proportions of respiration gases in the rooting-zone.
- This also decreases movements of weed propagules from one place to another in field specifically of perennial weeds.
- Mycorrhizal network developed in the soil proliferate in the soil without mechanical losses that enhances plant access to water and nutrient outside their forage areas.

B. Permanent covering of sufficient organic matter over the soil surface: The minimal 30% coverage of the residue over the soil surface gives towards the natural environment in the agro-ecosystems. The use of live mulch and crop residue retention on soil surface using special mulch tillage techniques or practices is an important component of CA. *In situ* mulch formed by the residue of a dead or chemically killed cover crop left in place is generally becoming an integral component of mulch tillage techniques that provides favorable microclimate for the crop growth and development and avoids extremes. Evaporation loss from the maize crop field can be arrested by covering the soil with organic farm waste like straw or retention of crop residues. Beside dead organic materials of crops sown live mulch maize are *Sesbania*, sunnhemp, greengram, blackgram, etc. Whatever amount of residue of no use for animal or human to be kept in field mostly as anchored (standing) to facilitate crop sowing and enhanced soil biological activities. The advantages of mulching in CA are as follows:

- Buffering against severe impact of solar radiation and rainfall due to moderation of microclimate and it maintain/moderate soil temperature
- Reducing soil erosion and less salt accumulation on soil surface
- This act as a substrate for soil organisms' activity and thus enhances soil biological wealth.
- The residue also enhances surface and underground soil faunal activity and mites that helps in enhancing natural enemies of pest and diseases.
- Act as a layer for protecting soil moisture losses caused by evaporation specifically at early crop growth stages.
- The better soil moisture condition enhances soil nutrient availability and uptake for crop.
- Smothering of weeds causes their lesser infestation in crop due to mulching effect.
- The biopore developed by residue and biological activities facilitate water movement by increased hydraulic conductivity and infiltration rate.

C. Profitable sustainable crop rotation: Cropping sequences and rotations that include legumes are desirable for CA based system.

- Minimal rated of build-up of populations of pest species, through life cycle disruption;
- Biological N-fixation in appropriate conditions, limiting external costs:
- Prolonged slow-release of such N from complex organic molecules derived from soil organisms;
- Range of species, for direct harvest and/or fodder;
- Soil improvement by organic-matter addition at all depths reached.

Benefits of CA

For wider adoption of any technology, the stakeholders interested in the possible advantages he/she is going to harvest by adoption of a technology. The CA is a technology that provides various visible and non-visible benefits over conventionally tilled agriculture. The CA based crop management practices provided multiple benefits of soil health, environment, economic return for a perfect sustainable agriculture (Fig. 1).

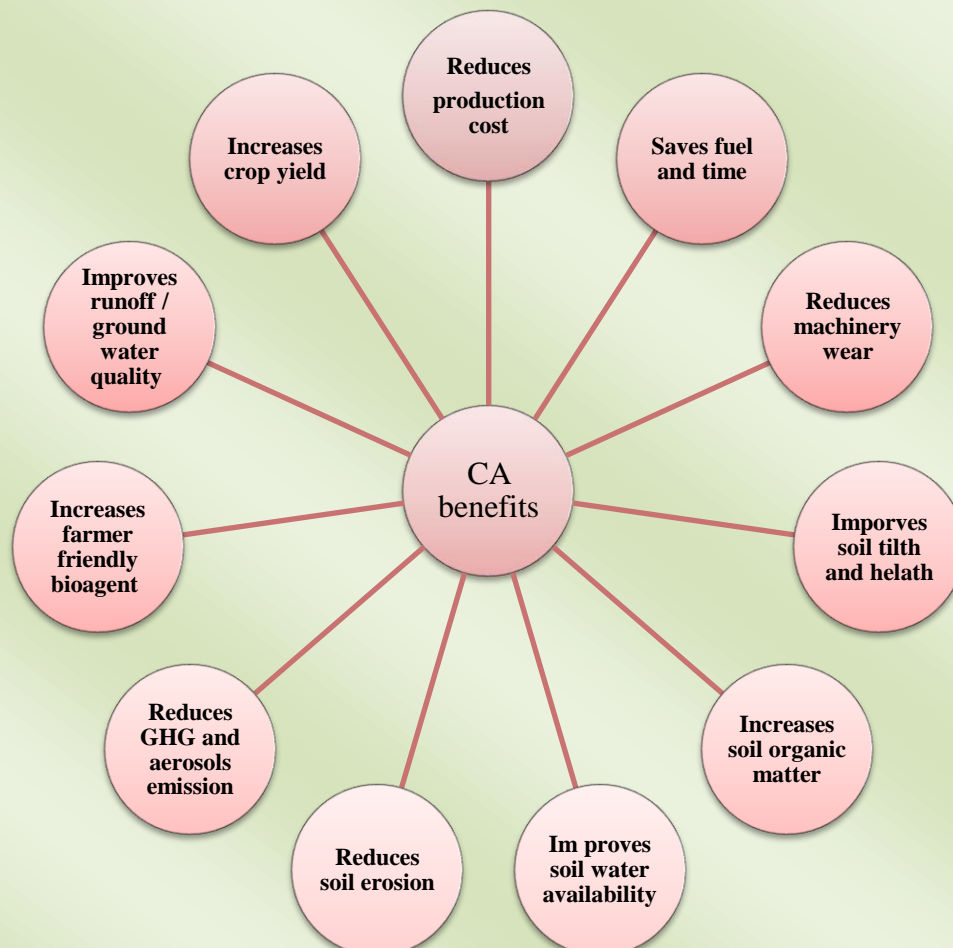


Fig. 1. Top 11 conservation agriculture benefits.

The benefits accrued due to CA can be grouped as economical, agronomic and environmental as follows:

A. Economic benefits: The positive impact of conservation agriculture on the distribution of labour during the production cycle and, even more important, the reduction in labour requirement are the main reasons for farmers in Latin America to adopt conservation

agriculture, especially for farmers who rely fully on family labour. The three major economic benefits can result from CA adoption improve production efficiency are:

1. Time saving and thus reduction in labour requirement.
2. Reduction of costs, e.g. fuel, machinery operating costs and maintenance, as well as a reduced labour cost.
3. Higher efficiency in the sense of more output for a lower input.

B. Agronomic benefits: The constant addition of crop residues leads to an increase in the organic matter content of the soil. In the beginning, this is limited to the top layer of the soil, but with time, this will extend to deeper soil layers. Organic matter plays an important role in the soil. The fertilizer use efficiency, water-holding capacity, soil aggregation, rooting environment and nutrient retention all depend on organic matter.

Adopting conservation agriculture leads to improvement of soil productivity by:

- Organic matter increase: The CA enhances soil.
- In-soil water conservation.
- Improvement of soil structure, and thus rooting zone.

C. Environmental and social benefits that protect the soil, environment and make agriculture more sustainable.

- Residues on the soil surface reduce the splash-effect of the raindrops, and once the energy of the raindrops has dissipated the drops proceed to the soil without any harmful effect. This results in higher infiltration and reduced runoff, leading to less erosion.
- The residues also form a physical barrier that reduces the speed of water and wind over the surface. Reduction of wind speed reduces evaporation of soil moisture.
- Greater infiltration should reduce flooding, by causing more water storage in soil and slow release to streams. Infiltration also recharges groundwater, and thus increasing well supplies and revitalizing dried up springs.
- The lesser soil erosion reduces sedimentation and indirectly reduces maintenance costs of drinking water treatment, dams and hydroelectric power plant.
- Improvement of run-off and ground water quality as residue hold the harmful agrochemical which degrades by photo and biological degradation.
- Improvement of air quality due to reduction in aerosols and GHG emission specially carbon dioxide.
- It enhances the biodiversity and density as soil microbes (bacteria, virus, fungi etc) and friendly faunal diversity (Colembela, mite, betel, entomopathogenic nematode, ant, termite etc).
- Carbon sequestration: Systems, based on high crop residue addition and no tillage, accumulate more carbon in the soil, compared to the loss into the atmosphere resulting from plough-based tillage. This could have profound consequences in the fight to reduce green house gas emissions and enhanced carbon sequestration into the atmosphere and thereby help to forestall the calamitous impacts of global warming.

Adoption of CA in the world

The CA has adopted over 180 m ha in 79 countries that accounts for 12.5% of worlds cropped area (Table 1). The main driving force at farm level was cost saving, flexibility in time of planting, less water requirement and favorable support from government. To potentially make the Indo-Gangetic Plains (IGP) productive in a sustainable manner, conservation agriculture (CA) has to be effectively adopted and out scaled into the existing agricultural system (Jat et al., 2016). However, the adoption of the CA in India is still very less (1.5 m ha) as it was targeted in a limited number of the cropping systems.

Table 1. Adoption of CA in the world. (Kassam et al., 2019)

S No.	country	CA area M ha 2008/09	CA area M ha 2013/14	CA area M ha 2015/16
1	USA	26,500.00	35,613.00	43,204.00
2	Brazil	25,502.00	31,811.00	32,000.00
3	Argentina	19,711.00	29,181.00	31,028.00
4	Canada	13,481.00	18,313.00	19,936.00
5	Australia	12,000.00	17,695.00	22,299.00
6	Paraguay	2400.00	3000.00	3000.00
7	Kazakhstan	1300.00	2000.00	2500.00
8	China	1330.00	6670.00	9000.00
9	Bolivia	706.00	706.00*	2000.00
10	Uruguay	655.10	1072.00	1260.00
11	Spain	650.00	792.00	900.00
12	South Africa	368.00	368.00*	439.00
13	Germany	354.00	200.00	146.00
14	Venezuela	300.00	300.00*	300.00#
15	France	200.00	200.00*	300.00
16	Finland	200.00	200.00	200.00
17	Chile	180.00	180.00*	180.00#
18	New Zealand	162.00	162.00*	366.00
19	Colombia	102.00	127.00	127.00#
20	Ukraine	100.00	700.00	700.00#
21	Italy	80.00	380.00	283.92
22	Zambia	40.00	200.00	316.00
23	Kenya	33.10*	33.10	33.10#
24	United Kingdom	24.00	150.00	362.00
25	Portugal	25.00	32.00	32.00#
26	Mexico	22.80	41.00	41.00#
27	Zimbabwe	15.00	90.00	100.00
28	Slovakia	10.00	35.00	35.00#
29	Sudan	10.00	10.00*	10.00#
30	Mozambique	9.00	152.00	289.00
31	Switzerland	9.00	17.00	17.00#
32	Hungary	8.00	5.00	5.00#

33	Tunisia	6.00	8.00	12.00
34	Morocco	4.00	4.00	10.50
35	Lesotho	0.13	2.00	2.00
36	Ireland	0.10	0.20	0.20
37	Russia	-	4500.00	5000.00
38	India	-	1500.00	1500.00#
39	Malawi	-	65.00	211.00
40	Turkey	-	45.00	45.00
41	Moldova	-	40.00	60.00
42	Ghana	-	30.00	30.00#
43	Syria	-	30.00	30.00#
44	Tanzania	-	25.00	32.60
45	Greece	-	24.00	24.00#
46	Korea, DPR	-	23.00	23.00#
47	Iraq	-	15.00	15.00#
48	Madagascar	-	6.00	9.00
49	Uzbekistan	-	2.45	10.00
50	Azerbaijan	-	1.30	1.30#
51	Lebanon	-	1.20	1.20#
52	Kyrgyzstan	-	0.70	50.00
53	Netherlands	-	0.50	7.35
54	Namibia	-	0.34	0.34#
55	Belgium	-	0.27	0.27
56	Pakistan	-	-	600.00
57	Romania	-	-	583.82
58	Poland	-	-	403.18
59	Iran	-	-	150.00
60	Estonia	-	-	42.14
61	Czech republic	-	-	40.82
62	Austria	-	-	28.33
63	Lithuania	-	-	19.28
64	Croatia	-	-	18.54
65	Bulgaria	-	-	16.50
66	Sweden	-	-	15.82
67	Latvia	-	-	11.34
68	Uganda	-	-	7.80
69	Algeria	-	-	5.60
70	Denmark	-	-	2.50
71	Slovenia	-	-	2.48
72	Bangladesh	-	-	1.50
73	Swaziland	-	-	1.30
74	Tajikistan	-	-	1.20

75	Vietnam	-	-	1.00
76	Cambodia	-	-	0.50
77	Laos	-	-	0.50
78	Luxemburg	-	-	0.44
79	Cyprus	-	-	0.27
Total		106,505.23	156,738.96	180,438.64

*2013/14 values taken from 2008/09; #2025/16 values taken from 2013/14; Source: 2008/09 and 2013/14 estimates.

CA benefits in various cropping systems:

Less soil disturbance reduces germination and emergence of *Phalaris minor* (Gulli danda). Field trials have indicated that *Phalaris minor* population is reduced by nearly 40% in the first year of zero tilling as compared with conventionally tilled fields. The adoption of CA in maize has led to enormous benefits in improving resource use efficiency, crop productivity, profitability and soil health parameters in various agro-ecologies in India. In permanent bed plots, residue retention reduced the water requirement by 50–55 ha-mm, and improved water productivity by 9.4–27.6%, 17.7–30.4%, 21.7–42.6% and 33–57.2% in maize, wheat, mustard and mungbean, respectively compared to no residue plots (Jat et al., 2019). Retention of the residues is very important for CA success as a 4-year study showed that crops planted on the permanent bed with crop residue (PB+R) registered 11.7% increase in system productivity compared to PB without residue (PB–R) (Jat et al., 2019a).

In a long-term study on CA initiated by ICAR-IIMR with four maize systems viz., MWMB: Maize-Wheat-Mungbean, MCS: Maize-Chickpea-*Sesbainia*, MMuMb: Maize-Mustard-Mungbean, MMS: Maize-Maize-*Sesbania*. In this study, we analysed the SOC, physical and biological properties of soil at various depths after 7 years of continuous zero-tillage (ZT), permanent bed (PB) and conventional tillage (CT) in diversified maize rotations (Parihar et al., 2016a). Compared to CT plots, the soil physical properties like water-stable aggregates (WSA) > 250 mm were 16.1–32.5% higher, and bulk density (BD) and penetration resistance (PR) showed significant ($P < 0.05$) decline (11.0–14.3 and 11.2–12.0%) in ZT and PB plots at 0–15 and 15–30 cm soil layers. The soil organic carbon (SOC) increased by 34.6–35.3% at 0–15 cm, and 23.6–26.5% at 15–30 cm soil depths with conservation agriculture (ZT and PB) based crop establishment techniques over CT. Similarly, the soil microbial biomass carbon (MBC) under CA-based systems increased by 45–48.9% in 0–30 cm profile depth of a sandy loam (Typic Haplustept) soil. Significant ($P < 0.05$) improvement in soil enzymatic activities i.e., Fluorescein diacetate, dehydrogenase, b Glucosidase and Alkaline phosphatase were also recorded in the CA-based treatments. Significant ($P < 0.05$) synergistic effects of summer legumes (mungbean and *Sesbania*) with winter legume/cereal in crop rotations were observed on SOC, WSA, BD, PR and Ksat at 0–15 and 15–30 cm depths. Thus, this long-term study suggests that CA-based crop management with selected diversified maize-based rotations (MCS and MWMB) can be a viable option for enhancing soil health.

Along with soil health benefits in the above study, it was found that in the initial two years, higher system productivity (maize equivalent yield) was recorded in PB (8.2–8.5 Mg ha⁻¹),

while from third year onwards ZT registered maximum productivity (11.3–12.9 Mg ha⁻¹). The system glucose equivalent yield increased by 0.6 Mg ha⁻¹ under ZT and PB compared to CT. Economic profits from maize-based rotations were invariably higher either in maize-mustard-mungbean (MMuMb) or maize-wheat-mungbean (MWMb) systems. Synergistic effects of summer legumes (mungbean and Sesbania) after winter legume/oilseed/cereal were observed on the yield of individual crop vis-a-vis system productivity and irrigation water use. ZT and PB practices reduced the irrigation water requirement by 40–65 ha-mm and 60–98 ha-mm, respectively compared to CT system, resulted in enhanced system water productivity by 19.4% equally under both ZT and PB. Net profit from the maize-based systems under ZT was up to 31% higher with 72\$ ha⁻¹ lower production cost compared to CT. Results from our study showed that adoption of CA-based tillage practices in MMuMb and MWMb system for sustainable increase of crop and water productivity in the north-western region of India (Parihar et al., 2016).

Deploying CA in India: The availability of machinery and herbicide based weed management methods in major crops like rice, wheat, maize and coarse cereals in recent past made the possibility of CA in India. The effective weed management measures also available in other pulses and oilseeds as well so this system of cultivation can be extended in most of the cropping systems in India. There is a wider choice for the adoption of maize under CA in various cropping system across agro-ecologies in India. The best CA-based cropping systems identified in are given in Table 1.

Table 1. Conservation agriculture-based maize systems in different ago-climatic zones of India (compiled from various sources).

Agro-climatic region	Potential CA-based Cropping system
Western Himalayan Region	Maize-wheat Maize-oat
Eastern Himalayan Region	Summer rice/maize-mustard Maize-maize-legumes Maize-french bean Maize-mustard
Lower Gangetic Plain region	Autumn rice-maize Jute-maize
Middle Gangetic Plain region	Maize-wheat-mungbean
Upper Gangetic Plain region	Maize-mustard-mungbean
Trans Gangetic Plain region	Maize-chickpea
Eastern plateau and hills region	Maize-wheat Maize-chickpea
Central plateau and hills region	Maize-wheat Maize-chickpea
Southern plateau and hills region	Rice-maize Maize-chickpea
East coast plain and hills	Rice-maize-urbean

region	
West coast plain and hills region	Maize-pulses Rice-maize
Gujarat plains and hills region	Maize-wheat Maize-mustard
Western dry region	Maize-mustard Maize-chickpea
Island region	Rice-maize

Growing of crop under CA:

Maize can be successfully grown without any primary tillage under the no-till situation with less cost of cultivation, higher farm profitability and better resource use efficiency. Under such condition, one should ensure good soil moisture at sowing and seed and fertilizers should be placed in-band using a zero-till seed-cum-fertilizer planter with furrow opener as per the soil texture and field conditions. The technology is in place with a large number of farmers particularly under rice-maize and maize-wheat systems in peninsular and eastern India. However, use of appropriate planter having suitable furrow opener and seed metering system is the key to the success of the no-till technology. Happy seeders can be used for seeding the maize under zero-tillage conditions. The seed can also be successfully sown in wet paddy fields by following methods:

- i) **Manual dibbling:** In this method, a row to row spacing of 60cm (24") and plant to plant spacing of 20 cm (8") is maintained by using a rope and holes are made with a hard stick and the seeds are dibbled in the holes at a depth of 1". Majority of the farmers practice manual dibbling. This method involves a cost of Rs.5000-6000 with 12-15 farmers to cover one hectare.
- ii) **By tractor-drawn dibbler:** The maize seed is sown by using a tractor-drawn dibbler. It is locally fabricated implement with 3 to 5 wheels fixed at a distance of 18" to 24" and makes holes at a spacing of 8". With this implement, one can make holes in a one-hectare field within two hours and 6-8 persons will be sufficient to put the seed in the holes. In this method, the cost is reduced by nearly Rs. 2500 ha⁻¹ compared to manual dibbling.
- iii) **Zero- till seed cum ferti-drill:** Nowadays zero-till seed cum ferti-drill having furrow opener and seed metering systems is available. It works with 35 HP tractor and covers an area of 1 hectare in two hours. Both the seed and fertilizer can be sown simultaneously with this implement. The cost of the implement is Rs.60,000/-
- iv) **Turbo happy seeder:** This is a modified, advanced and light weight version of the PAU-ACIAR developed 'Happy Seeder' to plant a crop in presence of loose and or anchored residues. This machine chops the residues in a narrow 5-6 cm wide strip in front of the tines, places seed and fertilizer in the slit opened for placement of seed and fertilizer. This machine is capable of seeding into the loose residue load of up to 8-10 tonnes/ha, distributed uniformly across the field. The machine costs around Rs 2 lakhs.

Effective weed management for CA: Since there is no preparatory tillage, weeds become a serious problem in initial years of maize cropping under conservation agriculture. The initial year's better weed control reduces weed menace in CA maize and thus care should be taken in initial years of adoption. Hence, the weed problem in the initial 2-3 years can be effectively tackled in maize production under conservation agriculture. The selection of early vigour single cross hybrid cultivars also helps in reducing weed losses in maize under CA. The field should always be under cultivation and even if it is not under cultivation weed needs to be controlled in a fallow period to no seed bank development.

A pre-emergence application of Paraquat @ 0.5-0.6 l ha⁻¹ in 500 l of water either one day before the sowing of maize or immediately after sowing will control the regrowth of paddy stubbles as well as monocot weeds. This is to be followed by Atrazine @ 1.0 kg ha⁻¹ in 500 l of water to control broad-leaved weeds effectively for 30-20-30 days for maize, sorghum and pearl millet. If the broad-leaved weeds are found even after one-month post-emergence application of 2, 4-D sodium salt 80% WP @ 2.5 kg ha⁻¹ in 500 l ha⁻¹ will be desirable. At present, use of new herbicide molecule viz., Tembotrione @ 120 ml/ha or Topramezone @ 25.2 g/ha provides effective weed control in maize and can be used up to the knee-high stage of the maize crop for effective weed management. In rice and wheat, a good amount of post and pre-emergence herbicides are available to control the weeds. In rice, pyrazosulfuron, azim sulfuron, bispyribac, fenoxaprop and pendimethalin available for effective weed control. In wheat isoproturon, sulfosulfuron, clodinafop-propargyl and fenoxaprop-p-ethyl should be applied 30-35 days after sowing after pre-emergence application of pendimethalin.

The layering of the component technology with CA using precision input management leads to further gains in benefits of CA. The precision nutrient management taking benefits of the residue recycling and previous crop nutrition with target yield using Nutrient Expert in maize leads to enhanced yield and resource use efficiency (Parihar et al., 2017) The use of sub-surface drip layered in CA proved to be highly beneficial and the resource use efficiency can be enhanced manifold (CIMMYT, 2019). Similarly, full CA-based MMuMb/MWMB system with the use of proper N sources like Neem/ sulphur coated urea as slow-release coated fertilizers could augment the system productivity, resource-use efficiency, farm profitability while sustaining the natural resources in Western IGP in India and other similar agro-ecologies (Jat et al., 2019). Recently, the green seeker guided N application had shown potential to optimize the N application in maize grown in CA that will help in enhancing nutrient optimization in real-time (ICAR-IIMR, 2018 and 2019).

There are various innovations happened in Peninsular India for the adoption of zero-tillage maize (Jat et al., 2009). The wet paddy field after harvest does not allow sowing crop on time, which forced the farmers to adopt the CA, based maize cultivation and the productivity of some districts like Guntur, East Godavari had touched to 10 t/ha and area under ZT maize touched up to 1.5 lakh ha (Jat et al., 2011). The conservation agriculture in maize systems can be taken forward by mass awareness, development of locally suited scale appropriated

machinery and technology demonstrations at the farmer's field for enhancing natural resource sustainability, profitability and soil health in Indian agriculture.

Way forward for CA adoption: The CA adoption in India can be increased by addressing following issues:

- ✧ Customized CA for various agro-ecologies and farm typology
- ✧ Farmer participatory research
- ✧ Videos on the do's, don'ts and benefits
- ✧ Identification of domains by SWOT analysis
- ✧ Strengthening of input management tailored to CA
- ✧ Harnessing interaction of Genotype x Environment x Management interactions
- ✧ Incentive/recognition to farmers adopting it as carbon credit, resource saver
- ✧ Availability of scale appropriate machinery

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Integrated Pest Management of Mango

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Mango (*Mangifera indica* L.) is considered as fruit of excellence and thus has prominent position among commercial fruits grown in India. A Konkan region of Maharashtra is famous for a leading variety 'Alphanso'. The economy of this region is mainly deepened upon the mango crop. The warm and humid climate of this region is most congenial for development of pests and disease. Mango crop is known to be infested by more than 100 of insect pests and diseases.

There are several pests/diseases which limits the production of this crop. Among the insect pests, the mango hopper *Idioscopus niveosparsus* is considered to be the most serious, capable to cause 60-70 per cent yield loss (Godase *et.al.* 2004). Recently, the infestation of mango thrips is found to be increased in few pockets of Konkan. The nymphs and adults lacerate the leaf tissues as well as the panicle, fruit rind and suck the cell sap which oozes out from damaged tissues (Anonymous, 2013).

Among the other important pests, fruit fly, *Bactrocera dorsalis* is important one. The intensity is higher during May – June. Mango shoot borer, *Clumetia transversa* is another important pest of mango observed in Maharashtra. It is active during on the new emerging shoots. The Stem borer, *Batocera rufomaculata* is another dangerous pest observed in Maharashtra which results in to death of the tree, if infestation remains unnoticed. It has been observed that the infestation of mealy bug, *Ferissia24virgata* has been increased during the recent years. Also the infestation of stone weevil, *Sternochetes mangiferae* has noticed on small scale (Chavan *et al.*, 2009).

The infestation of leaf feeding insects like *Monolepta* beetle, leaf cutting weevil – *Deporus marginatus*; leaf eating caterpillar – *Thalassodius dissita* and leaf miner – *Acrocercops syngamma* is increasing on vegetative flush. Also the pests like fruit borer, scale insects, leaf webber and red mites are occasionally causing considerable damage in the recent years (NICRA 2011). Thus to avoid the economical loss it is necessary to know the proper identification, nature of damage and integrated management knowledge of these pests.

Important pests of Mango

1) **Mango hopper:** *Idioscopus clypealis* Leth., *I. niveosparsus* Leth., *I. nagpurensis*
Amritodus atkinsoni Leth., and *A. brevistylus*
(Hemiptera: Cicadellidae)

Marks of identification:

The most serious pest of the mango prevalent all over the country causing heavy damage to mango crop. Of the several species of mango hopper, *I. nagpurensis* is the smallest of all; *I. niveosparsus* is intermediate while *Amritodus atkinsoni* is largest of all. **Adults** measure about 3 to 5 mm in length. It is wedge shaped, grey coloured insect having three black spots on the head and whitish band on the neck. The wings are sloping at an angle over body. Hind legs are well developed in adult which help in taking quick hops. **Nymphs** are smaller than adults and wingless. Both nymphs and adults walk diagonally.

Nature of damage:

Both nymphs and adults suck cell sap from the tender foliage, inflorescence and tender fruits. The tender leaves get twisted and sometimes dries off. The inflorescence becomes weak and shedding of flowers and tender fruits takes place. Also the hoppers excrete honey dew like substance on which saprophytic fungi *Capnodium mangiferum* develops on the sugary secretion giving complete blackish appearance to the plant. This symptom is locally called ‘Khar’ or ‘Chikta’. The photosynthetic activity of plant is hampered because of thick coating of black sooty mould on the leaves. During cloudy weather, the hopper development occurs rapidly

Management

Cultural control:

- ✓ Pruning of dense orchards in the month of December, orchard sanitation and field sanitation, thinning of branches.
- ✓ Avoid dense planting, maintained open canopy; prune overcrowded overlapping branches after rainy season.
- ✓ Avoid excess use of nitrogenous fertilizers.

Biological Control:

Application of bio-agents, *Metarhizium anisopliae* @ 1x 10⁸ cfu/ml or *Beauveria bassiana* @ 10⁸ cfu /ml on tree trunk once during off season and twice at 7 days interval during flowering season. (Gurav, 2012)

Chemical Control:

Schedule of insecticide application for the management of mango hoppers.

Sr. No	Time of Spray	Recommended Insecticides	Quantity of pesticide per 10 lit.	Remark
1	First spray at vegetative flush after monsoon	Deltamethrin 2.8% EC	9 ml	It gives protection from mango hoppers which were occurred after rainy season on new flush.

2	Second spray at bud burst stage	Lambda Cyhalothrin 5% EC	6 ml	For Powdery mildew mix Hexaconazole 5 % EC 5 ml or Sulphur 80 % WP at 20 gm per 10 lits of water. In cloudy weather condition for management of Anthraco se mix Carbendazim 12 % + Mancozeb 63 % at 10 gm per 10 lits. of water.
3	Third spray 15 days after 2 nd spray	Imidachloprid 17.8% SL	3 ml	At the time of 3 rd , 4 th and 5 th spray for management of Powdery mildew
4	Fourth spray 15 days after 3 rd Spray	Thiamethoxam 25% WDG	1 gm	Hexaconazole 5 % EC 5 ml per 10 lits. of water. If Hexaconazole is not available use Sulphur 80 % WP at 20 gm per 10 lits of water. In cloudy weather condition for management of Anthracnose mix Carbendazim 12 % + Mancozeb 63 % at 10 gm per 10 lits. of water.
5	Fifth spray 15 days after 4 th spray	Diamethoate 30% EC Or Lambda Cyhalothrin 5% EC	10 ml 6 ml	
6	Sixth spray 15 days after 5 th spray if necessary.	Insecticide recommended for 5 th spray but not used for the 5 th spray	-	If Mango hoppers crossed ETL level (Need based spray)

(Godase *et.al.* 2001, Godase *et.al.* 2002, Munj *et.al.* 2014, Patil *et.al.* 2003)

**2) Thrips: *Scirtothrips dorsalis*, Hood, *Thrips flaves*, *Thrips hawainis*
(Thysanoptera: Thripidae)**

Adult is yellowish in colour, very small in size measuring about 1 mm in length. Many species are found together. The female lay eggs in the veins on the lower surface of leaves. Eggs hatch out within 3 to 5 days. Nymphal period is 10 to 14 days. Pupation takes place in soil. Infestation is severe during December to February.

Nature of Damage

The nymphs and adults lacerate the leaf tissues as well as the fruit rind and suck the cell sap which oozes out from the damaged tissues. On leaves the infestation is sever on the edges and veins. Due to which the leaf edges turn upward and the leaves drop down during severe incidence. It also attack on inflorescence If attack occurs on fruits, the fruits become shabby,

unattractive with light brown colour, which fetches less price in the market. However, pulp of the fruit remains unaffected.

Management

Spray Dimethoate 30 EC 12 ml/10 lit (No label claim) as and when infestation is noticed. If possible the spray should be given on the backside of the young leaves and on immature fruits. To control the thrips incidence on fruits give spray of Spinosad 45 SC (2.5ml/10 lit.) followed by second spray of thiamethoxam 25 WDG (2gm/10lit.).

3) Mango shoot borer : *Chlumetia transversa* Walk. (Lepidoptera; Noctuidae)

Marks of identification :

Adult is small, blackish grey coloured moth measuring about 8-9 mm in length and 16 to 18 mm in wing expanse. The newly hatched larva is yellowish but as it grows becomes pinkish with some whitish patches on its body.

Full-grown **caterpillar** measures about 16 to 18 mm in length and 2 to 3 mm in breadth.

The **pupae** are light brown to dark brown in colour and measure about 8 to 9 mm in length and 1 to 2 mm in breadth.

Nature of damage :

The larva on hatching enters into the tender shoots by boring through leaf stalk and feed on internal contents. The infested shoots wither and dry up. The presence of larvae inside the shoots can be recognized from the holes present on tender shoots and fresh excreta or fibrous material around the holes. Infested shoots fail to induce flowering. In addition to this, pest also damages flower panicles and flower buds by boring into them and feeding internally. It adversely affects flower induction as well as fruit setting. It is one of the important pests of mango blossom and young seedlings.

Management:

Removal and destruction of infested shoots alongwith larvae.

Larval ectoparasite : *Bracon greeni*

Monitor the newly emerged shoots/panicles for pest infestation and if infestation exceeds 10 per cent immediately spray with Monocrotophos 36 SL (14ml/10 lit.).

4) Fruit fly : *Bactrocera dorsalis* Hendel., *B. zonatus* Saunders., *B. diversus* Coq. *B. tau*, *B. correctus* Bezzi. and *B. hageni* (Diptera: Tephritidae)

Marks of identification:

Adult is 5 mm long, small fly with single pair of transparent out stretched wings and conical shaped yellowish brown abdomen. The brown and grey coloured patches distinguish these flies from others.

Eggs are white, oval and elongated. The **maggots** are dirty white, legless and 12 mm in length when full grown. Body of maggot goes on tapering at one end.

Nature of damage:

Both **adults and maggots** are capable to cause damage. Females with their needle like ovipositor deposit eggs beneath the rind of developing fruits. The incision made while laying eggs serves as entry for fermenting organisms. The maggots on hatching enter inside the fruit and feed on the pulp. As a result of maggot damage and deposition of excreta, brown spots are developed at the site of injury. As the maggots grow inside the brown patch extends. The infested fruits rot quickly and drop down. The late maturing varieties of mango and guava are more susceptible.

Management:

Cultural control

Sanitation of orchard is the most important measure against fruit flies.

Prior to harvest (30-40 days) collect and disposed off infested and fallen fruits to prevent further multiplication and carry-over of population.

The undersized fruits left on the tree should be picked and destroyed.

Ploughing of orchard during November-December to expose pupae to sun's heat which kills them.

If infestation is heavy, bait splash on the trunk only, once or twice at weekly interval is recommended. To prepare bait splash, mix 100 gm of jaggery in one litre of water and add 1 ml of Deltamethrin.

Mechanical control

Install "**Rakshak traps**" developed by Dr. B.S.K.K.V, Dapoli. @ 4 traps/ ha. Keep the traps hanging on the tree above 1 to 3 meter from ground. Methyl eugenol (3 ml/trap) has been used in this trap as fly attractant while any detergent (5gm/lit) is used for killing flies.

Harvest the fruits at 80% maturity.

Physical control

Hot water treatment of fruit at 47 °C for 50 mins for Alponso and 50-60 minutes for Kesar.

Vapour Heat Treatment.

5) Mango stem borer : *Batocera rubus* L., *B. rufomaculata* Deg., *B. roylei* Hope.
 B. numetor and *B. titana* Thoms.

(Coleoptera: Cerambycidae)

Marks of identification :

Adult is stoutly built, dark brown longicorn beetle measuring about 50 to 55 mm in length. Adults possess two large kidney shaped orange spots on the prothorax and a thick spine like projection on its either side. The elytra is decorated with small light orange spots.

Eggs measure about 5.0 to 6.5 mm in length, shining white in colour and oval in shape. The full-grown **grubs** are fleshy, yellowish ivory in colour and 85 to 95 mm in length with well defined segmentations. **Pupae** are yellowish brown to dark brown and measure about 50 to 55 mm in length.

Nature of damage :

After hatching, the immature larva bores into the bark initially and afterwards it enters into the main stem by tunneling through the bark. Due to which stem becomes hollow internally. The gum and frass found exuding from the infested portion. The infested tree leads to death if the infestation remains unnoticed

Management :

Avoid making injury to the main stem.

Do not cut the live branches unnecessarily. If cut, follow swabbing of Clorpyrifos 20 EC (5ml/ lit.).

Observe the tree trunk carefully and if the gum and frass found exuding then find out the live holes from which the frass is exuding. Widen the hole with hand drill, insert a small PVC pipe in it and pour a mixture of Dichlorvos 76 EC (10 ml.) + Kerosene (20 ml.) and then seal the hole.

Destroy the severely damaged and dead trees from the orchard otherwise such trees will act as a reservoir for further spread.

**6) Mango stone weevil : *Sternochetus mangiferae* Fab.
(Coleoptera:Curculionidae)**

Marks of identification :

Adult is short, stoutly built, oval, dark brown weevil measuring about 6 mm in length and 3 mm in breadth. Antennae are 10 segmented. Weevils are found inside the stone. **Eggs** are minute in size and whitish in colour. **Grub** is white, thick, fleshy and legless.

Nature of damage :

The **grubs** on hatching from eggs make their way through the pulp and damage the stone by boring and feeding on its inner content. The pest passes through all the stages of its growth inside the stone. The grubs and adults feed and damage the cotyledons. No signs of infestation are noticed outside the fruit. The discolouration of the pulp adjacent to the stone due to its excreta is often seen when the infested fruits are cut. The pest is not highly injurious to mango fruits but their presence within fruits has rendered them unacceptable to foreign countries. The sweet varieties of mango viz., Alphonso, Bangalora, Neelam, Totapuri etc., are relatively more damaged.

Control measures :

Deep ploughing of orchard to expose the hibernating adults.

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Climate Change and Sustainable Soil Health Management

S. K. Sharma

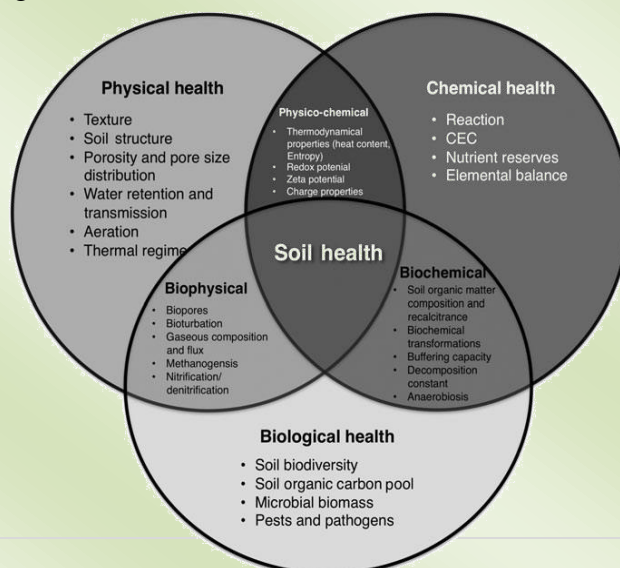
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As a result of climate change, land degradation and losses in biodiversity, soil has become one of the world's most vulnerable resources (FAO and ITPS, 2015a and 2015b). Addressing soil and land degradation is a core challenge for sustainable development. Soil and land degradation has adverse impacts on ecosystem services that help safeguard food security, maintain water quality and availability, protect human health and establish the basis for a range of socio-economic activities. Sustainable soil and land management practices that are adapted to the local biophysical and socio-economic conditions can provide options for enhancing the interactions among soil, water, livestock and plants, which can prevent, slow or stop soil degradation and mitigate the impacts of climate change (Lal, 2013).

Soil health refers to the capacity of soil to perform agronomic and environmental functions. Important among these functions are: agronomic/biomass productivity, response to management and inputs, and resistance to biotic and abiotic stresses. With reference to agricultural land use, soil health refers to its capacity to sustain and support growth of crops and animals while also maintaining and improving the environment.

Key soil properties important to maintaining good soil health include favourable soil texture and structure or tilth, good internal drainage, optimal water, and nutrient retention capacities and soil reaction. Relevant soil processes include good aeration, low susceptibility to erosion, and strong nutrient cycling. An optimal level of soil organic matter (SOM) content is essential to all key soil properties and processes, which are strong determinants of soil health. To be in good health, a soil must also be relatively free from pests and pathogens including nematodes and weeds, and have adequate nutrient reserves and suitable elemental concentrations and balance. A healthy soil must also have strong resistance to degradation processes and be able to recover following a perturbation because of inherent resilience (Magdoff 2001).



Different Components of soil health

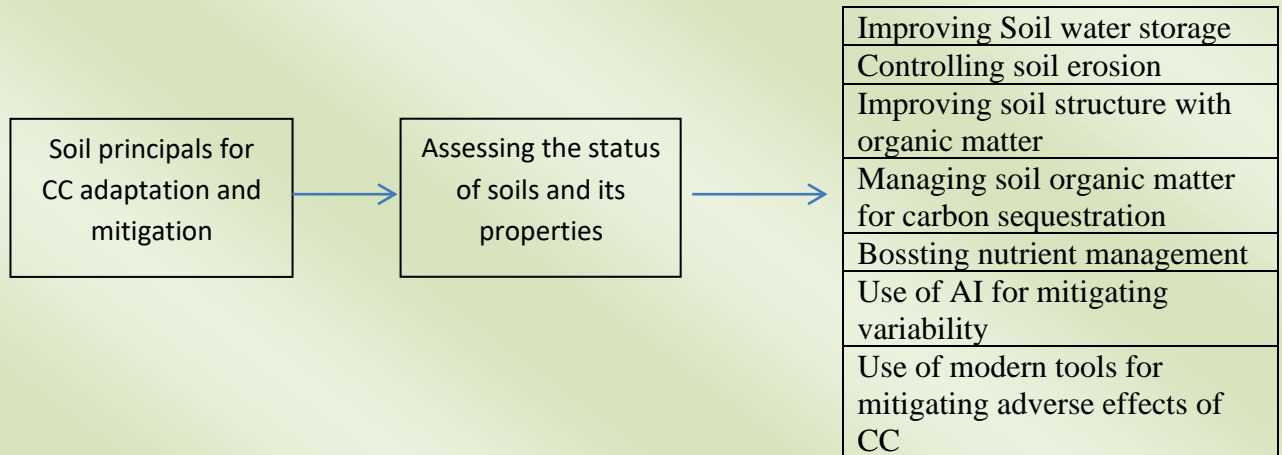
Thus, maintaining and enhancing these soil properties above the threshold/critical levels are essential to sustaining/improving soil health. Enhancing the soil organic carbon pool also improves agro-ecosystem resilience, eco-efficiency, and adaptation to climate change.

Some of the options to mitigate the effect of climate change on soil health are:

- Development of management practices that favour C sequestration or prevent further losses will help to reduce the potential SOC decline due to the climate change, and because of the importance of SOC to soil health and plant productivity, maintenance or restoration of SOC will help to reduce the threats of food security due to climate change.
- Research and development in organic farming systems, which has been gradually increasing, is likely to underpin developments in farming practice that can be exploited by all farmers to support adaptation to climate change.
- Maintaining and improving soil structure through adoption of conservation practices can help to minimise potential impact and further help to adapt agricultural systems to climate change.
- Reduced or erratic rainfall, and more frequent and severe periods of drought lower the capacity of soils to make water and nutrients available to plants.
- More intense extreme weather events, along with higher evaporation and transpiration rates, will lead to increased erosion by water and wind, and accelerated runoff; reduce groundwater recharge; and reduce the availability of soil moisture for plant growth.
- Higher soil surface temperatures will increase the rates of mineralization of soil organic matter and impair the soil's capacity to sequester carbon and retain water, which will ultimately limit plant growth.
- Higher temperatures cause soil salinization and increase the evaporation rates and the accumulation of salts (e.g sodium chloride, calcium and magnesium sulfate and chloride) in the soil surface layers. Salinization can hinder plant growth and reduce yields on productive agricultural lands. High levels of soil salinity can be tolerated only if salt-tolerant plants are grown with properly managed irrigation and drainage systems. In almost every irrigated area in the world, the groundwater is affected to some extent by salinity (Palaniappan and Gleick, 2009; FAO, 2011). When there is a predominance of sodium ions, soils can become sodic. This presents particular challenges, as sodic soils tend to have very poor structure that limits or prevents water infiltration and drainage, and exacerbates the risk of water stagnation and erosion.

There are many already proven soil management practices that can help farmers adapt to the likely adverse effects of increasing weather variability and climate change, and that can, in many cases, also reduce agricultural greenhouse gas emissions. The widespread adoption of these practices has the potential to make a major contribution to the achievement of national food security and development goals. Figure given below outlines

the principles for climate change adaptation and mitigation on which these practices are based.



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Oral/Poster Presentations

1. Studies on weed infestation and survivability of mulberry cuttings of S-1635 mulberry genotype

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Abstract

The investigation report explores the kind of weeds infestation in mulberry nursery and placed under respective families. During the present studies it was found that two weeds infestation were predominant in the mulberry nursery viz., *Cynodon dactylon* L and *Parthenium hysterophorus* L. Further, the survivability of mulberry cuttings planted for raising mulberry saplings for distribution among Adopted Seed Rearers (ASR) was above 90 % in all the nursery beds.

Keywords: ASRs, Cuttings, Infestation, Mulberry nursery, Weeds, Survivability

2. Sustainability of Horticulture and Excessive Use of Pesticides on Apple in Kashmir

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Abstract

Jammu and Kashmir the leading producer of temperate fruits in India, provides employment to lakhs of people directly or indirectly. Being a dominant sector in the Union Territory, provides highest livelihood and food security to dwellers. Horticulture is significant contributor to the domestic product and earns huge earnings through export orientation. Apple being the dominant crop in horticultural crops in the valley is highly pesticide dependent. The pesticide trade has overwhelmingly increased in the region with few positive and negative implications both on environment, human health and economic well-being of the people in the region. This paper presents an estimated analysis of horticulture sector in the valley and involvement of huge costs to its sustainability. Being a sensitive activity, lot of

negativity is involved with this trade. The pesticides on one hand are very costly and on the other hand are very sub-standard and spurious which has posed several ill-effects on the sustainability of the apple cultivation. From the results, it can be concluded that large number of respondents doesn't consider the activity as remunerative one at present, because of huge cost involvement and also due to high insect-pest infestation. High pesticide use has also posed huge health costs on the people of the region which is also a serious concern for the sustainability of horticulture in the region. The study employs Cobb-Douglas linear production function, Cost of Illness method and Contingent valuation Method for analyzing the requisite data. The study concludes, if use of pesticides in apple continues at current pace in Kashmir, the sustainability of horticulture seems to be in great threat in coming years.

Keywords: Sustainability, excessive pesticide use, cost incurring, threat, health costs, Ill-effects.

3. Growth, Yield Attributes and Yield of *Rabi* Fennel (*Foeniculum vulgare* Mill.) as Influenced by Different Time of Sowing, Variety and Spacing

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Abstract

A field experiment was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, Sardar krushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* 2015-16 to study the effect of sowing time (3rd week of October, 1st week of November and 3rd week of November), variety (Gujarat Fennel-2, Gujarat Fennel-11 and Gujarat Fennel-12) and spacing (45 cm and 60 cm) on growth, yield attributes and yield of *rabi* fennel. The experiment evaluated in split plot design with four replications by keeping time of sowing as main plot and combination of variety and spacing as sub plots. The result showed that the crop sown in 3rd week of October (D1) recorded significantly superior growth parameters, yield attributes and highest seed yield (1423 kg ha⁻¹) and stover yield (4080 kg ha⁻¹). While, variety GF-12 (V3) noticed higher values of growth parameters, yield attributes and maximum seed yield (1411 kg ha⁻¹) and stover yield (4030 kg ha⁻¹). Similarly, superior growth parameters, yield attributing characters and seed yield (1346 kg ha⁻¹) and stover yield (3914 kg ha⁻¹) were registered with 45 cm (S1) row spacing as compared to

wider row spacing *i.e.* 60 cm (S2). The harvest index was not remarkably influenced by different times of sowing and spacing but marked effect of various varieties on harvest index was recorded. This study revealed that higher growth, yield attributes and yield can be achieved by sowing the fennel variety GF-12 during 3rd week of October at 45 cm row spacing under North Gujarat Agroclimatic condition.

Keywords: Fennel, Sowingtime, Variety, Spacing, Yield

4. Yield, Quality and Economics of *Rabi* Fennel (*Foeniculum vulgare* Mill.) as Influenced by Different Time of Sowing, Variety and Spacing

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Abstract

A field experiment was conducted during *rabi* season of 2015-16 at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar to study the effect of sowing time, variety and spacing on yield, quality and economics of *rabi* fennel (*Foeniculum vulgare* Mill.). Eighteen treatment combinations comprising of three sowing times *i.e.*, 3rd week of October (D1), 1st week of November (D2) and 3rd week of November (D3), three varieties *viz.*, Gujarat Fennel 2 (V1), Gujarat Fennel 11 (V2) and Gujarat Fennel 12 (V3) and two spacings *i.e.*, 45 (S1) cm and 60 cm (S2) were evaluated in split plot design with four replications by keeping time of sowing as main plot and combination of variety and spacing in sub plot. The results revealed that crop sown in 3rd week of October (D1) recorded significantly superior growth, yield, quality attributes as well as economics. While, variety GF 12 (V3) noticed higher values of growth, yield, quality attributes and economics. Similarly, superior growth parameters, yield and quality attributing characters and economics were registered with 45 cm (S1) row spacing as compared to wider row spacing *i.e.* 60 cm (S2). The test weight was not remarkably influenced by different spacing but marked effect of different times of sowing and varieties was recorded. This study revealed that higher growth, yield, quality attributing characters and economics can be achieved by sowing the fennel variety GF 12 during 3rd week of October at 45 cm row spacing under North Gujarat Agro-climatic condition.

Keywords: Economics, Fennel, Quality, Sowing time, Variety, Spacing, Yield

5. Experimental Study on Natural And Chemical Insecticides and Pesticides

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Abstract:

Synthetic insecticides are very efficient in insect control but can be harmful for the environment and health. Pesticides have now become an essential part of agricultural production. They cause disturbances in ecosystem functioning; however, many pesticides are not easily degradable; they persist in soil, leach to ground-water and surface water and contaminate wider environment and are toxic for a wide range of non-target organisms. The adverse effects of pesticides on non-target organisms, especially insect's natural enemies and pollinators, have received the most attention in this regard because of their value in integrated pest management (IPM) and pollination processes, respectively. Pesticides can enter the human body through inhalation, oral or dermal exposure, and well documented to be the main cause of several diseases such as cancer, respiratory diseases, skin diseases, endocrine disruption, and reproduction disorders. To reduce the intensive use of pesticides, it is an urgent need to promote the organic farming practices and search for the effective biopesticides or biological agents to control agricultural pests in order to reduce the use of chemical pesticides. The useful and informative survey was done to make awareness for use of biological insecticides. Experimental studies on chemical and natural insecticides and pesticides carried out in rural area such as Kasegaon, Shene and Tambave

Keywords: chemical and natural pesticides, survey report, chemical tests.

6. Population dynamics of aphid, *Aphis gossypii* Glover infesting isabgul under North Gujarat Agro-climatic conditions

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Abstract

A field experiment was conducted on the population dynamics of *Aphis gossypii* Glover during *rabi*2017-18 at Chiman bhai Patel College of Agriculture, Sardar krushinagar. The results showed that the aphid infestation was started from 1st week of January (1st Standard

Meteorological Week) and gradually increased up to 4th week of February (8th Standard Meteorological Week) with a peak population of 2.40 aphid index. During the peak period, the minimum and maximum temperatures and morning and evening Relative Humidity (R.H.) were recorded 33.6°C and 13.8°C and 65.9 and 37.0 per cent, respectively. Among the natural enemies, the lady bird beetle larva was found active between 4th week of January and 3rd week of March. Lady bird beetle adult found active between 4th week of January and 4th week of March, whereas, larval population of syrphid fly was recorded during 1st week of January to 2nd week of March, 2018. The larval population of lady bird beetle and syrphid fly had highly significant positive correlation with aphid, whereas, ladybird beetle adult had significant positive correlation.

Keywords: Isabgul, population dynamics, isabgul aphid, *Aphis gossypii* Glover, predators, abiotic factors, lady bird beetle, syrphid fly, correlation.

7. Quality Planting Material Production in Tropical Tuber Crops for Safeguarding Food Security in the State of Kerala

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Abstract

Tropical tuber crops are considered as 'Future Crops' in the context of climate change to ensure food security to our growing population. It includes cassava, sweet potato, aroids, yams and minor tuber crops. In a scenario where climate change has become a reality, tuber crops are considered to be climate resilient crops too. However, inadequate availability of quality planting material (QPM) is a major handicap faced by farmers for large scale cultivation of these crops. The major constraints in quality planting material production are low multiplication ratio, lack of availability of healthy planting material, longer time for released varieties to reach farmers and high cost of planting material. Quality planting material can be produced by many techniques viz. miniset technique, vine cutting technique, micro propagation and true seed production. Miniset is the optimum reduced size of planting material in tuber crops for rapid multiplication. It is a fast and dependable method which can be adopted by farmers also for the production of QPM (George *et al.*, 2004). Minisets may be planted in polybags (Nahar and Tal, 2012) or in portraits and then transplanted to the field. Propagation using vine cuttings ensures rapid multiplication of planting material in possible tuber crops, sparing the tubers for food purpose. Sweet potato and coleus are commercially propagated by vine cuttings obtained from tubers planted in nursery. Tissue culture methods have been found effective in producing a large number of disease free, uniform plantlets in a

short time. It has been widely used to produce virus free plants using meristem culture technique. Propagation of cassava through true seeds is advantageous for enhancing multiplication rate, elimination of cassava mosaic virus disease, longer seed viability, ease of storage and transport. But it has not become popular due to difficulty in seed production and high heterogeneity of seedling population. Quality standards for planting materials of different tuber crops have been formulated by CTCRI (2017).

Keywords: Micro propagation, miniset technique, quality planting material, true seed production tuber crops, vine cutting technology

8. Life Cycle, Seasonal Abundance and Management of Shoot Borer, *Chilo infuscatellus* (Snellen) in Sugarcane

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Abstract

The shoot borer, *Chilo infuscatellus* (Snellen) is widely distributed in sugarcane growing areas in all tropical and sub tropical regions. It has been considered a major pest of sugarcane growing areas. The female laid eggs in a several masses on the ventral surface of leaves close to the midrib. The egg laying capacity was 324-352 and incubation period ranged from 4.25 to 4.45 days with an average of 4.40 days. The larva passed through five instars and total larval period varied from 16.66 to 17.03 days with an average of 16.94±0.12 days. Pupa was obtect type, brownish in colour and take place in inside stem in silken cocoon and its period varied from 3.62 to 3.80 days with an average of 3.71± 0.04 days. Total life cycle of *Chilo infuscatellus* from egg to adult emergence varied from 31.95 to 32.82 with an average of 32.28 ± 0.20 days. The shoot borer was first noticed in the field from 1st fortnight of March and continued to 2nd fortnight of August. There was steady increase in the population of larvae during two months (April and May) after which it gradually decreased. The maximum incidence was recorded in the first fortnight of May and lowest in the second fortnight of August. Management of this pest is only through integrated pest management (IPM) tools.

Keywords: Abundance, life cycle, management, sugarcane, shoot borer

9. Tamarind for improving Rural Livelihood Security through Sustainable Integrated Farming

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Throughout tropics, tamarind (*Tamarindus indica* L.; $2n=24=2x$) is an economically important species. It is grown unattended in backyards, roadsides or wastelands. It is a multipurpose tree for agroforestry system. Tamarind has been growing in India since centuries. It is a nutritious crop, growing on marginal lands, making it highly valuable in ensuring food security for rural poor. The tree is commonly known as Imli and has traditionally been used as a shade tree in the villages. Once established, the tree develops a large tap root which protects it from strong winds and cyclones, making it well suited to the region. It is also considered to be a suitable tree for inter-planting with other commercial forest species. The tree starts bearing from 6-8 years and productive life of tree can last for 50-70 years after which it declines. The normal life span is 150 years. A typical established tree yields between 50-100Kg of collectable fruit. This fruit is harvested during multiple picks over an 8-10-week period between February and April. Apart from tamarind pulp other byproducts such as seed, shell, fiber is also useful for various purposes. Procurement and processing start from February and lasts up to mid-June. One person can process 15-20Kg pods per day and earn around Rs 400/day. The whole family gets involved during this period for processing thus employment is generated. Basic primary processing, collective marketing and value addition activities have potential of improving livelihood. Given the great potential of this neglected and underutilized species to address global challenges such as hunger, poverty and climate change adaptation, there is need to revisit research and development priorities in its favor to develop strategies together with stakeholders to improve its conservation and use.

10. Effect of root stocks and Grafting Time and Graft Success and Growth of Peach Cv. Shan-I-Punjab In Sub-Tropics of India

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Abstract

The present investigation was carried with the aim to study the effect of time of grafting and rootstock on graft success and growth in low chill peach cv. Shan- e-Punjab under sub tropics of Haryana (India). Study comprising of three different rootstocks viz., Peach cv. Sharbati seedling and Japanese Plum cv. Kala Amritsari and European plum cv. Green Gage rooted cuttings grafted on 9th and 25th January with three replications. Results reveal that advanced grafting (9th January) had significantly higher graft success (64.75%) and sprouting (69.02%) over 25th January, whereas, all growth parameters viz., plant height, percent increase in scion diameter, fresh and dry weight of shoot and root, relative water content, leaf nitrogen and total chlorophyll contents were significantly superior when wedge grafting was done on 25th January. On the other hand, among different rootstock, Sharbati seedling as rootstock performed better as compared to Kala Amritsari and Green Gage cutting for all the above recorded parameters. This investigation additionally gives the chances for further research to explore whether this pattern proceeds in the productive year of the peach plant.

Keywords: European plum, grafting time, Japanese plum, peach, rootstocks

11. Aerenchyma and Adventitious Root Response of Tomato Genotypes to Flooding Stress

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Abstract

Tomato was considered to be the most sensitive to flooding stress among all the vegetable crops. The study was conducted to explore the stem and adventitious roots in response to ethylene production in tomato genotypes. The experiment was conducted on 4 genotypes in the submergence tank at the Glass house, Department of Crop Physiology, Tamil Nadu Agricultural University (TNAU), Coimbatore. Flooding stress was imposed to 10D old

transplanted plants of all the genotypes and it was maintained at 5cm level for 7 days. Four genotypes were selected for this experiment based on their morphological and physiological performance in the preliminary study. The genotypes are LE 523 and LE 828 (tolerant genotypes) PKM 1 and CO 3 (susceptible genotypes) were used in the experiment. Result of the study expresses the large number of adventitious roots was recorded in LE 523 (65) and LE 828(64) when compared to PKM 1 (17) and CO 3 (21). Among all the genotypes ethylene production was significantly higher in LE 523 (1.801 nl/ g of fresh weight/ hr) followed by LE 828 (0.587 nl/ g of fresh weight/ hr) whereas less amount of ethylene production was observed in CO3 and negligible amount in PKM 1. Variation of ethylene production among genotypes determines the formation of aerenchyma on the hypocotyls region. Aerenchyma formation on the hypocotyl region was increased on the seventh day of flooding stress on LE 523 and LE 828 was observed. Whereas CO 3 and PKM 1 recorded less aerenchyma formation which is not only due to less ethylene production but also due to high cell membrane disintegration and more cell lysis that resulted in crop failure before the flowering and fruiting stages. Therefore LE 523 and LE 828 are being tolerant because of more adventitious root and aerenchyma formation facilitated by ethylene under flooding stress which helped the plant to withstand.

Keywords: Adventitious roots, Aerenchyma formation, Ethylene, Flooding and Tomato

12. Influence of modification of morphoframe through Ethylene and Maleic hydrazide on growth and yield of cotton hybrids

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Abstract

A field experiment were conducted at Main Cotton Research Station, Navsari Agricultural University, Surat during the *Kharif* 2011-12 and 2012-13 to study the Influence of Modification of Morphoframe on Physiology and Yield in Cotton. The experiments were laid out in Randomized Block Design (Factorial concept) with twelve treatments *viz.*, first factor (Growth regulators) (T₁) - Control (00 ppm), (T₂) - Ethylene 45 ppm at squaring stage, (T₃) - MH 500 ppm at 85 DAS and (T₄) - Ethylene + MH and second factor (Cotton hybrids) (V₁) - RCH 2 (BG-II), (V₂) - Vikram 5 (BG-II), (V₃) - G.Cot Hy-12 and replicated three times. The results indicated that Single application of Ethylene and MH (Maleic hydrazide) was found significantly effective in enhancing most of the parameters over control. Ethylene application

recorded significantly greater plant height, LAI, RGR, reducing sugars, yield, seed index and lint index besides that it reduced days to 50 per cent boll bursting, maturity, took lesser growing degree days and heliothermal units compared to the control. Application of MH at 85 DAS significantly increased chlorophyll content and required more days to 50 per cent boll bursting, maturity, took more growing degree days and heliothermal units with lower seed and lint index besides usual increase in physiological parameters, growth and yield as compared to remaining treatments. In terms of net return and cost benefit ratio both Ethylene and MH were much advantageous over check. Application of Ethylene (45 ppm) at squaring stage followed by MH (500 ppm) at 85 DAS recorded significantly higher LAI, LAD, CGR, RGR, NAR, dry matter, squares, flowers, green bolls, sympodia, mainstem nodes, chlorophyll content, GDD, HTU, number of bolls (at harvest), boll weight, biomass and yield, and brought about better net return and benefit cost ratio over control and over Ethylene and MH alone. Amongst the three cotton hybrids, Vikram 5 (BG-II) recorded significantly higher LAI, LAD, CGR, RGR, NAR, dry matter accumulation, fruiting forms (square, flowers and bolls), sympodia, mainstem nodes, chlorophyll content, reducing sugars content, number of bolls, boll weight, biomass, seed cotton yield, seed and lint index than conventional hybrid G. Cot Hy-12. *Bt* hybrids, RCH 2 (BG-II) was observed significantly less days taken to 50 per cent boll bursting, maturity, growing degree days and heliothermal units compared to G. Cot.Hy-12.

Keywords: Growth Modifier, Bt Cotton, Physiological Parameters, Morphological parameters, heliothermal units and Yield contributing characters

13. Sustainable Horticultural Production for Socio Economic and Nutritional Development

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Abstract

The world has made strides in reducing hunger and protein malnutrition but considerable progress is required to reduce micronutrient (vitamins and minerals) malnutrition, which is estimated to affect the health of up to two billion people. Horticultural crops besides improving biological productivity and nutritional standards also have enormous scope for enhancing profitability. This group of crops comprising fruits, vegetables, root and tuber

crops, plantation crops, medicinal and aromatic plants, spices and condiments and ornamental crops, would constitute core of any such agro-economic strategy. Past investment has been rewarding in terms of increased production, productivity and export of horticultural produce. However, challenges confronting are still many. Although, the country is second largest production of fruits and vegetables; the availability of fruits and vegetables still continues to be much below the dietary requirements. With increase in per capita income and accelerated growth of health conscious population, demand for horticultural produce is on increase which is expected to further accelerate, which will require more production. But the production has to be competitive both in terms of quality and price. Thus, the potentialities, which exist, need to be harnessed and gains have to be sustained. Development of improved cultivars with high quality characteristics, productivity, resistance to pest and disease and tolerant to a biotic stresses. The technologies must improve the efficiency of water and nutrients and variability in yield, quality and also reduced post harvest crop losses. Timely availability of quality seed and planting material is also important. Consequently, horticultural development has to be seen as integrated approach, addressing important gaps, in harnessing the potential through targeted research with focus on enhancing efficiency. Thus, technology driven horticulture is expected to address the concern for complimentary and nutritional security, health care leading to ultimately economic development.

Keywords: sustainable horticulture, socio economic development, nutrition security, qualitative and quantitative attributes, agronomical practices, organic horticulture.

14. Study on Quantifying and Correlating the Texture Profile of Paneer with its Moisture Content during Storage

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Abstract

The present study was undertaken to study the effect of storage temperature on the textural properties of market sample of Paneer and to investigate the significance of the effect of ambient (fluctuating) versus steady storage temperature condition on the textural properties of products. Ambient storage in the glass shelves or jar is the most common and preferred method of storage by vendor in India. So the market sample of product were procured and stored at designated temperature conditions ($5 \pm 1^{\circ}\text{C}$, $80 \pm 5\% \text{RH}$) incubator at ($18 \pm 1^{\circ}\text{C}$, $55 \pm 5\% \text{RH}$) and ($30 \pm 1^{\circ}\text{C}$, $55 \pm 5\% \text{RH}$), and at ambient condition ($18-30^{\circ}\text{C}$, $70 \pm 5\% \text{RH}$) for different time periods, i.e. up to acceptability of products and analyzed for the change in

textural properties. The moisture content of Paneer stored at all temperature conditions showed a decrease with increase in storage period. The product, initially at $54.09 \pm 3.79\%$ moisture content, loses moisture to the environment at a rate dependent on the temperature of storage. The hardness of Paneer stored at refrigeration temperature showed slight variation with increase in storage period, but that stored at ambient and other temperatures showed a definite increase with increase in storage period. Other primary textural characteristics viz. Adhesiveness, Cohesiveness and Springiness and the secondary textural characteristics viz. Gumminess and Chewiness varied in diverse manner with the period of storage. The primary textural characteristics of Paneer are not significantly affected by the fluctuation of ambient storage temperature, for the short shelf life of about 2 days at that temperature.

Keywords: Paneer, Textural properties, Cohesiveness, Adhesiveness, Springiness

15. Effect of Zinc Application on Quality of Wheat Grain (*Triticum aestivum* L.)

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Abstract

In plants, zinc plays a vital role as a catalytical, structural and regulatory co-factor of many enzyme reactions. Zinc is necessary for the metabolism of carbohydrates, protein synthesis, the biosynthesis of growth hormones, in particular of indole acetic acid and the maintenance of the integrity of cell membranes. The deficiency symptoms first appears on young leaves as zinc is an immobile nutrient in plants. Zinc deficient leaves remains small with extended necrotic spots and interveinal chlorosis on the upper leaf surfaces. Zinc deficiency is major problem in cereal crops. Therefore, zinc agronomic fortification of wheat and other cereal crops is being urgently addressed and highly prioritized as a research topic. Increasing the zinc content of food crop resulting in better crop production is an important global challenge. A pot culture study entitled “Agronomic fortification of wheat as influenced by graded levels of zinc” was conducted during *Rabi* 2017-2018 at Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola. The significantly highest test weight, carbohydrates and protein content were observed in the treatment of soil application of RDF + ZnSO₄ @ 30 kg ha⁻¹. It is concluded that the soil application of ZnSO₄ @ 30 Kg ha⁻¹ + RDF (80:40:40 kg ha⁻¹ N, P₂O₅, K₂O) at the time of sowing recorded highest wheat grain quality viz test weight, carbohydrates and protein content.

Keywords: Agronomic fortification, quality, wheat, zinc.

16. Organic Farming Technology for Higher and Eco-Friendly Cowpea Production in Southern Telangana Region

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Abstract

The present studies were undertaken to develop an effective package of organic farming for cowpea crop. Five treatment combinations resulting from three organic sources i.e. T1- farmyard manure + biofertilizers, T2- poultry manure + biofertilizers, T3-vermicompost + biofertilizers, T4- combination of farmyard manure, poultry manure, vermicompost along with biofertilizers and T5- recommended dose of chemical fertilizers were tested. The results revealed that farmyard manure + biofertilizers gave 9.7% higher green pod yield than the treatment having recommended dose of chemical fertilizers but at par with T2 (poultry manure + biofertilizers) and T4 (combination of farmyard manure, poultry manure, vermicompost along with biofertilizers). The organically produced cowpea fruits possessed long shelf life at room storage. Maximum uptake of nutrients was obtained from the treatment having the combination of farmyard manure, poultry manure and vermi-compost along with biofertilizers as well as all the organic manures improved the soil health.

Keywords: Cowpea, organic farming, yield, nutrient uptake, nutrient balance, shelf life

17. Sustainability through Homestead Agroforestry Systems - A Case Study in Southern Kerala, India

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Abstract

Desired goal of development and environmental management can be viewed as sustainability. The former notion of maximizing production in a relatively short span of time has switched to production systems with long periods of sustenance. The traditional practice of homestead

agroforestry is widely proclaimed as a sustainable land use system and has immense significance in a period of pandemic such as COVID 19. The concept involves farming for the family and by the family, and during the period of lockdown, ensures food, nutritional and emotional security to the members of the household. Popularisation of the agroforestry practice involves development of models to improve production and income from unit area and transform them into beacon home gardens. As part of the project on ‘Socioeconomic analysis and farmer participatory development of homesteads in Kerala’, a homestead of 0.184 ha in southern Kerala, India was selected based on the survey, for participatory development into a model homestead farm during 2014-2016. An inventory of the resources available with the farmer was made, evaluated and taking into account the interests of the farmer, interventions were planned and implemented to re- model the existing garden. Scattered planting and unutilised interspaces were plenty in the homestead. The interventions in the project included increasing the diversity, intensive tuber and vegetable cultivation, scientific crop management practices, systematic planting, *in situ* moisture conservation, introduction of rainshelter cultivation, ecofriendly pest management (*Pseudomonas*, *Beauveria* and *Verticillium*) and introduction of annual spices and poultry. Economic analysis of the homestead revealed a nearly six-fold increase in the net returns from the pre project period. The increased diversity, recycling of biowastes and conservation practices contributed more to the sustainability over and above the financial security assured. The homestead agroforestry model developed as detailed above is an eye opener to triumph over the challenges encountered in pandemic situations.

Keywords: Diversification, homestead agroforestry, interventions, pandemic, sustainability

18. Antibiosis Study of *E. vittella* on Selected Okra Genotypes

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Abstract

The experiment conducted of rearing of *E. vittella*; fruits from eight different okra genotypes (two from each grade *i.e.* resistant, moderately resistant, moderately susceptible and susceptible) were used. These genotypes included IC-974 and IC-90210 (0 to 5 %) as resistant, RHR-102 and IC-282229 (5.1 to 15 %) as moderately resistant, IC-133336 and IC-90251 (15.1 to 30 %) as moderately susceptible and Parbhani Kranti and 1557 (> 30.0 %) as

susceptible genotypes. *E. vittella* reared on fruits of resistant genotyp IC-90210 showed maximum larval period of 16.06 days whereas, larvae reared on susceptible genotype *i.e.* the genotype 1557 with minimum larval period of 10.18 days. Descending trend of larval period was observed from resistant to susceptible genotypes and it was ranged between 16.06 to 10.18 days, respectively. The larval survival per cent was ranged from 51.67 to 85.00 per cent. The susceptible genotype 1557 was significantly superior over rest of the genotypes with highest larval survival per cent of 85.00 as against minimum of 51.67 per cent in IC-974 which was categorized as resistant genotype. The differences in larval weight on different genotypes were statistically significant. Maximum larval weight was recorded on susceptible genotype 1557 (76.17 mg). The resistant genotype IC-90210 recorded minimum larval weight of 55.97 mg. From the results it was revealed that, larval weight was significantly reduced from susceptible to resistance genotypes. It was clear from the data that resistant genotypes had higher antibiosis effect on larvae than susceptible one. The resistant genotypes IC-974 and IC-90210 recorded maximum pupal period (10.50 and 10.95 days, respectively) with minimum pupal weight of 40.19 mg and 40.32 mg, respectively. On the contrary, the susceptible genotypes, 1557 and Parbhani Kranti recorded shortest pupal period of 6.51 and 6.64 days, respectively coupled with highest pupal weight of 56.53 mg and 55.12 mg. The per cent moth emergence was varied significantly and ranged from 80.00 to 96.67 per cent. The larvae reared on resistant genotype IC-90210 recorded minimum of 80.00 per cent moth emergence followed by genotype IC-974 (83.33 %) being at par with each other. Maximum moth emergence of 99.67 per cent was recorded in larvae reared on susceptible cultivar *i.e.* Parbhani Kranti which was at par with another susceptible genotype 1557 with 93.33 per cent moth emergence. The larvae reared on the resistant genotype *i.e.* IC-90210 recorded minimum growth index of 2.96 as against maximum growth index of 5.61 and 5.59 in susceptible genotypes *i.e.* Parbhani Kranti and 1557, respectively. Larvae reared on fruits of resistant genotypes *i.e.* IC-90210 and IC-974 laid less number of eggs per female (216.00 and 221.33 eggs/female, respectively). However, significantly highest fecundity per female was recorded on susceptible genotypes namely 1557 and Parbhani Kranti (373.00 and 361.00 eggs/female, respectively).

Keywords: Antibiosis, *E. vittella*, Okra shoot and fruit borer.

19. Studies on Biochemical Parameters Responsible for Resistance against Okra Shoot And Fruit Borer, *Earias vittella* (Fab.)

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Abstract

The moisture content was ranged from 81.16 to 90.33 per cent. The genotype Parbhani Kranti recorded maximum moisture content of 90.33 per cent which was at par with IC-113904 (89.77 %) and IC-43746 (89.56 %) whereas, the resistant genotype IC-90210 recorded a minimum moisture content of 81.16 per cent. The chlorophyll content in selected okra genotypes was ranged from 0.18 to 0.52 mg per gm. Significantly maximum chlorophyll content of 0.52 mg per gm was noticed in the genotype EC 128888 as against minimum chlorophyll content of 0.18 mg per gm in the genotype 1557. The results indicated that there was no relation between amount of chlorophyll content in fruits of selected okra genotypes and *E. vittella* infestation. Results indicated that, resistant genotypes contain maximum amount of total phenol as compared to susceptible and moderately susceptible genotypes. Maximum total phenol content of 1.27 and 1.17 per cent was recorded in the two resistant genotype *i.e.* IC 90210 and IC-974, respectively. However, two genotypes from susceptible and four genotype from moderately susceptible category *i.e.* IC -99724, 1557, IC-90251, IC-133336, Parbhani Kranti and 1957 recorded minimum of 0.59, 0.60, 0.61, 0.65, 0.68 and 0.69 percent total phenol content, respectively. The total soluble sugar content was ranged from 1.98 to 5.91 per cent. Moreover, it was noticed that, susceptible genotypes *i.e.* 1557 and Parbhani Kranti contained maximum total soluble sugar of 5.91 and 5.84 per cent, respectively as against minimum of 1.98 per cent and 2.13 per cent total soluble sugar in resistant genotypes *i.e.* IC-90210 and IC-974, respectively. Ash content in the tested genotypes was varied from 1.47 to 4.64 percent. Least of 1.47 percent ash was recorded in the genotype Parbhani Kranti which was at par with the genotypes 1557 and IC-90251 with 1.61 and 1.73 per cent ash, respectively. However, maximum ash content of 4.64 per cent was noticed in the genotype IC-974. The results showed that, the genotypes with minimum ash content were found to be susceptible to *E. vittella* infestation whereas, the genotypes with maximum ash content were found to be resistant to *E. vittella* infestation.

Keywords: Okra Germplasm, *Earias vittella* (FAB.) Biochemical Parameters

20. Study on Profitable Farming System in Madhya Pradesh

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Abstract

Integrated farming systems (IFS) are productive and profitable as they encourage habitat conservation, value addition and utilization of products and wastes as inputs in other enterprises with the farm. In simple terms, farming system strategy is integration of farm enterprises like dairy, poultry, piggery, fishery, sericulture, forestry etc., suited to a given agro climatic conditions and socio-economic status of the resource farmers for optimal utilization of resources bringing prosperity to the farmers. In farming systems agro technological package, one has to include not just crop production but also other complementary enterprises to increase farmer's income and family labour employment on long – term basis. Hence, study on profitable farming system conducted during 2018-19 in Mandla District to identify profitable farming systems among the existing farming systems i.e. Agriculture + Dairy + Horticulture, Agriculture + Dairy + Goat rearing + Horticulture and Agriculture + Dairy + Poultry + Horticulture, and worked out the Benefit Cost Ratio of each enterprises as the component results depicted that, among the types of farming systems studied, components of Agriculture + Dairy + Horticulture (1.47:1) has highest Benefit Cost Ratio followed by Agriculture + Dairy + Goat rearing + Horticulture (1.31:1) and lastly Agriculture + Dairy + Poultry + Horticulture (1.26:1).

Keywords: - Integrated Farming Systems (IFS), Benefit Cost Ratio (BCR), Profitable.

21. Organic Farming: Techniques and Management Practices

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Abstract

Sustainable agriculture show emphasis on optimizing production and minimizing dismissive environmental impacts and simultaneously enhancing methods for the protection, conservation and efficient use of natural resources. To boost up soil health and crop yield

Sustainable agriculture achieved an alternative to conventional farming. Organic farming plays an important role in sustainable agriculture practices as it exclude the use of synthetic harmful inputs such as pesticides , fertilizers etc and adapt the natural methodologies , use of green manure, compost , crop rotation to enhance biodiversity and soil biological activity, There is major need of organic farming as annual sales of organic products have increased three fold with increased establishment of natural food stores and these food industries guarantee high profit .o rganic farming helps to improve human health by lowering risks to certain disease conditions like cancer, infertility, and immunodeficiency. I t not only fights against global warming but helps in combat serious soil and land issues such as erosion. On comparing adjoining organic and chemically treated wheat fields showed that the organic field featured eight more inches of top soil than the chemically treated field and also had only one-third the erosion loss. Biodynamic, Various Techniques and specialized forms of Organic Farming includes Biological / Natural Pest and Weed Control., Composting. Mulching, Green Manuring and Cover Cropping., Crop Rotation and Poly-culture, Natural farming., Effective Microorganisms (EM),Diversity and productivity on the farm etc. By analyzing the vital role of organic farming to global health we should encourage the management and practices i.e. to ensure the quality of soil enriched with all nutrients as many essential micro and microorganisms feed on it and deliver minerals, vitamins and other micronutrients to crops. Other pest management practices include pest management, disease management, weed management, plant nutrition and information related to various guidelines to organic farming.

Keywords: Sustainable agriculture, Organic farming, Soil health, Effective microorganism, Pest management, Weed management

22. Role of Horticulture in Sustainable Agriculture

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Abstract

Horticulture for Sustainable Development with the aim of reducing micronutrient deficiency through the increased production and consumption of fruit and vegetables. Increased fruit and vegetable production brings many other benefits to people, such as enhanced income for smallholder farmers and other value chain participants, employment opportunities throughout the value chain, empowerment of women, and more sustainable agriculture when it is incorporated as part of an agricultural diversification program. The concept of “horticulture for sustainable development activities paves the way for the integration of subsistence

farmers, the landless and other resource-poor people once excluded from markets into broader economic activities. . Being mostly high value crops, horticultural crops contribute to wealth creation and horticulture can have a positive impact on the empowerment of women and contribute to the protection and enrichment of biodiversity and more livable cities This will play a significant role in sustaining rural communities and improving the living conditions of the poor. Elements of the value chain for horticultural crops create employment and open new market opportunities for fruit and vegetables to play a pivotal role in fighting the triple threats of hunger, micronutrient deficiencies and over nourishment

23. Study of variability and storage protein content in Urdbean [*Vigna mungo*]

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Abstract

Most official nutrition organizations recommend a fairly modest protein intake. The DRI (Dietary Reference Intake) is 0.8 grams of protein per kilogram of body weight, which amounts to: 56 grams per day for the average sedentary man. Since pulses are readily and cheaply available source of proteins, a genetically investigation, based on biometrical approaches, was carried out on blackgram genotypes during *kharif*, 2018-2020 to unfold the mystery relating to genetic variability existing among themselves in respect of characters, genetic advance, heritability, the correlations into the measures of direct and indirect effects on grain yield, genetic divergence among the genotypes in this respect. The experiment was conducted in RBD with 30 genotypes and three replications at RRS Chakdah during 2019-20 for estimation of genetic variability, heritability, genetic advance, correlation, path analysis and genetic divergence. Observations were recorded on five randomly selected competitive plants from each plot and replication for yield attributing traits and biochemical analysis for protein content was done. Analysis of variance revealed that mean sum of squares due to genotypes were highly significant for all the characters except seeds per pod and seed yield. Thus, revealing the existence of considerable variability in the material studied. The GCV was moderately high for number of branches/plant , number of pods/plant 100 seed wt and plant height, while the PCV showed the same tendency, suggesting that these traits should be taken into consideration. The magnitudes of heritability in broad sense were high for all the ten characters. It is varied from 34.16% in days to maturity to 99% in 100 seed weight. The data on the genetic advance over percent of mean for different characters expressed as percentage of the population mean, ranged from 1.95 % in case of storage protein content to as high as 47.44% in case of 100 seed weight. High heritability coupled with genetic advance in characters like number of 100 seed weight and seed yield/plant indicates the role of

additive gene action highlighting the importance of those traits for effective selection whereas characters like Number of primary branches/plant, pod length, number of pods/plant showed combination of high heritability and moderate genetic advance indicating the role of additive gene action which also added more number of useful traits for widening the scope of meaningful selection. In this study, high heritability coupled with genetic advance as percent over mean along with moderate to high GCV in characters like number of branches/plant (89.90, 33.02, 16.84), pod length (80.03, 20.17, 10.95) and number of pods per plant(63.62, 26.34, 16.04) indicates the role of additive gene action highlighting the importance of those traits for effective selection. Evidently, high heritability coupled with moderate or high genetic advance suggesting the role of additive gene action for yield/plant. However in this study the traits like number of seeds/pod (89.10, 18.42, 9.48) and seed yield/plant (91.30, 18.16, 5.14), 100 seed weight (99.03, 41.44, 5.10) where the high heritability coupled with GA but low GCV can be improved selection followed by heterosis breeding. Characters like pod length, number of pods/plant showed combination of high heritability and moderate genetic advance indicating the role of additive gene action too providing ample scope for selection, while the rest of the characters showed high heritability and low genetic advance indicating the role of both additive and non additive gene actions. Divergence analysis revealed that considerable amount of genetic divergence was present in the material under study. Based on Mahalanobis's D2 statistic, genotypes were grouped into five different clusters. Divergent parents from cluster I, II and V should be chosen for making intercrossing for obtaining better/heterotic segregants. Based on divergence study and per se performance, genotypes like Pant Urd 31, VBN-8 , CO-5 and NDU K-19 may be used.

24. Biophysical Traits Mediating Tritrophic Interactions among Brinjal Cultivars, Mealybug *Coccidohystrix insolita* and it's Natural Enemies.

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Abstract

Brinjal (*Solanum melongena*), a native of the Indian subcontinent, is one of the most popular vegetable crops belongs to the family Solanaceae. The cultivation of brinjal was seriously hampered by the pest infestation which includes the mealybug, *Coccidohystrix insolita*, a minor pest hitherto that changed its status to an economically important pest in brinjal. The biophysical characters of the host plants imparted a vital role in conferring the preference shown by pests and its natural enemy fauna. A study was conducted to identify the biophysical traits mediating host plant-pest-natural enemy interactions by screening ten

brinjal cultivars against *C. insolita* and its natural enemies at the College of Agriculture, Vellayani during 2018-2019. Among the tested cultivars, the lowest mealybug population was recorded in the cultivar, Pusa Uttam (38.58 / three leaves) whereas the highest population was observed in the hybrid cultivar, Udit (127.58 / three leaves). The cultivars Haritha (3.917) and Udit (2.083) attracted more number of coccinellid beetles whereas lowest population was recorded with Pusa Purple Long, Ponni and Pusa Uttam (0.33). The biophysical parameters like trichome density, the length-width ratio of leaf and number of branches plant⁻¹ exhibited a significant positive correlation with the population of mealybugs with correlation coefficients of 0.692, 0.702 and 0.644 respectively. The multiple regression equation obtained was $Y = 0.099 X_1 - 124.602 X_2 - 57.811 X_3 + 7.784 X_4 - 0.856 X_5 + 140.088$. The plant height exhibited a significant negative correlation with the mean population of coccinellids with a correlation coefficient of -0.691 whereas trichome density and the length-width ratio of leaf exhibited a nonsignificant positive correlation. The multiple regression equation obtained was $Y = 1.430 X_2 - 4.099 X_3 + 0.202 X_4 - 0.076 X_5 + 12.687$. A thorough understanding of the tritrophic interactions existing in the ecosystems aids in the manipulation of these interactions in integrated pest management options.

Keywords: Brinjal, *Coccidohystrix insolita*, resistance, morphological factors, tritrophic interactions, natural enemies

25. Sustainable Crop Production

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Abstract

Sustainability means meet the needs of present without compromising the ability of future generation to meet their own needs. Organic agriculture claims to be sustainable in the context of agriculture. Sustainability refers to the successful management of resources of agriculture to satisfy human needs while at the same time maintaining or enhancing the quality of the environment and conserving natural resources. Sustainability in organic farming must therefore be seen in a holistic sense, which includes ecological, economical and social aspects. The goal of sustainable agriculture is to maintain production at levels necessary to meet the increasing demand of an expanding world population without degrading the environment. Some important practices for sustainable crop production. First practice is crop rotation means growing a series of dissimilar types of crops in the same area in sequential seasons for various benefits such as to avoid the buildup of pathogens and pests that often occurs when one species is continuously cropped. Crop rotation also seeks to

balance the fertility demands of various crops to avoid excessive depletion of soil nutrients. Second practice is organic farming such a method of cultivation that does not involve the use of artificial inputs like chemicals to either enrich the soil, fight pests or increase productivity. Third practice is integrated nutrient management system envisages conjunctive use of organic manures, crop residues, biofertilizers, legumes in crop rotation and green manuring. It combines traditional and improved technologies to gain from the symbiosis and synergy of crop- soil-environment bio-interactions. Fourth practice is recycling of organic wastes. Fifth practice is bio-fertilizers such as rhizobium culture is an effective source of N supply to leguminous crops. Azotobacter and azospirillum help in N fixation and supply to crops like rice, wheat, sorghum, maize, cotton, sugarcane, fruit crops and vegetables.

Keywords: - Sustainability, production, organic, agriculture, crop, environment

26. Evaluation of essential oils and biological pesticide for organic pest management in garlic

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Abstract

Onion thrips, *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) is one of the destructive pest of garlic. The use of chemical insecticides is major tactic for the control of thrips in garlic. Sole reliance on chemical insecticides and injudicious use would result in development of insecticide resistance and negative effects on non-target species. Hence, search of eco-friendly alternatives are become necessary for the sustainable pest management. In this context, an experiment was conducted during *rabi* to evaluate two essential oils viz, Lemon grass oil, Eucalyptus oil and a biological pesticides Spinosad and neem oil along with other organic pest control components such as sticky traps and neem cake. The treatments were T₁ – Recommended dose (RD) Neem cake- Lemongrass oil @ - Lemon grass oil @ 4ml/L-Spinosad @0.3 ml/L (Blue sticky Trap); T₂ - RD Neem cake- Lemongrass oil-Lemon grass oil-Lemon grass oil - (Blue sticky Trap); T₃ - RD Neem cake-Eucalyptus oil@4ml/L-Eucalyptus oil @ 4ml/L-Spinosad @0.3 ml/L (Blue sticky Trap); T₄ - RD Neem cake- Eucalyptus oil- Eucalyptus oil- Eucalyptus oil (Blue sticky Trap); T₅ -RD Neem cake- Neem oil @2ml/L-Neem oil @2ml/L-Neem oil @2ml/L(Blue sticky Trap); T₆ - RD Neem cake-Spinosad @0.3 ml/L-Spinosad @ 0.3 ml/L-Spinosad @0.3 ml/L (Blue sticky Trap). The sprays were made at 45, 60 and 75 days after planting. Observation of thrips population and natural enemies including spiders, coccinellids, Orius sp and predatory thrips

was made after 48 hours of spraying. The results showed that the application of Spinosad at 40, 50 and 60 days after planting (DAP) and essential oils @ 40 and 50 DAP & one subsequent spray of Spinosad @ 60 DAP found to be the better in suppressing the thrips population compared to sole essential oils treated plot. Plots treated only with essential oils had higher number of NEs.

Keywords: IPM, garlic, biological pesticides, organic farming, thrips

27. Effect of various modules on population of whitefly on okra during *kharif* season in Vidharbha

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Abstract

Field studies were undertaken to assess the Effect of various modules against whitefly, *Bemisia tabaci* on Okra during *kharif* season in vidharbha of eight modules against whitefly during *kharif*, 2015-16 at Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.). The experiment was laid in Randomized Block Design (RBD) with three replications. All the treatment modules were significantly superior over untreated module. Among eight different modules tested the lowest population the minimum incidence of whitefly was recorded in M6 ST, SA, YST, Cyper, Tria, Fenpo, Ace+Spir 1.66/leaf and was found statistically at par with module M4 (1.89 whitefly/leaf), module M5 (1.90 whitefly/leaf) and module M3 (2.04 whitefly/leaf) and they were significantly superior over the remaining treatments. The treatment module M7, M1 and M2 in second order of merit accounted whitefly population to the tune of 2.56/leaf, 2.69/leaf and 2.97/leaf, respectively and they were statistically at par with each other and superior over M8. However, the untreated module M8 had observed the highest incidence of whiteflies (4.21/leaf).

Keywords: Okra, whitefly, YST, module

28. Efficacy of botanicals against *Fusarium oxysporum f. sp. dianthi*

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Abstract

Studies were conducted efficacy of botanical against *Fusariumoxysporumf.sp. dianthi* under in vitro conditions. The extracts of different botanical were tested against *F.oxysporum f.sp.dianthi* by poisoned food technique in in-vitro. Least growth of pathogen was recorded in extracts of Neem leaf extract showing excellent inhibitory effect of (78.19) per-cent reduction over control. Next best treatment was Eucalyptus extract (75.87) per-cent followed by Ashoka leaf extract (72.48) per-cent and Calotropis leaf extract (65.22) per-cent was least by others. Among the treatments Neem oil cake and Datura extract recorded maximum growth inhibition of (62.09) and (60.27) per-cent over control, respectively.

Keywords: Colotropis extract, *Fusarium oxysporum f.sp.dianthi*, Neem

29. Identification of elite genotype through gene action for indirect trait in mungbean

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Abstract

Diallel analysis was performed using ten mungbean genotypes and their 45 F₁ hybrids. The experiment was laid down in Randomized Block Design (RBD) with three replications during *kharif* 2012 at Centre of Excellence for Research on Pulses, Sardarkrushinagar Dantiwada Agriculture University, Sardarkrushinagar, Gujarat. As per Hayman's graphical analysis, the parental line GM 2 had maximum dominant genes for earliness. Similarly, the parental line COGG 192 was found having maximum recessive genes for increasing 100-seed weight.

Keywords: Dialle analysis, recessive, dominant, gene action.

30. Comparative Evaluation of Different Planting Techniques in Pigeonpea under Dryland Conditions of Maharashtra

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Abstract

In the scarcity zone of Maharashtra, monsoon is characterized by its uncertain and erratic nature. The agriculture in this region is often influenced by onset, amount of rainfall and intermittent dry spells. Sowing of pigeonpea in this region is mostly get affected due to moisture scarcity because of late onset and influenced inversely due to moisture stress at later stages and subsequently fails to produce economic yield. The field investigation on different planting techniques in pigeonpea viz, drilling, dibbling and transplanting with four cultivars was conducted on fixed location in factorial randomized block design at the Dry Farming Research Station, Solapur (MS) in rainy season. Significantly higher seed and biological yield was recorded under transplanting method. Pigeonpea sown by transplanting method attained 50 per cent flowering 12-15 days earlier than other methods under consideration. Significantly highest 100 seed weight (9.79 g), more number of pods per plant (113) and pod weight plant-1 (33.79 g) were noticed under transplanting. CUM (681 mm), MUE (1.38 kg ha⁻¹ mm) and RLWC (%) was recorded in this method. Transplanting was also found efficient in nutrient use and uptake. Highest gross returns (₹. 46388 ha⁻¹) were obtained from transplanting method. Among the different varieties under investigation, Phule Vipula found better in respect of yield and yield attributes, CUM, MUE and moisture extraction. Economically, Phule Vipula sown by transplanting method was best suited for scarcity areas of Maharashtra.

Keywords: RLWC, CUM, MUE, Transplanting Method, Moisture, Stress, Pigeonpea

31. Irrigating Safflower through Drip: A Perspective for Farmers of Scarcity Zone of Western Maharashtra

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Abstract

Water stress reduces plant physiological processes, cell division and enlargement and differentiation. Water is precious input in scarcity areas. Hence the measured quantity of water was applied through drip system on the basis of percent of cumulative pan evaporation at three critical growth stages. With reference to limited soil moisture, high evapotranspiration and wilting problems and achieving high yield per unit area, this work was undertaken to evaluate the response of safflower cultivars and plant densities to measured quantity through pressurized irrigation system. The experiment composed of three irrigation regimes as main plot factor *viz.* I₁: irrigation of 60 percent of CPE, I₂: irrigation of 80 percent of CPE, I₃: irrigation of 100 percent of CPE. Five combinations of variety X spacing *viz.* SSF-708 X 45x20 cm, SSF-748 X 45x20 cm, GMU-6878 X 45x20 cm, GMU-6878 X 30x20 cm, GMU-6878 X 30x15 were allocated in sub plots. Irrigation was applied at three physiological growth stages *i.e.* i) rosette ii) branching and iii) 50 per cent flowering. The irrigation was applied on the basis of cumulative pan evaporation (CPE) taken place between two successive phenophases. Significantly higher seed yield of safflower was recorded under I₃ (26.38 q ha⁻¹). The seed yield was increased under 100 percent of CPE regime (65.9 per cent over I₁). Based on the results, significantly highest harvest index was noticed in I₃ treatment (21.25 %) and the lowest value (19.99 %) was associated with stressed treatment *i.e.* I₁ (irrigation of 60 of CPE at 3 stages). I₃ by producing more capitulas and seeds per capitula (28.36 plant⁻¹ and 34.27 g plant⁻¹ resp.). Significantly the higher oil yield (788 kg ha⁻¹) was recorded under I₃, which was 67 per cent higher over stressed treatment I₁ (471 kg ha⁻¹). Water productivity exhibited the decreasing trend with increase in water quantity applied. It was 1.23, 1.20 and 1.14 kg m⁻³ under I₁, I₂ and I₃, respectively.

32. Influence of Frontline Demonstrations on Yield and Economics of Safflower

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Abstract

A total of 740 frontline demonstrations were conducted on farmer's field during last three decades (1988 to 2018) in scarcity zone of Maharashtra state. The components viz. whole package, thinning, improved variety, recommended dose of fertilizers, plant protection measures and intercropping were tested with local package of practices. The results indicated that net monetary returns as well as the benefit cost ratio were high in improved practices for the components as compared to local practice. The intercropping of gram and safflower (6:3) and use of RDF under rain fed conditions were the most economical component which increased 46 and 40 per cent in monetary returns over local practice. The results also revealed that awareness in respect of use of improved varieties, balanced fertilization, IPM module adoption and précised use of component technologies brought a significant change in their livelihood through additional income.

Keywords: Frontline Demonstrations, Components, Improved Technology, Safflower

33. A new spiny safflower variety SSF 13-71 for rainfed and irrigated conditions of the country

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Abstract

Safflower (*Carthamus tinctorius* L.) is an important *rabi* oilseed crop of the country and is mainly cultivated for its seed which is the source of rich in polyunsaturated fatty acids (Linoleic acid 78%). Maharashtra, Karnataka and Andhra Pradesh in peninsular India are the three most important safflower growing states in India. The area under safflower in India was 0.81 lakh ha, having 0.55 lakh ton production and productivity of 679 kg/ha (Anonymous

2017-18). In Maharashtra it is grown over an area of 0.39 lakh ha with production 0.21 lakh ha and average yield of 548 kg/ha. A Safflower genotype, SSF 13-71 is a spiny genotype derived through the pedigree selection method from a cross of Bhima X NARI 44. It was evaluated in station trial for yield evaluation during 2014-15 and tested in University multilocation varietal trial during 2017-18, simultaneously; it was evaluated in All India Coordinated Varietal Trial from 2016-17, 2017-18, and 2018-19. Based on the performance in station and university multilocation varietal trial and coordinated trials SSF 13-71 consistently recorded 9.84 % and 17.47 % higher yield over the check A1 and PBNS 12 respectively. Also SSF 13-71 recorded 14.98 % and 18.67 % higher oil yield over the check A1 and PBNS 12 respectively as it contains 29.2% oil. It was responsive to higher doses of fertilizer and late sown conditions. The variety SSF 13-71 was identified in Annual Group Meeting held at Kanpur during 4- September 2019 for rainfed and irrigated safflower growing areas of the country (Maharashtra, Karnataka and Telangana state).

Keywords: Safflower, genotype and SSF 1371

34. Correlation of Weather Parameters with Development of Leaf Spot of Safflower Caused by *Alternaria carthami*

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Abstract

A field experiment was conducted during 2019-20 to study the effect of different weather parameters viz., rainfall, humidity and temperature on the development and progress of *Alternaria* leaf spot under five different sowing conditions. The correlation studies revealed that the rainfall coupled with morning (RH-I) and evening (RH-II) relative humidity had a significant positive correlation with the development of *Alternaria* leaf spot of safflower in all sowing dates. The minimum temperature showed significant positive correlation with the development of *Alternaria* leaf spot of safflower in D₁ (05.09.2019), D₂ (20.09.2019), D₃ (30.09.2019) and D₄ (14.10.2019) and positive correlation in D₅ (28.10.2019) sowing date. Moreover, maximum temperature showed a negative correlation with the development of *Alternaria* leaf spot of safflower in all the sowing dates except D₁ (05.09.2019). The occurrence of rainfall resulting in rise in relative humidity (RH-I and RH-II) was observed to be congenial for the infection and further rapid build-up of the *Alternaria* leaf spot disease.

Keywords: Safflower, *Alternaria* leaf spot, correlation, weather parameters

**35. Tiny insects help tackle invasive pest of India: Rugose spiralling whitefly,
Aleurodicus rugioperculatus Martin**

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Abstract

The Rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin (Hemiptera: Sternorrhyncha: Aleyrodidae) has been invaded India in 2016 causing huge damage to the coconut crops and other host plants in different states of India viz., Tamil Nadu, Karnataka, Kerala and Andhra Pradesh. Rugose whitefly feeding causes stress to the coconut trees by removing water and nutrients from the leaves and also by producing honeydew, which covers the lower leaves and results in the growth of sooty mold. Moreover, in coconut there is no recommendation of pesticides by CIBRC for management of this invasive. In our experiment field survey was undertaken from August 2017 to February 2019 in major coconut growing districts of Tamil Nadu viz., Coimbatore, Tiruppur, Erode, Theni, Pudukottai and Kanyakumari to study the natural enemies of *A. rugioperculatus*. In the present study revealed that we were recorded one species of aphelinid parasitoid and nine species of predators against this new invasive pest. Which are naturally available in rugose spiralling whitefly affected coconut gardens and also in other host plants. Among all the natural enemies, three predators viz., *Mallada desjardinsi*, *Chrysoperla zastrowi sillemi* and *Cryptolaemus montrouzieri* was found maximum and also voraciously feeding (928 ± 6.00 , 640 ± 0.00 and 652 ± 2.00) on RSW life stages and reducing the population. One parasitoid from the Aphelinidae family, *Encarsia guadeloupa*. The natural parasitisation of *E. guadeloupa* ranged from 40 to 80 per cent. These entomophagous insects may provide additional opportunity to the coconut growing farmers of Tamil Nadu to utilize these potential biocontrol agents against invasive RSW.

Keywords: *Aleurodicus rugioperculatus*, Coconut, Invasive, Spiralling whitefly, Parasitoid and Predator

36. Effect of Different Cutting and Nitrogen Management Practices on Physiological Parameters of Dual Purpose Wheat

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Abstract

Dual purpose wheat can serve fodder as well as grain purposes because it is adapted to a wide range of climates and soil types. Growing of tall wheat (c-306) for dual purpose is one of the methods to harvest nutritive fodder in early winter months when scarcity of fodder is very common without affecting grain yield of wheat. A field experiment was conducted to study the effect of cutting and nitrogen management practices on chlorophyll content, canopy temperature and canopy temperature depression (CTD) in dual purpose wheat during the *Rabi* seasons of 2015-16 and 2016-17 at Agronomy Research Farm, CCS HAU, Hisar (Haryana). The experiment was laid out in a RBD with 3 replications and 18 treatments. The crop was harvested for green fodder after 55 days of its sowing at two different stubble heights i.e. 5 and 10 cm. Study revealed that more chlorophyll content was reported under 75 kg N/ha but that was statistically at par with 60 kg N/ha. Chlorophyll content was not significantly affected by dose of nitrogen, but that was affected by time of nitrogen application. Less chlorophyll content was observed under the treatments where complete dose of nitrogen was applied before cut. The highest chlorophyll content was recorded under cutting at 10 cm stubble height with 75 kg N/ha applied at sowing_{1/3} + after cut_{2/3} (37.8 and 36.63) during 2015-16 and 2016-17, respectively. Canopy temperature and CTD of dual purpose wheat did not vary significantly among different cutting and no cutting treatments with different doses and application time of N during two years of experimentation. Canopy temperature of crop was not affected by cutting at 55 DAS during both the years, thus there was no crop stress observed under any treatment.

Keywords: Canopy temperature, CTD, Chlorophyll content, dual purpose, wheat c-306,

37. Effect of High Plant Densities and Fertility Levels on Nutrient Content and Uptake by Summer Groundnut

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Abstract

An experiment was conducted during the *summer* season of 2014-15, to study the “Effect of high plant densities and fertility levels on nutrient content and uptake by *summer* Groundnut” at the research farm on Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Factorial Randomized Block Design with three replications. Nine treatment combinations were formed with a view to integrate three planting densities and three fertilizer levels. The allocation of treatments was made by random method. On the basis of results obtained in the present investigation, the effect of high plant densities on Nitrogen, Phosphorus and Potassium uptake in plant were more when crop grown with treatment S₃ (20 x 10 cm) spacing i.e. (plant population) @ 5 lakh ha⁻¹ which were 156.52 Kg N ha⁻¹, 25.22 Kg P ha⁻¹ and 85.16 Kg K ha⁻¹. Similarly, the same components were lowest in crop grown at S₁ (30 cm x 10 cm) spacing i.e. (pp) @ 3.33 lakh ha⁻¹. Among the fertilizer levels, Nitrogen, Phosphorus and Potassium uptake in plant re-ordered maximum under the treatment F₃ (125 % RDF) were 162.13 Kg N ha⁻¹, 25.84 P ha⁻¹ and 87.36 Kg K ha⁻¹ respectively. The same character were obtained lowest when crop grown with 75 % RDF. The interactions of planting densities and fertilizer levels on Nitrogen in uptake haulm and Potassium uptake in haulm were found to be significant during experimental year.

Keyword: Plant densities, Fertility levels, *Summer*, Nutrient content, Groundnut and Uptake

38. SSR markers analysis to study the genetic diversity of *Sclerotinia sclerotiorum* isolates

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Abstract

The *Sclerotinia sclerotiorum* (Lib.) de Bary is a destructive plant pathogen that belongs to division Ascomycota and infects more than 500 cultivated and wild plant species. This fungus causes white mold disease in Indian mustard (*Brassica juncea*) that lead to heavy losses in yield as the incidence of this disease could be up to 72 - 80% at some of the locations in Rajasthan, Punjab and Haryana. Lack of effective field resistance to *Sclerotinia* in cultivated species of rapeseed-mustard has stimulated the interest of researchers towards finding out variations occurring at the cultural, morphological and molecular characteristics to analyze the changes evolving in the population of *S. sclerotiorum*. In the present study, twenty isolates of *S. sclerotiorum* (HSR, CDR, BWN, MGH-N, SIR, FTB, BWL, DRN, HGH, MGH-MK, RTK, DBL, PAU, BKN, RSN, NHR, BKN2, 5324, 6323, and 4042) were studied for morphological and molecular diversity. Morphological variability was observed for type of growth, diameter of mycelia, sclerotia initiation, and number & pattern of sclerotia formation among the isolates. For molecular diversity, genomic DNA of twenty isolates was amplified using seventeen SSR primer pairs and polyacrylamide gel electrophoresis was carried out for the separation and detection of the amplified products. UPGMA dendrogram generated using programme NTSYS-PC (version 2.02) software grouped all the twenty isolates in two major clusters I and II at a similarity coefficient of 19%. Major cluster I and major cluster II further clustered into two sub clusters at a similarity coefficient of 31% and 22% respectively. The number of alleles per locus varied from 1-4. This research will assist better understanding of the genetic variability and help to improve disease management practices of *Sclerotinia* stem rot in the breeding programs of Indian mustard.

Keywords: *Sclerotinia*, SSR markers, PAGE, Genetic diversity.

39. Farmer participatory evaluation of integrated nutrient management systems on yield and economics of Banana variety Nendran grown as intercrop in the coconut-based homesteads of Western Ghat region of Kollam district

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Abstract

Banana is a heavy feeder of nutrients and a stable supply of nutrients from planting to bunch maturity is vital for the production of bigger and quality bunch. There is huge quantity of organic wastes available after harvest in the form of pseudostems and leaves and hence there is a scope of recycling the waste using earthworms, a major soil macro flora and fauna that constitute an important group of secondary decomposers. The nutritional contents of vermicompost can be improved by enrichment with organic additives. With this back ground a field study was conducted with the financial support of Western Ghat cell of Govt of Kerala in the farmers field of 3 panchayaths of Kollam district viz., Kummil, Yeroor and Vilakkudy which came under the agroclimatic unit -12 from 2015 July to 2018 with an objective to find out the effect of integrated plant nutrient system on yield and economics of banana variety Nendran. The experiment was laid out in randomized block design with 9 treatments and 3 replications. The different treatments were T₁ –Farmers Practice, T₂- NPK as per Package of practices recommendations of Kerala Agricultural University(POP),T₃- NPK as per soil test value, T₄- 75% N,P + 100 % K+ Azospirillum and AMF (Arbuscular Mycorrhizal Fungi),T₅- 75% N,P K +PGPR Mix(Plant growth promoting rhizobacteria) , T₆- 50% N,P + 100% K +Azospirillum and AMF (+ Top dress with VC (Vermicompost) @5 kg,T₇- 50% NPK + PGPR Mix 1+Top dress with VC (5 kg),T₈- 50% N,P + 100% K +Azospirillum and AMF+ Top dress with Enriched VC (2.5 kg), T₉- 50% NPK + PGPR Mix 1+Top dress with enriched VC (2.5 kg). The enriched vermicompost was selected from the incubation study (neemcake+rock phosphate). The result of the field experiment revealed that the treatment T₃ ie., soil test based nutrient management was the best nutrient management option with high net return and benefit cost ratio. At the same time, the integrated nutrient management system involving vermicompost and enriched vermicompost with 50 % N ,P and 100% K + biofertilizers AMF+Azospirillum gave a favourable net income and benefit cost ratio which was lower than the treatment T₃,T₂, T₄ and T₅ apart from the higher microbial population which ensured an ecofriendly viable nutrient package. This nutrient package also effectively recycled the biomass produced ie., farm waste in the banana plantation of coconut-based homestead to a high value vermi compost.

40. Assessment of existing nutrient management practices on soil health in the banana growing tracts of Western Ghats region of Kollam district under the agroecological unit AEU 12(Southern and central foot hills)

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Abstract

Undulating topography of the Western Ghats region, heavy rainfall, unscientific agricultural practices, human interventions, high temperature *etc.* cause serious soil and water erosion which in turn leads to the loss of soil nutrients, rapid depletion of soil organic matter and soil fertility. Indiscriminate and unscientific use of complex fertilizers and minimum or non-use of organic manures and liming material by farmers of these regions also intensified the deterioration of soil health which might have led to multiple nutrient deficiencies in many crops especially in banana as it is a nutrient responsive crop. Hence a study was conducted to assess the effect of existing nutrient management practices on soil health in the banana growing tracts of Western Ghats region of Kollam district, Kerala under the agroecological unit 12 (southern and central foot hills). For this, soil samples were collected from the fields of progressive banana farmers of Yerror, Vilakudi and Kummil panchayats which came under the agroecological unit 12- southern and central foot hills (10 farmers from each panchayath)and were analyzed for various parameters *viz.*, pH, EC, Organic carbon, P, K, secondary nutrients, micro nutrients and soil microbes *viz.*, fungi, bacteria and actinomycetes. The data on soil parameters were categorized into low, medium and high based on soil fertility ratings. The results revealed that in general, the soils were acidic in nature (pH varied from 4.39 to 6.18) and the nutrients especially potassium, calcium, magnesium and boron were found to be low. The organic carbon content was medium in range (0.51 to 1.5 %) in all samples tested. The available phosphorus was medium (10 to 24 kg/ha) in more than 76% of soil samples tested and available potassium in soil was low (<116 kg/ha) in 66.67% of samples tested. Among the secondary nutrients, deficiency of calcium, magnesium and sulphur were observed in 50, 30 and 13.33 % of soil samples tested respectively. With respect to micro nutrients, adequate quantity of iron, manganese, zinc and copper were observed in samples tested. Among the micro nutrients, the boron was deficient in 86.67 % of soil samples tested. The population of soil actinomycetes was very low in all samples collected from the three panchayaths when compared to soil bacterial and fungal population.

41. Plant Protection through Eco-friendly Practice for Sustainable development

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Abstract

Modern agricultural practices and the input services has resulted in exponential growth in crop production in India, particularly in northern region states of the country. Though self-sufficiency has been achieved, but it affect the environmental negatively such as serious agricultural pollution. Implementation of eco-friendly agricultural practices can effectively overcome the negative affect on environment. The term “eco-agriculture” was coined by Charles Walters, economist, author, editor, publisher and founder of Acres Magazine in 1970. An eco-friendly agriculture might be characterized as the utilization of information and assets in a deliberate manner to create wanted yield without harming the earth. Eco-friendly farming practices is the agricultural system which aims at cultivation of land in such a ways that the soil is kept dynamic with its living activities in good health and at the same time keeping the environment clean, maintaining ecological balance and providing stability to production level without polluting the soil, water and area. The indigenous practices for plant protection in crops as identified and documented might be integrated with ongoing research at various agricultural research centres, eventually leading to the development of viable packages for crop protection and their dissemination to local and regional farming communities. The farmer’s innovations to control the pests by use of neem extract, and use of solutions prepared from dinkamali and besharam’s (*Ipomoea carnea*) leaves, and the larvae of the same insect that affect crop. The farmers were implementing these practices because: they help reduce crop losses, they are compatible with the farming system, they are easy to handle, and the products used are locally available, eco-friendly, cost effective and compatible with the socio-cultural situations of farmers. Farmers are needed to popularize eco-friendly farming with requisite economic and structural backup should be fulfilled for increasing the utilization and marketability in relation to eco-friendly farming. The success of eco-friendly farm approach totally depends on awareness of the approach supported by the authentic sources of inputs and knowledge from technical persons. There is an urgent need to create reciprocal learning platforms between scientific and farming communities for further showcasing and refining the existing grassroots innovations and practices towards more sustainable life ways.

Keywords: Eco-friendly practices, pest, innovation, plant protection.

42. Integrated Farming System towards Sustainable Development of Agriculture and Economic Upliftment of Farming Community

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Abstract

Agriculture in India is the pivotal sector for ensuring food and nutritional security, sustainable development, generating employment opportunities and for alleviation of poverty towards sustainable development of agriculture. Integrated Farming System (IFS) is a reliable way of obtaining high productivity with substantial nutrient economy in combination with maximum compatibility and replenishment of organic matter by way of effective recycling of organic residues/wastes which can improve the farming community by economic upliftment. Integrated farming system is a commonly and broadly used word to explain a more integrated approach to farming as compared to monoculture approaches. It refers to agricultural systems that integrate livestock and crop production or integrate fish and livestock and may sometimes be known as Integrated Bio systems. In this system, inter-related set of enterprises is used so that the “waste” from one component becomes an input for another part of the system, which reduces cost and improves production and/or income. The achievements in increasing socio-economic condition of farming community have been realized with challenges of providing and increasing incomes, generating employment opportunities, reducing risks in agriculture, developing agri-infrastructure and improving quality of rural life need priority attention. Within the sustainable agriculture framework, integrated farming system (IFS) is one approach towards transforming the idea of sustainable development from concept to reality. Execution of a series of reform measures is needed to solve these problems of sustainable agriculture and economic upliftment of farming community. The development and implementation of integrated farming systems are of special importance for sustainable agriculture development to enhance the socio-economic condition of farming community to improve quality of life of resource poor farmers and maintain sustainability in agriculture.

Keywords: Integrated Farming system, economic upliftment, farming community, development.

43. Response of Genotypes to Different Nitrogen Levels on Growth, Sugar Yield and Quality of *Spring* Sugarcane (*Saccharum officinarum* L.)

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Abstract

A field experiments was conducted to assess the response of promising sugarcane genotypes to fertilizer levels during spring season 2011-12 and 2012-13 at the Central Sugarcane Research Station, Padegaon. The genotype CoM 05082 produced significantly highest cane and CCS yields (113.55 and 15.27 t ha⁻¹, respectively) than rest of the genotypes. However, it was at par with CoSnk 5104 in respect of CCS yield (14.76 t ha⁻¹). The application of 125% of recommended fertilizer dose of nitrogen to spring sugarcane produced significantly higher cane and CCS yield (115.29 and 15.74 t ha⁻¹, respectively) than rest of nitrogen levels. It was followed by 100% of recommended dose of nitrogen. Growth and yield attributes *viz.*, germination, tillering ratio, millable height, cane girth and number of internodes per cane was significantly higher in genotype CoM 05082. The spring planted sugarcane receiving 125% of recommended dose of nitrogen was significantly superior to the other levels for the growth and yield attributes *viz.*; millable height, average cane weight and number of internodes cane.

Keywords: Sugarcane genotype, Fertilizer, Spring, Yield, Quality

44. Fodder Cultivation: An Option to Conserve Rice Summer Fallows

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Abstract

The conservation of summer rice fallows is a prime concern as it is a static source of rice production. However, the main threat to the summer fallow is weed population, which take up the soil moisture along with nutrients. This in turn pose deficiency of moisture and nutrients to the subsequent rice crop. Thus, the better option to conserve the summer fallow is to cultivate the land with suitable crops. At this context, in the summer rice fallow of double

cropped low land rice field, four different fodder crops were raised under varying nitrogen regimes with the objective of evaluating its effect on weeds, during 2017-18. The experiment was laid out in Randomized Block Design. The fodder crops were fodder cowpea (CO- 9), rice bean (Bidhan- 2), fodder maize (African tall), fodder sorghum (CO (FS) 31). The varying nitrogen regimes were 100, 75 and 50 per cent recommended dose of nitrogen (RDN). The weed composition in the experimental field included grasses, sedges and broad-leaved weeds. Both at 20 and 40 DAS, the weed population was more in fallow treatment. The weed dry matter production was significantly more in the fallow plot. At 40 DAS, weed dry matter production was relatively less in fodder cowpea. Weed smothering efficiency (WSE) was relatively greater in all the fodder crops except fodder cowpea at 20 DAS. However, at 40 DAS the WSE in rice bean, fodder maize and fodder sorghum declined, while in fodder cowpea it increased.

Keywords: Weeds, fodder crops, nitrogen, summer rice fallows, conservation of fallow land

45. Fertilizer-manure blocks- a novel concept for slow release of nutrients in vegetables

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Abstract

Fertilizer-manure blocks were developed and were tested in the trials conducted at RARS Pattambi. The study included two experiments, laboratory incubation study and a pot culture experiment. In the experiment-I fertilizer manure blocks were developed by mixing organic materials in five different proportions along with per plant recommended dose of nutrients calculated based on KAU-POP (Package of Practices) recommendations and were incubated in soil up to 60 days. The results of the incubation study revealed that, fertilizer-manure blocks made of all five proportions (treatments T₁-T₅) showed slow release pattern with respect to various nutrients as compared to sole fertilizer placement. When compared among the fertilizer-manure blocks (T₁-T₅) treatment T₁ (proportion-1) exhibited slow release behavior to a greater extent and synchronization with physiological need of the crop and hence, was selected for the conduct of the pot culture experiment. In pot culture study and fertilizer- manure blocks were prepared in two dimensions (100 g and 25 g) using three dosage of fertilizers (100 per cent POP, 50 per cent POP, and 25 per cent POP). Okra variety Arka Anamika was used as the test crop. The experiment consisted of 11 treatments with 3 replications. Fertilizer-manure blocks showed significant effect on growth and yield of okra.

Treatment T₇ (blocks of 100g size containing 25% of the recommended dose of nutrients placed 5cm below the level of planting and top dressing of 50% of KAU POP recommendation) had recorded highest value for number of fruits per plant, fruit yield per plant, fruit length, fruit girth as well as number of seeds per fruit. Application of fertilizer manure blocks had shown significant influence on the available nutrient status of the soil after final (N, K, P, Ca, Mg, S, Zn, Cu, B) harvest.

Keywords: Fertilizer-manure blocks, slow release fertilizers, matrix based fertilizers, okra

46. Morphological Variations in *Leucinodes orbonalis* (Guenée) Populations from Different Agro Climatic Zones of India

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Abstract

Shoot and fruit borer, *Leucinodes orbonalis* is an important insect pest infesting brinjal in India. In our study, we conducted morphological studies on *L. orbonalis* populations collected from five different agro-climatic zones of India viz. Middle Gangetic plain, Trans Gangetic plain, Eastern plateau and hills, Western plateau and hills, Southern plateau and hills. Differences were observed among the studied populations with respect to occurrence body colour in larvae, existence of anal hairs in pupae and spot patterns in the wings of adult moths. Four different larval colour morphs observed were honey beige, Congo pink, paradise pink, and dark orange colour morphs. Existence of anal hairs in pupae was found to be a common trait in male as compared to that of females. Four different spot patterns were also observed on the forewings while two different spot patterns were observed on the hind wings of the adult moths in the studied populations. Such differences clearly indicate the possibility of existence of sub-species in *L. orbonalis* populations of India.

Keywords: *Leucinodes orbonalis*, larval colour morph, anal hairs, forewing and hind wing.

47. Effect of Neem Products against Fusarium Wilt Disease (*Fusarium oxysporum* f. sp. *lycopersici*) In Tomato Seedlings

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Abstract

Tomato (*Lycopersicon esculentum* L.) is one of the most popular and widely grown vegetable in the world. Fusarium wilt due to *Fusarium oxysporum* f.sp. *lycopersici* causes high damage to the production of tomato. An investigation at research laboratory in the Department of Plant Pathology, SHUATS, Allahabad was carried out to evaluate the effect of Neem products viz., neem leaf extract, neem seed kernel extract, neem cake, neem bark and neem oil @ 0.50% and carbendazim (treated check) @ 0.20% against *F. oxysporum* f.sp. *lycopersici* under *in-vitro* condition by poisoned food technique. The experiment was laid out in a complete randomized design with six treatments and three replications. The neem products significantly inhibited the mycelial growth of *F. oxysporum* f.sp. *lycopersici* as compared to control. Carbendazim (treated check) and Neem seed kernel extract were the best treatment which inhibited 74.37% and 58.13% mycelial growth of *F. oxysporum* f.sp. *lycopersici*, respectively. Followed by neem oil (48.17%), neem leaf extract (33.51%), neem cake (29.83) and neem bark (21.48%). The germination percentage of tomato treated with *F. oxysporum* f.sp. *lycopersici* was also carried out in plastic trays under green house condition with seven treatments and three replications. Among neem products, neem seed kernel extract was found to be the most effective treatment and recorded maximum germination percentage followed by neem oil, neem leaf extract, neem cake and neem bark @ 0.50%.

Keywords: *Fusarium oxysporum* f. sp. *Lycopersici*, *Lycopersicon esculentum* L., Neem products and poisoned food technique.

48. Seasonal occurrence and diversity of arthropods in deshi cotton ecosystem under Akola conditions of Maharashtra.

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Abstract

Present investigation was carried out at Department of Entomology, Dr. PDKV Akola (MS) India during *kharif* 2016. It is revealed from the survey that, deshi cotton ecosystem harbored total 24 insect fauna out of which 15 insects were categorized as pests and 9 were natural enemies (NEs). In deshi cotton crop ecosystem sucking pests viz leafhopper, whitefly, aphids, thrips were in peak during 38th, 39th, and 40th SMW American boll worm (40th, 41th SMW), spotted boll worm (43rd SMW), pink boll worm (48th, 49th SMW), red cotton bug (48th and 49th SMW) were predominant insect pests and spiders, LBB, mallada, chrysopa, syrphid fly were dominant during 34th, 35th, 36th and 37th SMW. The simple correlation studies indicated that rainfall had significantly positive correlation with American boll worm population; maximum temperature had significantly positive correlation with mite, spider, lady bird beetle and malada. However, negative significant association was noticed between maximum relative humidity with mite, spotted boll worm and red cotton bug population. High per cent abundance was recorded by aphids followed by red cotton bugs, mites and leafhoppers with moderate to rich biodiversity of arthropod fauna was noticed in deshi cotton ($H' = 2.489$) crop ecosystem at Akola.

Keywords: *kharif* crop ecosystem, deshi cotton, natural enemies, pests, biodiversity.

49. Importance of canopy management to optimize the production of quality fruits

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Abstract

Canopy in a fruit tree refers to its physical composition comprising of the stem, branches, shoot and leaves. Canopy management of the fruit trees deals with the development and maintenance of the structure in relation to size and shape, orientation of branches and light interception for the maximum productivity and quality. The basic concept in canopy management of a perennial tree is to make the best use of land and the climatic factors for an increased productivity in three dimensional approaches. The canopy management, particularly its components like tree training and pruning, affects the quantity of sunlight intercepted by trees, as tree shape determines the presentation of leaf area to incoming radiation. An ideal training strategy centres around the arrangement of plant parts, especially, to develop a better plant architecture that optimizes the utilization of sunlight and promotes productivity. Light is critical for growth and development of trees and their fruits. The green leaves harvest the sunlight to produce carbohydrates and sugars which are transported to the sites where they are needed – buds, flowers and fruits. Better light penetration into the tree canopy improves tree growth, productivity, yield and fruit quality. The density and orientation of planting also impact light penetration in an orchard. Generally, in close planting, quicker shading becomes a problem. An east-west row orientation results in more shading as compared to the western and southern orientation of trees. Strong bearing branches tend to produce larger fruits. The problem of a fruit grower is initially to build up a strong and balanced framework of the trees, then equips them with appropriate fruiting. Obviously, pruning in the early years has to be of a training type to provide strong and stocky framework with well spaced limbs or any other desired shape.

Keywords: Canopy, light penetration, training, pruning

50. Comparison of physical and chemical and nutritional properties of popular conventional and non conventional organic manures

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Abstract

Organic amendments can directly supply both macro and micro-nutrients but the, nutrient content is highly dependent upon the source and quality of the organics. In the current situation wide gap existed between demand and supply for organic manures both in organic farming as well as in farms adopting good agricultural practices. The new thermochemical waste processing method reported by Sudharmaidevi *et al.* (2017), provides a quick and sustainable solution for hygienic waste disposal and the production of organic manure. In the present study organic manures were prepared in four different methods and along with FYM were characterized for its various properties. The aerobic compost (AC), microbial compost (MC), vermi compost (VC), and thermo chemical organic fertilizer (TOF) were prepared from identical wastes and TOF-F was prepared by fortifying the TOF. The physical properties of all the organic manures under study conformed to the quality standards of FAI (2017). The pH of all the organic manures was in the acidic range and all manures under study had a safe EC. The total organic content (TOC) of all manures remained significant and the highest TOC (48%) was observed in the case of TOF. The dissolved organic carbon was detectable in traces in all manures. The nonconventional organic manure when fortified (TOF-F) had the highest N content of 3.27% followed by MC (2.89%). Vermicompost (VC) registered the highest value P value (1.10%) and differed significantly from all other manures. The K content of organic manures varied in the order TOF-F > TOF > VC > MC > AC > FYM.

Keywords: Organic manure, Compost, Thermochemical organic fertilizer, Total organic carbon.

51. Intrusion of a highly invasive pest bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi (Hemiptera: Aleyrodidae), its invasion and occurrence in India

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Abstract

The first occurrence of bondar's nesting whitefly was reported from islands of Andaman & Nicobar, and coconut palms of Kerala. It requires a dab-hand to distinguish *Paraleyrodes* species in the fields. Adults are smaller than other whitefly species. A pair of grayish brown bands forms an "X" pattern on the forewings. Nymphs produce flocculent wax and long, thin, rod-like filaments. A clear wax band containing a row of short wax filaments resembles a "skirt" around nymphs. Fourth instar nymphs are translucent yellow and surrounded by a "nest" of white wax. Heavy Bondar's nesting whitefly infestations produce circular, white "nests" that create a polka-dot pattern by contrasting with black sooty mold. It has a wide host range. Direct feeding by dense whitefly infestations may cause premature leaf drop and decreased plant vigor. Untreated infestations may eventually kill the plant.

Keywords: Bondar's nesting whitefly, invasive pest, coconut, occurrence, nature of damage.

52. Economic Evaluation Different Agroforestry Systems In Dry Temperate Regions Of North-Western Himalayas

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Abstract

There are several reasons to adopt and maintenance the agroforestry in changing scenario of advanced farming systems. Understanding the economic and financial value of agroforestry requires quantification and market development of the mix of values associated with an agroforestry. The present study is the outcome of economic diagnosis of different agroforestry systems in north western region of Himachal Pradesh, India. The major horticulture produce in this area is Apple (*Malus domestica*). It has got great future prospects in terms of export. It does influence in the socio-economic life of the inhabitants of Kinnaur

district Himachal Pradesh. Results reveal that Gross Return ($2065230.07 \text{ Rs ha}^{-1}\text{yr}^{-1}$), Total Expenses ($774526.32 \text{ Rs ha}^{-1}\text{yr}^{-1}$) are significantly higher in agrihorticulture system while net return ($1648322.21 \text{ Rs ha}^{-1}\text{yr}^{-1}$) and Benefit-cost ratio (5.87) was significantly higher in agrihortisilviculture and agrisilviculture system respectively. (C₂) High hills temperate dry and cold climatic condition was significantly higher Gross Return ($1907610.931 \text{ Rs ha}^{-1}\text{yr}^{-1}$) whereas net return ($1425428.12 \text{ Rs ha}^{-1}\text{yr}^{-1}$) and benefit-cost ratio (4.63) was significantly higher in (C₁) Dry temperate high hills climatic condition. Interaction between agroforestry systems and climatic conditions shows gross return ($2496328.04 \text{ Rs ha}^{-1}\text{yr}^{-1}$) and net return ($1667249.85 \text{ Rs ha}^{-1}\text{yr}^{-1}$) was significantly higher in agrihorticulture system and agrihortisilviculture system situated in C₂ climatic condition and benefit-cost ratio (8.91) was significantly higher in agrisilviculture system which was located in C₁ climatic condition.

Keywords: Agroforestry B: C ratio; Economic evaluation

53. Impact of Agroforestry Systems: A Review

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Abstract

Agroforestry is a collective name of all agricultural process which related to scientific management of land that increases overall production under different manners. The security of our natural resources decreasing every day, these processes will be increased the pressure of natural forests and agriculture. We are staying on the stage where we have to take a hard decision to conserve our natural resources with sustainability. In this context, agroforestry makes sure a scientific solution to all these problems which provide a vast series of good public services. Under this review paper, we discussed various environmental services and conclude that the incorporation of native tree species on farmland can be diversified the farm income and promote maximum use of land. While, Nutrient pumping is one of the best intangible environmental services of the agroforestry system in which productivity of land can be utilized sharply, at the same time agroforestry boosts the soil health in the course of decomposition of raw materials. Biodiversity and C sequestration in agroforestry systems is typically higher than in conventional agricultural systems. Two or more interacting plant species in a given area create a more complex habitat that can support a wider variety of fauna. Tree cover accounts for more than 75% of the global carbon pool. Agroforestry can significantly contribute to climate change mitigation along with adaptation benefits. Adoption of agroforestry drove carbon storage and increased livelihoods simultaneously among small-

scale farmers. Agroforestry has a wide range of systems and practices, with their selection and use-dependent on ecological, biophysical, and social factors.

Keywords: Agroforestry, Environmental services, Nutrient Cycling and Biodiversity.

54. Efficacy of Bio-Organic Sources on Morphological, Biochemical and Yield Attributing Characters on Pomegranate cv. Mridula

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Abstract

The experiment was undertaken in the Department of Fruit Science, KNK College of Horticulture, Mandsaur, RVSKVV, Gwalior (M.P.) during June to December 2016. The experiment was laid out in Randomized Block Design with total 15 treatments combinations including control. Treatments were comprised of organic manures (FYM, Vermicompost and Neem cake) and biofertilizers (*Trichoderma viride* and VAM) were comprised with three replications. Statistically analysed data shows that the maximum increase in plant height (0.96 m), canopy spread E-W direction (0.94 m) and N-S direction (0.96 m), ascorbic acid, tannin and maximum anthocyanin at harvest with the application of T₁₄ (5kg FYM + 1.5kg Vermicompost + 1.5kg Neem cake + 20g VAM + 20g *Trichoderma viride*) which was significantly superior among all the treatments applied. Whereas, maximum chlorophyll content (65.17 SPAD value) was obtained with the application of T₁₂ (6.5kg FYM + 2kg Vermicompost + 1.5kg Neem cake + 25g VAM) which was significantly superior among all the treatments and control. Among all treatments, treatment, T₁₃ (2kg Vermicompost + 1.5kg Neem cake + 25g VAM + 25g *Trichoderma viride*) produced maximum number of fruits/plant (44.00) and highest yield per tree (13.22 kg).

Keywords: Pomegranate, FYM, vermicompost, neem cake, biofertilizers

55. Systematic Spray Schedule of Fungicides for Management of Purple Blotch of Onion

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Abstract

Onion (*Allium cepa* L.) is the important vegetable crop of the globe because of its nutritive and economic values, which is grown in both *Kharif* and *Rabi* seasons. Purple blotch of onion caused by *Alternaria porri* (Ellis) Cif is most destructive disease of onion crop growing areas of Maharashtra state. In present investigation on “Integrated Management of Purple Blotch of Onion caused by *Alternaria porri* (Ellis) Cif., was conducted during *rabi* season, 2015-16 on the farm of Plant Pathology Section, College of Agriculture, Nagpur. *In vitro* evaluation revealed that hexaconazole at 0.1 per cent caused significant inhibition (94.11%) followed by propiconazole 0.1 per cent (92.94%) of test pathogen, over the untreated control. Under field condition, these fungicides applied as foliar spray also significantly influenced purple blotch intensity and its reduction over untreated control. Minimum disease intensity was recorded with 0.1 per cent hexaconazole (11.85%) and 0.1 per cent propiconazole (13.84%) both treatments were at par to each other, but significantly superior over rest of the treatments. The maximum per cent disease control was recorded with 0.1 per cent hexaconazole (77.00) and 0.1 per cent propiconazole (73.16), followed by *T. harzianum* and garlic clove extract.

Higher onion bulb yield was obtained with 0.1 per cent hexaconazole (267.45 q ha⁻¹) and 0.1 per cent propiconazole (264.53q ha⁻¹) both were at par, but significantly superior over rest of the treatments. Highest incremental cost benefit ratio 1:17.02 was recorded by 0.1 per cent hexaconazole. Thus it was concluded that 0.1 per cent hexaconazole spraying could be effective economical to control purple blotch disease of onion.

Keywords- Onion, Purple blotch, *Kharif*, Fungicide, Hexaconazole, Mancozeb

56. Exploration of ovipositional behavior of *Antheraea mylitta* (D) to enhance the fecundity

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Abstract

Indian tasar silkmoth, *Antheraea mylitta* is an economically important wild silkmoth species distributed across India. Despite high potential of country's tropical tasar industry there is an inadequacy in the supply of commercial silkworm seed. Thus there is a need to address this problem with certain innovative approaches. Exploration of host plant leaf volatiles mediated ovipositional behavior is one of those options, which can be tried to enhance the fecundity in *A. mylitta*. Generally, the selection of a suitable site for oviposition by phytophagous insects is critical for the successful development of the offspring's and it also governs the reproductive capacity of insects. The behavioral events leading to oviposition are mediated to a large extent by chemical cues associated with potential host plants. Perception of chemical cues that affects oviposition involves receptors on antennae, tarsi, mouthparts or the ovipositor. With this background we have carried out a preliminary study at CTR&TI, Ranchi to know the egg-laying preference in natural condition on the host plant *Terminalia arjuna*. Results revealed that there was a significant difference in the preference for egg-laying among different locations on the host plant ($F=3.51$; $df= 2, 27$; $P=0.044$). During the study, *A. mylitta* females laid more eggs on the leaf (62 eggs, mean) compared to stem (7.10 eggs, mean) and soil (14.20 eggs, mean). These results show that in spite of semi domestication over many years tasar silk moth still prefers the leaves for egg laying under the natural condition and this behavior of the tasar silkmoth also indicates that *A. mylitta* may still retains its natural instinct of egg-laying behavior under natural condition. Hence, there is a possibility that there are certain chemical cues involved in regulating the ovipositional behavior of tasar silk moth in the nature. However further detailed investigations towards role of host plant leaf volatiles in reproductive biology/ovipositional behaviour of tasar silkmoth could help to identify and use of those volatile compounds in grainage to boost seed production in tasar culture by enhancing the fecundity of tasar silkmoth.

Keywords: *Antheraea mylitta*, Oviposition, Volatiles and Fecundity.

57. Effect of foliar application of plant growth regulators and micronutrients on growth, quality and yield of acid lime (*Citrus aurantifolia* L.) CV. Sai Sarbati

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Abstract

The present investigation entitled “Effect of plant growth regulators and micronutrients on growth, quality and yield of acid lime” was conducted at Sweet Orange Research Station, Badnapur. The objective of this experiment was to study the effect of plant growth regulators and micronutrients on growth, yield and quality of acid lime. The experiment was laid out in Randomized Block Design (RBD) with three replication and 13 treatments. Comprising spraying of Gibberellic acid (GA3) at 50 ppm along with micronutrients combination of ZnSO₄ + FeSO₄ at 0.5% and 1% both, NAA at 100 ppm along with micronutrients combination of ZnSO₄ + FeSO₄ at 0.5 and 1 % both and control. The observations on different parameter viz., plant height, plant spread, days required for initiation of new vegetative flush, days required for flower initiation, days required for harvesting, number of flower/shoot, fruit set per cent, fruit drop per cent, number of fruits/tree, fruit weight, fruit volume, yield Kg/tree, juice per cent, peel per cent, total soluble solids, acidity, ascorbic acid, total sugars, reducing sugars and non-reducing sugars were recorded. Among all the treatments, T11 GA3 (50 ppm) + ZnSO₄ (1%) + FeSO₄ (1%) recorded maximum increase in plant height (0.25 m), plant spread East-West spread (3.74 m), North-South spread (3.54 m) and minimum days required for initiation of new vegetative flush (17.00 days), flower initiation after vegetative flush (14.00 days) and harvesting (144.00 days). While among all treatments, (T11), GA3 (50 ppm) + ZnSO₄ (1%) + FeSO₄ (1%) recorded maximum number of fruits/tree (148.00 fruits/tree), fruit weight (43.33 g), fruit volume (41.30 ml), yield (6.41 kg/tree), fruit set (51.20 %), number of flower/shoot (18.57) and minimum fruit drop (35.20 %). Treatment T11, GA3 (50 ppm) + ZnSO₄ (1%) + FeSO₄ (1%) recorded maximum TSS (8.570B), Ascorbic acid (30.35 mg/100 ml juice), juice per cent (50.60%), total sugars (1.825%), reducing sugars (0.90%), non-reducing sugar (0.92 %) and maximum per cent acidity (7.07%) and minimum peel per cent (25.21%).

58. Utilization of Cheaply Available Spent Broiler Breeder Hen Meat to Develop Nutritionally Improved Sausages

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Abstract

Meat from spent broiler breeder hens is sold at a lower price because of its poor texture and acceptability when compared to the broilers. The present study was designed for proper utilization of this less expensive meat to produce cheaper and economically viable nutritious value added chicken sausages. Significantly ($P<0.01$) higher percent crude protein, total ash, water holding capacity, salt soluble protein extractability, total protein extractability and significantly ($P<0.01$) lower percent crude fat and moisture were recorded for spent broiler breeder hen meat when compared to the broiler meat. Spent broiler breeder hen sausages had significantly ($P<0.05$) higher cooking yield, emulsion stability, crude protein, crude fat, total ash and lowest pH, cholesterol, penetration value and sensory scores than broiler meat sausages.

59. Rice (*oryza sativa*) residue management options and effects on the soil properties and crop productivity.

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Abstract

Rice residue can be managed by burning, incorporation, surface retention and mulching, and baling and removing the straw. Rice residues are important because they improve the soil properties. Due to high silica content rice straw is not used as a feed for animals. A sequence of rice-wheat that yields 7 t ha^{-1} of rice and 4 t ha^{-1} of wheat removes more than N 300, P 30 and K 300 kg ha^{-1} from the soil and the residues of rice and wheat amount to as much as $7-10 \text{ t ha}^{-1} \text{ yr}^{-1}$. Farmers have to manage $5-7 \text{ t ha}^{-1}$ of rice residues and for planting wheat. Burning of rice residue results losses of N (up to 80%), P (25%), K (21%) and S (4-60%), air pollution (@ CO_2 13 t ha^{-1}) and loss of soil of organic matter. This loss is one of the recognized threats to sustainability but burning help to kill harmful insect and pests. Incorporation helps to build up of Soil organic matter, soil N, P and K and increases yield of wheat and rice compared to

burning. The disadvantage of incorporation is the immobilization of inorganic N. Surface retention of residues increases soil NO_3^- by 46%, N uptake by 29%, and yield by 37% compared to burning. Residue management practices affect soil physical properties soil moisture, temperature, aggregate formation and bulk density. Rice straw incorporation coupled with organic manure increases grain yield of wheat improves soil physical condition and increases microbial activity than residue removal or burning. Thus proper management of residues improves soil properties and the sustainability in crop productivity.

**60. Effect of Sewage Sludge on soil properties, growth and yield attributes of potato
(*Solanum tuberosum* L.)**

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Abstract

Sewage Sludge, also referred as biosolids, is a byproduct of sewage treatment process. Land application of sewage sludge is one of the important disposal alternatives. Composition of activated sludge is as N- 5.0- 6.5 %, P_2O_5 - 3.0-3.5%, K_2O - 0.5-0.7%. A field experiment was conducted at the experiment farm of Mata Gujri College, Fatehgarh sahib to examine the short term effect of municipal sewage sludge application on physical, chemical and biological properties of soil, growth and yield of Potato. Control and four treatments adopted in this study were, 100% NPK, three sludge applications i.e. 5, 10, 15 t ha⁻¹. The results showed a positive effect of sewage sludge on different parameters, Bulk density was decreased, increase in mean weight diameter, porosity. Organic carbon in sludge amended soil can increase as far as threefold compare to inorganic fertilizers. Increase in dehydrogenase activity and microbial biomass carbon. shows how sludge at 15 t ha⁻¹ produced most prominent effect on yield of potato and the entire potatoes crop requirement of nitrogen, while Cd and Pb concentration level in soil and potato tuber were under the maximum value allowed by the regulation. Keeping in view the increasing trends in the prices of chemical fertilizers and the excellent fertilizing and soil amendment properties of sewage sludge, land application of sewage sludge appears to be the most convenient, beneficial and cost effective method of sludge disposal especially in a developing country like India where agriculture forms the major occupation to sustain country's economy.

61. Effect of Biorational Control on *Coccinellids* and Spiders in Soybean

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Abstract

Bio-rational studies were carried out at experimental field of Department of Agril. Entomology, College of Agriculture, Badnapur during *kharif* 2017 for control of major pests in soybean. Experiment was laid out in RBD with eight treatment and three replications. The effect of treatments were also recorded in respect of *Coccinellids* in soybean. The data recorded seven days after treatments revealed that the mean population* of *Coccinellids* was significantly highest in experimental plots planted with trap crop castor as a treatment (3.3 *Coccinellids*/mrl**), compared to rest of treatments and was at par with intercrop sorghum (2.7 *Coccinellids*/mrl), Mechanical control (2.7 *Coccinellids*/mrl), NSKE 5% (2.2 *Coccinellids*/mrl), Neem oil 5% (2.1 *Coccinellids*/mrl) and untreated plot (2.8 *Coccinellids*/mrl). Second best treatment was *Pongamia* oil 2% (1.4 *Coccinellids*/mrl). The treatment of Chlorpyrifos 20EC @2ml/lit recorded least population (0.3 *Coccinellids*/mrl) which proved it was unsafe to beetles. The effect of treatments were also recorded in respect of Spiders in soybean. The data recorded seven days after treatments revealed that, the mean population* of Spiders was significantly highest in experimental plots planted with trap crop castor as a treatment (2.7 Spiders/mrl**), compared to rest of treatments and was at par with Intercrop Sorghum (2.3 Spiders/mrl), Mechanical control (1.8 Spiders/mrl), NSKE 5% (1.8 Spiders/mrl), Neem oil 5% (1.7 Spiders/mrl) and untreated plot (2.4 Spiders/mrl). Second best treatment is *Pongamia* oil 2% (1.1 Spiders/mrl). The treatment of Chlorpyrifos 20EC @2ml/lit recorded least population (0.4 Spiders/mrl) which proved it was unsafe to beetles.

Keywords: *Coccinellids*, Spiders, NSKE, Neem oil, Trap crop, Intercrop, Mechanical control, *Pongamia* oil, Chlorpyrifos.

*Mean population includes grubs, pupa and adult, ** meter row length

62. Correlation coefficient between Natural enemies and weather parameters

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Abstract

The experiment was conducted in experimental field department of Agril. Entomology College of Agriculture Badnapur, during *kharif* season 2017. In soybean field the 10 days after germination, observations were recorded Natural enemies at weekly interval from 5 randomly selected spot of 1 meter row length. Table correlation coefficient between *Coccinellids* occurrence and weather parameters. The minimum temperature ($r= 0.315$) and rainfall ($r= 0.128$) had positive effect on *Coccinellids* population but non-significant correlation while maximum temperature ($r= -0.055$) and wind velocity ($r= -0.140$) shown negative non-significant correlation. Minimum relative humidity ($r= 0.570^*$) and maximum relative humidity ($r= 0.705^{**}$) had the favourable influence over *Coccinellids* population with significant correlation. The correlation coefficient between *Chrysopa* population and weather parameters showed that the all weather factors like minimum temperature ($r= -0.302$), maximum temperature ($r= -0.078$), minimum relative humidity ($r= -0.393$), maximum relative humidity ($r= -0.494$), rainfall ($r= -0.302$) and wind velocity ($r= -0.065$) were registered negative non-significant correlation with *Chrysopa* population. The correlation coefficient between spider population and weather parameters revealed that the minimum temperature ($r= 0.248$), minimum relative humidity ($r= 0.413$) and maximum relative humidity ($r= 0.466$) these all parameters had positive effect on population of spiders with non-significant correlation. Maximum temperature ($r= -0.059$), rainfall ($r= -0.237$) and wind velocity ($r= -0.396$) reflected negative non-significant correlation with spider population. The correlation coefficient between predatory pentatomid bugs population and weather parameters indicates that the minimum temperature ($r= -0.377$), maximum temperature ($r= -0.363$), rainfall ($r= -0.138$) and wind velocity ($r= -0.058$) exhibited negative non-significant correlation. Whereas the minimum relative humidity ($r= 0.173$) and maximum relative humidity ($r= 0.180$) had positive effect on population of predatory pentatomid bugs with non-significant correlation.

Keywords: Correlation coefficient, Natural enemies, Weather parameters

63. Correlation coefficient between sucking pests and weather parameters

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Abstract

The experiment was conducted in experimental field department of Agril. Entomology College of Agriculture Badnapur, during *kharif* season 2017. In soybean field the 10 days after germination, observations were recorded at weekly interval from 5 randomly selected plants incidence of sucking pests recorded per 3 leaves per plant. The correlation coefficient between leaf hoppers population and weather parameters showed rainfall ($r = -0.225$) and wind velocity ($r = -0.449$) had negative but non-significant correlation however of minimum temperature ($r = 0.278$), maximum temperature ($r = 0.071$), minimum relative humidity ($r = 0.337$) and maximum relative humidity ($r = 0.302$) had positive but non-significant correlation with leaf hoppers. The correlation between whitefly population and weather parameters revealed that minimum temperature ($r = 0.317$), maximum temperature ($r = 0.048$), minimum relative humidity ($r = 0.269$) and maximum relative humidity ($r = 0.283$) had positive effect on pest population but non-significant correlation. Whereas rainfall ($r = -0.217$) and wind velocity ($r = -0.425$) had negative effect on whitefly population with non-significant correlation. The correlation coefficient between aphids population and weather parameters showed that the rainfall ($r = -0.309$) and wind velocity ($r = -0.484$) had negative non-significant correlation with aphids population. The minimum temperature ($r = 0.321$), maximum temperature ($r = 0.053$), minimum relative humidity ($r = 0.339$) and maximum relative humidity ($r = 0.387$) also had non-significant correlation with aphids but positive.

Keywords: Correlation coefficient, Sucking pests, Weather parameters

*Significant at 5% ($r = 0.553$) **Significant at 1% ($r = 0.684$)

64. Correlation coefficient between Defoliators and weather parameters

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Abstract

The experiment was conducted in experimental field department of Agril. Entomology College of Agriculture Badnapur, during *kharif* season 2017. In soybean field the 10 days after germination, observations were recorded defoliators at weekly interval from the number of caterpillars was counted 5 randomly selected spot of 1 meter row length. The correlation coefficient between *H.armigera* population and weather parameters revealed that rainfall ($r=0.180$), wind velocity ($r=0.007$) had positive non-significant correlation. The minimum temperature ($r=-0.053$), maximum temperature ($r=-0.267$), minimum relative humidity ($r=-0.052$) and maximum relative humidity ($r=-0.051$) had negative effect on *Helicoverpa* population with non-significant correlation. The correlation coefficient between *S.litura* population and weather parameters revealed that the minimum relative humidity ($r=0.273$) and maximum relative humidity ($r=0.297$) had positive but non-significant correlation. However minimum temperature ($r=-0.097$), maximum temperature ($r=-0.214$), rainfall ($r=-0.110$) and wind velocity ($r=-0.135$) had negative effect on *S.litura* population with non-significant correlation. The correlation coefficient between *C.acuta* population and weather parameters. The minimum temperature ($r=0.138$), minimum relative humidity ($r=0.223$) and maximum relative humidity ($r=0.233$) had positive effect on multiplication but non-significant correlation while maximum temperature ($r=-0.048$), rainfall ($r=-0.233$) and wind velocity ($r=-0.299$) had negative effect on *C.acuta* population with non-significant correlation.

Keywords: Correlation coefficient, Defoliators, Weather parameters

* Significant at 5% ($r=0.553$) ** Significant at 1% ($r=0.684$)

65. Significance of Food Waste and its Management

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Abstract

Food waste actually refers to the food that is of good quality and fit for human consumption but that does not get consumed because it is discarded either before or after it spoils. It may be because of negligence or a conscious decision to throw food away. Food is wasted due to lack of confidence and skills in food preparation, lack of planning prior to shopping, lack of knowledge about food storage and lack of understanding about labelling on foods. Food loss is mainly due to reduction in the quality before it reaches the consumer. Food loss and waste have many depressing economic and environmental impacts. In an economic way they represent a wasted investment that can reduce farmers' incomes and increase consumer's expenses. Environmentally, food loss and waste cause a many impacts, including unnecessary greenhouse gas emissions and inefficiently used water and land, which can lead to decrease in natural ecosystems. One of the solutions to this problem is to increase effectiveness and waste reduction in the food supply chain. Food security and sustainability perspective includes packaging that plays important role in containing and protecting food as it moves through the supply chain to the consumer, formulation of animal feed, composting to create nutrient-rich fertilizer, anaerobic digestion to produce energy-rich biogas, feeding surplus food to needy people etc.

Keywords: Food Loss, Food Waste, Packaging, Food security, Supply Chain.

66. Effect of Foliar Nutrition on Growth, Yield and Quality of Horsegram

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Abstract

The study was conducted to measure Effect of foliar nutrition on growth, yield and quality of horsegram during the *kharif* 2018 at Research Farm of College of Agriculture, Dhule. The soil of the experimental field was low in available nitrogen (225.40 kg ha⁻¹), medium in

phosphorus (19.20 kg ha⁻¹) and moderately high in potassium (362.27 kg ha⁻¹). The experiment was laid out in randomized block design with three replications and eight treatment viz., T₁: absolute control, T₂: RDF (12.5:25:00 N :P₂O₅ :K₂O kg ha⁻¹) (soil application), T₃: RDF+ Urea 2% spray at 45 DAS, T₄: RDF + DAP 2% spray at 45 DAS, T₅: RDF + 19:19:19 0.5% spray at 45 DAS, T₆: RDF + 13:00:45 0.5% spray at 45 DAS, T₇: RDF + 12:61:00 0.5% spray at 45 DAS and T₈: RDF + 00:52:34 0.5% spray at 45 DAS (foliar spray respectively). Application of recommended dose of fertilizers along with foliar nutrition of water soluble fertilizer 19:19:19 @ 0.5% at 45 DAS to horse gram obtained significantly highest gross monetary returns (₹40020 ha⁻¹), net monetary returns (₹19492 ha⁻¹) and benefit cost ratio (1.95) than other nutrient management treatments during investigation. It could be concluded that, the horse gram crop fertilized with application of recommended dose of fertilizers along with foliar nutrition of water soluble fertilizer 19:19:19 @ 0.5% at 45 DAS registered maximum growth, yield attributes, grain yield, grain quality and economic return.

67. Biochemical Basis of Resistance in the Rice Landraces against Brown Planthopper (*Nilaparvata lugens* Stal.)

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Abstract

Rice is the most important staple food crop in Asia and is affected by various biotic and abiotic stresses throughout its growing period. Among biotic stresses insect pests play an important role. Of various insect pests Brown plant hopper (*Nilaparvata lugens* Stal.; Homoptera: Delphacidae) is most destructive and causing significant yield loss in most of the rice growing regions of Asia. In recent years, there is higher level of occurrence of BPH due to climate change. Conventional measures to reduce BPH damage to rice included the application of chemical insecticides which is expensive, ineffective and harmful to ecosystem under elevated climatic conditions. These chemicals can also kill BPH predators, such as *Anagrus nilaparvatae*, which may lead to increased pest incidence as well as change in BPH biotypes. For the management of increased pest population, use of resistant rice varieties is the most economical and efficient method. Identification of resistant sources is very important as the biotypes of the pest is changing its behavior from time to time and the earlier released resistant rice varieties showing susceptibility to the pest. Investigation on the

biochemical basis of resistance in the eight landraces along with the resistant and susceptible check were studied at V.C. Farm, Mandya, by assaying the activity of defense enzymes. In the present study, landraces Ratnachoodi, Rajbhog and Nazarbatha recorded the highest level of peroxidase, Honasu, Rajamudi and Nazarbatha had highest level of polyphenol oxidase, Nazarbatha, Rajamudi and Kottayam had higher level of PAL, highest activity of phenols in all the landraces and the greater expression of chitinase was seen after three days after infestation and which was higher in PTB 33, Nazarbatha and Honasu. These landraces have to be characterized for resistance genes can be utilized as donors in resistance breeding.

Keywords: Rice, landraces, defense enzymes, BPH

68. Estimation of Major Nutrients in Rice Landraces and Their Impact of Resistance to Brown Planthopper (*Nilaparvata lugens* Stal.)

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Abstract

Rice is an important food crop in Asia, during the growing periods it suffers from various biotic and abiotic stresses which directly or indirectly reduces yield. Among various biotic stresses insect pest *i.e.*, brown plant hopper (*Nilaparvata lugens* Stal.) is a major threat to rice production and causing significant yield loss in most of the rice growing regions of Asia. In recent years, there is higher level of occurrence of BPH due to climate change. To manage this pest farmers are solely depended on the chemical insecticides, which is not safer to the environment and human beings as well. Hence the identification of resistant donors is the need of the hour. Growing the resistant varieties, cultivars and judicious application of fertilizers will play an important role in offering the resistance to the insect pest.

In the present study the resistant land races were studied to estimate the major nutrients in them and their relation in conferring the resistance against to BPH. The estimation of nutritional constituents revealed that the landraces JBT 3614, Ratnachoodi, Honasu, Baiganmanji and Rajbhog had lower nitrogen content and higher potassium content compared to other landraces and susceptible check TN 1 and Jaya and there is a variation in phosphorus content in landraces and susceptible checks. The lower the nitrogen and higher the potassium concentration will be the prime factor to confer resistance in the genotypes.

These landraces have to be characterized for the resistance and they can be used in development of resistant varieties against BPH.

Keywords: BPH, Nitrogen, Potassium, Rice, landraces

69. Performance of Different Linseed Genotypes to Seed Rate under Utera Condition

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Abstract

A field experiment was conducted under All India coordinated Research Project on linseed at Agriculture Farm, College of Agriculture, Nagpur in *Rabi* Season 2019-20. The experiment was laid out in Factorial Randomized Block Design with three replication in which performance of three genotypes BRLS-106, Shekhar and T-397 was tested for three seed rate 30, 40 and 50 Kg ha⁻¹. The results revealed the seed yield was significantly affected due to various genotype tested and highest seed yield was observed in the genotype BRLS-106 as compare to Shekhar and T-397 under *utera* condition. The seed yield was significantly affected due to different seed rate and recorded maximum seed yield at the seed rate of 50 kg ha⁻¹ which is significantly superior over 40 and 30 kg ha⁻¹ seed rate. This might be due to the maximum plant population per hectare at maximum seed rate, more number of seeds per capsule. Increase in the seed rate from 30 to 40 kg ha⁻¹ recorded 72 kg ha⁻¹ increase in yield, however, when seed rate increases from 40 to 50 kg ha⁻¹ recorded only 35 kg ha⁻¹ increase in yield. Seed rate was significantly affected the net monetary return which was maximum at seed rate of 50 kg ha⁻¹. The interaction effect of genotypes and seed rate was found significant and highest seed yield was recorded in the interaction of BRLS-106 with 40 kg/ha seed rate (786 kg ha⁻¹). Net monetary return was also recorded highest in the interaction of entry BRLS-106 with 40 kg ha⁻¹ seed rate (25031 Rs.ha⁻¹). It is concluded that yield potential of the genotype BRLS-106 was 25.8% highest on zonal check Shekhar and 15.1% more on national check T-397 under *utera* condition. Economic return was highest in the interaction of BRLS-106 at 40 kg ha⁻¹ seed rate.

(Keywords: Genotype, seed rate, linseed, *utera*, seed yield, economics)

70. Influence of Seed Rates and Spacing on Growth, Yield and Economics of Linseed

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Abstract

Seed rate and row spacing are management practices that affect flax seed yield. Hence to find out the optimum quantity of seed rate and spacing for higher production in irrigated linseed, the present experiment was conducted under AICRP on Linseed, College of Agriculture, Nagpur during *Rabi* Season of 2019-20 in Factorial Randomized Block Design with three replication. Two spacing 30 and 40 cm with four seed rate 10, 15, 20 and 25 kg ha⁻¹. Results indicated significant effects of seed rates and spacing on all yield components, reflecting the importance of seeding rate and spacing for linseed growth, yield and yield components. Maximum plant height was recorded after using the seed rate at the rate of 25 kg ha⁻¹ and with 30cm spacing which was at par with seed rate 20 kg ha⁻¹. The other growth parameters like number of branches, number of capsules per plant and test weight was found higher in the treatment having the seed rate of 10 kg ha⁻¹ and in the spacing of 45cm. Seed yield of linseed was recorded highest by using the seed rate at 15 kg ha⁻¹, which was at par with at the seed rate of 20 kg ha⁻¹ and in the closer spacing of 30cm between rows i.e. 9.15% more as compare to row spacing of 45cm. Gross monetary returns, net monetary returns and B:C ratio was also recorded maximum in the seed rate of 15 kg ha⁻¹ and with 30cm row spacing. It is concluded that advancement in seed rate by lowering down up to 15 kg ha⁻¹ increases the productivity and profitability of linseed.

(Keywords: Linseed, seed rate, spacing, growth and yield)

71. Tasar Silkworm Waste to Wealth by Cordyceps

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Abstract

Cordyceps militaris an entomopathogenic fungus belonging to Ascomycota, Sordariomycetidae, Hypocreales, and Cordycipitaceae and is one of the most important traditional medicinal mushrooms. *Cordyceps militaris* which internally parasitizes larva and pupa of lepidopteran insects and forms fruiting bodies on their insect hosts. *C. militaris* produces bioactive compounds viz., polysaccharides, cordycepin, adenosine, amino acid, organic selenium, ergosterol, sterols, cordycepic acid, superoxide dismutase (SOD), and multivitamins. Cordycepin (3-deoxyadenosine) is one of the most important biologically active metabolites. It has roles in immunological regulation, anticancer, antifungus, antiviral, antileukemia, and anti-hyperlipidemia activities. As a result, the market price and demand of this fungus is increasing consistently, which has encouraged many entrepreneurs for producing *Cordyceps* for the nutraceutical and pharmaceutical purposes. In Sikkim, cordyceps is used to cure 18 diseases. The value of the cordyceps varies with the cordycepin levels in the fruiting body. Price of *C. militaris* varies from 1-4 lakhs per kg dried fruiting bodies. The demand for this mushroom is increasing in India. Though many Asian countries produce them on cereals in the laboratory at mass level, the cordycepin levels are greater when it is grown on insect media such as silkworm. *C. militaris* is most suitable for lab culture than *C. sinensis*. Tasar sericulture has traditional heritage value in India as it is mainly practiced by the tribals since time immemorial. In India, total production of Tasar raw silk production is 2988 MT (2017-18). On an average 1 MT fibre generates 2 MT pupal waste. Tasar sector achieved 53 lakh Disease free layings (DFL) production in 2018-19. For 1 DFL production on an average 4 moths are required. Every year in India large volumes of tasar cocoons are processed for silk purpose and later reeled pupae are thrown as waste. After oviposition and mother moth examination moth tissues can be used. These wastes/refuses are in the process to be turned into wealth by growing cordyceps with cost effective technological interventions.

Keywords: *Cordyceps militaris*, silkworm wastes, *Antheraea mylitta*, Cordycepin, medicinal mushroom.

72. Molecular screening of tomato genotypes against root-knot nematode

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Abstract

Tomato (*Lycopersicon esculentum* L.) belonging to the family Solanaceae is one of the most important vegetable grown throughout the world. Yield and quality of tomato crop is adversely affected by various biotic and abiotic stresses. Out of various biotic stresses, root-knot nematode (RKN) causes a huge damage. Chemical control is feasible but it is costly and represents only a temporary solution. Also, conventional breeding program for nematode resistance in vegetable crops is cumbersome and time consuming as it involves screening, successive crossing and selection steps based on careful phenotypic analysis. Grafting utilizing resistant rootstocks has proven to effectively manage RKNs and improve yield in naturally infested nematode soils. A dominant resistant gene *Mi* has been detected to possess resistance against RKN. Molecular markers closely linked to *Mi* greatly facilitate molecular screening of genotypes in laboratory for resistant genotypes. Thus, there is a need to identify sources of resistance in the available rootstocks for managing the RKN problem in tomato fields. This study was thus initiated to screen and identify potential rootstock(s) among fifty-seven genotypes for resistance. *Mi23*, a co dominant SCAR marker for the *Mi-1.2* gene located within the *Mi-1* locus was used for molecular screening and it was found that three genotypes has alleles specific for resistance against RKN in heterozygous condition (*Mi/mi*). These 3 resistant genotypes can be directly used in field as rootstock against RKN.

Keywords: tomato; nematode resistance; molecular marker; screening

73. Assessment of improved variety of vegetable pea variety PSM-3 through on farm testing in Dindori district of Madhya Pradesh

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Abstract

Dindori District is located at 22°56'06.8"N 81°04'56.4"E. on the banks Narmada rivers of Madhya Pradesh. Pea is one of the *rabi* season vegetable in district. Krishi Vigyan Kendra laid down On Farm Testing Demonstration in the year 2019-20 introducing new, high yielding variety PSM-3. The OFT were carried out in village-Mohgaon, Block-Samnapur, District Dindori in supervision of KVK. The productivity and economic returns of pea in recommended package and practice were calculated and compared with the corresponding farmer's practices (local check). Improved practices recorded higher yield as compared to farmer's practices. The improved technology recorded higher yield of 80 q/ha .The average yield increase was observed 31.50 percent In spite of increase in yield of pea, technology gap, extension gap and technology index existed. The improved technology gave higher gross return (160,000 Rs./ha), net return (92,000 Rs./ha) with higher benefit cost ratio (2.35) as compared to farmer's practices. The variation in per cent increase in the yield was found due to the poor management practices, lack of knowledge and poor socio economic condition. Under sustainable agricultural practices, with this study it is concluded that the OFTs programmes were effective in changing attitude, skill and knowledge of improved package and practices of pea adoption.

Keywords: Pea, OFTs, Economic impact, Yield q/ha, Adoption, B: C ratio

74. Crop production of Oilseeds and Pulses under changing climate

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Abstract

Food production, food security and climate change are intrinsically linked. Food insecurity and climate change (CC), the twin crises that may define the future of agriculture. Crop production, which is vital to global food security, is being affected by climate change all over the world. CC affects agriculture and food production through complex paths and affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of income. It has been predicted by the IPCC that there is a probability of 10–40% loss in crop production in India by 2080–2100 due to global warming (IPCC, 2007). The demand for food as well as for feed is constantly rising in view of ever-increasing population and improving per capita income. The projected pulse requirement for the year 2030 is 32 Mt with an anticipated required growth rate of 4.2% (IIPR Vision 2030). The projected annual growth rate of edible oil demand is 5.97%, whereas growth rate of projected supplies are 2.13%. India needs to produce 17.84 Mt of vegetable oils to meet the nutritional fat needs of projected population of 1685 million by 2050. This is equivalent to roughly 59.41 Mt of oilseeds, assuming that there is no change in the proportion of different oilseeds produced in the country. Pulses and oilseeds are highly vulnerable to climate change as these crops are grown under rainfed conditions. The drought and high temperature both have been the recurrent events during the present scenario of climate change. Rainfed pulses and oilseeds suffer due to severe water crisis because of delayed monsoon and uneven distribution of rainfall or complete failure of rains. Unless urgent and sustainable measures are established, climate change will continue to put pressure on agricultural ecosystems, particularly in regions and for populations that are particularly vulnerable.

75. Crop Residue Burning: - Impact on Environment

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Abstract

Climate change is one of the most arising issues facing us now a day. It should also be noted that polluted air is the second highest health risk factor in India (Balakrishan, Dey, Gupta, *et al.* 2019). Burning of crop residues/farm wastes causes severe pollution of soil, water and air on local as well as regional levels. More than 600 MT of crop residues are generated every year, out of which cereal like rice and wheat are the major contributors accounting nearly 70% followed by fibre crops, oil seed, pulses and sugarcane. Only rice contributes 53% of crop residue among all cereal crops. As a result of green revolution increase in agricultural production is contributing significant growth in crop residues. Furthermore, the mechanization of Indian agriculture has resulted in development and adaptation of combine harvester, which leaves crop residues of harvested crop in field by most of the farmers in country particularly in the states like Punjab, Haryana, central and western part of U.P. Burning of residues in open field is not only harming the atmosphere but also a serious threat for soil fertility and productivity. Soil is known as the Soul of infinite life. Burning of crop residues is not good for soil health. Estimated that burning of paddy straw result in nutrient losses via; 3.85 million tone of organic carbon, 59,000 trillion of nitrogen, 20,000 trillion phosphorus and 34,000 trillion of potassium (Ojha and Tiwari, 2019). This also seriously affects nutrients budget in the soil. Burning of crop residues also affect the soil temperature, pH, moisture and other properties. Change in temperature results in decline in the microbial population which slow down the decomposition of organic matter which affects aggregates formation and its stability. Burning of crop residue gaseous emission can result in health risk, aggravating asthma, chronic bronchitis and decreased lung function.

We can use of crop residues for various alternate uses such as fodder for animals, use of crops stubble for the generation of electricity, use as input in the paper/pulp industry, incorporation in soil and mulching, direct seeding by zero till or happy seedier and use as a bio char etc. Awareness must be created between the farming communities about the harmful impacts of crop biomass burning and importance of crop residues incorporation in soil for maintaining sustainable agricultural productivity.

Keywords: crop residue, gaseous emission, residue burning, soil fertility, soil health.

76. In vitro evaluation of systemic and non systemic fungicides against early blight (*Alternaria solani* Ellis and Martin) Jones and Groutof tomatounder temperate conditions of Kashmir

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Abstract

In vitro studies were conducted to evaluate the comparative efficacy of systemic and non-systemic fungitoxicants against *Alternaria solani* (Ellis and Martin). Both systemic and non-systemic fungicides were evaluated for their efficacy against the mycelial growth of *A. solani* by using the poisoned food technique. On an overall mean basis, Mancozeb proved the most effective, exhibiting a mean mycelial growth inhibition of 83.10 per cent, followed by Dodine and Polyram causing 77.00 and 57.10 per cent mean inhibition, respectively, while Propineb proved the least effective among test non-systemic fungitoxicants, showing only 51.88 per cent mean inhibition. The maximum inhibition of 77.11 per cent was achieved at 500 µg a.i ml⁻¹, which decreased as the fungitoxicant concentration decreased. The minimum inhibition of 53.65 per cent was recorded at a concentration of 50 µg a.i ml⁻¹. Amongst the systemic fungicides, Difenoconazole proved the most effective, exhibiting a mean mycelial growth inhibition of 81.08 per cent, followed by Flusilazole and Hexaconazole causing 74.47 and 70.82 per cent mean inhibition, respectively, while Myclobutanil proved the least effective among test systemic fungitoxicants, showing only 41.83 per cent mean inhibition. The maximum inhibition of 72.63 per cent was achieved at 50 µg a.i ml⁻¹, which decreased as the fungitoxicant concentration decreased. The minimum inhibition of 51.85 per cent was recorded at a concentration of 10 µg a.i ml⁻¹. Mancozeb and Dodine caused 91.66 and 90.00 per cent mycelial growth inhibition at 500 µg a.i ml⁻¹. Difenoconazole and Flusilazole caused 96.25 and 89.74 per cent mycelial growth inhibition at 50 µg a.i ml⁻¹.

Keywords: *Alternaria solani*, fungi toxicants, mycelial growth

77. Need of Organic Farming towards Sustainable Agriculture in India: A Review

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Abstract

India produces a large variety of food crops including cereals, pulses and oilseeds, and diversified agriculture is the priority of the Central Government. The modern system of farming is becoming unsustainable by deteriorating environment, soil and declining crop productivities due to chemical contaminations. Conventionally grown foods have adverse health effects due to the presence of pesticide residue, more nitrate, heavy metals etc. (Das *et al.*, 2010). The time has come for the nation to understand that organic farming is the only way to function in an eco-friendly system while sustaining and increasing the crop productivity. In India, the demand for organically grown produce is more as people are more aware now about the safety and quality of food and the organic process has a massive influence on soil health, which is devoid of chemical pesticides. Organic cultivation has an immense prospect of income generation too (Bhardwaj and Dhiman, 2019). Moreover, organic products carry a premium price in the market which makes organic farming more profitable. An effective agricultural sector strategy can contribute to a broader development of agricultural productivity, food security, generation of rural employment and poverty reduction while promoting the conservation of the natural resource base (Soumya 2015). India ranks first in organic farming in the world with an area of 1.78 Million Ha (Willer and Lernoud, 2019). Prime Minister encouraged other states to imitate the “Sikkim model” as Sikkim is India’s first organic state. Government of India has been undertaking measures to promote organic farming with the aim to improve soil fertility and help to double the farmers’ revenues by the year 2022 (Rajamani, 2018). Various newer technologies have been invented in organic farming such as integration of mycorrhizal fungi, nano biostimulants, precision agriculture etc. The soil in India is bestowed with various types of naturally available organic nutrient resources that aid in organic farming (Reddy, 2010; Deshmukh and Babar, 2015); India also has diversified agro-climatic region and tremendous potential which provides vast scope to become a major organic producing country at international level and India can build a sustainable agriculture system and nutritionally, ecologically, and economically healthy nation in near future.

Keywords: Organic farming, Sustainable agriculture, Food security

78. Transplanting in Pigeonpea- A contingency measure for realizing higher productivity in Dindori District

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Abstract

Pigeonpea being a *Kharif* crop most often faces vagaries or uncertainties of rainfall extremities resulting in poor yield realization as it is primarily dependent upon plant population survived until maturity. Maintaining adequate number of plants in presence of both abiotic and biotic stresses is therefore, poses challenge towards sustainability in production. To counteract this, the potential of certain crop contingencies including transplanting of pigeonpea seedling in main field so as to maintain adequate plant population for compensating yield loss during *Kharif* season is being explored. In this context, a field experiment was carried out at Krishi Vigyan Kendra, Dindori for two years (2017-19) in a Red and black soil with the objectives of studying the feasibility and refining the existing technology of transplanting pigeonpea and its suitability under tribals area. The study revealed that irrespective of age of seedling (weeks after transplanting) and material for raising seedling in nursery, an additional seed yield to the tune of 845 kg/ha (27.4%) was realized under transplanting on ridges over the flat bed; and was largely attributed to 9.8% higher pods/ plant. Poly bags raised seedlings transplanted at an early age of 3 weeks on the ridges out yielded over both 4 and 5 weeks. The study also suggested that replacement of missing plants in direct seeding by transplanting poly bags raised seedlings to the extent of 10 % under field condition was feasible and economical in comparison to sole transplanting in the entire field at 3 or 4 weeks (of nursery raising). Thus, the study confirmed the feasibility of pigeonpea transplanting and explored the possibility of replacing the gaps in plant population due to direct seeding with transplanting of poly bag grown seedlings for realization of higher yield under field conditions of Northern hills of C.G .

Keywords: Crop contingency, Economics, Ridge furrow planting, Seed yield, Transplanted pigeonpea.

79. Application of Market Information System of Cotton Crop in Sirsa District of Haryana

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Abstract

The present study was conducted in sirsa district, Dabwali and Baragudha blocks of Haryana which was selected purposively on the basis of maximum production under cotton crop. From district, four regulated markets were randomly selected due to maximum arrival, *i.e.*, Dabwali, Sirsa, Ellenabad and Kalanwali under the cotton crop. Out of the total sample, 60 farmers from sirsa district so 30 farmers from each block and 10 traders from each regulated market, so 40 traders from sirsa district were randomly selected. Out of the expectations of farmers on quality, prices in potential markets, price projections, only arrivals and prices were documented and disseminated with traditional/modern approach. Hence, there was a need to create awareness among the farmers through the agricultural extension agencies like the State Department of Agriculture, Krishi Vigyan Kendras, *etc.* Therefore, the marketing information on agricultural commodities is incorporated in the extension services along with production aspects to the farmers. Forecasting of prices showed that the prices of cotton crop in sirsa district were moving in same trend as predicted. The Dickey-Fuller test indicated that the order of integration of prices among selected markets was similar with zero suggesting that the prices are integrated in the long run in district. ARIMA model could be used for forecasting prices of other agricultural commodities and transmitted through a network to the farmers, so that enable them to make appropriate production and marketing decisions.

Keywords: Marketing Information System, regulated markets, price forecasts, cointegration, traders, farmers

80. Efficacy of *Trichoderma harzianum* isolates against anthracnose of Chilli (*Capsicum annuum* L.) by dual culture technique

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Abstract

The anthracnose of chilli is one of the most devastating diseases. *C. capsici* was isolated from disease samples and the isolate of *C. capsici* was confirmed on the basis of disease symptoms, morphological and cultural characteristics. The various factors, viz., nutritional, physical and toxicological factors showed wide variation on growth of *C. capsici*. The five isolates of *Trichoderma harzianum* from different locations of Allahabad were screened against *C. capsici* by dual culture test for their antagonistic ability. An investigation at research laboratory in the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad was carried out to evaluate all the isolates were found effective significantly in inhibiting the growth of test fungus. Maximum (87.71) and minimum (68.19) percent inhibition were recorded in *T. harzianum* isolate 5 and *T. harzianum* isolate 2 respectively. The *T. harzianum* isolate 5, *T. harzianum* isolate 4 and *T. harzianum* isolate 3 were statistically at par in their efficacy of inhibition. Whereas maximum mycelial growth of pathogen (10.75 mm) was observed with *T. harzianum* isolate 2 followed by *T. harzianum* isolate 1 (9.35 mm). The *in vitro* evaluation of isolate of *T. harzianum* confirmed their efficacy against *C. capsici*.

Keywords: Chilli, *Trichoderma harzianum* and *Colletotricum capsici*.

81. Efficacy of neem based plant products against *C. capsici* by poisoned food technique

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Abstract

The anthracnose of chilli is one of the most devastating diseases. *C. capsici* was isolated from disease samples and the isolate of *C. capsici* was confirmed on the basis of disease symptoms, morphological and cultural characteristics. The various factors, viz., nutritional, physical and toxicological factors showed wide variation on growth and sporulation of *C. capsici*. An investigation at research laboratory in the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad was carried out to evaluate two neem based plant products, viz., Neem Seed Kernel Extract (NSKE) and neem oil were tested to see their performance in inhibiting the radial growth and sporulation of *C. capsici* by poisoned food technique. All the neem based plant products showed their influence on the mycelial growth and sporulation of the fungus. Neem Seed Kernel Extract (NSKE) maximum inhibited the mycelial growth of the *C. capsici* compared to neem oil and minimum as compared to control. Maximum sporulation was observed in Neem Seed Kernel Extract (NSKE) as compared to neem oil and minimum as compare to control, whereas minimum sporulation was recorded in neem oil as compare to Neem Seed Kernel Extract (NSKE) and control. Thus, neem oil was found highly effective in per cent inhibition of mycelial growth as well as sporulation and also all the neem based plant products adversely affect the growth and sporulation of *C. capsici*.

Keywords: Chilli, Neem based plant products, and *Colletotricum capsici*.

82. Efficacy of plant extracts and fungicide against *C. capsici* by poisoned food technique

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Abstract

The anthracnose of chilli is one of the most devastating diseases. *C. capsici* was isolated from disease samples and the isolate of *C. capsici* was confirmed on the basis of disease symptoms, morphological and cultural characteristics. The various factors, viz., nutritional, physical and toxicological factors showed wide variation on growth and sporulation of *C. capsici*. An investigation at research laboratory in the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad was carried out different plant extracts were studied to evaluate their performance in inhibiting the radial growth and sporulation of *C. capsici* by poisoned food technique. All the plant extract showed their inhibitory influence on the growth of *C. capsici*. The radial growth of *C. capsici* was minimum in combined application of neem, garlic, ginger, onion plant extract and garlic bulb extracts as compared to control. Thus all the extracts of plants of different species adversely affect the growth of *C. capsici*, among them combined application of neem, garlic, ginger, onion plant extract minimum inhibited the mycelial growth as well as sporulation of the fungus. Fungicide was assessed by poisoned food technique *in vitro* to find out the effective inhibitor for growth and sporulation of *C. capsici*. Minimum inhibition of mycelial growth of *C. capsici* was recorded by Carbendazim (0.2 %), as compared to all plant extracts and control *in vitro*. Minimum sporulation of *C. capsici* was observed under Carbendazim. *In vitro* evaluation of fungicide showed minimum inhibition of *C. capsici* by Carbendazim at their recommended doses. Carbendazim (0.2 %) was tested against anthracnose of chilli and clearly indicated that Carbendazim (0.2 %) was effective in inhibiting the disease appearance and mycelial growth and sporulation of *C. capsici*. The unsprayed check showed lesion length of anthracnose after inoculation.

Keywords: Chilli, Plant Extracts, Carbendazim and *Colletotricum capsici*.

83. Effect of treatments on anthracnose disease management of chilli (*Capsicum annuum* L.) in pot condition

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Abstract

The anthracnose of chilli is one of the most devastating diseases. *C. capsici* was identified from disease samples and the identification of *C. capsici* was confirmed on the basis of disease symptoms, morphological and cultural characteristics. An investigation in research field of the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad was carried out to evaluate observations on anthracnose disease incidence were recorded; starting from its appearance, first spray of fungicides and plant extracts were taken immediately after disease incidence was noticed. A total three sprayings of all the treatments were given starting at first appearance of anthracnose disease per cent disease incidence (PDI) and its percent disease control (PDC) over control were calculated. After first spraying, the disease incidence was ranged from 21.88 (Combine application of neem, ginger, garlic and onion plant extract) to 35.86 (*Trichoderma harzianum* isolate 5) as against 42.04 per cent in unsprayed control, all treatments were found significantly superior over unsprayed control. After second spraying, the disease incidence was found to be reduced slightly over that of observed after first spraying and it was ranged from 13.25 (Carbendazim) to 29.12 (*Trichoderma harzianum*) as against 56.91 per cent in unsprayed control, all treatments were found significantly superior over unsprayed control. The disease incidence recorded at 15 days after 3rd spraying was found to be decreased steadily and it was ranged from 15.07 (neem oil) to 25.42 (*Trichoderma harzianum*) as against 60.76% in unsprayed control, and all the treatments were found significantly superior over unsprayed control.

Keywords: Chilli, Plant products, Plant Extracts, Carbendazim and *Colletotricum capsici*.

84. Effect of *Trichoderma harzianum*, neem based plant products and plant extracts against anthracnose of chilli (*Capsicum annuum* L.)

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Abstract

The anthracnose of chilli is one of the most devastating disease. *C. capsici* was isolated from disease samples and the isolate of *C. capsici* was confirmed on the basis of disease symptoms, morphological and cultural characteristics. The various factors, viz., nutritional, physical and toxicological factors showed wide variation on growth and sporulation of *C. capsici*. An investigation at research laboratory in the Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad was carried out to evaluate antagonistic ability of different isolates of *Trichoderma harzianum* was tested by dual culture technique. Among them *T. harzianum* isolate 5 was found most effective in inhibiting the growth of *C. capsici*. The toxicological factors like Neem Seed Kernel Extract (NSKE) was found most effective in inhibiting the growth of *C. capsici* compared with neem oil, combined application (neem, garlic, ginger, onion plant extracts) and garlic bulb extract.

Keywords: Bio-agents, *Colletotricum capsici*, fungicide, plant extracts and plant products.

85. Analysis of Production of Linseed (*Linum usitatissimum* L.) in Dindori District

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Abstract

Linseed (*Linum usitatissimum* L.) has multi-purpose role for human nutrition, animal feed and also for industrial purposes mainly as a source of drying oil and fiber. It is an important oil crop in Dindori which is mostly grown as a sole crop and also in intercropping because of its high nutritive value, though little is known about the quality of traditional genotypes

grown by farmers. Frontline demonstration is the long-term educational activity conducted by agricultural scientists in a systematic manner on farmers' field to show the worth of new practice/technology under the micro-farming situation. The Krishi Vigyan Kendra, Dindori had conducted the frontline demonstrations (FLDs) on oilseeds during 2018 to 2019. The KVK had organized 50 FLDs on Linseed (*Linum usitatissimum* L.) in three villages viz., Ghundisarai, Dhanras and Russamal from Dindori district. Therefore, the aim of present study was to determine the impact of frontline demonstrations (FLDs) on yield, adoption, varietal replacement of oilseed crops and its horizontal spread in Dindori district. To get the adequate size of the sample, 100 FLDs beneficiary farmers were selected as the sample for the present study. The study was conducted in experimental designs (Before-After and Control-Treatment) of social research. The findings showed that significant increase in the average yield of demonstration plot (8.6 q ha⁻¹) over the control plot (3.8 q ha⁻¹) of Linseed crop. FLDs showed a positive impact on the adoption of production technologies in Linseed. The 'Local' variety of were replaced by improved varieties such as 'JLS 66'. The area under improved varieties increased periodically. Thus, it can be inferred that FLD is an effective extension intervention to demonstrate the production potential of improved technologies in oilseed crops on farmers' field. Therefore, it is recommended that the extension agencies engaged in transfer and application of agricultural technologies on farmer's field should give priority to organize frontline demonstrations (FLDs) on cluster basis for harnessing the productivity potential of oilseed crops in the country.

Keywords: Frontline demonstrations, Yield, Adoption, Varietal replacement and Horizontal spread

86. Sustainability through market linkage - Review

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If you had your meals today, then it goes without saying, but thanks a farmer. Can you live without food? Can we even imagine our live without food? Food is as important as oxygen and water .while oxygen and water are produce by our imaginary gods, food is produced by our living God, the farmer of India. Undoubtedly agriculture is the backbone of India, one of the largest producers in the world and produce about more than 280 million tons contributing to more than 15% of India's GDP. There are ample numbers of products that are yielded in our country, but unfortunately for many years, "The recorded production has always been associated with ample production and a huge downfall in the price of the commodity". This leads us to ask why the farmer's plights in a country like India are in such a bad shape? Many factors together contributes towards the above described scenario among which the most

surprising and incompatible reason is the output management .Ranging from the insufficient storage to infrastructure to defective supply chain , the downstream suffers the most ,often lead to sad but true end ,Suicides. so now its alarming time that something need to change to withstand the pace of time . Agricultural marketing thus becomes the core that can bring a change from falling in the webs of losses to profits it's the high time for changing the traditional means of marketing that primarily constitute mandis to modern models of marketing that are increasingly gaining favors among the producers, along with the cooperative models that have given immense benefits . International trades and cooperation can also go hand in hand in stabilizing the profit levels and managing the stock of produce.

Marketing with Mandi: Traditional the Indian agricultural markets have been abled through a network of regulated markets. Most state government along with UT administrations have enacted laws to regulate the agriculture markets with the purpose the save the farmer from falling into a dead trap and also to ensure better pricing and timely payments. Agriculture markets in India are reinforced and regulated under the State APMC Acts. The whole area of the state is divided and declared as market, managed by market committees constituted by the State government.

87. Sustainable Agriculture for Natural Resource Management: An extension perspective

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Abstract

Making the transition to sustainable agriculture is a process that integrates environmental health, economic profitability and social and economic equity. It is the responsibility of all participants in the system, including farmers, laborers, policymakers, researchers, retailers, and consumers. When the production of food and fiber degrades the natural resource base, the ability of future generations to produce and flourish decreases. To sustainably supply and use water, it is important to develop drought-resistant farming systems even in "normal" years, including both policy and management actions, improving water conservation and storage measures, providing incentives for selection of drought-tolerant crop species, using reduced-volume irrigation systems, managing crops to reduce water loss, or not planting at all. Options to improve air quality include incorporating crop residue into the soil, using appropriate levels of tillage, and planting wind breaks, cover crops or strips of native perennial grasses to reduce dust. Reducing tillage, managing irrigation to reduce runoff and keeping the soil covered with plants/mulch reduces soil erosion. By helping farmers to adopt practices that reduce chemical use and conserve scarce resources, sustainable agriculture

research and education can play a key role in building public support for agricultural land preservation. Educating land use planners and decision-makers about sustainable agriculture is an important priority. Policies and programs are needed to address the issues related to labour problem, working toward socially just and safe employment that provides adequate wages, working conditions, health benefits, and chances for economic stability. To be more sustainable over the long-term, farm labor must be acknowledged and supported by government policies and carefully considered when assessing the impacts of new technologies and practices. Economic development policies are needed that encourage more diversified agricultural production on family farms as a foundation for healthy economies in rural communities. In combination with other strategies, sustainable agriculture practices and policies can help foster community institutions that meet employment, educational, health and cultural needs. Market led and demand driven production strategies should also foster sustainable practices. Consumers can play a critical role in creating a sustainable food system. Through their purchases, they send strong messages to producers, retailers and others in the system about what they think are important. Food cost and nutritional quality have always influenced consumer choices.

Keywords: Sustainable agriculture, Natural resource management, Extension strategies

88. Food Security and Sustainable Agriculture- A Review

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A brief Introduction about food security

As the world population continues to grow, much more effort and innovation will be urgently needed in order to sustainably increase agricultural production, improve the global supply chain, decrease food losses and waste, and ensure that all who are suffering from hunger and malnutrition have access to nutritious food. Many in the international community believe that it is possible to eradicate hunger within the next generation, and are working together to achieve this goal. The Sustainable Development Goal to “End hunger, achieve food security and improved nutrition and promote sustainable agriculture” (SDG2) recognizes the inter linkages among supporting sustainable agriculture, empowering small farmers, promoting gender equality, ending rural poverty, ensuring healthy lifestyles, tackling climate change, and other issues. The Zero Hunger Challenge has since garnered widespread support from many member States and other entities. It calls for:

- Zero stunted children under the age of two
- 100% access to adequate food all year round
- All food systems are sustainable
- 100% increase in smallholder productivity and income

- Zero loss or waste of food

Extreme poverty and hunger are predominantly rural, with smallholder farmers and their families making up a very significant proportion of the poor and hungry. Thus, eradicating poverty and hunger are integrally linked to boosting food production, agricultural productivity and rural incomes. Agriculture systems worldwide must become more productive and less wasteful. Sustainable agricultural practices and food systems, including both production and consumption, must be pursued from a holistic and integrated perspective. These methods will help to our farmers to retain sunstability

89. Hidden potential of morpho-physiological traits to combat against terminal stress in bread wheat

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Abstract

Two hundreds recombinant inbred lines (RILs) of the cross WH711/WH1021 were grown in randomized block design at CCSHAU, Hisar, during *Rabi* 2018-19 under timely sown and late sown conditions. The substantial amount of genetic variability was observed for all the traits. The traits such as CTD 2, total antioxidant activity, transpiration rate, photosynthetic rate and number of effective tillers per meter showed high GCV, PCV, heritability and genetic advance under both conditions. The grain yield per plot showed a positive and significant correlation with grain filling duration, number of effective tillers per meter, spike length, number of spikelets per spike, number of grains per spike, biological yield per plot, harvest index, 1000 grain weight, seed density, NDVI 1, NDVI 2, CTD 1, CTD 2, SPAD 1, SPAD 2, relative water content, total antioxidant activity, stomatal conductance, transpiration rate and photosynthetic rate under both environments. The path analysis revealed that biological yield per plot, harvest index, 1000 grain weight and number of effective tillers per meter were main contributor towards grain yield per plot. Regression analysis demonstrated variability for grain yield per plot was due to biological yield per plot, harvest index, seed density, CTD 1 and SPAD 1. The principal component analysis for morphological traits and physiological traits indicated that the first two components accounted for more than 42% and 85% of the total variance, respectively. Based on euclidean cluster analysis, RILs were grouped into nine and eight clusters, cluster IX and cluster VIII were identified most divergent as well as high mean values for most of the traits. Composite interval mapping (CIM) identified a total of 7 QTLs, *i.e.* 6 for morphological traits and 1 for physiological traits.

Keywords: Variability, correlation, regression, PCA and QTLs.

90. Vertical farming: A silent revolution in agriculture- A review

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Abstract

Due to the limited access of land for farming and wide spread of pandemic disease *i.e* Covid-19 there is a need for sustaining farming tasks so as to pave the way for adding to food needs. Many aspects press on food industry and processing such as: growth of population and its growing needs accordingly, reduction of natural sources due to growing cities, earth erosion, different forms of contamination, advent of bio-fuels, restrictions imposed on food production techniques affected by customers and rule providers which requires better quality, less use of chemicals and many useful environmental attempts ‘from farm to fork’ (Albajes *et al.*, 2013). Therefore, it has led to more interest in providing healthy food and incorporating it in the sustainable development project. With the aim of increasing crop yield per unit area of land, the concept of vertical farming is currently gathering momentum. By farming upwards rather than outwards, this technique aims to reduce pressure on traditional agricultural land and by incorporating soil-free growing systems is particularly attractive for use in urban areas. In a nutshell, vertical farming is an emerging technology with several variations being tested throughout the world, and new innovations and technology will likely increase the energy efficiency and profit margins of the farms in near future. It is a technically demanding and expensive approach to crop production. Vertical farming therefore necessitates a combined technical approach to factors including lighting, growing system, crop nutrition, energy efficiency, construction and site selection.

Keywords: Vertical farming, natural sources, sustainable and soil-free growing systems

91. Plant Genetic Resources for Food Security and Sustainable Development of Agriculture

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Abstract

Today, the world is facing serious societal challenges in the areas of food security, environment, energy, and health. Historically, conservation of plant genetic resources and their use in sustainable manner to develop varieties of desired trait, needed to address these

challenges. Conservation of plant genetic resources is required for the evolution, survival and adaptation of crop species as well as crops improvement for sustainable development. Decline of plant genetic resources in alarming rate, threatened global food security by losing the ability of crops to adapt biotic and abiotic stresses. Plant diversity remains a key component of global food security, peace and prosperity for the foreseeable future. Millions of lives depend upon the extent to which crop genetic improvement can keep pace with the growing global population, changing climate, and shrinking environmental resources. While there is still need to conserve plant genetic resources and are expected to play crucial roles in meeting the chronic demands of global food security. However, genetically improved seed is only part of the solution. Such seed must be integrated into ecologically based farming systems and evaluated in light of their environmental, economic, and social impacts by using plant genetic resources for sustainable agriculture. In this review, I describe that *Ex-situ* and *In-situ* conservation of plants can guarantee the availability of Plant Genetic Resources for Food and Agriculture for present and future generation. Conservation through sustainable utilization promotes long term conservation for the resources.

Key words: Plant Genetic Resources, Food Security, Conservation, Climate change, Sustainable Agriculture

92. Organic farming research for sustainable environment-current status and opportunities for future development

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Abstract

Organic farming is the practice that relies more on using sustainable methods to cultivate crops and it avoids chemical inputs that do not belong to the natural eco system. Environmental policies framed across the globe consider the importance of organic farming in achieving sustainable development of environment. Due to rises environmental concerns in modern agricultural practices, the role of organic farming has risen considerably with its net sale of 40 billion US dollars every year. But the organic sector yet to achieve its full potential. Organic farming is in direct relationship with environmental sustainability due to its role in enhancing natural health of environment. The recent development of the scientific, legislative, economic and environmental aspects of organic farming. The impact of organic farming on biodiversity and soil fertility is discussed in comparison with conventional systems. A significant barrier for wide application and future development of organic farming is the existing diversity of national and international policy instruments in

this sector. Special attention is paid to up-to-date research techniques that could help solve a number of the problems typically faced in plant organic farming. It is argued that organic farming is still not productive enough to be considered fully sustainable. This underlines the necessity of strong support for more effective implementation of scientific research innovations and improvement of the networking between all stakeholders – organic producers, scientists and corresponding policy makers at the national and international level.

Keywords: Organic farming, Environment, Conventional Farming, Soil fertility, Sustainable agriculture, biodiversity

93. Studies on integrated nutrient management in sweet corn (*Zea mays* L.var. *saccharata sturt*)

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Abstract

A field experiment was conducted during *khari* season of 2019 at the Experimental Farm, Department of Agronomy College of Agriculture, Latur to study the effect of integrated nutrient management in sweet corn (*Zea mays* L.var. *saccharata sturt*). The experiment was laid out in a randomized block design with seven treatments and replicated thrice. The treatments were T₁- 100% RDF, T₂ - 100% RDF + FYM @ 5 t ha⁻¹, T₃ - 75% RDF + FYM @ 5 t ha⁻¹, T₄ - 100% RDF + Vermicompost @ 2.5 t ha⁻¹, T₅ - 75% RDF + Vermicompost @ 2.5 t ha⁻¹, T₆ - 100% RDF + FYM @ 5 t ha⁻¹ + Vermicompost @ 1.25 t ha⁻¹+*Azospirillum* and T₇ -75% RDF + FYM @ 5 t ha⁻¹ + Vermicompost @ 1.25 t ha⁻¹ + *Azospirillum*. The result revealed that the application of 100% RDF + FYM @ 5 t ha⁻¹ + Vermicompost @ 1.25 t ha⁻¹+*Azospirillum* significantly produced higher growth characters viz., plant height (200 cm), number of functional leaves (17.60), dry matter accumulation (128.33 g), leaf area (76.35 dm²) and yield attributed namely length of cob (33.02 cm), girth of cob (23.33 cm), number of kernel row cob⁻¹ (16.83), number of kernel cob⁻¹ (783.33), total weight of cob plant⁻¹ (387.40 g). Green cob yield (10621 Kg ha⁻¹) and green fodder yield (21824 Kg ha⁻¹) of sweet corn were significantly highest with the application of 100% RDF + FYM @ 5 t ha⁻¹ + Vermicompost @ 1.25 t ha⁻¹ +*Azospirillum*

Keywords: Sweet corn, INM, RDF, FYM, vermicompost, azospirillum, yield.

94. Agronomic biofortification of zinc in rice- A Review

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Abstract

Among various micronutrients, Zn deficiency in soils and plants is a global micronutrient deficiency problem reported in many countries. Rice (*Oryza sativa* L.) is the dominant staple food for more than half of the world's population, which contains low levels of micronutrients, most of which is lost during processing for food. The possible solutions to correct micronutrient deficiency in humans may be food supplementation, food fortification or biofortification. Soil + foliar application of Zn fertilizers under field conditions are highly effective and very practical way to maximize uptake and Zn accumulation in grains and foliar application of zinc at late growth stages increases the grain Zn content. A field experiment was conducted during the two consecutive years 2013-14 and 2014-15 in Thaladi season at two different Zn deficient sites at the wetlands of TNAU farm, Coimbatore to study the effect of soil plus foliar zinc application on zinc concentration in grain of different rice genotypes. The experiment was laid out in a split plot design, replicated which was three times. Main plot treatments were Zn at two levels (-Zn and +Zn, 100 kg ZnSO₄.7 H₂ O ha⁻¹ at basal and 0.5 per cent ZnSO₄.7H₂O foliar spray thrice at flowering, milk and dough stages of rice plant) and sub plot treatments were rice genotypes (18 Nos.) with a plant spacing of 20 X 15 cm. Zinc concentration in whole grains and processed rice grains (brown rice and polished rice) of different rice genotypes were determined. From the pooled data of two consecutive year field experiments, the results revealed that the soil plus foliar application of Zn increased the grain Zn concentration by 43 % over NPK alone. ADT 38 recorded highest Zn concentration in whole grain (37.8 mg kg⁻¹) and brown rice (34.0 mg kg⁻¹) under zinc applied treatment; whereas under zinc stress condition the maximum Zn concentration in whole grain (25.2 mg kg⁻¹), brown (22.4 mg kg⁻¹) and polished rice (10.4 mg kg⁻¹) was recorded in Improved white Ponni. The zinc concentration in brown rice ranged from 12.7 to 34.0 mg kg⁻¹ and there was a significant effect in Zn concentration due to zinc application. The high Zn concentration in brown rice was registered in ADT 38 (34.0 mg kg⁻¹) that had statistical par lance with Improved white ponni (33.8 mg kg⁻¹) in zinc applied treatment; whereas low Zn concentration was recorded in PYR 1 (20.6 mg kg⁻¹). The zinc concentration of polished rice in main plots ranged from 6.5 to 15.7 mgkg⁻¹. Within the sub plots, TRY 1 had significantly higher Zn concentration followed by ADT 38 and the lower Zn concentration was noted in BPT 5204.

Keywords: Zinc, Brown rice, polished rice, Rice genotypes

95. Productivity and profitability of Relay cropping of Muskmelon (*Cucumis melo* L.) in wheat (*Triticum aestivum*)

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Abstract

Due to continuous increase in the cost of different agriculture inputs i.e. seeds, fertilizers, pesticides, diesel, labour etc. farmer's income per unit area and time is decreasing day by day due to stagnation in yield per unit area of different crops. To overcome this problem, On – Farm –Trials were conducted by CCS HAU, KVK Panipat during the year 2016-17 and 2017-18 on relay cropping of muskmelon in wheat. Average yield (34 qt/ha of wheat +56 qt/ha of muskmelon and 32 qt/ ha of wheat + 54 qt/ha of muskmelon) and net returns per hectare (Rs. 115000.00 and Rs. 120500.00) were higher under relay cropping system as compared to sole crop of wheat (45 & 46 qt/ha) and muskmelon (81 and 88 qt/ha) during both the years respectively. Net returns per hectare (Rs. 10500.00 and 102900.00) were recorded higher under 10 channels of muskmelon per 0.4 hectare as compared to 8 and 12 channels per 0.4 hectare during both the years. Transplanting of muskmelon seedlings on 17th February was found most suitable as compared to 10th and 24th February during both the years.

Keywords: Relay cropping, net returns, channels, productivity

96. Effects of Rising Water Table on Productivity and Economics of Major Crops in district Rohtak, Haryana

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Abstract

The study was conducted to determine the economic profitability and constraints faced by the farmers in Rohtak district of Haryana. This study was conducted among 100 farmers, 60 farmers with problematic farms and 40 farmers were normal farms. The average water table depth in district before monsoon (in the month of June) was 5.67 m in the year 2003 which was highest in last 23 years reduced up to 5.02 m in 2005. After 2006, the water table was

in the range of 4.0-5.0 mt upto 2012 and it was further reduced to level of 3.50 mt in 2019. Per acre total cost of cultivation in wheat was considerably higher (Rs. 33398) in normal farm situation than in problematic conditions (Rs. 28553). The yield level of wheat under both conditions has varied significantly. The per acre wheat yield attained was only 14.45 quintals under problematic situation against 19.35 quintals under normal conditions. Per acre total cost of cultivation of basmati paddy was significantly higher (Rs. 41334) in normal farms as compared to problematic farms (Rs. 37009). The value of B: C ratio was higher on normal farms against problematic farms revealing that cultivation of basmati paddy under normal condition yielded higher returns. Ground water was brackish, lack of proper drainage facilities, excessive use of canal water, and adopting water intensive paddy-wheat cropping system over years. Installation of deep tube wells/sub-surface drainage system for pumping out of ground water in canals was only the most appropriate solution to overcome the problem of rising water table. A significant number of respondents (> 70%) were agreed to adopt remedial measures like use of ground brackish water mixed with canal water for irrigation purpose and adoption of low water requiring crops.

Keywords: B:C ratio, water table, problematic farms, wheat and paddy crop

97. Fortification of Muffins: A Review

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Abstract

Fortification of muffins with Protein and Dietary fiber aim to reach target group which have greater needs of this nutrient and also provide more nutrition than basic one. Muffin is sweet, High calorie baked products and widely acceptable by all ages group due to characteristic taste and even low-price product. Several nutritional sources have been studied which indicates that small variation in formulation of wheat flour and other flour shall improve the nutritional status than basic one without affecting on original nutrients. Sincere efforts of Researchers are underway to improve the formulation and promote universal fortification of muffins. According to many research papers Small variation in ingredients can improve or enriched its nutritional status. This review mainly focuses on the recent trends in fortification and current knowledge in Relation to muffins.

Keywords - Muffins, Fortification, Nutritional status, Wheat, Protein, Dietary fiber.

98. Biofortification to combat malnutrition- A Review

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Abstract

For the entire world, the food system does not provide sufficient quantities of nutritious and balanced meals, especially for the underprivileged vulnerable, which are generally referred to as the 'Hidden Hunger' micronutrient malnutrition. The mineral shortage in developing countries causes low productivity and decreases the GNP. Developing staple meals with micronutrients is also a valuable prevention method for the most vulnerable people. The nutrients and public health programs must be used entirely. These tools need to be completely exploited through the nutrients and public health groups to combat micronutrient malnutrition out of which the most effective technique is "Biofortification". Biofortification is the appropriate key to eradicate hidden hunger by the means of staple crops. Whereas, it is a cost-effective method as well as feasible means of reaching population who may have limited availability and access to diverse diets. Because biofortification combines increased micronutrient content with preferred agronomic, quality, and market traits, biofortified varieties match or outperform the usual varieties that farmers grow and consume. Marketed surpluses of biofortified crops make their way into retail outlets in both rural and urban areas, reaching additional populations who may be likely to suffer from micronutrient deficiency. A one-time investment in plant breeding yields micronutrient-rich varieties for farmers to grow for years to come and the same varieties can be evaluated in other target geographies with similar agro-ecological conditions, thus multiplying the benefit of the initial investment. Biofortification is one solution among many that are needed to solve the complex problem of micronutrient deficiency, and it complements existing interventions. While the right mix of interventions is country- and context-dependent, scaling up the use of biofortified crops has the potential to benefit millions of people.

Keywords: Hidden hunger and Biofortification

99. Socio-economic Status of Vegetable Growers in Solan District of Himachal Pradesh

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Abstract

The present paper attempts to examine the socio-economic status of vegetable growers in Solan district of Himachal Pradesh. The study was conducted in Kandaghat and Solan blocks by taking representative sample of 100 farmers. The study reveals about socio economic of the farmer based on education level, type of family, the main source of income. Education level of the vegetable growers was high. Nearly 87.39 per cent of family members were literate at overall level and literacy index was 2.70, indicating average level of quality of education. Cropping intensity was found 178.22 per cent, which indicates that there is a scope to increase the farm efficiency. In vegetable crops, maximum area was under tomato (0.27 ha.) followed by capsicum (0.20 ha.), beans (0.09 ha.) and ginger (0.03 ha.) in *Kharif* and in *Rabi* season, maximum area was under pea (0.30 ha.) followed by cauliflower (0.11 ha.), garlic (0.08 ha.), onion (0.06 ha.) and potato (0.02 ha.). It is interesting to note that on an average, gross returns from vegetable cultivation contributed about 56.91 per cent towards the total farm gross income of sampled vegetable growers.

Keywords: socio-economic status, vegetable growers, Himachal Pradesh.

100. Performance of Teff (*Eragrostis tef* [Zucc.] Trotter) Under Different Planting Methods and Nutrient Management

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Abstract

The field experiment was conducted at ICAR- Krishi Vigyan Kendra, Haveri, Karnataka on red sandy loam soil to study the “Performance of Teff (*Eragrostistef* [Zucc.] Trotter) under different planting methods and nutrient management”. The experiment was laid out in Randomized Complete Block Design with Factorial concept, consisting two factors *viz.*, Factor 1: Two Planting methods (M₁: Line sowing and M₂: Transplanting) and Factor 2: Five Nutrient management (N₁: Control, N₂: 100 % organics (6 t FYM ha⁻¹), N₃: 20:10:10 kg N:P₂O₅:K₂O ha⁻¹, N₄: 30:15:15kg N:P₂O₅:K₂O ha⁻¹ and N₅: 40:20:20 kg N:P₂O₅:K₂O ha⁻¹ [6 t FYM ha⁻¹ commonly applied to all the three fertilizer treatments]) replicated thrice.

Transplanting of teff seedlings recorded significantly higher number of effective tillers (449.0 m^{-2}), grain weight (0.31 g ear^{-1}), grain yield ($239.95 \text{ kg ha}^{-1}$) and straw yield ($406.84 \text{ kg ha}^{-1}$), crop nutrient uptake ($6.35, 1.09$ and $3.64 \text{ kg N, P and K ha}^{-1}$, respectively), gross returns ($\text{₹ } 84,999 \text{ ha}^{-1}$), net returns ($\text{₹ } 53,106 \text{ ha}^{-1}$) and B-C ratio (2.66) over line sowing. Among different nutrient management, application of $20:10:10 \text{ kg N:P}_2\text{O}_5:\text{K}_2\text{O ha}^{-1}$ along with 6 t FYM ha^{-1} resulted in significantly higher grain yield ($269.27 \text{ kg ha}^{-1}$), gross returns ($\text{₹ } 95,220 \text{ ha}^{-1}$), net returns ($\text{₹ } 63,136 \text{ ha}^{-1}$) and B-C ratio (2.96) which was on par with application of $30:15:15 \text{ kg N:P}_2\text{O}_5:\text{K}_2\text{O ha}^{-1}$ along with 6 t FYM ha^{-1} . Significantly higher moisture, protein, fat and ash content in teff grains were observed under application of $20:10:10 \text{ kg N:P}_2\text{O}_5:\text{K}_2\text{O ha}^{-1}$ (10.70, 11.77, 2.58 and 2.91 %, respectively). Application of $30:15:15 \text{ kg N:P}_2\text{O}_5:\text{K}_2\text{O ha}^{-1}$ and $40:20:20 \text{ kg N:P}_2\text{O}_5:\text{K}_2\text{O ha}^{-1}$ recorded on par values with application of $20:10:10 \text{ kg N:P}_2\text{O}_5:\text{K}_2\text{O ha}^{-1}$ with respect to quality parameters.

Keywords: Transplanting, lodging, fertilizers

101. Strigolactones: Potential target for Genomic editing in oilseeds production

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Abstract

Strigolactones (SLs) are a novel class of plant hormones that play an essential role in biotic and abiotic stress responses. However, SLs acts as germination signal for *Orobanche* seeds in the soil and causes it to attach to the Mustard plants through haustorium. The narrow genetic diversity of crop varieties makes it challenging to find a Mustard germplasm with reduced and fine-tuned SL production. Therefore, the manipulation of SL biosynthesis pathway through precise genome engineering may reduce production of SLs in Mustard plants and root exudates which could further compromise the germination of parasitic plant seeds, and thus reduce crop losses. SLs are apocarotenoid compounds synthesized from β -carotene. The first step in the pathway is the conversion of all-trans- β -carotene to 9-cis- β -carotene by the β -carotene isomerase D27. Two Carotenoid Cleavage Dioxygenases (CCDs), then work sequentially to convert 9-cis- β -carotene into a C27 aldehyde (performed by CCD7) and then into carlactone (by CCD8). Both CCD7 and CCD8 are known to be essential for the production of SLs and the germination stimulant and are therefore good targets for manipulation. A cytochrome P450 dioxygenase (MAX1) is thought to act on carlactone to produce a SL. SL activity is also likely influenced by transport potentially involving an ATP binding cassette transporter (PDR1/PDR12). The CRISPR/Cas9 system can be used to produce the much-needed genetic diversity and generate varieties with fine-tuned levels of

metabolites such as SLs. Another advantage of CRISPR/Cas9 mediated approach is that the mutation introduced can be segregated away from the T-DNA expression construct used to produce Cas9/sgRNA and non-transgenic mutated plants of agricultural importance can be produced.

Keywords: Orobanche; Mustard; Genome editing; CRISPR

102. Adverse effects of excessive use of Pesticides in Agriculture-review

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Abstract

The use of pesticides for pest mitigation has become a common practice all around the world. Their use is not only restricted to agricultural fields, but they are also employed in homes in the form of sprays, poisons and powders for controlling cockroaches, mosquitoes, rats, fleas, ticks and other harmful bugs. Due to this reason, pesticides are frequently found in our food commodities in addition to their presence in the air. Worldwide, 40 % of the agricultural produce is lost due to plant diseases, weeds and pests collectively. If there had been no pesticides, crop losses would have been many folds greater. Moreover, these crop saving substances not only protect the crops from damage rendered by pests, but they also increase the yields of crops considerably thus, pesticides benefit the crops. However, they also impose a serious negative impact on the environment. Excessive use of pesticides may lead to the destruction of biodiversity. Many birds, aquatic organisms and animals are under the threat of harmful pesticides for their survival. Pesticides promise the effective mitigation of harmful bugs, but unfortunately, the risks associated with their use have surpassed their beneficial effects. Non- selective pesticides kill non-target plants and animals along with the targeted ones. Moreover, with the passage of time, some pests also develop genetic resistance to pesticides. Pesticides have been classified based on the action as destroying, repelling and mitigating agents. Insects and pests are getting immune to the commercial pesticides due to over usage. Recently pesticides have been developed which target multiple species. Now days, chemical pesticides and insecticides are becoming a dominant agent for eliminating pests. When these chemical pesticides are used in a combination of effective natural enemy than that result in enhanced integrated pest management and act as a comprehensive prophylactic and remedial treatment. Worldwide pesticides are divided into different categories depending upon their target. Some of these categories include herbicides, insecticides, fungicides, rodenticides, molluscicides, nematocides and plant growth regulators. Non-regulated use of pesticides has led the environment into disastrous consequences. Serious

concerns about human health and biodiversity are rising due to overuse of pesticides. Pesticides are considered to be more water soluble, heat stable and polar that makes it very difficult to reduce their lethal nature. Pesticides are not only toxic to people related to agriculture, but they also cause toxicity in industries and public health work places. Depending upon the target species, pesticides can cause toxicities in natural flora, natural fauna and aquatic life. In the present paper toxicological aspects of different kinds of pesticides have been reviewed and discussed.

Keywords: Pesticides, types of pesticides, excessive use, adverse effects, Toxicological aspects

103. Nitrogen fertilization with drip irrigation in Onion

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Abstract

Drip fertigation provides an efficient method of fertilizer delivery and if properly managed and can reduce overall fertilizer application rates and minimizes the adverse environmental impact on crop production. The field experiments entitled “*Effect of drip irrigation and nitrogen fertigation on growth, yield and quality of onion*” were conducted during Rabi season of 2016-17 and 2017-18 at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. The experiment was laid out in a Split Plot Design with sixteen treatment combinations comprised of four levels of drip irrigation (60, 80, 100 and 120% CPE) as main plots and four levels of nitrogen fertigation (75, 100, 125 and 150 kg/ha) as sub plots and one control treatment replicated thrice. The seven to eight week old seedlings of onion cv. Hisar Onion 4 were transplanted at 15 x 10 cm spacing during the first week of January in both years. The growth parameters, *i.e.*, plant height, number of leaves per plant, leaf length and days to maturity were recorded maximum under drip irrigation at 120% CPE as compared to other levels of drip irrigation, whereas the all yield and quality parameters were recorded maximum with drip irrigation at 100% CPE as compared to other levels of irrigation. Among the different levels of nitrogen fertigation, all growth parameters were observed maximum with 150 kg/ha nitrogen fertigation as compared to other levels of nitrogen fertigation. Yield and quality parameters were recorded higher under 125 kg/ha nitrogen fertigation as compared to rest of fertigation treatments in both years. Interaction of irrigation and nitrogen fertigation also significantly affected the almost all growth, yield and quality parameters of onion.

Keywords: Fertigation, growth, yield, quality and onion

104. Recycling of Nutrients from Litters of Silkworm Larva to It's Host Plants in Tasar culture

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Abstract

Recycling of nutrients takes place in natural way in the forest to retain the fertility status of soil. Out of many factors which causes in maintaining the fertility status of soil of tropical forest, tasar culture is one of the important ecological systems. The tasar silkworm, *Antheraea mylitta Drury* is polyphagus in nature having a number of primary and secondary host plants. Extensively, it thrives on leaves of primary tasar food plants- *Terminalia tomentosa* (Asan), *Terminalia arjuna* (Arjuna) and *Shorea robusta* (Sal) which are widely available in the forest area of tropical belt of India. An investigation on nutrient content of litters of tasar silkworm larva which consumed leaves of primary tasar host plants was carried out to know the efficacy in maintaining the soil fertility status. Comparative study on nutrient contents of other locally available organic manures viz. cow dung and vermi-compost was also undertaken to understand the effectiveness of tasar silkworm litters in recycling of nutrients in eco-system. Nutrient content of N was estimated by Kjeldahl method using Kjelplus nitrogen estimation system. P, K, Mg and Zn contents were estimated by following standard procedure of di-acid digestion method as described in the book of HLS Tandon. Nutrient content of Nitrogen (N), Phosphorous (P), Potassium (K), Magnesium (Mg) and Zinc (Zn) in litters of tasar silkworm was found at par with nutrient content of vermi-compost. However significant difference in nitrogen content of cow dung was found with other two organic manures. Average nitrogen content in silkworm litters, vermi-compost and cow dung was found as 0.80%, 0.74% and 1.16% respectively. Similarly, P contents in silkworm litters, vermi-compost and cow dung were estimated to be 0.23±0.03%, 0.23±0.04% and 0.25±0.04 ; K contents as 0.63±0.14%, 0.72±0.04 and 0.65±0.02; Mg as 0.57±0.04%, 0.76±0.05% and 0.69±0.01; and Zn as 70.08 ppm, 70.50 ppm and 112.4 ppm respectively. Thus tasar culture is very much important to maintain the living system.

Keywords: polyphagus, host plants, tasar silkworm, litters, cow dung and vermi-compost.

105. Vanya Silk - A perspective to conserve the ecosystem and stabilise rural women economically

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Abstract

In developing country like India, participation of female population(48.18%) could play a significant role in economic development. Most of female populace live in rural belt and due to family burden(34%), lack of motivation associated with health condition(53%) and meagre knowledge of scientific techniques(13%), this usable manpower contribute too less to the economy. Tropical sericulture is a forest based agro-industry, holding a great opportunity for rural women due to it's low investment, high return and short crop duration. *Antheraea mylitta* Drury, with its primary host plants viz. *Terminalia arjuna*, *T. tomentosa* and *Shorea robusta* forms a ideal ecosystem befitting for economy of tribal people. In recent past there has been several government initiatives like Mahila Kisan Sashaktikaran Pariyojna (MKSP), Vanya Cluster Promotion Programme (VCP) and Tribal Sub Plan (TSP) addressing to the development of tasar sector covering about 40,000 sericultural farmers in Odisha, Jharkhand, Chhattisgarh, Bihar and West Bengal. The total employment generation stood at to 8.60Mn (2018-19). MKSP covered 100% women while other two had representation of 30% women. The first emphasis was on development of new plantations of tasar host plants and more than 6000 hectares were developed and maintained. There was involvement of women in almost all aspects starting from nursery raising, plantation, maintenance of plantation, tasar silkworm egg production, rearing of silkworm leading to cocoon production. Women from tribal families were also trained on reeling, spinning and weaving activities of tasar silk. They have taken up these activities in SHG mode for earning their livelihood to the tune of Rupees 12 to 15000 per month and thus boosting their family economy. Wild tropical tasar flora and fauna is abundantly distributed in Peninsular Central India, a tribal dominant region. Besides, new plantations are created improving the ecology as well. Technical support, guidance and motivation will not only conserve ecosystem but also uplift economic condition of rural women populace.

Keywords: *Antheraea mylitta*, conservation, economic upliftment, Vanya silk, tribal women

106. Higher Income in Maize through Fertilizer Management and Hand Dibbling in Maize Responded Higher Productivity in Betul District

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Abstract

Maize is one of the most important crops grown in Betul during the *Kharif* season. The farmers used uncontrolled rate of fertilizers and seed rate in this crop. Therefore, as the dose of hybrid varieties is more the present study was conducted to test the application of STV based nutrient application in hybrid maize and maize. The present experiment was conducted on farmers field for 2 years 2017-2019 to evaluate the result. Therefore, it was observed that by application of imbalance fertilizers the farmers obtained. The adoption of new technology for sowing of maize on ridges by hand dibbling and control application of fertilizer based on soil test value including organic manure resulted in higher benefit: cost ratio with lower cost of production. Application of fertilizer on the basis of soil test values also reduced the amount of fertilizers. The seed rate was also reduced and the dose of fertilizer was also reduced. Obtained higher yield of maize of about 40 quintal/hectare. The farmer obtained about net profit of Rs. 31,000 per year by spending only Rs. 23,000. The farmer saved the seed up to 60% less incidence of weeds, insect pest and disease was observed, chemical fertilizer consumption reduce up to 50%. Therefore, the yield obtained from this method was 40 q/hectare.

Keywords: Hand dibbling, soil test values, STV based fertilizers, Fertilizer consumption, B:C ratio, Fuel consumption

107. Seed Invigouration Treatments for Improved Nutrient Uptake and Soil Nutrient Status of Grain Cowpea, *Vigna unguiculata* (L.) Walp

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Abstract

Cowpea is an important multipurpose pulse crop. Being a legume crop, it is an integral part of sustainable agriculture. Seed invigouration is quite a new term and be used for both seed pelleting and priming. The experiment was conducted with an objective to assess the effect of seed invigouration with zinc sulphate and borax on grain cowpea. Total NPK uptake by crop was the highest in seed priming with ZnSO₄ 0.05 per cent for 4h. However, seed priming with ZnSO₄ 0.05 per cent for 4h + *Trichoderma viride* seed treatment 10 g kg⁻¹ seed recorded the highest Zn uptake and seeds pelleted with borax 100 mg kg⁻¹ seed recorded the highest B uptake. Results on nutrient status of soil after the experiment revealed that seeds primed in ZnSO₄ 0.05 per cent for 4h recorded the highest organic carbon content and available N status. Seeds pelleted with borax 100 mg kg⁻¹ seed recorded the highest available P and seeds primed in ZnSO₄ 0.05 per cent + *Trichoderma viride* seed treatment 10 g kg⁻¹ seed recorded the highest available K status. Seed priming with ZnSO₄ 0.05 per cent for 4h recorded the highest available soil Zn status, whereas, seed pelleting with borax 100 mg kg⁻¹ seed recorded the highest available soil B status. Hence it can be concluded that seed priming with ZnSO₄ 0.05 per cent can be recommended for better nutrient uptake and soil nutrient availability in grain cowpea.

Keywords: seed invigouration, grain cowpea, seed priming, seed pelleting, nutrient uptake

108. Insect pests of cashew apples, seasonality, damage and natural enemies

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Abstract

The cashew (*Anacardium occidentale* L.) is an important commercial tree nut crop. Its nuts as well as apples are edible. Like cashewnuts, cashew apples are also damaged by birds and several insect pests in the field reducing their economic value. Among the pests, cashew apple and nut borer, fruit flies and beetles are important. Several insect pests including apple and nut borers (ANB) (*Thylacoptila paurosema*, *Hyalospila leuconeurella*), flies (*Drosophila* spp., *Dacus* sp.), Hemipteran bugs, (*Riptortus* sp., *Helopeltis antonii*, *Nezara viridula*, *Toxotera odinae*, *Ferrisia virgata*, *Planococcus* sp., *Catacanthus incarnatus*), hairy caterpillars (*Euproctis* spp.), thrips (*Scirtothrips dorsalis*), beetles (*Clinteria* sp., *Popillia* sp.) etc damage the fruits during different developmental and maturity stages. The dried cashew apples in the field were also attacked by *Carpophilus* sp. (Nitidulidae) and *Araecerus fasciculatus* (Anthribidae). Observations revealed that the fallen over ripe cashew apples are being infested by the sap beetles (*Lasiodactylus* sp.), which may help in decomposition of apples which needs further studies. Among all, the damage by apple and nut borer is important. In cashew plantations of ICAR-DCR, Puttur, 5-7 % infestation is commonly noticed every year, and up to 15 % infestation has been noticed during certain months. They prefer tender nuts and all stages of apples. Larvae remained inside the apples until they fall on to the ground. Number of larvae remained inside the apples ranged from one to five. The incidence starts from December on the flowers initially followed by nuts and apples. But during February-March, infestation is seen more on nuts, and the population reaches a peak during March-April. Three larval parasitoids have been recorded on ANB larvae, *Phanerotoma* sp. (Braconidae), *Thrathala flavorbitalis* (Ichneumonidae) and an unidentified dipteran fly, among which parasitism by *T. flavorbitalis* was high (up to 46.2 to 50 % parasitism) under field conditions. Parasitism was high in apples collected during April-May compared to January-February. Thus, collection of infested apples in field during initial infestation period and destruction can reduce spread of ANB.

**109. Evaluation of Bio-Rational Management Tools against Sugarcane Woolly Aphid,
Ceratovacuna lanigera Zehntner**

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Abstract

The sugarcane woolly aphid (SWA), *Ceratovacuna lanigera* Zehntner (Homoptera: Aphididae) became a threat to the sugarcane crop as well as sugar industry. In India *C. lanigera* has been reported as a serious pest of sugarcane in Maharashtra and Karnataka states during July and September, 2002, respectively. Basu and Banerjee in 1958 reported it for the first time from West Bengal. During 2002, the pest epidemic was reported from Maharashtra and Karnataka. By the end of 2004 it had spread to almost all the sugarcane growing areas in the country. The crop of six to 12 months old was more vulnerable to the attack by this pest. Its infestation usually occurred in patches in the beginning and then spread into the entire field within a short span of two to three weeks. Both nymphs and adults of these aphids desap the undersurface of the leaves along the midrib and then they spread to the entire under surface, covering it with flocculent waxy secretion. These aphids excrete honeydew which often covers the entire upper surface of the leaves, leading to growth of sooty mould. To study the effectiveness of some bio-rational management tools against this pest, an experiment was conducted during 2017-18 and 2018-19 in the field condition. The field experiment was laid out at UBKV, Pundibari, Cooch Behar (W.B), India. Based on polled statistically analysis, the cumulative efficacy of the treatments 14 days after application was in the range of 100 to 35.76 per cent. The treatments of T1-Imidacloprid (100 %) and T2-*Verticillium lecanii* (68.68%) were significantly superior among all the treatments and it should be included for the control of this pest. While T3-*Metarhizium anisopliae* (58.43%), T5-Azadirachtin (56.78%) and T4-*Beauveria bassiana* (49.88%) were moderately effective. Least was recorded in treatment T6-Neem oil (35.76%).

Keywords: Management, sugarcane, woolly aphid.

110. Jackfruit for nutritional security and livelihood of rural communities of India

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Abstract

Jackfruit (*Artocarpus heterophyllus*) is an important underutilized tree which is grown under both tropical and subtropical part of the world including India. It has been in cultivation in India from ancient times (3,000-6,000 years ago) and distributed in southern states like Karnataka, Kerala, Tamil Nadu, Goa, coastal Maharashtra and also in other states like, Assam, Bihar, Tripura and Uttar Pradesh. It is also called as poor man's fruit because of its affordability and availability in large quantities during the season. ICAR-Indian Institute of Horticultural Research (IIHR) has done extensive survey in different districts of Karnataka to identify superior jack lines. About 128 samples were collected and evaluated for basic horticultural and organoleptic traits. Based on the results of the evaluations, fourteen best collections were further evaluated for phytochemical composition such as carotenoids, lycopene, sugars, phenols, flavonoids, antioxidant, vitamins and TSS. It is found that varieties with deep coppery red and yellowish orange colour flakes have high amounts of carotenoids and lycopene ranging from 0.42 to 5.83 mg/100g and 0.03 to 2.26 mg/100g, respectively as compared to white colour flakes. Total antioxidant activity ranged from 8.95 to 40.46 and 9.42 to 91.84 mg AEAC/100g in FRAP and DPPH assay, respectively, which indicated potential of its health promoting and functional food components. Two superior accessions were identified and released as farmers' variety named as Siddu and Shankara. The flakes of these varieties are attractive coppery red coloured and sweet, and significantly proved better as compared to other collected genotypes which always fetch higher prices in the market. These varieties are suitable for commercial planting and home gardens. Further, these varieties also contribute towards food and nutritional security as they are rich in total carotenoids, lycopene and vitamin C. These varieties are helping farmers to secure a better livelihood and in long run they can be instrumental to boost the region's economy.

Keywords: Jackfruit, Nutrition, Rural livelihood

111. Drone: First used for Locust Control in India- Review

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Abstract

Agriculture in India constitutes more than 60% of occupation. It serves to be the backbone of Indian economy. It is very essential to improve the productivity and efficiency of agriculture by providing safe cultivation of the farmer. The implementation in agricultural fields of fertilizers and pesticides is essential for crop yields. Because of the velocity, precision and efficiency of the spray procedure, the use of aircraft becomes prevalent. The farmers spray pesticides throughout the farm with spray bags. Farmers must carry the spray sac for pesticides which strains them. Even then, farmers cannot distribute pesticides equally throughout the farm. And it'll also take time. The user can spray the liquids uniformly throughout the field using drones. To overcome the limitation of importing equipment, Department of Agriculture, Cooperation & Farmers' Welfare (DAC&FW), under Make in India initiative, has taken up the challenge to indigenously develop a vehicle mounted ULV sprayer for locust control. Leading the initiative, the Mechanization and Technology Division of DAC&FW got a prototype of the sprayer developed through an Indian manufacturer. The trials of the sprayer have been successfully conducted in Ajmer and Bikaner district of Rajasthan. The other approvals required for commercial launch are underway. This is a major breakthrough as this will end the dependence of importing a very important equipment of locust control. The Drone has been used first time for locust control operations in 28th May 2020 in Jaipur District in Rajasthan .Drone is effective for locust control where they can spray insecticides at the height and in places where regular sprayers can not reach they can kill locust which are perched on high trees.

Keywords: ULV sprayer, Drone, pesticides, Agriculture

112. Assessing Efficacy of Newer Insecticides for Management of Tea Mosquito Bug (TMB) *Helopeltis antonii* Sign. In Cashew (*Anacardium occidentale* L.)

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Abstract

Cashew (*Anacardium occidentale* L.) is prone to considerable damage by insect pests during the cropping season, which is presently being managed by insecticidal intervention. The recent restrictions due to ecological concern have led to scarcity of effective pesticides. Hence alternate ecologically safer insecticides with target specificity comprising of neonicotinoids; carbamates; pyrazoles; synthetic pyrethroids and an IGH were evaluated for their efficacy against the major pest of cashew, tea mosquito bug (TMB) *Helopeltis antonii* Sign. Observations on a) mortality induction and b) damage score- an indication of deterrence were recorded for the test insecticides - thiomethaxom (0.1g/L & 0.2g/L), actemapid (0.5g/L), carbosulfan (2.0 ml/L), buprofezin (2.0 ml/L) and recommended insecticide L-cyhalothrin (0.6ml/L) against TMB under laboratory and field evaluations. The lab trials were done for up to 5 DAT (days after treatment). As tender cashew shoots could not retain their turgidity after 5 days, the residual toxicity of test insecticides beyond 5 DAT was done by spraying the test insecticide onto tagged flushing branches and evaluating those treated tender cashew shoots at 10 DAT, 15 DAT, 30 DAT and 45 DAT. Both adults and nymphs of TMB were allowed for feeding on the treated cashew shoots and mortality levels and damage score were recorded after 12 h. and analyzed statistically. The findings indicated that; thiamethoxam (0.2g/L) and acetamiprid (0.5g/L) could induce 100 per cent mortality of the test insects up to 10 DAT, which was on par with the recommended insecticide L-cyhalothrin (0.6ml/L). Buprofezin (2.0ml/L) and carbosulfan (2.0 ml/L) could not induce any mortality of the TMB adults nor nymphs beyond 3DAT. Thiamethoxam (0.2g/L) and acetamiprid (0.5g/L) resulted in a higher mortality of above 80.0 per cent up to 30 DAT, and hence can be included in IPM recommendations for TMB. However, none of the tested insecticides or recommended insecticide could induce significant mortality of > 20.0 per cent on 45 DAT. The feeding damage score was nil in two test insecticides viz., thiamethoxam(0.2g/L) and acetamiprid (0.5g/L) as well as, L-cyhalothrin(0.6ml/L) on 10 DAT, indicating their effectiveness in repelling feeding by TMB while the damage scores gradually increased after 15 DAT, due to break down of active ingredients.

Keywords: Cashew, tea mosquito bug , *Helopeltis antonii*, newer insecticides, pest management

113. Farmer participatory evaluation of integrated nutrient management systems on yield and economics of Banana variety Nendran grown as intercrop in the coconut-based homesteads of Western Ghat region of Kollam district

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Abstract

Banana is a heavy feeder of nutrients and a stable supply of nutrients from planting to bunch maturity is vital for the production of bigger and quality bunch. There is huge quantity of organic wastes available after harvest in the form of pseudostems and leaves and hence there is a scope of recycling the waste using earthworms, a major soil macro flora and fauna that constitute an important group of secondary decomposers. The nutritional contents of vermicompost can be improved by enrichment with organic additives. With this back ground a field study was conducted with the financial support of Western Ghat cell of Govt of Kerala in the farmers field of 3 panchayaths of Kollam district viz., Kummil, Yeroor and Vilakkudy which came under the agroclimatic unit -12 from 2015 July to 2018 with an objective to find out the effect of integrated plant nutrient system on yield and economics of banana variety Nendran. The experiment was laid out in randomized block design with 9 treatments and 3 replications. The different treatments were T₁ –Farmers Practice, T₂- NPK as per Package of practices recommendations of Kerala Agricultural University (POP), T₃- NPK as per soil test value, T₄- 75% N,P + 100 % K+ Azospirillum and AMF (Arbuscular Mycorrhizal Fungi), T₅- 75% N,P K +PGPR Mix (Plant growth promoting rhizobacteria) , T₆- 50% N,P + 100% K +Azospirillum and AMF (+ Top dress with VC (Vermicompost) @5 kg, T₇- 50% NPK + PGPR Mix 1+Top dress with VC (5 kg), T₈- 50% N,P + 100% K +Azospirillum and AMF+ Top dress with Enriched VC (2.5 kg), T₉- 50% NPK + PGPR Mix 1+Top dress with enriched VC (2.5 kg). The enriched vermicompost was selected from the incubation study (neemcake+rock phosphate). The result of the field experiment revealed that the treatment T₃ i.e., soil test based nutrient management was the best nutrient management option with high net return and benefit cost ratio. At the same time, the integrated nutrient management system involving vermicompost and enriched vermicompost with 50 % N ,P and 100% K + biofertilizers AMF+Azospirillum gave a favourable net income and benefit cost ratio which was lower than the treatment T₃, T₂, T₄ and T₅ apart from the higher microbial population which ensured an ecofriendly viable nutrient package. This nutrient package also effectively recycled the biomass produced i.e., farm waste in the banana plantation of coconut-based homestead to a high value vermi compost.

Keywords: Banana, nutrients, vermicompost, soil test based nutrient management

114. Assessment of existing nutrient management practices on soil health in the banana growing tracts of Western Ghats region of Kollam district under the agroecological unit AEU 12 (Southern and central foot hills)

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Abstract

Undulating topography of the Western Ghats region, heavy rainfall, unscientific agricultural practices, human interventions, high temperature *etc.* cause serious soil and water erosion which in turn leads to the loss of soil nutrients, rapid depletion of soil organic matter and soil fertility. Indiscriminate and unscientific use of complex fertilizers and minimum or non-use of organic manures and liming material by farmers of these regions also intensified the deterioration of soil health which might have led to multiple nutrient deficiencies in many crops especially in banana as it is a nutrient responsive crop. Hence a study was conducted to assess the effect of existing nutrient management practices on soil health in the banana growing tracts of Western Ghats region of Kollam district, Kerala under the agroecological unit 12 (southern and central foot hills). For this, soil samples were collected from the fields of progressive banana farmers of Yerror, Vilakudi and Kummil panchayats which came under the agroecological unit 12- southern and central foot hills (10 farmers from each panchayath) and were analyzed for various parameters *viz.*, pH, EC, Organic carbon, P, K, secondary nutrients, micro nutrients and soil microbes *viz.*, fungi, bacteria and actinomycetes. The data on soil parameters were categorized into low, medium and high based on soil fertility ratings. The results revealed that in general, the soils were acidic in nature (pH varied from 4.39 to 6.18) and the nutrients especially potassium, calcium, magnesium and boron were found to be low. The organic carbon content was medium in range (0.51 to 1.5 %) in all samples tested. The available phosphorus was medium (10 to 24 kg/ha) in more than 76% of soil samples tested and available potassium in soil was low (<116 kg/ha) in 66.67% of samples tested. Among the secondary nutrients, deficiency of calcium, magnesium and sulphur were observed in 50, 30 and 13.33 % of soil samples tested respectively. With respect to micro nutrients, adequate quantity of iron, manganese, zinc and copper were observed in samples tested. Among the micro nutrients, the boron was deficient in 86.67 % of soil samples tested. The population of soil actinomycetes was very low in all samples collected from the three panchayaths when compared to soil bacterial and fungal population.

Keywords: Banana, soil health, nutrients management systems

115. Estimation of *Corcyra cephalonica* eggs requirement for laboratory rearing of *Chrysoperla zastrowi*

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Abstract

Chrysoperla zastrowi is an important generalist predator feeds on variety of small insects and eggs of many lepidopteron and coleopteran insects. It eats several hundreds of small insects during its developmental period and passes through two moults and three instars. In bio-control laboratories, it is generally reared on *Corcyra cephalonica* eggs. Therefore, to know the daily, instar wise and total requirement of *Corcyra cephalonica* eggs an experiment was conducted at Bio-control laboratory, during October, 2016. Study revealed that, *Chrysoperla zastrowi* on an average consumed 815.7 eggs (Range 713-981 eggs) during its total larval period of 9-11 days. The instar wise consumption was 41.9 (Range: 15-69 eggs), 150.5 (Range: 105-199 eggs) and 561.8 (Range: 523-746 eggs) eggs per first, second and third instar, respectively. Thus it is an obvious that, third instar larvae are the most voracious feeder and consumed 13.41 per cent and 3.73 per cent more eggs than first and second instar, respectively.

116. Management of Yellow Vein Mosaic Disease of Okra Using Suitable Resistant Varieties

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Abstract

The whitefly borne virus inflicts okra yellow vein mosaic disease that is capable of causing up to 94 percent yield loss. Effective management of this disease includes vector control as well as use of resistant varieties. Krishi Vigyan Kendra Kollam during 2017-18 conducted an on farm evaluation to find out suitability of various resistant okra hybrids. Three hybrids

tested were good in terms of yield, but mosaic disease appeared in middle of season in Co4 & Arka Anamika, disease did not occur in any of the plots with Manjima. Manjima recorded highest yield of 16 tha⁻¹ and BC ratio of 2.55, seeds of this hybrid exhibited 98% germination in field, had higher fruit weight and number, average fruit weight was 37.68g with good taste and marketability. Arka Anamika had 80% seed germination. Though number of fruits were less, there was good marketability and average fruit weighed 30.22g; Arka Anamika recorded a yield of 14.9 tha⁻¹ with BC ratio of 2.37. Regarding Co4, the seed germination was 75%; though fruits were very tasty, they matured faster affecting marketability, average fruit weight was 27.06g and the total yield was 13.5 tha⁻¹ with BC ratio of 2.13. Farmers' preference was also towards Manjima and it was selected to be popularised in the district based on the findings of this trial.

Keywords: okra, yellow vein mosaic, Manjima

117. Evaluation of Integrated Management Practices against Rhizome Rot in Ginger

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Abstract

Ginger is an important spice crop as well as a medicinal plant. Fungal diseases are the major factors limiting ginger production; rhizome rot caused by fungi coming under the genus *Pythium* is a very dreaded disease which is capable of wiping out the entire crop. An on farm assessment was conducted by Krishi Vigyan Kendra Kollam during 2016-17 at the farmers' field of Kollam district and the results showed that prophylactic treatments with either bio control agents or fungicides would be helpful in preventing the disease. Among the three technology options tested, rhizome treatment in *Pseudomonas fluorescens* 50 grams per litre for 15 minutes before planting and application of organic manure enriched with *Trichoderma viride* 100 grams per pit at planting, drench and spray with *P. fluorescens* @ 45 days after planting and at monthly intervals based on disease intensity and severity recorded highest yield (18 tonnes/ha), BC ratio (3.27) and percentage yield increase over control (83.7). Treatment with IISR biocapsules (hard gelatin capsules containing ginger rhizobacteria) @ 20 capsules per hectare recorded a yield of 15.6 tonnes per hectare, BC ratio of 3.12 and 59 percentage increase in yield over control. Plots received the chemical treatment i.e. seed

rhizome treatment with mancozeb 0.3% and seed bed drenching with mancozeb 0.3% when disease is noticed- recorded 13.5 tonnes per hectare yield, BC ratio of 2.7 and 37.7 percentage increase in yield over control. Percentage disease incidence was 23 in control plots whereas disease was did not occur in all three treatments. Plots received treatment with *P. fluorescens* and *T. viride* showed luxuriant vegetative growth of plants with bold rhizomes; showing the growth promoting effects of these beneficial microbes.

Keywords: Ginger rhizome rot, *Pythium*, *Pseudomonas fluorescens*, *Trichoderma viride*

118. Screening and identification of high yielding lines of wheat for the Central Zone of India

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Abstract

Wheat (*Triticum aestivum L.*) is one of the most important cereal crops grown worldwide serving as a major source of calorie intake (FAO-STAT, 2015). It is considered as the second important staple crop after rice. Therefore, research on yield in wheat is immensely important. The yield of three hundred elite lines (received from Borlaug Institute of South Asia, Punjab, India) with local high yielding check variety. A total of three trials were conducted with fifty entries in each trails with two replications. The trials were conducted at Agricultural Research Field, Shri Vaishnav Institute of Agriculture, Shri Vaishnav Vidyapeeth Viswavidyalaya, Indore and BISA Farm Jabalpur, Madhya Pradesh, India using Alpha lattice design during *Rabi* season 2019-2020. Based on the individual trial analysis, results revealed that, 16 lines were found superior to local check while one line was superior to all local and international checks with an average yield of 8.87 ton/ha in trial 1. The same line showed highest thousand grain weight (53.1g). There were 13 and 5 lines better than local check in trial 2 and trial 3 respectively. The average yield of trial 1, trial 2 and trial 3 was 7.13, 7.21 and 6.39 tons/ha respectively. The selected lines will be further tested in station trial for variety release process by following the variety release process and guidelines.

Keywords: Trial, Alpha lattice design, local check

119. Management of Soil Fertility towards Sustainable Agriculture- Review

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Indian population is expected to be around 1.40 billion by 2026, reaching 1.66 billion by 2050. India's land area is about 2.5% of the global land area, where as it supports more than 16% of the global human population. The soils of India are deficient most of the nutrients, in this condition it is required to manage the soils with the cession yield. There is a major concern about the sustainability of Indian agriculture because of deterioration in soil fertility. Total food grain production in our country has risen from 50.62 million tonnes (1950-51) to 295.67 million tonnes (2019-20) and the net availability of food grains is 487 gram per person per day while, way back in 1951, the per capita availability of food grains was 395 gram. Increasing pressure on limited net cultivated agricultural land in India has resulted in over use of chemical fertilizers, excessive intercultural operations, lack of soil management similar types of cropping system etc. This has resulted in soil degradation and loss of fertility, which are emerging as major challenges for the Indian agriculture. Small land holding, limited agriculture cultivation area, rising population, and decline soil fertility, India is under serious threat of losing its, food surplus status in the near future. In order to achieve the target of food grain production in future management of soil is important. But, it is a challenge to achieve the target of production with hungry soils of India. Because, most of the Indian soils are deficient of macro and micro nutrients. As food grain production increased with time, the number of elements deficient in Indian soils increased from one (N) in 1950 to nine (N, P, K, S, B, Cu, Fe, Mn, and Zn). Wide spread Zn deficiency, followed by S, Fe, Cu, Mn and B in are common throughout the country. Improvement of Nutrient use efficiency (NUE) is an essential pre-requisite for expansion of crop production into marginal lands with low nutrient availability. Judicious application of fertilizer on right rate, right time, and right place will help to improve targeting both high yields and nutrient efficiency. There are many physical, chemical and biological properties that influence soil fertility like nutrient availability, Soil pH, amount of organic carbon, active soil life, soil structure, water infiltration, water holding capacity etc. to sustain the fertility towards advancing food security. Sustainability in farming required an integrated soil fertility management by the management of physical chemical and biological properties of soil to minimize the exhausting soil nutrients reserve and degradation of soil properties.

120. Identification of suitable peach varieties for quality fruit production under subtropical climate of Lucknow

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Abstract

Most farmers accept a new crop for farming when they are confident that they can successfully grow it in their fields. However, geographical location is a limiting factor for different groups of fruit crops. Therefore, low-chill peach varieties (Florida Prince, Pant Peach-1, Sharbati, Sharbati Surkha, Saharanpur Prabhat, Pratap, Shan-e-Punjab and Early Grandi) were planted at 3 m X 3 m during January, 2016 under subtropical climate of Lucknow with an objective of identifying suitable varieties for production of excellent fruits even in short period of cold weather in Northern plains, so that the best one can be adopted by the farmers of the Northern plains to generate alternative income. Result revealed earliest fruit maturity in Florida Prince (15-25 April) and Saharanpur Prabhat and late in Pant Peach-1 and Pratap (5-23 May), while, Maximum number of grade A size fruits (654.67), highest yield (52.37 kg/ plant) and yield efficiency (0.68 kg fruits/ cm² trunk cross-sectional area) were recorded in Pratap. The fruit weight was registered maximum (79.93 g/ fruit) in Pratap, which was non-significant with that of Early Grandi (74.81 g/ fruit), Sharbati Surkha was found to have highest TSS (14.00 °Brix) and lowest titrable acidity (0.09%). Correlation analysis exhibited that canopy volume and trunk cross-sectional area were positively correlated with yield, fruit girth and weight, while negatively correlated with TSS and titrable acidity. Thus peach can be successfully established under Subtropical climate of Northern plains, However most suitable variety can only be evaluated after few more years of study.

121. Efficacy of some insecticides against Whiteflies, *B. tabaci* infesting Tomato

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Abstract

Tomato (*Lycopersicon esculentum* L.) is grown worldwide either in the field, green houses or net houses. It is one of the most important protective crops. It is grown either for fresh fruits or for processing. India ranks second in tomato production after China. The total area of various vegetables in India is 10.3 million hectares with production of 181 million tonnes, of which tomato is cultivated in an area of 809,000 hectares with total production of 19696.9 MT and average productivity of 24.4 tonnes per hectare in 2016-17. Among all the known factors, insect pests are of prime importance and significantly affect the production. Almost all the stages of tomato crop, right from nursery to maturity, are attacked by a large spectrum of insect pests. More than 100 insect pests and 25 non-insect pests are reported to ravage the tomato fields (Lange and Bronson, 1981). Among whitefly, insects attack tomatoes from the seedling stage until harvesting.

Methodology: A field experiment was carried out at Central Experiment Station, Wakawali, from November 2017 to April 2018. Tomato variety Konkan Vijay seedlings were transplanted by following all agronomic practices in nine treatments was replicated in thrice. The insecticides were sprayed thrice. First spray of each insecticide was applied when incidence was noticed, while remaining two sprays were given at an interval of 15 days with manually operated knapsack sprayer. The observations were recorded in each treatment on randomly selected five plants. The pre treatment observations were recorded a day before application of insecticides and subsequently post treatment observations were recorded at third, seventh, tenth and fourteenth day after each spray in the early morning hours. Population was counted on three leaves top, middle and bottom and expressed as number on three leaves.

Result and Conclusion: The data on mean population of whitefly per three leaves per plant after three sprays revealed that the treatment Thiamethoxam 25 WG @ 0.01 per cent was the best treatment which was recorded minimum (3.35) mean pest population per three leaves and was at par with Chlorantraniliprole 2 SC @ 0.004 per cent (3.36) and Lamda-Cyhalothrin 5 EC @ 0.0025 per cent (3.39). The treatments Flubendiamide 20 WG @ 0.01 per cent (3.70), Dimethoate 30 EC @ 0.06 per cent (3.81), Azadirachtin 1 EC @ 0.003 per cent (3.88), Quinalphos 25 EC @ 0.025 per cent (3.90) and Indoxacarb 14.5 SC @ 0.0145 per cent recorded 3.99 mean populations of whiteflies per three leaves. All the above treatments were found to be superior over untreated control which recorded highest pest population (6.37 per three leaves).

Keywords: Whitefly, *B.tabaci*, Tomato, Management

122. Screening of genotypes against Whiteflies, *B. tabaci* infesting Tomato

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Abstract

Tomato (*Lycopersicon esculentum* L.) is one of the major and remunerative vegetable crops which have achieved tremendous popularity over the last century. Among all the known factors, insect pests are of prime importance and significantly affect the production. The foliage pests such as aphids, thrips and whitefly suck plant sap and cause leaf distortion and stunting of tomato plants (Waiganjo *et al.*, 2006). Whiteflies are known vectors of the tomato yellow leaf curl viruses (TYLCV) currently rank third among the economically and scientifically most important tomato viruses worldwide.

Methodology: To study the response of some promising genotypes of tomato against, whitefly a field experiment was carried out at Central Experiment Station, Wakawali, from November 2017 to April 2018. Seedlings of the tomato cultivars (35 days old) were transplanted in the well prepared field. All the recommended package of practices was followed. The genotypes were kept unsprayed throughout the cropping season. The observations were recorded as soon as the infestation is noticed. The population of whitefly was recorded at weekly interval during morning hours on five randomly selected and tagged plants in plot. Population was counted on three leaves top, middle and bottom and expressed as number on three leaves.

The experimental details:

Genotypes :			
I	DPLTo-1	xiv	DPLTo-14
Ii	DPLTo-2	xv	DPLTo-15
iii	DPLTo-3	xvi	DPLTo-16
iv	DPLTo-4	xvii	DPLTo-17
V	DPLTo-5	xviii	ARKA ALOK
vi	DPLTo-6	xix	BT-317
vii	DPLTo-7	xx	TH-802
viii	DPLTo-8	xxi	LE-626
ix	DPLTo-9	xxii	LE-415
X	DPLTo-10	xxiii	LE-474
xi	DPLTo-11	xxiv	LE-66
Xii	DPLTo-12	xxv	LE.1.2
xiii	DPLTo-13	xxvi	BL-142

Result and Discussion: The data on screening of cultivars against overall mean whiteflies population per three leaves per plant was in the range of 3.38 to 4.60. The highest mean population was recorded on the cultivar LE-415 (4.60 ± 0.44) per three leaves per plant. The mean population recorded in remaining cultivars in descending order was LE-626 (4.52), LE-474 (4.51), BL-142 (4.47), LE-1.2 (4.37), DPLTo-16 (4.35), Arka Alok and DPLTo-17 (4.33), TH-802 (4.32), BT.317 (4.29), LE-66 (4.20), DPLTo-15 (4.13), DPLTo-12 (4.01), DPLTo-13 (4.00), DPLTo-10 (3.65), DPLTo-6 (3.58), DPLTo-14, DPLTo-4 and DPLTo-7 (3.51), DPLTo-8 and DPLTo-3(3.48), DPLTo-5 (3.47), DPLTo-9 and DPLTo-11 (3.46), DPLTo-1 (3.45). The lowest population was recorded on the cultivar DPLTo-2 (3.38 ± 0.44) per three leaves.

Keywords: Whitefly, *B.tabaci*, Tomato, Screening, genotypes.

123. Effect of Weather Parameters on Chickpea (*Cicer arietinum* L.) Cultivars under Different Sowing Windows

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Abstract

Present invitation entitled “Effect of Weather Parameters on Chickpea (*Cicer arietinum* L.) Cultivars under Different Sowing Windows” was carried out during 2013-17 during *Rabi* season at Zonal Agricultural Research Station, Solapur, Maharashtra State (India). The experiment was conducted in split plot design with four replications. Treatment combinations were formed considering different cultivars viz., V 1 -Vijay, V 2 -Digvijay and sowing windows viz., S 1 -MW 38 (Sept 17-23), Uttara nakshtra, S 2 - MW 40 (Oct. 01-07), Hasta nakshtra S 3 - MW 42 (Oct. 15-21), Chitra nakshtra and S 4 - MW 44 (Oct. 29- Nov.04), Swati nakshtra. Among the four chickpea sowing window crop sown at MW 38 (S 1) (Uttara Nakshtra) produced significantly higher grain yield ($1088.4 \text{ kg ha}^{-1}$), total monetary returns (Rs. 39331 ha^{-1}), CUM (234.5 mm), (MUE) ($4.65 \text{ Kg ha}^{-1} \text{ mm}$), GDD (1006-1413 0 days), and RUE (2.41 g MJ^{-1}) than other sowing dates. Among the genotypes Digvijay produced significantly higher grain yield (983.2 kg ha^{-1}), total monetary returns (Rs. 35366 ha^{-1}) than other cultivars.

Keywords: Rabi chickpea, sowing windows, yield attributes, cultivar

124. Antibiosis mechanism of resistance to Pod borer, *H. armigera* in selected wild genotypes of pigeonpea

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Abstract

Pigeonpea (*Cajanus cajan* L.) Mill. is a major grain legume crop of the semi-arid tropics. It is grown extensively in India and other developing countries of Asia, Africa and Latin America. The experiment was conducted at Centre of Excellence for Research on Pulses, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujrat. Results revealed that, wild genotype, *Cajanus albicans* exerted the maximum antibiotic effect on egg period by extending up to 6.33 days. The shortest egg period (4.38 days) was recorded in genotype *Rhyncosia rothi*. The larval period was recorded longest (32.73 days) in *Cajanus albicans* whereas, it was shortest in *Cajanus scarabaeoides* accession no. KLM-736 (20.75 days). The longest pupal period of 26.00 days was observed in genotype *Cajanus albicans* and the shortest in *Lanceo latus* (20.15 days). The highest larval mortality of *H. armigera* (60.00 %) was noticed in genotype *Cajanus scarabaeoides* accession no. KLM-736 and proved less susceptible for the development. While, minimum larval mortality (25.00 %) was in genotype *Lanceo latus*. The adult emergence was lower in wild genotypes. The maximum percentage of adult emergence (40.00 %) was observed in genotype *Cajanus scarabaeoides* accession no. EC-122342 whereas, minimum in genotype *Cajanus scarabaeoides* accession no. KLM-736 (26.67 %). Growth index of *H. armigera* larvae was lower in comparatively resistant genotypes *Cajanus albicans* (1.12) followed by *Cajanus platycarpus* accession no. ICPW-61 (1.38), *Cajanus platycarpus* accession no. ICPW-15921 (1.39), and higher in susceptible genotypes *Cajanus scarabaeoides* accession no. EC-122342 (1.72) and *Rhyncosia bracteata* (1.71). Relatively higher male: female sex ratio observed in wild genotype *Rhyncosia rothi* (1:0.2) whereas, male was lower in *Cajanus scarabaeoides* accession no. EC-122342 and *C. platycarpus* accession no. ICPW-61 (1:1.1). The lowest larval and pupal weight was recorded in wild genotype *Cajanus scarabaeoides* accession no. KLM-736 (87.90 mg and 249.10 mg, respectively) and there were highest in *Cajanus platycarpus* accession no. ICPW-61 (122.52 mg and 300.89 mg, respectively). The minimum pupal length was noticed in wild genotype *Lanceo latus* (15.76 mm) whereas, it was maximum in *Cajanus albicans* (18.51 mm). Pupal width of *H. armigera* was found minimum in *Lanceo latus* (3.54 mm) and it was maximum in *Cajanus platycarpus* accession no. ICPW-61 (4.03 mm).

Keywords: Pigeonpea, Antibiosis, Mechanism of resistance, Pod borer, *H. armigera*

125. Growth, Yield and Economics of Pigeonpea (*Cajanus cajan* L. Millsp.) as influenced by phosphorus and biofertilizers under rainfed condition

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Abstract

The field investigation entitled “Effect of on growth, yield and economics of pigeonpea (*Cajanus cajan* L. Millsp.) as influenced by phosphorus and biofertilizers under rainfed condition” was conducted at Experimental Farm, Agronomy Section, College of Agriculture, Latur. The experiment was laid out in Factorial Randomized Block Design with two factors and replicated thrice. Whereas first factor comprises levels of phosphorus viz. 0 (control), 40, 50 and 60 kg P ha⁻¹, second factor comprises seed inoculations with biofertilizer viz. alone inoculation of Rhizobium @ 6 ml kg⁻¹ seeds, alone inoculation PSB @ 6 ml kg⁻¹ seeds and dual inoculation Rhizobium + PSB each of @ 6 ml kg⁻¹ seeds. The experimental site having gross and net plot size was 5.4 x 4.5 m² and 4.2 x 3.9 m² respectively. The recommended dose of fertilizer was applied at time sowing (25:50:00 NPK kg ha⁻¹ where P applied as per treatments). The sowing was done on 22 nd June 2016 by dibbling and harvested on 3 rd January 2017. All the cultural practices were followed by as per package of practices. The yield data for seed and straw yield for all plots were collected at the end of experimentation. Processed seed sample were digested and N was determined by micro kjeldahal method as advocated by Piper (1966). Protein content was calculated by multiplying N content by the factor 6.25. The application of phosphorus @ 60 kg ha⁻¹ given significantly higher growth and yield attributes, gross monetary return, net monetary return and B: C ratio over the rest of the levels of phosphorus. Whereas NMR was remained at par with 50 kg P ha⁻¹. Among three biofertilizer treatments, dual seed inoculation with Rhizobium + PSB was recorded higher growth and yield attributes, gross monetary return, net monetary return and B: C ratio than the individual seed inoculation of Rhizobium or PSB.

126. Studies on the effect of training system on cucumber (*Cucumis sativus* L.) cv. Malini grown under protected conditions

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ABSTRACT

The present investigation was conducted during 2016-17 at Vegetable research block, College of Horticulture – Mojerla, Sri Konda Laxman Telangana State Horticultural University, Mulugu to study the effect of different training systems on cucumber grown under protected conditions. The experiment comprised of total twelve treatments. Three training systems viz., T 1 (Single head training system), T 2 (Umbrella training system), and T 3 (Low middle training system) were followed. Training T 1 was best in regards to vegetative and yield attributing traits. Among the treatments of training the maximum numbers of fruits per vine (23.08), yield per vine (5.90 kg), yield per hectare (133.08 t/ha), marketable yield (128.02 t/ha) and lowest percentage of deformed fruits (4.01%) were recorded in T 1. Data on vine length and leaf area at different intervals of growth phase were recorded and results indicated that they differed significantly for both parameters T 1 recorded highest value. The results reported shown the maximum output from single head training system (T 1) indicating its significance.

Keywords: Cucumber, Training systems,

**127. Socio - economic Profile of beneficiaries women through vocational training in
Madhya Pradesh**

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Abstract

The study was conducted on 120 trainee's rural women in Madhya Pradesh state to ascertain their Profile of Socio - economic beneficiaries through vocational training. The socio-economic involvement of women is related to their status and role in the family and the society. Women is the back bone of agriculture, comprise the majority of agricultural labours in Madhya Pradesh. It is recognized that women's participation in income enhancing activities to increase their socio economic status and power in the society. The selected practicing farmers have been interviewed personally with the help of a well structured and pre-tested interview schedule. The findings of the study revealed that majority of the trainees rural women were 46.70 per cent were of middle age group, 44.16 per cent of primary school education, 43.85 per cent belonged to other backward caste, most of women 56.70 per cent were unmarried, 45.00 per cent medium family size, 35.83 per cent were medium economic motivation, 40.00 per cent having low duration of training perceived, 40.00 per cent found short type of vocational training, 49.16 per cent were medium information seeking behaviour, 41.66 per cent medium social participation and 44.16 per cent medium socio economic status.

Keywords — Socio - economic profile, vocational training and rural women.
