BioSCon,23

3rd BIOTIC SCIENCE CONGRESS, 2023

International Conference on

Advancement in Plant Health Research - Retrospect & Prospect

Date: 7th – 8th December, 2023

Venue: VISVA BHARATI, West Bengal, India

e-SOUVENIR cum Compendium of ABSTRACTS

Jointly Organized by

Society for Biotic and Environmental Research, *Tripura, India*

Department of Agricultural Entomology, Palli Siksha Bhavana, *Sriniketan, VISVA BHARATI, West Bengal, India*

Technical Collaborators

Lincoln University, *Missouri, USA*

Rajiv Gandhi University, *Arunachal Pradesh, India*

Sri Sri University, *Odisha, India*

ICAR-Central Agroforestry Research Institute, *Uttar Pradesh, India*

In Association with

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SOCIETY FOR BIOTIC AND ENVIRONMENTAL RESEARCH (SBER)

(Registered Under Society Registration Act 1860)

Registration No. 8067 OF 2019 NITI Aayog ID No. TR/209/0229149 ISO 9001:2015 Certified

ABOUT SBER

The SOCIETY FOR BIOTIC AND ENVIRONMENTAL RESEARCH (SBER) came into existence on 2018 in Tripura under Act XXI of 1860 (Regd. No. 8067 of 2019/ NITI Aayog ID No. TR/2019/0229149) as a nonprofit scientific and educational society of likeminded academician, researchers, scientists from all over the nation for the increased furtherance and diffusion on knowledge of Life Sciences in general and Environment Science in particular.

OUR AIM AND OBJECTIVE

The main objective of the society is to make attempt for the development and extension of scientific research related to Life Sciences including Agriculture and allied branches and implementation of these research out comes in the upliftment of scientific and farming community. Its major aims and objectives include promotion and dissemination of innovative research outcomes among young minds and researchers, setting up regional and state Chapters, to hold national/international level conferences, symposium, seminars, training, brainstorming sessions, meetings.

MEMBERSHIP

Any individual having degree or interest in Science and Environment including Agriculture and Allied branches of science/technology can be a member of the Society. The SBER shall consist of Honorary Members, Annual Members, Regular Members, Life Members, Student Members, Donor/Institutional Members. To be a member or fellow, the applicant must apply through online mode or through mail to the Secretary/Chairman along with membership fees.

Categories	Membership Fees (Rs.)
Student Member	1000
Annual Member	2000
Regular Member	3000
Life Member (E)	5000

For details about society and membership:

Website: www.sberindia.org // E-mail: secretary.sber@gmail.com // Mobile & Whatsapp: +91 9863023086

Published by Convenor, Biotic Science Congress (BioSCon, 2023) and *International Conference on "Advancements in Plant Health Research: Retrospect & Prospect"* on behalf of Society for Biotic & Environmental Research (SBER), Tripura, India with the technical guidance of conference committee.

प्रो. साकेत कुशवाहा
कुलपति
Prof. Saket Kushwaha
Vice Chancellor

राजीव गाँधी विश्वविद्यालय
केंद्रीय विश्वविद्यालय
रोनो हिल्स, दोइमुख- ७९१ ११२
अरुणाचल प्रदेश, भारत
Rajiv Gandhi University
Central University
Rono Hills, Doimukh – 791 112
Arunachal Pradesh, India

MESSAGE

It is with immense delight and a profound sense of pride that I extend a warm welcome to all participants of the International Conference on "Advancement in Plant Health Research - Retrospect & Prospect," slated to transpire from 7th to 8th December 2023. The conference theme, "Advancement in Plant Health Research - Retrospect & Prospect," resonates deeply in light of the escalating challenges faced by the global agricultural sector due to biotic and abiotic stresses. This gathering aspires to serve as a crucial platform for scientists, researchers, policy-makers and industry experts to converge, sharing their knowledge and expertise on the latest developments in plant health research.

The world is witnessing a significant and escalating challenge in sustaining crop yields, with biotic and abiotic stresses causing substantial losses. According to recent studies, the Food and Agriculture Organization (FAO) estimates that approximately 20-40% of global crop yields are lost each year due to pests, diseases and environmental factors. These losses not only jeopardize food security but also have profound economic implications, affecting the livelihoods of millions of farmers worldwide. The importance of addressing these issues through cutting-edge plant health research cannot be overstated. Our ability to advance agricultural practices, develop resilient crop varieties and implement sustainable pest management strategies will play a pivotal role in mitigating these losses and ensuring a stable and secure food supply for the growing global population. This conference serves as a vital platform to delve into these challenges, share insights, and collaboratively explore innovative solutions that will contribute to the resilience and sustainability of global agriculture

I am particularly pleased to acknowledge the collaborative efforts of the Society for Biotic and Environmental Research (SBER) and the Department of Agricultural Entomology, Palli Siksha Bhavana, Visva Bharati, Santiniketan, in organizing this conference. These esteemed institutions boast a long-standing tradition of excellence in research and education in the realm of plant health and their collaboration ensures the success of this event. The conference program boasts a stellar lineup of distinguished keynote, invited and plenary speakers from around the world, poised to share insights on the latest advancements in plant health research. Encompassing a diverse array of topics, including emerging threats to plant health, sustainable protection strategies, molecular approaches to disease resistance, integrated pest management, and precision agriculture, the presentations promise to be both enlightening and impactful. Beyond the plenary sessions, the conference agenda includes a series of oral and poster presentations by young researchers, providing a valuable platform for the next generation of plant scientists to showcase their work and engage with established experts in the field. I am confident that this conference will foster a stimulating and informative environment for all participants to learn, exchange ideas and cultivate new collaborations. The knowledge and experiences shared during this event will undeniably contribute to the advancement of plant health research and the formulation of sustainable agricultural practices.

My sincere appreciation goes to the organizing committee for their unwavering dedication and hard work in planning and executing this pivotal event. I extend heartfelt gratitude to the keynote, invited and plenary speakers for their willingness to share their expertise with us. I wish you a fruitful and enjoyable experience at the International Conference on "Advancement in Plant Health Research - Retrospect & Prospect."

Saket Kushwaha

दूरभाष:/Tel: +91-360-2277252 (Off.) 2277261 (आवास/Resi.) +91-9936451995 (M), फैक्स:/Fax: +91-360-2277317
ईमेल:/E-mail: saket.kushwaha@rgu.ac.in/vc@rgu.ac.in वेबसाइट:/Website: www.rgu.ac.in

UNIVERSITY OF CALCUTTA

Prof. Dr. Swapan K. Datta
FNA, FASc, FNASc, FNAAS, FTWAS
Distinguished Biotechnology Research Professor (DBT)
University of Calcutta

Former,
Vice, Chancellor, Visva Bharati
DDG (CS), ICAR, Govt. of. India
Sir Rash Behari Ghosh Professor, CU
Senior Scientist, IRRI, Philippines
Senior Scientist, ETH-Zurich, Switzerland

Laboratory of Translational Research
on Transgenic Crops,
Department of Botany
Annex Building - II
35, Ballygunge Circular Road
Kolkata - 700 019, India,

Mobile : 91-8768644777
E-mail : swpndatta@yahoo com
skdbot@caluniv.ac.in

Ref. No.

Date 01 Dec 2023

MESSAGE

It is with great delight that I announce the upcoming International Conference on "Advancement in Plant Health Research - Retrospect & Prospect (Hybrid Mode)," organized by the Society for Biotic and Environmental Research (SBER) in collaboration with the Department of Agricultural Entomology, Palli Siksha Bhavana, Visva Bharati, Sriniketan. This esteemed event is scheduled to take place from December 7th to 8th, 2023.

This international conference will serve as a global platform, bringing together experts and scholars from around the world to engage in meaningful discussions about the latest advancements and applications in the field of agriculture. The conference will feature speakers of international acclaim, providing a valuable opportunity for young researchers to showcase their work through both oral and poster presentations.

I am optimistic that this conference will foster a successful exchange of knowledge and experiences between mentors and mentees, greatly benefiting the aspiring agriculturists of the future on all major aspects of fundamental to modern biology including genome editing of Biotic stress and particularly in the context of changing scenario of climate change. I extend a warm welcome to all participants of the International Conference on "Advancement in Plant Health Research - Retrospect & Prospect. My sincere appreciation goes to our keynote, invited, and plenary speakers for their invaluable contribution to this conference. I would like to convey my best wishes to the organizers, anticipating a highly successful and impactful event.

S. K. Datta

Professor Swapan K Datta

Former, Founder Vice-Chancellor, Biswa Bangla Biswabidyalay

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(कृषिसंस्थान)
VISVA-BHARATI
संस्थापक
रवीन्द्रनाथटैगोर
FOUNDED BY
RABINDRANATH TAGORE
PALLI SIKSHA BHAVANA
(Institute of Agriculture)

P.O. SRINIKETAN-731236
Birbhum, West Bengal
Phone: 03463-264779
Rly. Station: Bolpur (E.R.)
Fax: 91-3463-264118

Ref. No. PSB/Z-S/150(1)/2023-24 Date: 29.11.23

From
Prof. A.K. Barik
Principal (Dean)

MESSAGE

This is my pleasure to announce that the Society for Biotic and Environmental Research is organising an International Conference entitled "Advancements in Plant Health Research: Retrospect & Prospect (Hybrid Mode)" in collaboration with the Department of Agricultural Entomology, Palli Siksha Bhavana, Visva Bharati, Sriniketan, scheduled to be held during December 7th to 8th, 2023. This conference holds substantial significance given the pressing reality that, despite increased agricultural production, global climate change, poses a significant threat, necessitating comprehensive measures to ensure food security in the future.

The theme of this conference aims to explore crucial aspects of recent advancements in agriculture. Organizing such an event at this time aligns with our objective of creating an environment for the exchange of ideas to propel agricultural progress. The conference will provide a platform for all participants and attendees to share and discuss evolving perspectives on agriculture, food security, climate change, and sustainable development. These discussions will encompass Sustainable Development Goals (SDGs) such as zero hunger, good health and well-being, quality education, clean water and sanitation, affordable and clean energy, responsible production and consumption, climate action, life below water, life on earth, and the initiation of partnerships for these goals.

The conference will offer valuable opportunities for networking and cultivating meaningful partnerships among various stakeholders. Keynote and plenary talks from leading scientists and experts, alongside oral and poster abstract presentations in various scientific sessions, will equip participants with the latest information in the field and insights to address current societal needs.

I sincerely anticipate that this international conference will be intellectually enriching and provide substantial benefits to young researchers, faculties, and students. I extend my warmest greetings and best wishes for the success of the conference.

PALLI SIKSHA BHAVANA ★ Visva-Bharati Sriniketan ★ (Institute of Agriculture)

(A.K. Barik) 29.11.23

Prof. B N Hazarika
Dean

MESSAGE

It gives me immense pleasure to announce that the Society for Biotic and Environmental Research (SBER) will be conducting an International Conference on "Advancements in Plant Health Research: Retrospect & Prospect (Hybrid Mode)" in collaboration with the Department of Agricultural Entomology, PalliSiksha Bhavana, Visva Bharati, Sriniketan, from 7th to 8th December 2023. This international conference, which will host speakers from around the world, provides an ideal platform for debates on the latest advancements and applications in the field of agriculture. Young researchers will have the opportunity to present their research through oral and poster presentations during the conference.

I am optimistic that this conference will serve as a successful meeting ground for mentees and mentors, greatly benefiting younger and more aspiring agriculturists. I extend a warm welcome to everyone attending the International Conference on Advancements in Plant Health Research: Retrospect & Prospect. My sincere appreciation goes to the keynote, invited, and plenary speakers for their participation in this conference. I convey my best wishes to the conference organizers and hope for its success.

(B N Hazarika)
Dean

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NATIONAL INSTITUTE OF PLANT HEALTH MANAGEMENT
Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Govt. of India
रा व स्वा प्र सं
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डॉ जे एलिस आर पी सुजीता
Dr. J. Alice R.P. Sujeetha
निदेशक (पादप जैव सुरक्षा) / Director (PBD)

राजेंद्रनगर, हैदराबाद – 500 030, तेलंगाना, भारत
Rajendranagar, Hyderabad – 500 030, Telangana, INDIA
फोन / Telephone: +91-40-24018788
ईमेल / E-mail: dirpgpniphm-ap@nic.in
टेलि फैक्स/Tele-Fax: +91-40-24015346, वेब/web: http://niphm.gov.in

MESSAGE **24.11.23**

According to the estimates of Food and Agriculture Organization of the UN (FAO), around 40% of the global agricultural crops are lost due to pests and cost $70 billion annually. Numerous challenges across the globe threaten the race to achieve food security. Top on the list of these challenges is crop and postharvest losses and quality reduction due to pests—insects, pathogens, nematodes, non-insect pests and weeds—on the field and in storage. Addressing the impact of pests on food security , India requires comprehensive and sustainable strategies and investments in research and development that will improve the plant health and livelihood of the farmers.

I am delighted to note that an ***International Conference on "Advancements in Plant Health Research: Retrospect & Prospect (Hybrid Mode)"*** is being organized by the Society for Biotic and Environmental Research (SBER) in collaboration with the Department of Agricultural Entomology, Palli Siksha Bhavana, Visva Bharati, Sriniketan, from 7th to 8th December 2023. This programme is highly relevant and need of the hour too. This conference in the context of Advancements in Plant Health is very appropriate.

I firmly believe that this conference will deliver a set of recommendations and will be useful to researchers, academicians, policy makers and industrialists to enhance agricultural development in the country.

I convey my heartiest congratulations to the organizers who are making every effort to make this International Conference a memorable and professionally rewarding event and a grand success.

(Alice R.P.Sujeetha)
24/11/23

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Use of Information and Communication Technology (ICT) in Integrated Pest Management (IPM)

Mukesh Sehgal

ICAR-National Research Centre for Integrated Pest Management, LBS, Building, Pusa Campus, New Delhi (110 012), India

E-mail: msehgalncipm@aol.com

Pest are the major constraints in Agriculture they causes significant loss to crop production. more usage of agrochemicals such as insecticides, fungicides, antibiotics, nematicides for insect pest, disease and nematode control not only degrades the environment but also adversly affects the human and animal health due to presence of residue. Of late, Integrated Pest Management (IPM) has gaining popularity in controling pest and diseases. IPM is such a technology, which integrates multiple environmentally safer and economically sound pest control methods. Digitalization in agriculture is increasingly becoming one of the key technologies for agricultural modernization in many parts of the world. Of late, a number of aids have been developed and are progressively being tested and deployed to support agricultural production systems, including those focussed on pest and disease management. The use of Information and communication technology (ICT)-driven processes in pest and disease management is a growing trend across the globe, particularly in supporting pest and disease diagnosis, reporting and alerts. ICT is the combination of information technology (IT) and communication technology (CT), or the merging of fixed and mobile telephone networks with computer networks. ICT has proved to be a powerful tool in pest forecasting as a prop to giving priority to prevention, as pest forecasting involves data acquisition, processing and information dissemination. ICT can also be very helpful in terms of enforcing integrated pest management (IPM). This chapter presents and the development and use of ICT in pest management.

Keywords: IPM, ICT, Pest, Management

Introduction

Agriculture is the backbone of Indian economy; nearly seventy percent of the Indian population depends on agriculture. Agricultural production in India has been significantly increased and country has achieved self-sufficiency in food grains. This was accomplish by use of new technologies such as growing of hybrids and high yielding varieties, fertilizers and pesticides, as well as by the increasing cultivated area. Nevertheless, the growth in agricultural production needs to be sustained to meet the food demand of increasing population. However, the prospects for bringing additional land under cultivation are limited, growth in agricultural production has to gain from increasing productivity (Singh *et al.*, 2017). One such way to increase the production and productivity is to reduce losses due to pest and diseases. These losses are mostly due to excess use of chemical pesticides and resurgence of pest. Integrated Pest Management (IPM) is such a technology, which integrates all the technology and utilizes all natural resources it is an holistic environmental safer and economically sound pest and disease control method, it integrates cultural, mechanical, biological, host resistance and chemical methods.

IPM not only protects the environment but also helps in conservation of natural enemies. IPM being knowledge intensive approach of crop protection emphasizes appropriate decision-making which is based on knowledge of interaction of the crop, pests and beneficial organisms that prey on pests. Besides Information on pests, a whole lot of other information is also enquired for correct decision making. Thus for successful implementation of IPM, farmers require timely access to relevant pest management information/knowledge and expertise which is not easily accessible to them in our country. In the absence of access to the pest management information/ knowledge and experts, the farmers are over-dependent on chemicals which not only degrades the environment but also affects the human health.

The use of ICT-driven processes in pest management is a growing trend across the globe, particularly in supporting pest and disease diagnosis, reporting and alerts. ICT is the integration of information technology (IT) and communication technology (CT), or the merging of fixed and mobile telephone networks with computer networks. ICT has proved to be a powerful tool in pest forecasting as a prop to giving priority to prevention, as pest forecasting involves data acquisition, processing and information dissemination. ICT can also be very helpful in terms of enforcing integrated pest management (IPM) (Lokeswari, 2016). Information and Communicational Technology (ICT) has several roles to perform for agricultural development starting

from decision support system of the trading of crops (Singh *et al.,* 2017).

In India, many initiatives have been taken for the development of Decision Support System (DSS) by various public and private organizations. Most of them are web-based database and information systems for cereal, pulses and oilseed crops, only few for vegetables which is the second largest crop group in terms of pesticide consumption. Here we have indicated some important ICT-DSS which have working on cereals, pulses oil seeds and other major agricultural and horticultural crops in the field of pest and disease management (Singh and Gupta, 2016).

***e-SAP* (Electronic Solutions against Agricultural Pests)**

e-SAP is an ICT based system developed by University of Agriculture Sciences, Raichur, Karnataka to help the farmers by providing solutions right in their field and also extension service workers in enhancing their efficiency. *e-SAP* mainly targets one of the critical requirements of a crop cycle, pest and disease management. *e-SAP* consists the features that brings the farmer, extension worker, scientist and policy maker on the same platform, thereby helping them to find solutions in lesser time that are more practical. It also allows the extension worker and farmers to do survey of pest attack or related problems right in the field, which is then automatically synthesized in the form of graphs and tables (Singh and Gupta, 2016).

Rice-Crop Doctor

MANAGE (National Institute of Agricultural Extension Management), Hyderabad developed an expert system to diagnose pests for rice crop and suggest preventive/ curative measures. The rice crop doctor illustrates the use of expert systems widely in the area of agriculture and more specifically in the area of rice production through development of a prototype, taking into consideration a few major pests and some deficiency problems limiting rice yield (Singh and Gupta, 2016).

Expert Systems for Grapes and Mushroom

Indian Institute of Horticultural Research Institute (IIHR), Bangalore has prepared the first software for use by the grape cultivators. This spontaneous response made them to undertake similar software for providing guidance to mushroom cultivators, which became extremely popular and a large number of growers using it regularly for getting solutions to their problems (Singh and Gupta, 2016).

AGREX

Center for Informatics Research and Advancement, Kerala has prepared an Expert System called AGREX to help the Agricultural field personnel to give timely and correct advice to the farmers. The Expert System finds its extensive use in the areas of fertilizer application, crop protection, irrigation scheduling, diagnosis of pests in paddy and post-harvest technology of fruits and vegetables (Singh and Gupta, 2016).

iKisan

iKisan is the ICT based information system initiative of the Nagarjuna group of companies, the largest private entity supplying farmers' agricultural needs. iKisan.com website provides agricultural information online to diagnose, analyze and advise about insect pests. This includes information on 20 crops, namely rice, chilli, cotton, soybean, maize, groundnut, turmeric, banana, citrus, coconut, tomato, red gram, Bengal gram, green gram, black gram, sunflower, sugarcane, castor and mango (Singh and Gupta, 2016).

SOYPEST

A web based fuzzy expert system, developed by National Research Centre for Soybean (NRCS), Indore in collaboration with Institute of International Management and Technology (IIMT), Gurgaon with an objective to provide IPM decision support to the soybean farmers through internet. This helps to identify active pest and to calculate the activity of active pest followed by their diagnosis (Saini *et al.,* 2002). Identification and diagnosis of pest is a knowledge based activity which is done by the system on the basis of damage symptoms, insect-pest morphology and pest images. SOYPEST uses knowledge based inferences for activity calculation (Singh and Gupta, 2016).

e-Sagu

It is an IT based Personalized Agro-Advisory System, developed by Media Lab Asia with International Institute of Information Technology (IIIT), Hyderabad. In this system, the agricultural experts generate the advice by using the latest information about the crop situation received in the form of both photographs and text. The agriculture expert advice is delivered to the farmer (typically once in a week/ two weeks depending on the type of crop) without their inputs. This is operating on several crops and farms in Andhra Pradesh since 2004. The impact results of the system show that the expert advices helped the farmers to achieve significant savings in capital investment and improvement in the yields (Singh and Gupta, 2016).

aAQUA

An archived multilingual multimedia question answer based communication System, aAQUA (almost All Questions Answered) developed by Media Lab Asia with IIT Bombay - which provides online answers to questions asked by farmers and agri-professionals over the Internet. It allows users to create, view and manage content in their native language (Marathi and Hindi). It also provides easy and fast retrieval of contextual information, documents and images using various keyword search strategies with the help of query expansion and indexing techniques. Using this, a farmer can ask a question on aAQUA from a kiosk (cybercafé); experts view the question and answer back, providing solutions to the problem (Singh and Gupta, 2016).

AgriDaksh

A tool for building online expert system which enables domain experts to build online expert system in their crops with minimal intervention of knowledge engineers and programmers. This is a generic system for all crops with ability to create knowledge models for new crops. It has Ontology based diseases diagnosis, insects identification and variety selection. This also captures location specific variety information with the ability to add multiple pictures for each variety. It has comprehensive plant protection module that provide information on diseases, insects, weeds, nematodes and physiological disorders. The system has been tested on Maize crop and is online for last one year (Marwaha, 2012).

EXOWHEM

A web based expert system developed for the wheat growing farmers of India. It provides the complete information about the Wheat Crop Management in the country. The system advises wheat varieties on the basis of area, cultural and climatic conditions and other characteristics of farmer's interest. The system carries detailed information about 300 varieties that have been stored in its knowledge base. It also suggests the appropriate cultural practices like field preparation, fertilizer application, schedule of irrigation etc. It guides them in protecting the crop from insects/ diseases/ weeds *etc*. (Islam *et al.,* 2012).

Rice Knowledge Management Portal (RKMP)

A web based portal for providing the most comprehensive agricultural knowledge directly from the scientific community. This is the first comprehensive agricultural portal of the country. RKMP serves as an information highway for sharing rice knowledge across the country. This caters to location specific information needs of many stakeholders in local languages. With about 20 platforms, more than 10,000 pages of content, 3000 minutes of audio, 50 video clips, The Extension and Farmers domains provide production know how, package of practices, FAQs, *etc*., in English and local languages. Portal also caters to information needs of exporters and farmers through the trade information system. Policy makers can directly access area, production, productivity trends of last four decades for all districts (Singh and Gupta, 2016).

Pest Management Information System (PMIS) for Important Crops

This application is developed by premier Institute working on IPM **is** National Center for Integrated Pest Management (NCIPM), New Delhi. This is a standalone generic database application to serve the needs of master trainers, KVKs, extension workers and progressive farmers, and workers of line departments (Sharma *et al.,* 2004). The software provides information on all aspects of crops *viz.*, Mustard, Groundnut, Basmati Rice, Cotton, Brinjal, Okra and Tomato crops such as crop information, agronomic practices, pests, diseases, natural enemies, nutrient disorders, resistant varieties, *etc*. This application could improve the efficiency of farmers' existing production systems for making farming more profitable (Singh and Gupta, 2016).

Pesticide Advisor

This is a database application for researchers and KVK extension workers which could help to select correct and safer pesticide at right doses and apply them correctly as well as safely. This application works as a simple tool giving a choice of recommended curative as well as preventive pesticides as per the recommendations of Central Insecticide Board and Registration Committee (CIB&RC), Government of India to control key pests, in major agricultural and horticultural crops. Its data intend to serve the all the technical needs of researchers, KVK experts, students and environmentalists. The software has detailed information for all the 198 approved pesticides (registered under Insecticides Act, GOI, 1968) such as target pests in different crops with doses, sprayers to be used, shelf life, environmental concerns such as impact of the pesticides on non-target organisms, pickers, applicators, ground water contamination, MRL (Codex Standard), manufacturers, importing source, chemical formula, structure *etc*. for over 723 pests on 94 crops for which the approved doses are available. Information on alternative to chemical pesticides such as bio pesticides is also made available. Users may also generate their own customized reports. E-Pest Surveillance System for Maharashtra: Pest surveillance or monitoring is the cornerstone of IPM (Grant *et al.,* 2006) as compared to calendar-based treatments IPM stresses monitoring of pest and determines when the action is necessary to be taken. The basic purpose of surveillance is to determine whether pests are present in the field at a level to initiate pest management interventions. Through regular and systematic pest surveillance, epidemic situations can be avoided by detecting damage before endemic establishment of a pest in any area (Singh *et al.,* 2012). Hence in 2009 NCIPM and Maharashtra state agriculture department joined hands to develop and implement ICT based pest surveillance and advisory system also called e-pest surveillance system for Cotton and Soybeans crops in the state (Singh and Gupta, 2016).

E-Pest surveillance system is basically an internet based system of capturing pest information from fields and producing - instant and customized pest reports to the plant protection experts to advise the state agriculture agencies who further advise concerned farmers and the same information is available for agricultural policy planners. Keeping in view the size of data and internet connectivity in remote areas, system was designed as having offline data entry and online pest reporting & advisory. On the basis of level of pest incidence in farmer's field, experts submit pest advisories which are disseminated by the system to the farmers through SMS. After successful implementation in Cotton Soybean, ice, Chickpea and Pigeon pea in Maharashtra, the system has also been extended to horticultural crops; Mango, Pomegranate, Sapota and Banana. This has also been replicated in pulses in Andhra Pradesh, Karnataka, and Uttar Pradesh and Maharashtra states and for Rice in Odisha state (Singh and Gupta, 2016).

Demerits of DSSs

There are many advantages in DSSs at the same time there are some lacnas. One of the main reasons for the poor application of DSSs in IPM in the country, has been the non-success of developers to target farmers as user, not pay attention to their level of knowledge, their need and requirements and furthermore to the environment in which they work. Most of the DSSs for agriculture developed in the country are either databases or information systems targeted to researchers, KVKs, extension workers or State Department of Agriculture (SDA personnel. Another lacunae of these system is that they push information to the users rather than collecting the farmer's field pest observations, processing the same and then provide the appropriate pest management solutions. Pest management is very complex process; hence there must easy and timely accessibility of pest management information or experts to the pest management practitioners. Since Indian farming community do not possess the knowledge about pest identification and how to record quantitative pest observations as per scientific pest-specific sampling plans which is essentially required to determine the pest incidence level vis-a-vis pest Economic Threshold Level (ETL) in his field so as to advise the farmers correct pest management option. There are other factors also responsible for affecting the level of pest incidence such as presence of natural enemies, weather and crop condition *etc*. These factors are necessary to be considered for determining the appropriate pest management option. Farmers can only observe the qualitative information about pest incidence, presence of natural enemies & weather conditions such as pest incidence low, medium or high and weather conditions as hot, dry, rainy and humid. This kind of observations contains lot of uncertainty. So the artificial intelligence techniques could be helpful in handling these uncertainties. Very little efforts have been made to use artificial intelligence techniques for the development of DSSs for pest management. Expert systems for soybean pest management developed by NRC on Soybean, is the only initiative taken using artificial intelligence technique, fuzzy logic. But this has been the developed for extension workers as user not for farmers. Moreover it is basically a pest identification and diagnostic tool (Singh and Gupta, 2016).

Conclusion

ICT is one of the potential tools in IPM in detection and diagnosis of pest and diseases, application of ICT in IPM has already

taken in all around the globe and it will continue to make tremendous influence on future IPM strategies. Timely availability of right information to the farmers for decision making can either result in application of pesticides saving crop worth crores of rupees or in non-application of pesticides saving the cost of involved pesticides and the environment from being polluted besides saving the beneficial organisms. Hence, in future it may be change it is emerging as a one of the potential novel tool in early detection, forecasting and management of pest and diseases in agriculture. Hence in future may not be possible to neglect the ICT components in IPM programmes.

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Dissection of Vascular-Memory Elucidates a Novel Perspective on 400 Million Years' of Plant-Aphid Association

Hossain Ali Mondal*, Farzana Ahmad, Ahanthem Malini Devi and Shagolsem Chinglembi Chanu

School of Crop Improvement, College of Post Graduate Studies in Agricultural Sciences (CPGS-AS), Umiam, Central Agricultural University (Imphal), Meghalaya (793 103), India

E-mail: mondal.cpgs.cau@gmail.com

Plant-insect interaction relationship is a product of 400 million years' of molecular association. Aphid being an agricultural pest is an exclusive phloem sap feeder for sucrose and amino acids. A long and slender stylet is evolved for an efficient siphoning vascular sap for its nutrition and proliferation. For studying the relationship, aphid herbivore vascular sap responsible for short term aphid infestation 'memory' as well as erasing of 'memory' in due time was targeted for 'molecular footprint' to uncover the evolutionary relationship between aphid and host plant. From the result, it was evidenced that the creation of vascular 'memory' as well as erasing of 'memory' was imprinted in vascular sap. The titre of antibiotic vascular metabolite in vascular sap, the titre of microbiota and molecular enrichment in vascular sap were correlated with 'memory', retention of 'memory' and erasing of the 'memory'. This finding gives a scope of re-thinking of host resistance to aphid proliferation as vascular memory was correlated with an elevated aphid proliferation. Thus, the present finding might deliver a new perspective in aphid control strategy for food and nutritional security issues in agricultural and horticultural crops loss as aphid causes a huge yield loss by sucking nutrient enriched phloem sap, hijacking host genetic program through effectors molecules delivery as well as vectoring notorious plant virus spread.

Keywords: Aphid, Host memory, Molecular footprint, Vascular sap

Acknowledgement

The author, HAM acknowledged sincerely to the Science and Engineering Research Board, Government of India for the financial support (Grant No. CRG/2019/004764).

Breeding Tomato, Chilli and Okra for Tolerance against Vector Borne Viral Diseases

Arup Chattopadhyay[1*], S.K. Masidul Islam[1], Soham Hazra[2], Subhradeep Pramanik[1], Subhrajyoti Sengupta1, Rajdeep Guha Mallick1, Asit Kumar Mandal3 and Pranab Hazra1

[1]Dept. of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India
[2]Dept. of Genetics and Plant Breeding, [3]Dept. of Plant Pathology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: chattopadhyay.arup@gmail.com

Vegetable production in the country is threatened by many biotic and abiotic challenges. Among the biotic challenges, viral diseases cause significant damage to the crop. The virus is member of the genus *Begomovirus* of the family *Geminiviridae*. The geminiviruses are plant infecting viruses characterized by their unique geminate particle morphology and circular single-stranded (ss) DNA genomes that are transmitted by the whitefly *Bemisia tabaci* Gen. and infect dicotyledonous plants. Collectively the geminiviruses have a broad host range and are responsible for economically significant losses in crops worldwide. Among the vegetables, ToLCV/TYLCV of tomato, PepLCV of chilli and BYVMV and OELCV of okra are the most problematic diseases which infect plants in all growth stages starting from 18-20 days after sowing/ transplanting. The marketable yield loss may reach up to 100% by the attack of these viruses. Most of public and private sectors have made significant contribution over the years towards developing many resistant OP varieties and hybrids. But now-a-days they are becoming susceptible or showing variable tolerance to these diseases. Much concerted efforts will be necessary to develop hybrids/ varieties having high yield, better fruit quality and durable resistance to these diseases across the country to sustain the productivity of tomato, chilli and okra. All India Coordinated Research Project on Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, West Bengal has been working on breeding for resistance to vector borne diseases in vegetables for the last 15 years. The important findings include studies on occurrence and severity of diseases at different growth stages, identification of donor parents for future breeding, identification of hybrids tolerant to these diseases, optimization of gamma rays for specific trait improvement, inheritance pattern of disease tolerance, biochemical basis of tolerance to these diseases, development of putative mutants and release of disease tolerant varieties. This paper deals with all the above aspects on disease resistant breeding in one of the hot spots in India.

Keywords: Breeding, Chilli, Okra, Tolerance, Tomato, Viral disease

Molecular Cross Talk between Crop Plants and Fungal Antagonists against Soil Borne Plant Pathogens

Pranab Dutta* and Madhusmita Mahanta

School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam, Meghalaya (793 103), India

E-mail: pranabdutta74@gmail.com

Fungal antagonists like *Trichoderma* spp. (Hypocreales) are used worldwide as a lucrative biocontrol agent. Interaction of *Trichoderma* spp. with host plant and pathogen at molecular level is important in understanding various mechanisms adopted by the fungus to attain a friend's status with their plant host with superior antifungal/ antimicrobial activity. Mycoparasitism, antibiosis, competition and induction of systemic acquired resistance (SAR) like response in synchrony is considered as the key factor deciding biocontrol potential of *Trichoderma*. Sucrose rich root exudates of host plant attract *Trichoderma*. Soluble secretome of *Trichoderma* plays a significant role in attachment, penetration and colonization of plant roots as well as modulates mycoparasitic and antibiosis activity of *Trichoderma.* This review aims to gather information related to *Trichoderma* interaction with plant and its role as a biocontrol agent of soil borne phytopathogens and to give a comprehensive idea on diverse molecular aspects of their interaction.

Keywords: Disease management, Host plant, molecular interaction, Soil-borne phytopathogen, *Trichoderma*

Role of Artificial Intelligence in Crop Protection

M. Pratheepa*, K. Subaharan, Richa Varshney, T. Venkatesan and S.N. Sushil

ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka (560 024), India

E-mail: mpratheepa.nbaii@gmail.com

In the era of 21st century, agriculture is facing many challenges now-a-days to feed the world population. The world population grows day by day and it reaches expected to cross 10 billion by 2050. Agriculture is the backbone of Indian economy, and India ranks second in the world in farm production. The crop loss has been approximated estimated around US$ 36 billion in India in post green revolution era. The low crop production is mainly due to insect pests, diseases and weeds on in important agricultural crops. Hence, there is a need of transition in farming system to adopt advanced and innovative technologies for more and sustainable production. In recent years Artificial intelligence gained popularity in agriculture and provides solutions in several areas like big data analysis, pest and disease forewarning models, mobile applications in IPM, Information and ICT based crop-advisory system, insect detection, pest and disease identification, *etc*. In the proposed paper, AI based applications discussed in detail to provide insights into innovative technologies and pave the way for knowledge dissemination and adoption of AI based technologies for more effective crop production and protection.

Keywords: Agriculture, Artificial intelligence, Crop protection, Insect detection, Integrated pest management, Mobile application

Underutilized Horticultural Crops of North East India and Their Exploitation Potential

B.N. Hazarika

Central Agricultural University, College of Horticulture and Forestry, Pasighat, Arunachal Pradesh (791 102), India

E-mail: bnhazarika13@yahoo.co.in

The North-East India the richest reservoir of plant diversity in India and is one of the 'biodiversity hotspots' of the world supporting about 50% of India's biodiversity. Northeastern region occupy 7.7% of total geographical area of country and harbours 50% of Indian flora (8,000 species) of which about 4% is endemic (2,526 species). The distinct tribes in the region have rich indigenous knowledge system on the use of components of biodiversity for their daily sustenance like food, fodder, shelter and healthcare. The region has several unique features such as fertile land, abundant water resources, evergreen dense forests of about 66%, high rainfall, and agriculture-friendly climate. Its unique phyto-geographical positions, topography and high degree of precipitation are some of the important factors which are mainly responsible for its enormous biological diversity. As a result, arrays of diverse plants are grown across the region ranging from tropical to alpine. A large number of diversity in fruits belonging to the genera Artocarpus, Annona, Averrhoa, Garcinia, Musa, Passiflora, Phyllanthus, *etc*. are reported from the region. Besides diverse vegetables particularly wild leafy vegetables, rare genotypes of cucurbits, solanaceous vegetables, chilli, ginger, turmeric, *etc*. are there with some unique quality because of their locational advantage. The region has a great ethno-cultural diversity with major and sub-tribes, which explains the wealth of traditional ecological knowledge among farmers. People of region have their own culture, tradition and medicinal system of treatment and knowledge acquired through close observation of nature. Its ethnic people living in the remote forest areas still depend to a greater extent on the forest ecosystems for their livelihood. They collect different medicinal plants and use them in traditional ways to cure their health related forms. The minor and wild fruits are mostly used to cure various gastrointestinal disorders, respiratory problems, cardiovascular compliance, muscular illness, bone diseases, gynaecological problem, cancers, snake bite, allergy and malaria *etc*. by local people of the region. This indigenous system of treatment based on such fruits is still an important part in social life and culture of the tribal people. However, this traditional knowledge of the local people has been transferred from generation to generation without proper technological interventions. This paper will discuss the potentialities of underutilized plants of North-East India.

Keywords: Horticulture, North East, Underutilized, Wild fruits

Importance of Biology of *Echinochloa colona* (L.) Link for its Management in Dry Direct-Seeded Rice

Pijush Kanti Mukherjee and Sonali Singh

ICAR-Directorate of Weed Research (DWR), Maharajpur, Jabalpur, Madhya Pradesh (482 004), India

E-mail: pkm_agronomy@yahoo.co.in

Thorough understanding of weed biology and ecology is important to the ability to develop an effective weed management program. Weed ecology and biology specifically deals with the persistence of weed, which refers its ability to repeatedly invade when it is apparently removed from the scene by the agent. Dry-seeded rice (DSR) is an emerging production system in Asia. DSR is such a system of rice cultivation that has the potential to decrease water consumption, in addition to lessening labour requirements and at the same time enhance resource-use efficiency and system productivity and check greenhouse gas emissions. Direct seeding; however, also has several potential disadvantages. Among them, inadequate weed control is the major reason for its poor performance. Weeds are major constraint to DSR production because of the absence of the size differential between the crop and the weeds and the suppressive effect of standing water on weed growth at crop establishment. *Echinochloa colona* has globally invaded rice fields causing severe grain yield loss of 27 to 62%. The management of the dominant *Echinochloa colona* has increased the aerobic rice yield by 3.92 to 7.84 fold compared to the unweeded control. Based on weed biology knowledge of *Echinochloa colona*, it is possible to identify integrated methods and application timings which provide the greatest impact on the reduction of crop-weed completion, temporal weed biomass production and weed seed production. This article briefly describes the importance of biology of *Echinochloa colona* in developing targeted management of these weeds in DSR.

Keywords: Biology of *Echinochloa colona*, Dry direct-seeded rice, Expansion of seasonality, Weed management

Introduction

Dry direct-seeded rice (DSR) is an emerging production system in Asia. In dry-DSR system of cultivation, weeds are the most difficult to control and, even when controlled, are a recurring menace throughout plant life. Although newly available herbicides may provide satisfactory weed control in DSR, an excessive use of herbicides may increase the risk of herbicide resistance and shifts towards problematic weed species. *Echinochloa colona* has globally invaded rice fields causing severe grain yield loss of 27 to 62% (Rao and Matsumoto, 2017). The management of the dominant *Echinochloa colona* has increased the aerobic rice yield by 3.92 to 7.84 fold (Gunawardane *et al*., 2013) compared to the unweeded control. Heavy infestations of *Echinochloa colona* may remove 60 to 80% of the nitrogen from the soil in addition to considerable amounts of macronutrients. Study of biology of *Echinochloa colona* is very important to understand its dynamics, seed ecology, phenology, seed production capacity, seed dormancy *etc*. Keeping in view on the importance of biology of *Echinochloa colona,* series of pot and petriplate experiments and field trials on dry direct-seeded rice - zero tillage wheat-zero tillage greengram cropping system were conducted to study the biology of *Echinochloa colona* under dry seeded condition of rice.

Methodology

Series of pot (20 cm diameter and 17 cm depth) and petriplate (16 cm diameter and 3.5 cm depth) experiments to study the biology of *Echinochloa colona* were initiated on 6th August 2022 and the experiments were continued up to November 2023. In these experiments known number of seeds of *Echinochloa colona* were placed manually in sterilized soil at the respective burial depth of the seeds at 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 cm soil depth and observations on emergence of weed seedlings, emergence of inflorescence, dropping of seeds, leaf emergence were taken. In field experiments, initiated on 27th June 2022, different combination of pre and post-emergence herbicides were evaluated as treatments for controlling weeds in DSR. In case of zero tillage wheat and zero tillage greengram, each plot of the DSR (13 m × 5 m) was divided into two equal parts in which one part was treated with herbicide and other part was untreated. Recommended fertilizer doses were applied in rice, wheat and greengram.

Results and Discussion

Effect of Burial Depth of Weed Seeds' on Emergence of Seedlings and Phenology of Echinochloa colona

Emergence of Seedlings of Echinochloa colona

Data in table 1 revealed that 25.2 to 32.2% of the total seeds distributed from 0 to 9 cm soil depth have emerged in which 17.4 to 20.2% during 0 to 10 DAS, 3.2 to 8.6% during 11 to 20 DAS, 2.2 to 3% during 21 to 30 DAS and 0.4 to 2.4% during 31 to 40 DAS. No emergence of weed seedlings was recorded beyond 40 DAS and 9 cm soil depth. 3.4 to 4.6% emergence of weed seedlings from total seeds distributed from 0 to 9 cm soil was recorded beyond 20th day and majority of the seedlings' emergence was contributed from the seeds placed at greater depth of the soil. It was recorded that total emergence of seedlings of *Echinochloa colona* and emergence pattern were varied due to variation of burial depth of the seeds (Figure 1).

Table 1: Effect of burial depth of seeds of *Echinochloa colona* on emergence of its seedlings

Burial depth of seeds (cm)	Emergence (%) of seedlings of *Echinochloa colona*									
	Total emergence		0 to 10 DAS		11-20 DAS		21-30 DAS		31-40 DAS	
	August 2022	September 2022	August 2022	September 2022	August 2022	September 2022	August 2022	September 2022	August 2022	September 2022
0	88	78	80	62	08	14	0	02	0	0
1	46	34	32	28	12	06	02	0	0	0
2	42	30	18	26	24	04	0	0	0	0
3	38	26	22	24	10	02	06	0	0	0
4	38	24	20	12	12	0	06	10	0	02
5	20	20	10	12	08	0	02	04	0	04
6	20	14	08	04	08	04	04	02	0	04
7	18	12	08	02	04	0	02	02	04	08
8	06	08	02	02	0	0	04	02	0	04
9	06	06	02	02	0	02	04	0	0	02
ESTSD	32.2	25.2	20.2	17.4	8.6	3.2	3	2.2	0.4	2.4

ESTSD: Emergence of seedlings (%) from total seeds distributed from 0 to 9 cm soil depth

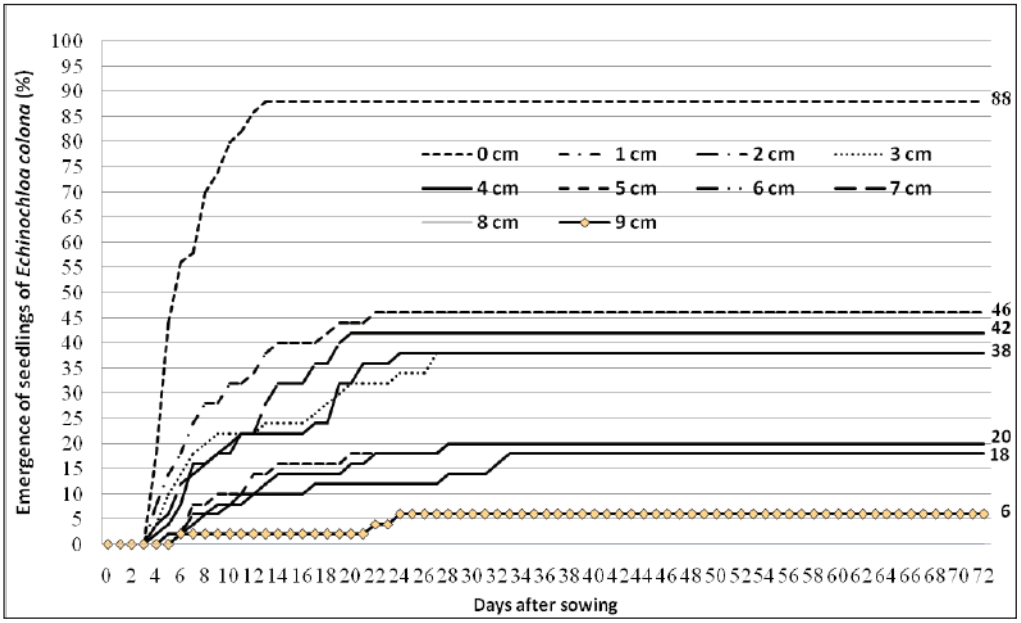

Figure 1: Effect of burial depth of seeds of Echinochloa colona on emergence of its seedlings

Phenology of Echinochloa colona

Phenology is the study of the timing of plant developmental stages in response to environmental factors. There are several factors affecting weed phenology. Seed ecology in terms of seed burial depth affected the reproductive stage of *Echinochloa colona* during the rainy season. *Echinochloa colona* plants initiated first inflorescence from 34 to 40 DAS and complete dropping of seeds from all the inflorescences was recorded within 48 to 59 DAS in case of seedlings emerged from 0 to 7 cm soil depth. However, considerable delay in initiation of inflorescence from 51 to 55 DAS and complete dropping of seeds from all the inflorescences within 72 to 77 DAS were recorded from the *Echinochloa colona* plants emerged from 8 to 9 cm soil depth. Synchronization of inflorescence emergence and shorter duration from initiation of first inflorescence to complete dropping of seeds ranging from 14 to 19 days were recorded from the *Echinochloa colona* plants emerged from 0 to 7 cm soil depth. However, staggered emergence of inflorescence and longer duration from initiation of first inflorescence to complete dropping of seeds ranging from 21 to 22 days were recorded from the *Echinochloa colona* plants' emerged from 8 to 9 cm soil depth (Figure 2).

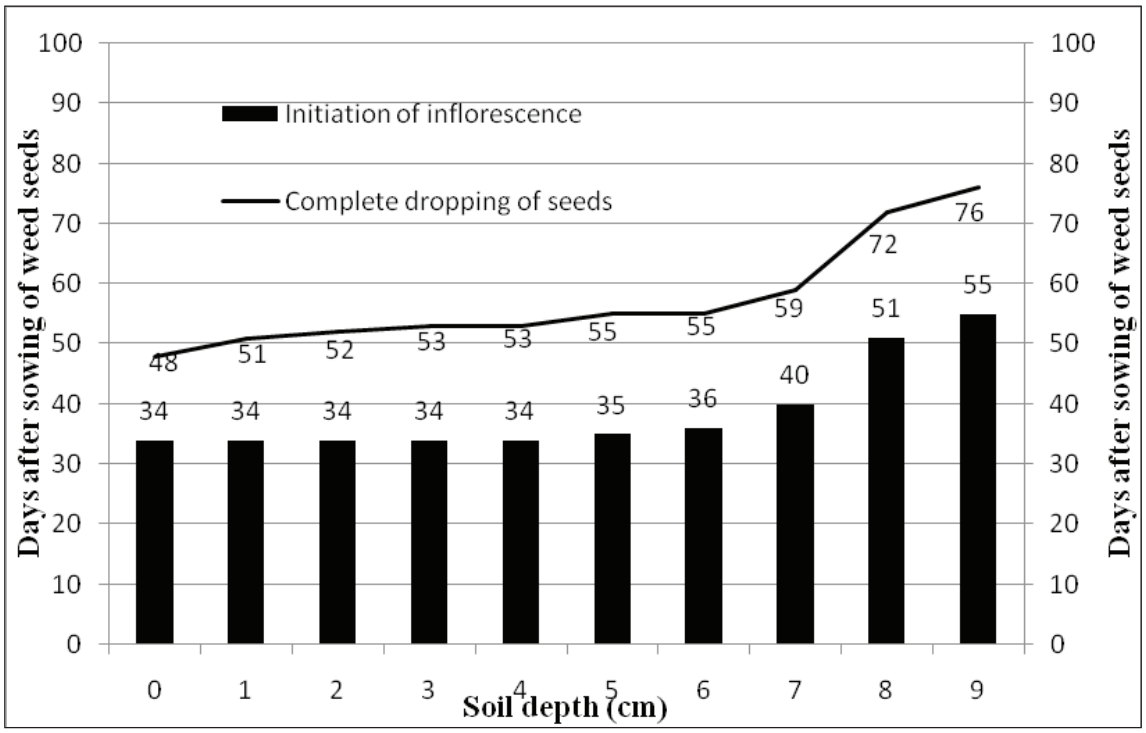

Figure 2: Effect of burial depth of seeds on emergence of inflorescences and complete dropping of seeds of *Echinochloa colona*

Emergence of Echinochloa colona from Green Seeds

Results revealed that complete dropping of seeds from all the inflorescences was recorded within 48 to 59 DAS in case of seedlings emerged from 0 to 7 cm soil depth. Study also revealed that emergence of seedlings of *Echinochloa colona* was recorded from its green seeds dropped from the inflorescences. In this experiment green seeds of *Echinochloa colona* was collected on 19th May 2022 and 23rd August 2022 from mung and rice crop, respectively.

Emergence (%) of seedlings from green seeds was compared with 9 months mature seeds. The results revealed that green seeds of *Echinochloa colona* registered 37 to 41% emergence of seedlings with the emergence of first seedling at 14 DAS, whereas 9 months old matured seeds recorded 90% seedlings' emergence with the emergence of first seedling at 2 DAS (Figure 3).

Leaf Emergence of Echinochloa colona

The results of the experiment revealed that seedling emergence was started at 2 DAS and total numbers of 85 seedlings were emerged from the seeds resided at surface soil. Emergence of 1st leaf, 2nd leaf, 3rd leaf and 4th leaf was started at 3, 7, 13 and 15 DAS or 2, 6, 12 and 14 days after emergence of 1st seedlings, respectively. All the emerged seedlings completed its 1st, 2nd , 3rd and 4th leaf formation at 9, 12, 17 and 22 DAS or 8, 11, 16 and 21 days after emergence of 1st seedlings, respectively (Figure 4). As most of the post-emergence herbicides become effective at 2-3 leaf stage of *Echinochloa colona*; therefore, the results

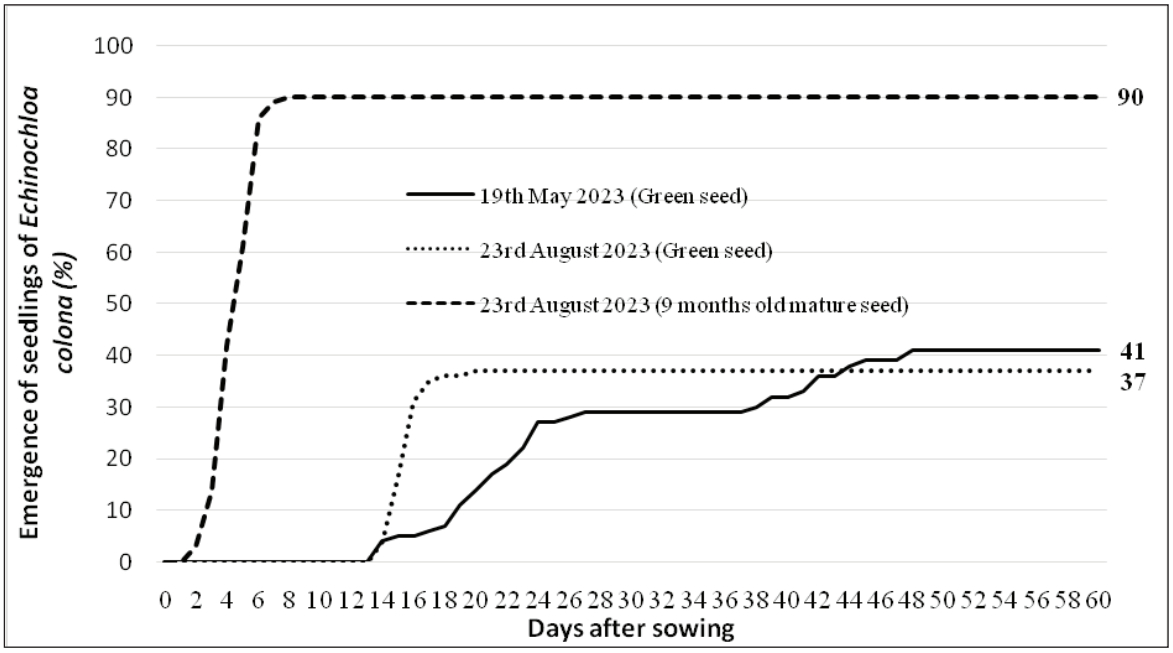

Figure 3: Emergence of *Echinochloa colona* from green and mature seeds resided at surface soil

indicated that the duration from 11 to 14 days after emergence of 1st seedlings could be the appropriate timing for application of post-emergence herbicides to control *Echinochloa colona* effectively.

Seed Production Capacity of Echinochloa colona and Expansion of Its Seasonality

In partially weedy plots (1 HW at 60 DAS) of DSR, *Echinochloa colona* plants contributed the average number of 5415 seeds/m^2 on surface soil at 50 DAS. Seed contribution capacity was varied from 576 to 4675 seeds/m^2 as influenced by different weed management treatments. *Echinochloa colona* started to appear in all the growing season, *i.e.*, summer, rainy and winter season in rice-wheat-greengram cropping system and contributed large number of seeds to the soil seed bank. Expansion of seasonality of *Echinochloa colona* was recorded in untreated plots (without herbicide) of zero tilled wheat and it produced total seeds of 1122/m^2 during the heading stage of wheat. *Echinochloa colona* also appeared and produced 37084 seeds/m^2 in untreated (without herbicide) zero tilled greengram plots during summer season and altogether contributed large number of seeds to the soil seed bank.

Conclusion

Effect of burial depth on germination and emergence of *Echinochloa colona* indicated complete insight of periodicity of germination of the weed. Information generated on seed ecology, phenology, seed rain, distribution of seeds across the soil profile, emergence from green seeds can lead to take decision on timing of adopting weed control measure and to develop targeted weed management strategies. Expansion of seasonality of *Echinochloa colona* beyond rainy season and its seed contribution potential to soil seed-bank are very much important to predict periodicity of *Echinochloa colona*, its temporal weed biomass and future crop-weed competition. Knowledge on biology of *Echinochloa colona* can lead to develop diversified weed management programme and such programme should not exclude the use of herbicides but increase efficiency of herbicides in DSR.

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Value Addition in Vegetables-based Enterprises

T.K. Maity and Tridip Bhattacharjee

College of Agriculture, Tripura, Lembucherra, West Tripura (799 210), India

E-mail: proftkmaity@gmail.com

Vegetables play a major role in Indian agriculture by providing food, nutritional and economic security and more importantly, producing higher returns per unit area and time. In addition, vegetables have higher productivity, shorter maturity cycles, high value and greater income leading to improved livelihoods. Due to the development in production technology in Horticulture, vegetable production in India has now reached the level of 212.53 million tonnes from 11.48 million hectares during 2022-23 witnessing a growth rate of 3.82% in total production over the last two decades. However, being highly perishable, about 25-30% of the total production of vegetables goes to waste from the time of harvesting till they reach the consumers while a large number of vegetables are not available throughout the year because of their seasonal nature of production, warranting the need of their preservation through storage and processing to ensure their availability in the offseason. It is, therefore, necessary to make them available for consumption throughout the year in processed or preserved form and to save a sizeable amount of losses. At present, about 2% of the total produce is processed in India mainly for domestic consumption.

It is a known fact that more than 80% of our farmers are small and marginal with fragmented landholdings. In addition, the woes of the small farmers are far too many. They raise multiple products in small quantities with heavy wastage. Farmer's organizations are either non-existent or disorganized, unlike the unorganized traders, and there is exploitation by commission agents/ traders. Thus, there is an urgency to strengthen the network of post-harvest management and cold-chain infrastructure (grading/ packing centres, pre-cooling units, refrigerated vans, cold storage *etc*.) both in the areas of production and at the retail outlets. Indian farmers get only about 30% share of the payment made by the consumer for their produce. This necessitates value addition to his production to increase the income of the farmers and improve the quality of produce. Through conventional or modern processing techniques, the value of the commodities can be increased by converting them to different products leading to the enhancement of the post-harvest shelf-life of the produce.

The food processing industry ranks fifth in its contribution to value addition but tops the list in terms of employment opportunities with approximately 1.5 million employed consisting of 19% of the total investment in the industrial sector but contributing 18% to the GDP. Employment potential in the post-harvest and value-addition sector is considered to be very high. Every Rs. 1 billion invested in fruits and vegetable processing in the organized sector generates 140 persons per year of employment. The same level of investment in Small Scale Investment (SSI) units creates 1050 persons on the day of employment per year. The SSI unit in the food industry employs 4,80,000 persons, which accounts for 13% of all SSI units employed. Thus, vegetables have great potential for value addition and diversification to give a boost to the food industry, create employment opportunities and give better returns to the farmers.

Keywords: Entrepreneurship, Food processing, Horticulture, Value addition

Agronomic Biofortification of Nano Zinc Oxide in Crop Production

Kalipada Pramanik* and Sk. Naim Aktar

Dept. of Agronomy, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: kalipada.pramanik@visva-bharati.ac.in

Introduction

Biofortification is the process by which the nutrient concentration of food crops is improved through conventional plant breeding, or improved agronomic practices or modern biotechnology without sacrificing any characteristic that is chosen by consumers or most importantly to farmers (Nestel *et al*., 2006). It is documented as a nutrition-sensitive-agriculture intervention that can lessen vitamin and mineral deficiency (Ruel *et al*., 2013). There are several examples biofortification like zinc-biofortification of maize, rice and wheat, iron-biofortification of beans, cowpea and pearl millet and pro-vitamin A carotenoid-biofortification of cassava, maize, rice and sweet potato (Bouis *et al*., 2011; Saltzman *et al*., 2013). Naturally, it was found that biofortified crops are richer in nutrient content than non-biofortified crops. Therefore, assuming similar micronutrients bioavailability (La Frano *et al*., 2014) and its retaining (De Moura *et al*., 2015) after cooking or processing and storage, persons will consume (Muñoz *et al*., 2008) and absorb (Rosado *et al*., 2009) more micronutrients from eating biofortified crops than non-biofortified crops. Among various biofortification techniques, conventional plant breeding takes much time to development of new variety, sophisticated technology is needed for molecular approach, genetically modified crop is not accepted in all countries whereas agronomic biofortification offers advantages in terms of cost, rapid implementation and adaptability, the choice of strategy depends on the specific goals, resources and constraints of a given agricultural context.

Agronomic Biofortification

Agronomic biofortification is a strategy used in agriculture to enhance the nutritional density of crops through agronomic approaches, such as the application of chemical fertilizers through soil or foliar or priming or coating or even through soil amendments. The primary goal is to enhance the levels of essential nutrients, such as vitamins and minerals, in the edible parts of crops to improve their nutritional quality and quantity. While agronomic biofortification can involve various nutrients, it is often used to address deficiencies in micronutrients like zinc, iron *etc*.

Agronomic Biofortification Advantages

❖ *Cost-effective*: Agronomic biofortification can be a cost-effective approachover conventional breeding or molecular approaches. The application of nutrient-enriched compounds, such as fertilizers, is often easier, simpler and more affordable.

❖ *Rapid implementation*: It can be implemented relatively quickly compared to the time-consuming processes of developing and breeding new crop genotypes through conventional methods or molecular techniques.

❖ *Adaptability to existing varieties*: It can be used to existing crop varieties without the need for extensive breeding efforts. This makes it adaptable to local agricultural practices and existing varieties, ensuring faster adoption.

❖ *Flexibility*: It is a flexible technique that can be custom-made to address specific nutrient deficiencies in different regions and crops. It allows for the modification of nutrient levels based on local conditions.

❖ *Addressing immediate nutrient needs*: It provides a quicker solution compared to waiting for the development of biofortified crop varieties in areas where nutrient deficiencies are acute and immediate action is required.

❖ *Minimal regulatory hurdles*: Agronomic biofortification may face fewer regulatory hurdles compared to the release of genetically modified organisms (GMOs) resulting from molecular approaches.

❖ *Low environmental impact*: Compared to certain molecular approaches that involve genetic modifications, agronomic biofortification generally has a lower environmental impact.

Role of Zinc in Crops and Humans

Zinc (Zn), which is regarded as a crucial micronutrient for plants and is considered to be a vital micronutrient for plants. Zn has

a significant role in the biochemistry and metabolism of plants owing to its significance and toxicity for biological systems at specific Zn concentrations, *i.e.*, insufficient or harmful above the optimal range. There are several reasons for zinc deficiency in plant systems such as (a) soils with low zinc content or poor zinc availability particularly in sandy or highly weathered soils (b) soil having high pH (c) high levels of soil phosphorus can create insoluble complexes with zinc, reducing its availability for plant uptake (d) inadequate application of zinc-containing fertilizers or the use of imbalanced fertilizers (e) waterlogged conditions can lead to reduced zinc uptake by plant roots, aggravating zinc deficiency. Zinc plays several crucial roles in plants such as: (a) zinc is a cofactor for many enzymes involved in various metabolic processes, such as photosynthesis, respiration and nitrogen metabolism in plants. This is the only element found across all six enzyme classes *i.e.*, lyases, transferases, hydrolases, isomerases, oxidoreductases and ligases. Zn influences the activity, structural integrity and folding of numerous proteins as a fundamental or catalytic enzyme (Castillo-González *et al*., 2018; Zaheer *et al*., 2020b) (b) zinc is essential for DNA synthesis and cell division, crucial processes for plant growth and development (c) Zn plays a role in the synthesis of proteins, contributing to the overall structure and function of plant tissues (d) it helps plants mitigate with various environmental stresses, including drought, salinity and oxidative stress (e) adequate zinc levels are essential for appropriate root development, enabling plants to efficiently absorb water and nutrients from the soil (f) it is critical for the development of seeds, influencing seed vigor and quality (g) zinc is involved in the activation of defense mechanisms, contributing to the plant's ability to resist diseases (h) it facilitates the uptake and transport of other nutrients, enhancing overall nutrient efficiency in plants.

Zinc deficiency is now recognized as one of the most common micronutrient deficiencies and is becoming increasingly significant in crop production. Zinc deficiency in plants can have significant adverse effects on their growth, development and overall health. Zinc is an essential micronutrient for plants and its absence or insufficient availability in the soil can lead to various physiological and metabolic disruptions. There are some common effects of zinc deficiency in plants:(a) stunted growth due to its crucial role for cell division and elongation and its absence hampers normal growth processes in plants (b) chlorosis due to the disruption of chlorophyll synthesis (c) reduced photosynthesisis due to impair the process of converting sunlight into energy (d) zinc deficiency may cause abnormalities in leaf development, leading to distorted or malformed leaves (e) delayed flowering and fruit development is due to impacting reproductive processes (f) reduced absorption of essential elements like phosphorus and iron (g) disrupt enzyme function, affecting critical biochemical pathways in plants (h) susceptibility to diseases is due the weakened state of the plant makes it more vulnerable to infections (i) zinc-deficient plants may exhibit reduced tolerance to environmental stresses such as drought, salinity and temperature extremes, (j) zinc deficiency may affect seed development and quality, leading to reduced seed germination and vigor.

Zinc essentiality was established in 1869 for plants, in 1934 for experimental animals and in 1961 for humans (King *et al*., 2006). A syndrome of anemia, hypogonadism and dwarfism was reported in a 21-year-old Iranian farmer in 1961 who was subsisting on a diet of unrefined flat bread, potatoes and milk (Prasad *et al.*, 1963). Shortly after, a similar syndrome was observed in Egyptian adolescents who had similar dietary history to that of the Iranians, mainly subsisting on bread and beans (Sandstead *et al.*, 1967). There are several functions of zinc in human nutrition like (a) Zn is crucial for the proper functioning of the immune system and it is involved in the development and activation of immune cells, helping the body defend against infections (b) it is essential for growth and development, particularly during childhood, adolescence and pregnancy (c) it is involved in cell division and the synthesis of proteins and DNA (d) Zn plays a role in cognitive function and brain health and involved in neurotransmitter regulation and may contribute to memory and learning (e) it helps in wound healing and tissue repair (f) it helps in the synthesis of collagen, a key component of skin and connective tissues (g) It is involved in the production of sperm and the development of the fetal brain during pregnancy (h) prevention of diarrhea (i) zinc is involved in the metabolism of carbohydrates, fats and proteins, contributing to overall energy production.

Zinc deficiency in humans is now known to be a significant malnutrition problem world-wide. It is more prevalent in areas of high cereal and low animal food consumption. The diet may not essentially be low in zinc, but its bio-availability plays a major role in its absorption. Phytic acid is the main known inhibitor of zinc absorption. More than 30% world's population is Zn deficient. Here are some key features related to zinc deficiency in humans: (a) inadequate dietary intake of zinc through a diet lacking in zinc (b) poor bioavailability is due to high intake of dietary fiber, phytates (found in grains and legumes) and calcium (c) chronic alcohol consumption can impair zinc absorption and increase urinary zinc excretion, contributing to zinc deficiency (d) aging may reduce absorption of zinc as well as changes in dietary habits.

The normal range for serum zinc levels is typically around 70 to 120 micrograms per deciliter (µg/dL). The Recommended Dietary Allowance (RDA) for zinc for adults is around 11 mg per day for men and 8 mg per day for women. Serum zinc

levels below 70 µg/dL are often considered indicative of zinc deficiency. Symptoms and health effects of zinc deficiency are (a) impair the immune system (b) delayed wound healing (c) growth retardation and developmental issues (d) reduced sense of taste (hypogeusia) and smell (hyposmia) (e) dermatitis and hair loss (f) loss of appetite (anorexia) (g) hormonal imbalance particularly of insulin and sex hormones (h) chronic diarrhea and impair nutrient absorption can occur (i) neurological symptoms, including numbness and tingling.

Mitigation of Zinc Deficiency in Crops and Humans through Agronomic Biofortification

Mitigating zinc deficiency in both crops and humans involves an amalgamation of agronomic, dietary and supplementation approaches. Mitigation of zinc deficiency in crops through application of zinc-containing fertilizers, such as zinc oxide or zinc sulfate or foliar application of zinc solutions directly onto plant leaves or seed priming or coating seeds with zinc-containing compounds before planting helps enhance early plant growth and development. Addition to these adding organic matters to the soil can improve zinc availability, rotating crops with legumes, which have the ability to fix atmospheric nitrogen, can improve soil fertility and zinc availability for subsequent crops.

Mitigating zinc deficiency in humans encompasses various strategies aimed at ensuring a satisfactory intake of zinc, enhancing zinc absorption and addressing factors that contribute to deficiency. Mitigating zinc deficiency in humans through dietary strategies like consume zinc-rich foods *i.e.*, nuts, seeds, legumes and whole grains; dietary diversification and enhance zinc bioavailability through cooking, soaking, fermenting, or sprouting certain plant foods. Another approach through zinc supplementation as well as multivitamin and mineral supplements but these approaches are costlier and it should be done under the guidance of healthcare professionals.

Agronomic Biofortification through Nano Zinc Oxide

Nanotechnology is the most emerging technology in 21st century in the earth, which can lead to a new revolution in field of agricultural science. The first ever concept of Nanotechnology was presented in 1959 by Richard Feynman. Nanotechnology term has been coined by Norio Taniguchi (1974). It has been widely used in the field of plant sciences to explore its potential influences in improving crop yields as well as nutrient contents in biomass. Zinc oxide nanoparticle is the second most abundant metal oxide after iron and it is inexpensive, safe and as well as it can be prepared easily (Kalpana *et al.*, 2018). Nano zinc oxide (nano-ZnO) displays unique features compared to its bulk counterpart due to its nanoscale dimensions (1-100nm). Nano-ZnO particles have a high surface area-to-volume ratio, high reactivity, strong adsorption capacity, slow release of nutrients, target delivery etc. Scientists have different opinions regarding the positive or negative implications of application of nano-ZnO like inhibition of seed germination, reduction in biomass accumulation and chlorophyll content and excessive generation of ROS in plants (Chen *et al*., 2018; Lin and Xing, 2008). On the other hand, application of nano-ZnO at 50 ppm has been reported to improve the seedling growth and reduce the excessive production of ROS whilst adverse impacts on rice seedling growth have been observed at 500 and 1000 ppm concentrations (Singh *et al*., 2018).

The mode of application of nano-ZnO involves soil, foliar and seed treatments (Itroutwar *et al*., 2018). The seed invigoration treatments including seed priming and coating with nano-ZnO are considered comparatively eco-safe and economically judicious (Itroutwar *et al*., 2018). In these approaches low concentration of nano-ZnO adsorption on the surface of the seed coat followed by their penetration and movement through seed tissue layers which significantly improves germination and crop biomass (Neto *et al*., 2020). Therefore, seed priming and coating is a targeted delivery approach to enhance the availability of micronutrients or other elements during the early growth of the plants (Acharya *et al*., 2020).

Research Findings of Agronomic Biofortification Nano-ZnO on Crops

Rice is a staple food for a large portion of the global population, because it is an essential source of energy, vitamins, mineral ingredients and rare amino acids for people consuming rice in daily life especially in developing countries (Yan *et al*., 2021; Phattarakul *et al*., 2012). Therefore, the quality of rice plays an important role in the daily life of individuals who consume rice as their primary food source. However, the Zn content of rice is exceedingly low, at approximately 20 mg kg^{-1} and could not supply the human body's demands that require 40-50 mg kg^{-1}(Cakmak *et al*., 2010; Zeng *et al*., 2009). Zinc deficiency in rice plants can lead to poor grain quality and negatively impact human health. Nano zinc oxide application to rice fields through different methods, including soil application, foliar spray, or seed coating may enhance yield and the uptake of zinc content in rice plants compared to traditional zinc sources. The application of nano-ZnO reported higher rice yield with more panicle

number (4.83-13.14%), spikelets per panicle (4.81-10.69%), 1000-grain weight (3.82-6.62%) and filled grain rate (0.28-2.36%) over control treatment (Zhang *et al*., 2021). The application of nano-zinc fertilizer can increase the Zn content of grains and promote root development, improving rice growth (Yang *et al*., 2021; Ali *et al*., 2019). Compared with the control, the applied nano-ZnO of the basal stage increased the Zn content in rice grain by 20.46-41.09% (Zhang *et al*., 2021).The application of nano ZnO increase zinc content in all parts of the grains, with a prominent enhancement in the edible portions, thereby enhancing the bioavailability of this vital nutrient and also stimulate the activity of proline oxidase, ultimately leading to a considerable increase in 2-acetyl-1-pyrroline (2-AP) content (Wang *et al*., 2023).

Wheat is another energy food and widely used crop, as it is consumed by 50% of the population as a staple diet, because wheat contains dietary fibers, carbohydrates and more vegetable proteins, which are required for human nutrition (Curtis *et al*., 2014). Zinc deficiency can lead to decrease crop yields and lower nutritional quality. The nanoscale properties of zinc oxide are believed to enhance the efficiency of zinc uptake by wheat plants, as nanomaterials often have higher reactivity and bioavailability. Agronomic biofortification aims to increase the zinc content in wheat grains, improving both crop yield and nutritional quality. Nano zinc oxide may enhance the bioavailability of zinc in wheat, ensuring that the nutrient is readily usable by the plant. The application of zinc nano-fertilizer not only significantly increase the growth attributes, yield attributes and grain and stover yield of wheat but also zinc content and uptake in grain and stover (Prajapati *et al*., 2018). The seed priming of wheat varieties with 100 ppm nano-ZnO significantly enhance plant height, number of effective tillers, number grains per spike, number of spikelets per spike, test weight, grain and biological yield than untreated seeds (Ram *et al*., 2023).

Maize is used as a third most important crop, after rice and wheat. It is not only used for human and animal feed, but it is widely used in the corn starch, baby corn and corn oil industries, as well (Shah *et al*., 2016). Maize (*Zea mays* L.), a high nutrient demanding crop, requires balanced nutrition, particularly the requirement for micronutrients such as zinc is substantial (Tariq *et al*., 2014; Hacisalihoglu, 2020). The zinc requirement is demonstrated as high vulnerability of maize to exhibit zinc (Zn) deficiency syndromes and, therefore, maize is considered as a Zn deficiency indicator plant (Mohan *et al*., 2015).An increase in vegetative and yield parameters viz., number of plants, plant height, stover yield, plant biomass, acid detergent fiber (ADF%) and hemicellulose contents and shoot zinc (Zn) content on treatment of seeds with nano-ZnO at 20 mg L^{-1} concentration as compared to bulk $ZnSO_4$ and control treatments (Tondey *et al*., 2021). The application of nano-ZnO increase in root and shoot length, chlorophyll, carotenoid content amylase activity and to alter the antioxidant enzyme composition in plants (Srivastav *et al*., 2021).

Groundnut is often considered the “king of oilseed crops” due to its economic importance and widespread cultivation for oil production. Groundnut seeds are rich in oil, with oil content ranging from 40% to 50% of the total seed weight. This high oil content makes groundnut a valuable source for oil extraction. Zinc deficiency in groundnuts can lead to various symptoms, including stunted growth, interveinal chlorosis, reduced pod development and abnormal leaf development. Application of nano-ZnO at 50 ppm increase yield parameters like number of pods $plant^{-1}$, number of kernels pod^{-1}, seed index, kernel yield and different oil quality parameters like palmitic acid content, linoleic acid content, ecoseonic acid content and lignoceric acid (Molla, 2023).

Chickpea (*Cicer arietinum* L.) is considered an important legume crop widely used for food and fodder globally. It serves not only as a primary source of dietary protein but also considerable amount of carbohydrates (Yegrem, 2021). Micronutrient deficiency of zinc (Zn) is currently a major problem in developing countries due to the use of high-yielding varieties, intensive cropping systems, inadequate supplies of micronutrients and losses of organic matter content caused by erosion and pollution. The nano-fertilizers show more potential in increasing the Zn uptake as compared to the bulk forms, as the single application of nano-fertilizers is equally effective compare to two applications using bulk sources (Dhaliwal *et al*., 2021). These results may be due to the higher translocation of nano-fertilizers as compared to their bulk counterparts (Elemike *et al*., 2019).

Conclusion

Agronomic biofortification offers advantages in terms of cost, quick execution and adaptability, the choice of strategy depends on the specific goals, resources and constraints of a given agricultural context. Agronomic biofortification with nano zinc oxide (nano-ZnO) presents a promising avenue for enhancing zinc levels in crops and addressing micronutrient deficiencies. Nano-ZnO can be utilized as a seed priming or coating or foliar for enhancing crop yields in the future. The proper use of ZnO NPs would also be beneficial in augmenting crop produce quality for human nutrition.

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Can Edible Insect Farming be a Viable and Sustainable Option for Rural Livelihood and Nutritional Security in India?

Badal Bhattacharyya*, Shimantini Borkataki and K. Sindhura Bhairavi

Dept. of Entomology, Assam Agricultural University, Jorhat, Assam (785 013), India

E-mail: badalassam@gmail.com

The exploration of edible insects and entomophagy has become a promising avenue due to the rising cost of animal protein, food and feed insecurity, environmental pressures and increasing population growth. Insects as food have always been an integral part of regular human diet. Insects provide significant nutritional, economic and ecological benefits which makes them budding contributors to food security and livelihoods for the growing world population. Insects form part of traditional diet of at least 2 billion people in more than 100 countries, especially in Africa, Asia and in Latin America. About 255 species of insects are taken as food/ feed by different tribes of India, predominantly among the tribes of North east India. The Northeast India is a distinctive fragment of the Indo-Burma Hotspot which ranks the 6th among the 25 biodiversity hotspots of the world, which accounts for its rich diversity and plethora of insect resources. More than 200 species of insects having food and therapeutic value have already been documented by various workers from this region. Despite of their immense potential as food/ feed, edible insect fauna of this region is not fully explored. Edible insects are mostly harvested from natural habitats and sold in the urban markets as an unorganized sector. Overexploitation and bungling for commercialization impose a threat to the edible insect fauna and some of their vital ecosystem services. Therefore, concerted efforts should be made on scientific ways of conservation of this rich biowealth and their further bioprospecting, complete nutritional profiling, development of economically viable mass rearing techniques, bringing trade and commerce to entomophagy, valorising traditional diets, safety, legal aspects *etc*. so as to harness the potential of this sector for the nutritional and livelihood security.

Keywords: Edible insect, Livelihood security, Protein, Rural livelihood

The Future of Molecular Plant Pathology: Integrating Bioinformatics, Computational Biology and Artificial Intelligence

Sandip Debnath

Dept. of Genetics and Plant Breeding, Institute of Agriculture, Visva-Bharati University, Sriniketan, West Bengal (731 236), India

E-mail: sandip.debnath@visva-bharati.ac.in

Introduction

The future of molecular plant pathology is poised at a transformative crossroads, where the integration of bioinformatics, computational biology and artificial intelligence (AI) promises to revolutionize our understanding and management of plant diseases. This extended abstract outlines the key areas of this integration and its potential impacts.

Keywords: Artificial intelligence, Bioinformatics, Computational biology, Disease prediction, Genomic data, Machine learning, Molecular plant pathology, Sustainable agriculture

Emergence of High-Throughput Technologies in Molecular Plant Pathology

Molecular plant pathology has traditionally relied on lab-based diagnostics and empirical observations. However, the advent of high-throughput sequencing technologies has opened new avenues for pathogen detection and characterization. Genomic and transcriptomic analyses now allow for a deeper understanding of pathogen biology and host-pathogen interactions. These technologies generate massive datasets, necessitating sophisticated computational tools for analysis and interpretation.

Role of Bioinformatics in Plant Pathogenomics

Bioinformatics has become an indispensable tool in molecular plant pathology, facilitating the processing and analysis of large-scale genomic data. By employing various algorithms and databases, bioinformatics helps in identifying novel pathogen strains, understanding genetic variability among pathogens and revealing mechanisms of disease resistance in plants. Additionally, it aids in the annotation of pathogen genomes, thereby enhancing our understanding of pathogen evolution and epidemiology.

Computational Biology: Modeling and Simulation

Computational biology extends beyond data analysis, incorporating mathematical modeling and simulation techniques to predict disease outbreaks and spread. It enables the construction of models that simulate host-pathogen interactions, offering insights into the dynamics of disease progression. These models can also be used to evaluate the effectiveness of disease management strategies and to predict the impact of environmental changes on disease dynamics.

Artificial Intelligence: A Game Changer in Disease Prediction and Management

AI, particularly machine learning and deep learning, has the potential to transform molecular plant pathology. Machine learning algorithms can analyze complex datasets to identify patterns and correlations that are not evident through traditional analyses. For instance, AI can be used to predict disease outbreaks based on environmental data and historical disease incidence. Deep learning, with its ability to handle vast and diverse data types, can be instrumental in image-based diagnostics, enabling the automatic detection of disease symptoms from plant images.

Integrating AI with Genomic and Environmental Data

One of the most exciting prospects is the integration of AI with genomic and environmental data. This approach can lead to the development of predictive models that consider both genetic factors of the pathogen and the plant, as well as environmental conditions. Such models could predict not only the likelihood of disease occurrence but also suggest the most effective management strategies.

Challenges and Future Directions

While the integration of bioinformatics, computational biology and AI offers immense potential, it also poses significant challenges. These include the need for standardized data formats, data sharing protocols and interdisciplinary collaboration. There is also a need for more advanced AI models that can handle the complexity and variability of biological data.

Furthermore, the ethical implications of AI in agriculture, particularly regarding data privacy and the potential for biased decision-making, must be addressed. Ensuring that these technologies are accessible to farmers and plant pathologists, especially in developing countries, is also crucial.

Conclusion

The integration of bioinformatics, computational biology and AI marks a new era in molecular plant pathology. This approach not only enhances our understanding of plant diseases but also paves the way for innovative disease management strategies. The future of molecular plant pathology is thus not just about understanding diseases at the molecular level, but also about harnessing the power of computational and AI tools to predict, prevent and manage plant diseases more effectively. As we advance, it is imperative to navigate the challenges and leverage these technologies for sustainable agriculture and food security.

Study on Carbon Mineralization as Affected by the Different Organic Amendments in an Acid Soil

Saikat Bera[1], B.C. Verma[2*], S.P. Datta[3], S. Saha[2], S.K. Naik[4], D. Mahanta[5] and R.K. Paul[6]

[1]Division of SS&AC, ICAR-IARI, Jharkhand (825 405), India
[2]CRURRS (ICAR-NRRI), Hazaribag, Jharkhand (825 302), India
[3]Division of SS&AC, ICAR-IARI, New Delhi (110 012), India
[4]ICAR-RC-ER, Regional Station Ranchi, Jharkhand (834 010), India
[5]Division of Agronomy, ICAR-IARI, New Delhi (110 012), India
[6]ICAR-IASRI, New Delhi (110 012), India

E-mail: bibhash.ssac@gmail.com

Mineralization of organic amendments is an important process to release the nutrients in soil which is essential for plants, microbes *etc*. Mineralizations of these amendments are also responsible for release of carbon in form of carbon dioxide (CO_2) and are getting a serious concern in relation to climate change. For sustainable development, integrated nutrient management (INM) is recommended to sustain soil and environmental quality as well as to enhance productivity. Mineralization of these organic amendments is a very crucial process in INM as they release nutrients to the soil as well as CO_2 to the environment. Carbon mineralization in soil is governed by different soil and environment factors, hence predicting carbon (C) mineralization is very important for agricultural ecosystem. Several works had been carried out to study the carbon mineralization; however, the information on carbon mineralization from organic amendments and their comparison at different temperatures are not available for the acid soil of Jharkhand. To achieve the objective, an incubation experiment was conducted with five treatments namely, rice residue, FYM, biochar and *Dhaincha* amended soil and soil alone (control). Series of 50.0 g soil were taken in 500 ml conical flasks in which organic amendments were added at the rate of 2.3 g/kg of soil. Nitrogen was added through urea solution at two doses 0 and @ 40 mg/kg. The samples were incubated at two temperatures *viz*., 20 and 30 °C and at field capacity soil moisture for different periods 0, 1, 2, 4 and 8 weeks. Results of incubation experiment indicated that highest carbon mineralization was recorded in rice residue followed by *Dhaincha*, biochar and FYM. Across the treatments and incubation periods, around 28.6 % increase in CO_2 evolution was observed as the temperature was increased from 20 °C to 30 °C, while nitrogen added treatments recorded 9% more CO_2 evolution than treatments without nitrogen addition. It was noticed that the rate of CO_2 release was comparatively slow in the beginning followed by a sharp increase, after that a gradual decline occurred as the time progressed. It was concluded from the study that carbon mineralization would be higher in summer with nitrogen (urea) addition condition as compared to winter season. To maintain the carbon status in soil, FYM and biochar addition can be recommended for this region.

Keywords: Amendments, Carbon, Mineralization, Organic

Chemical Composition and Antifungal Activity of Selected Essential Oils against Toxigenic Fungi Associated with Maize in South-Western Ethiopia

Birhane Atnafu[1,2*], Chemeda Abdeta[1], Fikere Lamessa[1], Abdi Mohammed[3] and Alemayehu Chala[4]

[1]Dept. of Horticulture and Plant Sciences, Jimma University, Jimma, PO Box 378, Ethiopia
[2]Dept. of Plant Sciences, Bule Hora University, Bule Hora, PO Box 144, Ethiopia
[3]School of Plant Sciences, Haramaya University, Dire Dawa, PO Box 103, Ethiopia
[4]School of Plant and Horticulture Sciences, Hawassa University, Hawassa, PO Box 05, Ethiopia

E-mail: birhane.atnafu@gmail.com

Abstract

Maize grains are highly susceptible to toxigenic fungi contamination both in pre- and post-harvest. The problem is more common in developing countries where pre- and post-harvest management is poor. Essential oils are considered as viable alternatives to chemical pesticides in managing insect pests and disease-causing agents including fungal pathogens. The result reports the chemical composition and antifungal activities of essential oils extracted from three aromatic plants *i.e.*, *Thymus vulgaris*, *Coriandrum sativum* and *Cymbopogon martini*, cultivated in Ethiopia. Chemical analysis results revealed the presence of 32 compounds in *Coriandrum sativum* with Hexanedioic acid, bis (2-ethylhexyl) ester (46.9%), 2-Decenal, (E)-(12.6) and linalool (8.3%) being the dominant ones. *Thymus vulgaris* essential oils constitute 25 compounds of which Thymol (34.4%), o-cymene (17.5%) and Gamma-Terpinene (16.8%) are the major components. Twenty-five compounds were detected in *Cymbopogon martinii* of which Geraniol (51.4%), Geranyl acetate (14.5%) and Trans-ß-Ocimene (11.7%) were dominant. The essential oils of the tested plants had very high antifungal activity (up to 100% efficacy) against *Aspergillus flavus*, *Aspergillus niger*, *Fusarium graminearum* and *Fusarium verticillioides* in vitro and on maize grains. The anti-fungal activities of these essential oils were dependent on the major components such as thymol, Hexanedioic acid, bis (2-ethylhexyl) ester and geraniol. The study confirms the potential of these essential oils as bio-fungicides to manage the effects of potentially toxigenic fungi and their toxins consequently.

Keywords: Bioactivity, Bio-pesticides, Efficacy, Fungi, Mycotoxins

Green Wilt Disease of Ginger (*Zingiber officinale* Rose): A Major Threat among the Ginger Growing Farmers of North Bengal

Rakesh Yonzone[1*] and Surajit Khalko[2]

[1]College of Agriculture (Extended Campus), Uttar Banga Krishi Viswavidyalaya, Majhian, Dakshin Dinajpur, West Bengal (733 133), India
[2]Uttar Banga Krishi Viswavidyalaya, Majhian, Dakshin Dinajpur, West Bengal (733 133), India

E-mail: rakesh@ubkv.ac.in

Abstract

Green wilt disease of ginger caused by *Ralstonia solanacearum* is one of the most important pathogens and a serious problem in Kerala and North-Eastern region of the country especially in Sikkim and West Bengal. The study was carried out at the Regional Research Sub-station (Hill Zone), Kalimpong, Uttar Banga Krishi Viswavidyalaya and Department of Plant Pathology, Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal with an objective to estimate the losses caused by the disease, characterise the pathogen and identification of source of resistance/ tolerance. Considering blocks the highest bacterial wilt incidence was recorded on Bijanbari block (46.63%) and lowest disease incidence on Kalimpong II (26.64%) in 2020-21. However, in 2021-22 highest bacterial wilt incidence was recorded on Takdha block (31.92%) and lowest disease incidence on Kalimpong I (15.09%). Based on host range and their ability to utilize disaccharides and sugar alcohols the pathogen were identified as Biovar III and Race IV. The disease caused by the pathogen had significant and positive correlation with Nitrogen (N) content in soil. Screening of major available genotypes for two consecutive years (2020-21 and 2021-22) for determination of resistant/ tolerant lines indicated ACC-587 and GCP-14 as moderately tolerant where as local varieties Gorubathaney, Bhaisey and Nangrey were found highly susceptible.

Keywords: Blocks, Genotypes, Ginger, Incidences, *Ralstonia solanacearum*

Management of Leaf Spots of Marigold Caused by *Alternaria tagetica*

Lydia Vanlaltani[1*] and H. Meronbola Devi[2]

[1]*Dept. of Plant Pathology, School of Crop Protection, College of Post Graduate Studies, CAU (Imphal), Umiam, Meghalaya (793 103), India*

[2]*Dept. of Plant Pathology, SASRD, Nagaland University, Medziphema Campus, Nagaland (797 106), India*

E-mail: lydiafanai06@gmail.com

Abstract

Leaf spot and flower blight of marigold caused by *Alternaria tagetica* is one of the most important diseases. The pathogen *A. tagetica* was isolated and identified according to its morphological characters observed microscopically and the symptoms it caused on marigold plant. To determine the most effective fungicides four fungicides *viz*., Mancozeb 75WP, Copper oxychloride 50WP, Carbendazim 50WP and Saaf 75WP were tested at three different concentrations against *A. tagetica*. Mancozeb at 0.2% showed the maximum mycelial growth inhibition (84.90%) followed by 0.25% and 0.10% with inhibition percent of 83.68% and 82.68% respectively. The systemic fungicide, Saaf at 0.25% was found the second most effective with 80.82% mycelial growth inhibition. Among the three fungal bioagents *viz*., *T. harzianum*, *T. asperellum* and *T. virens*, *T. harzianum* showed the maximum percent mycelial growth inhibition (46.82%) followed by *T. virens* (42.95%), whereas the least percent mycelial growth inhibition (45.41%) was recorded in *T. asperellum*. Eight botanical extracts *viz*., Turmeric, Garlic, Parthenium, Neem, Periwinkle, Bougainvillea, Korpad and Ashoka were tested against *A. tagetica* by poisoned food technique. Among the botanical extracts tested, Garlic cloves (20%) extract recorded the highest percent mycelial growth inhibition (78.25%) followed by 10% with growth inhibition of 73.11%, Turmeric at 10% (61.94%) and Parthenium at 20% (60.99%). The compatibility test of *T. harzianum* with four selected fungicides was conducted and observed *T. harzianum* was compatible with Mancozeb 75WP at 0.1% and Copper Oxychloride 50 WP at 0.1% and 0.2% but incompatible with Carbendazim 50 WP and Saaf 75 WP at all the tested concentrations.

Keywords: *Alternaria tagetica*, Bioagents, Botanicals, Fungicide, Marigold

Major Diseases of *Kharif* Crops Grown in Barmer District of Rajasthan - A Report

Durga Prasad

Dept. of Plant Pathology, College of Agriculture, Baytu, Agriculture University, Jodhpur, Rajasthan (344 034), India

E-mail: dp.coabaytu@gmail.com

Abstract

A survey was conducted to determine the status of major diseases of crops grown in the Barmer district of the *Marwar* region of Rajasthan, India. Five blocks and three villages in each block were surveyed through a random field survey method during the collection of diseased samples every Sunday for the practical classes of agricultural students of the College of Agriculture, Baytu, in the months of August & September, 2023. Percent disease incidence was recorded on randomly selected plants in a particular field of selected location. The incidence of diseases was observed on the basis of typical field symptoms and later the association was confirmed through microscopic examinations in the laboratory. In the *Kharif* season, pearl millet (*Pennisetum glaucum*) is the predominant crop of the Barmer district followed by cluster bean (*Cyamopsis tetragonoloba*) and moth bean (*Vigna aconitifolia*). Sesame (*Sesamum indicum*) and green gram (*Vigna radiata*) are other important *Kharif* oilseed and pulse crops, respectively. In view of maximum disease incidence, yellow mosaic (virus), leaf crinkle/ curl (virus), bacterial leaf spot/ blight (*Xanthomonas phaseoli*) of green gram; green ear/ downy mildew (*Sclerospora graminicola*), rust (*Puccinia substriata*) and blast (*Pyricularia grisea*) of pearl millet; Phytophthora stem blight (*Phytophthora parasitica* var. *sesame*) and phyllody (Phytoplasma) of sesame; yellow mosaic (virus) and bacterial leaf spot/ blight (*Xanthomonas axonopodis* pv. *cyamopsidis*) of cluster bean were recorded with >50% incidence. However, charcoal rot (*Macrophomina phaseolina*), web blight (*Rhizoctonia solani*), Cercospora leaf spot (*Cercospora canescens*) and anthracnose (*Colletotrichum lindemuthianum*) of green gram; Alternaria blight/ leaf spot (*Alternaria sesame*) of sesame,sorghum rust (*Puccinia purpurea*) and Alternaria blight/ leaf spot (*Alternaria cyamopsidis*) of cluster beanwere noticed with 10 to 50% incidence.

Keywords: Green gram, *Kharif*, Moth bean, Pearl millet, Rajasthan, Sesame

Population Fluctuation of Gram Pod Borer in *Rabi* Pulses of West Bengal

Soumita Bera[1*], Sabyasachi Ray[1] and A. Banerjee[2]

[1]Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India
[2]AICRP on MULLaRP, Directorate of Research, BCKV, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: soumitabera98@gmail.com

Abstract

Rabi pulses contribute more than 60% of the total pulse production. Among the various constraints, main biotic stresses that hinder pulse productivity include various insect pests. A research study has been conducted at District Seed Farm (AB Block) of BCKV located at Kalyani, Nadia, West Bengal during the *Rabi* season of 2021-22 to study the incidence pattern of gram pod borer (*Helicoverpa armigera*) in relation to prevailing weather parameters and to record the population fluctuation in four *Rabi* pulse crops *viz*., chickpea (var. KWR 108 and JAKI 9218), field pea (var. Rachna and VL 42), lentil (var. IPL 220 and L 4727) and grass pea (var. Prateek and Ratan). The larval population of *Helicoverpa* on field pea first appeared during vegetative stage then gradually increased and declined near maturity; in lentil and grass pea it was recorded from flowering stage and continued up to maturity; in chickpea it was observed from pod formation stage and continued up to maturity. All the weather parameters exhibited non-significant correlation with the larval population of *Helicoverpa* recorded on field pea and lentil while, regression studies denote that maximum and minimum temperature exhibited the most influence on the population density of *Helicoverpa* in grass pea and chickpea, respectively. From the comparative study it was found that *Helicoverpa* first appeared on lentil and field pea during first week of January and the population arrived on grass pea on last week of January. The pest was recorded during January to February on lentil, field pea and grass pea and after that the population shifted to grass pea, field pea and chickpea during February to March. Chickpea was the most preferred crop as the highest population observed on this crop coinciding with pod formation stage.

Keywords: Chickpea, Gram pod borer, *Helicoverpa armigera*, Pulses, Rabi

Diversity of Storage Pathogen Responsible for the Short Shelf Life of *Citrus* spp.

Devanushi Dutta[1,2*] and Pranab Dutta[2]

[1]Assam Agricultural University, Jorhat, Assam (785 013), India
[2]College of Post Graduate Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya (793 103), India

E-mail: devanushid@yahoo.com

Abstract

Post-harvest pathogens can cause a significant loss of the produce during storage, handling, processing, or transporting by changing the biochemical properties of fruits and vegetables. In order to get an idea of post-harvest decay pathogens affecting the quality of citrus fruit, a survey was conducted during 2023 to *Suhkhoi* and *Umiam* of Ri bhoi district of Meghalaya, and collected the fully ripened fruits with diseased symptoms of *Citrus reticulata*, *C. sinensis* and *C. limon* in poly bags and critically studied its symptom of the affected fruit at Plant Pathology laboratory, CPGS-AS, Umiam, Meghalaya before further processing. The infected samples were surface sterilized with 2% sodium hypochlorite (NaOCl) and cultured in PDA plates and incubated at 25±2 °C. Based on the cultural and morphological characteristics, the isolated pathogens were identified as *Aspergillus niger*, *Aspergillus flavus*, three species of *Penicillium* spp., *Mucor* spp., two species of *Fusarium* spp. and *Geotrichum* spp. Amongst the pathogens isolated so far, *Penicillium* species were identified as the most dominating pathogen over the rest of the pathogens. To inhibit the growth of post-harvest decay pathogens, gluconate stabilized silver nanocoating of fruits can be a promising option by creating nanometer-thick ultra-thin layers onto the surface of coated materials in nanoscale that may seal the pores of the skin to reduce gas exchange or moisture loss or may penetrate the cell membrane, and bind to the cellular organelle of the pathogen like DNA, RNA, protein, or lipid hampering their normal pathway and ultimately resulting in microbial cell death. With these mechanisms, gluconate-stabilized silver nanoparticles may pave the way to be used as a coating material to delay microbial growth and prolong the storage life of fruit.

Keywords: *Aspergillus*, Gluconate, Nanocoating, *Penicillium*, Shelf life

Potential of Wild Tomato Extracts for the Management of H. armigera

Tanjil Rahman[1*], Anjumoni Devee[2] and Pranab Dutta[1]

[1]*School of Crop Protection, College of Post-Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam, Meghalaya (793 103), India*
[2]*Dept. of Entomology, Assam Agricultural University, Jorhat, Assam (785 013), India*

E-mail: tanjilrahman6766@gmail.com

Abstract

Both laboratory and field experiments were conducted to study the potential of wild tomato extracts against *H. armigera*. *Solanum pimpinellifolium*, a wild relative of the cultivated tomato has been reported to possess insecticidal and acaricidal properties. Therefore, methanolic and aqueous extracts of *S. pimpinellifolium* was evaluated for the management of *H. armigera* during 2020-2021. In respect of LC_{50} values based on 72 hrs and 96 hrs exposure, the order of toxicity against *H. armigera* were recorded as wild tomato methanolic extract > wild tomato aqueous extract > neem leaf extract. During the field studies, 15 days after second spray of treatments showed that the percent fruit damage was found to be minimum in wild tomato methanolic extract (10%) (12.94%), followed by wild tomato aqueous extract (10%) (17.65%), wild tomato aqueous extract (5%) (18.03%), neem leaf aqueous extract (5%) (19.36%), wild tomato methanolic extract (5%) (20.27%), wild tomato aqueous extract (3%) (23.61%) and wild tomato methanolic extract (3%) (28.70%).

Keywords: Aqueous extract, *H. armigera*, LC_{50}, Methanolic extract, Wild tomato

Combating Pearl Millet Maladies: Unveiling Disease Resistance Mechanisms for Sustainable Agriculture

Harshit Singh[1*], Pranab Dutta[2], Madhusmita Mahanta[1] and Lydia Vanlaltani[1]

[1]*School of Crop Protection, CPGS-AS, CAU (Imphal), Umiam, Meghalaya (793 103), India*
[2]*College of Post Graduate Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya (793 103), India*

E-mail: harshitsingh11122@gmail.com

Abstract

Pearl millet (*Pennisetum glaucum*) is a widely cultivated millet variety, historically grown in Africa and the Indian subcontinent. It is well-suited for regions with drought, low soil fertility, low moisture and high temperatures and can thrive in saline or acidic soils. The nutritional profile of pearl millet includes phenolic compounds known for their antioxidant and anti-inflammatory properties, which can help reduce oxidative stress and inflammation, contributing to overall health improvement. However, pearl millet cultivation faces challenges from various biotic and abiotic stresses, with blast disease being a major threat caused by fungal pathogens affecting different millet varieties. A comprehensive assessment in India using GPS technology identified the presence of downy mildew (DM) disease in pearl millet crops across 34 evaluated villages, with varying incidence rates. Genomics research in pearl millet has advanced with the availability of draft genomes, aiding breeding programs to develop resistant lines against DM. Fungal pathogens employ secreted effectors to manipulate transcription, defense signaling and metabolic processes in host plants, promoting resistance against biotic stress. The effector protein 35,983 g from *Sclerospora graminicola* emerges as a potential biomarker for screening downy mildew-resistant pearl millet lines globally. Furthermore, the pearl millet-associated microbiome consists of rhizospheric, phyllospheric and endophytic microbial communities, which play vital roles in plant health, nutrient uptake, pathogen protection and drought and disease tolerance. In summary, pearl millet stands as a resilient crop with significant nutritional value and the potential to combat challenges posed by diseases like Downy mildew, Blast, Rust, Smut and Powdery mildew (PM). Advances in genomics, effector proteins and understanding the plant microbiome contribute to the development of resistant varieties and enhance the cultivation and utilization of pearl millet in diverse agricultural settings.

Keywords: Abiotic stresses, Defense signalling, Disease tolerance, Effector protien, Pearl millet, *Sclerospora graminicola*

Efficacy of Fungal Endophytes of Tea Ecosystem for the Management of Blister Blight

Ritika Raj*, Madhusmita Mahanta, Pritam Das, Rajni Raj and Pranab Dutta

School of Crop Protection, CPGS-AS, Umiam, Meghalaya (793 103), India

E-mail: ritikaraj0201@gmail.com

Abstract

Tea is the widely used non alcoholic beverages around the world, contributing major role in strengthening the economy of country and making India the 2nd largest tea producing country in the world. *Exobasidium vexans* an obligate parasite causing blister blight disease in tea has serious implications on quality of tea production. The disease occurs severely in areas having high rainfall, relative humidity and low temperature. The pathogen targets the economic part of tea plant that is tender shoots, and chemicals are indiscriminately used to manage this menace. Moreover, there are no reports of biological control of the disease caused by *E. vexans*. To fulfill this research gap, a study was conducted to explore the fungal endophytes of three different tea ecosystems of north eastern region of India and evaluated against the pathogen. The *in vitro* study indicated that amongst different endophytes, *Trichoderma* spp. was found very promising in suppressing the growth of pathogen with percent inhibition of 60-70%. Study on the mode of action revealed that *Trichoderma* parasitized *E. vexans* by coiling around its hypha followed by penetration, which ultimately leads to leakage of cell contents and finally disintegration of hyphal cells. Moreover, hyphal breakage of pathogen was also observed which could be due to the toxic metabolites released by *Trichoderma*. This study indicates that there are scopes of *Trichoderma* in management of blister blight of tea, however, there is need to conduct field experiment to validate this research finding.

Keywords: Blister blight, Endophytes, *Exobasidium vexans*, Tea, *Trichoderma* spp.

Diversity of *Fusarium* spp. in North-East India and Its Integrated Management with Homeopathic Medicines and Biocontrol Agents

Pritam Das*, Madhusmita Mahanta, Ritika Raj, Rajni Raj and Pranab Dutta

School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya (793 103), India

E-mail: pritampar@gmail.com

Abstract

Tea [*Camellia sinensis* (L.) O. Kuntze] is one of the second most consumed beverages in the world. India is the second largest producer of tea and one of the world's largest consumers of tea. Among several fungal diseases such as root rots, leaf spots and stem canker *etc*., the dieback disease caused by *Fusarium solani* is considered as one of the most economically important foliar diseases of this crop responsible for huge crop losses up to 50-60%. Laboratory and field experiments was conducted where samples were collected from the different locations of NE India *viz*., Assam, Meghalaya and Arunachal Pradesh to find out the diversity of *Fusarium* spp. in tea ecosystem. Isolation was done from the infected samples and cultural and morphological characterization was performed in the laboratory of SCP, CPGS-AS, Umiam. *In vitro* efficacy of biocontrol agents such as *Trichoderma reesei¸ Metarhizium robertsii*, *Beauveria bassiana*, *etc*. was done with the isolated *Fusarium* spp. and *T. reesei* was found to have percent inhibition of the pathogen, this was followed by *M. robertsii*. Under field condition the application of homeopathic medicines such as *Arnica montana*, *Arsenicum album* along with UmTricho (a *Trichoderma harzianum* based liquid bioformulation) was done at an interval of 30 days and observations was made after the treatments and result till date is encouraging in suppressing the disease incidence and enhancing plant growth.

Keywords: Biocontrol agents, *Fusarium solani*, Homeopathic medicines, UmTricho

Efficacy of Gluconate Stabilized Silver (Ag) and Gold (Au) Nanoparticles on Wilt of Tomato Caused by *Ralstonia solanacearum* Smith.

Rajni Raj*, Madhusmita Mahanta, Ritika Raj, Pritam Das and Pranab Dutta

College of Post Graduate Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya (793 103), India

E-mail: rajnicau3112@gmail.com

Abstract

The tomato, *Solanum lycopersicum* L. is one of the most economically and nutritionally significant vegetable crops worldwide. However, the crop is affected by numerous biotic and abiotic stresses that pose obstacles to realizing its full production potential. The most devastating disease of tomato is bacterial wilt (BW) caused by *Ralstonia solanacearum* which occur in hot and humid areas. Control of bacterial wilt is difficult, because the pathogen is soil-borne and has a wide host range. So, there is the need to establish resistance against this pathogen through nanotechnology. The infected tomato leaf samples were collected from Pehbah district of East Khasi Hills, Meghalaya**,** India. Ooze test was conducted for the confirmation of pathogen. Isolations were performed on triphenyl tetrazolium salt (TTC) medium. Pink colonies with white periphery form after incubation for 48 hours at 28 °C on TTC medium. Pathogens were found positive for gram staining, KOH test, Kovacs oxidase test, Catalase test and Simmon's citrate agar test. *In-vivo* efficacy of gluconate stabilized Ag (silver) and Au (gold) nanoparticles (NPs), AgNPs, AuNPs, CuNPs against the pathogen was studied using agar well method and disc diffusion method at 100 percent concentration and eleven different concentrations. AgNPs at concentration 100% at pH 7 was found to be best among all the treated concentration.

Keywords: Agar well method, Disc diffusion method, Nanoparticles (NPs), Nanotechnology, Triphenyl tetrazolium salt (TTC)

Diversity of Native Parasitoid Complex Affecting Fall Armyworm (*Spotoptera frugiperda*) in West Bengal and Bihar, India

Subhajit Pal[1*], Swarnali Bhattacharya[1], Tapamay Dhar[2] and Gangavarapu Nikhitha[3]

[1]*Dept. of Agricultural Entomology, Institute of Agriculture, PSB, Visva-Bharati University, Sriniketan, Bolpur, West Bengal (731 236), India*

[2]*Regional Research Sub Station (Old Alluvial Zone), Uttar Banga Krishi Viswavidyalaya, Mathurapur, Malda, West Bengal (732 203), India*

[3]*University of Nebraska-Lincoln, Lincoln, NE (68583-0816), USA*

E-mail: subhajitpal23623@gmail.com

Abstract

Spodoptera frugiperda, also known as Fall Armyworm (FAW), is a highly polyphagous pest that has caused significant damage to maize crops around the world. Since its first detection in India in 2018, FAW has spread rapidly to all major maize-producing states. This has led to increased reliance on synthetic insecticides, which can have negative consequences for human health and the environment. To explore the potential of native natural enemies to help control FAW in India, a field survey was conducted in ten districts of West Bengal and Bihar during the rabi and summer seasons of 2021-2022. FAW egg masses and larvae were collected from both sprayed and unsprayed fields. The survey revealed a high diversity of native parasitoids attacking FAW, with ten hymenopteran species identified. The most abundant parasitoid species were *Microplitis manilae* (a larval parasitoid) and *Telenomus remus* (an eggparasitoid). Parasitism rates were significantly higher in unsprayed fields compared to sprayed fields. This suggests that synthetic insecticides can disrupt the natural biological control of FAW. Our findings indicate that native natural enemies have the potential to play a significant role in the management of FAW in India. This knowledge can be used to develop sustainable and cost-effective agro-ecological management strategies that integrate the use of natural enemies with other methods.

Keywords: Cost-effective, Fall armyworm, Hymenopteran species, Sustainable

Umtricho (*Trichoderma harzianum*): A Feasible Organo-Biocontrol Agent for Pea Cultivation

Punabati Heisnam[1*], Abhinash Moirangthem[1], Golmei Langangmeilu[2] and Pranab Dutta[3]

[1]*College of Agriculture, Central Agricultural University, Iroisemba, Imphal, Manipur (795 004), India*
[2]*Dept. of Agronomy, College of Agriculture, IGKV, Raipur, Chhattisgarh (492 012), India*
[3]*College of Post-Graduate Studies in Agricultural Sciences, CAU, Umiam, Meghalaya (793 103), India*

E-mail: anuheisnam@gmail.com

Abstract

A field experiment was conducted to study the effect of feasible use of *Trichoderma harzianum* based bioformulation *UmTricho* on the pea (*var*. Makhyat Mubi) under College of Horticulture and Forestry, Central Agricultural University, Pasighat region of Arunachal Pradesh during 2021. The experiment includes seven different treatment combinations of *Trichoderma harzianum* based bioformulation *UmTricho*, *i.e.*, T_1: Control; T_2: Seed Treatment at 10 ml L^{-1} of water; T_3: Soil application at 1 kg enriched compost m^{-2}, T_4: Foliar application at 10 ml L^{-1} of water, T_5: T_2+T_3, T_6: T_2+T_4 and T_7: T_2+T_3+T_4. All the treatments were replicated thrice and arranged in randomized block design. Observation of seed germinations, plant growth parameters and disease incidence were recorded. Results reveal that the treatment T_7 recorded highest seed germination (%), plant growth parameters (plant height, number of branches, *etc*.), yield attributing characters and yield of the crops which is found to be at par with T_5. A recorded of 20 days early flowering in all treated plot as compared to control. Studies focused on the efficacy of biocontrol agents at natural field condition through evaluation and demonstration leads to maximum productivity of pea. Disease incidence like damping off, wilt and rust were also found to be lowest in T_7 followed by T_5, T_3 and T_4 respectively. The seed treated at 10 ml L^{-1} of water along with soil application at 1 kg enriched compost and foliar application at 10 g L^{-1} of water found most effective to reducing the incidence with enhanced seed germination (%), plant growth parameters.

Keywords: Disease incidence, Foliar application, Pea, Seed and soil treatment, *Trichoderma harzianum*, UmTricho

Effect of Bioactive Metabolites of Native Strain of *Trichoderma harzianum* for Management of Major Foliar Diseases of Maize in Meghalaya

Madhusmita Mahanta*, Pranab Dutta, Ritika Raj, Pritam Das, Rajni Raj and Harshit Singh

School of Crop Protection, College of PG Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya (793 103), India

E-mail: madhusmita.mahanta12@gmail.com

Abstract

Trichoderma is a versatile ascomycetes fungus with lucrative biocontrol potential with having plant growth promoting activity. To understand their biocontrol abilities, an isolate of *T. harzianum* (*Th*) native to Meghalaya was evaluated *in vitro* against two major pathogens of maize, *viz*., *Rhizoctonia solani* and *Exserohilum turcicum* with significant inhibitory effect. The bioactive metabolite of *T. harzianum* was isolated, characterized and evaluated against the targeted pathogens. A field experiment was conducted for two seasons against Banded leaf and sheath blight and *Exserohilum* leaf blight with eight treatment combinations of bioactive metabolite of *T. harzianum*. The results revealed a decrease in percent disease incidence and severity with enhanced plant growth parameters and yield attributing parameters. A positive effect on total soil organic carbon percentage and total microbial populations as compared to the control was also observed during the experimentation. The results are indicative of the antifungal activities and PGP abilities of the bioactive metabolite of *T. harzianum*. The findings of the experiments may be useful as an effective way of managing the targeted diseases of maize.

Keywords: Disease management, Foliar disease, Maize, Metabolite, *Trichoderma harzianum*

Exploring the Antifungal Potential of Botanicals against Alternaria Leaf Blight of Radish and its Phytochemical Profiling by GC-MS Analysis

Sudharshan Keralapura Ramachandra*, Ranjan Kumar, T. Rajesh and Pranab Dutta

School of Crop Protection, College of PG Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya (793 103), India

E-mail: sudharshankr1996@gmail.com

Abstract

Vegetables of Cruciferous family hold global significance, face a severe threat from Alternaria blight, a pervasive and highly damaging disease causing black spots and blight on leaves in field conditions, resulting in reduced yield and seed quality. The present study aims to conduct a comprehensive investigation, including a survey of disease prevalence, isolation of the pathogen, extraction of botanicals, and the assessment of their efficacy through *in vitro* and *in vivo* studies in radish, along with the identification of components in the most effective botanicals using GC-MS. In the survey, an average Disease Incidence of 41.2% and a Percent Disease Index of 18.9% were observed within the three districts of Meghalaya. Molecular characterization of the isolated pathogen revealed 100% similarity to *Alternaria burnsii* using the neighbor-joining method in MEGAX software. Out of fifty weed species screened at a 10% concentration against the pathogen, *Hemidesmus indicus*, *Lippia alba*, *Chromolaena odorata* and *Solanum violaceum* exhibited the highest mycelial inhibition. In further *in vitro* evaluations of these four botanicals at different concentrations (2.5%, 5.0%, 7.5%, 10.0% and 12.5%) revelled that at 12.5% plant extract of *H. indicus* and *L. alba* exhibited most effective, inhibition of 82.96% and 76.60%, respectively, followed by *C. odorata* (71.93%) and *S. violaceum* (63.53%). Based to promising *in vitro* results, these botanicals were assessed in pot experiments. Among the four botanicals, highest percent disease reduction was observed in *H. indicus* and *L. alba* of 69.79% and 60.44%, respectively at 12.5% concentration. Eventually all four botanicals effectively reduced disease incidence and index while increasing radish yield.

Keywords: Alternaria blight, Cruciferous, Botanicals, GC-MS, Radish

Pathogenic Mycoflora Associated with Farmers' Saved Paddy Seed from the Archaeological Places of Assam

Devanushi Dutta[1*], Pranab Dutta[1] and Prakash Borah[2]

[1]School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya (793 103), India

[2]AICRP on Seed, Assam Agricultural University, Jorhat, Assam, (785 013), India

E-mail: devanushid@yahoo.com

Abstract

The world's largest river island - Majuli and the pyramid of Assam – Charaideo, are the two historically important places that preserve indigenous local rice varieties by cultivating since long back and used to store the harvested seed with traditionally made structures. Seeds being the basic planting material, the study of the seed health of those indigenous local cultivars are an important aspect. To understand the pathogen infestation of stored seeds a survey was conducted during 2020-21 and 2021-22 and collected a sum total of hundred three (103) seed samples comprising thirty-four (34) different varieties from five (5) different divisions of Majuli and hundred two (102) seed sample comprising of twenty-eight (28) different varieties from four (4) different block of Charaideo district of Assam were collected for further processing. Seed germination percent, moisture content as well as the frequency of pathogen-associated was evaluated by blotter method as per the ISTA protocol in the seed pathology laboratory at Assam Agricultural University, Jorhat, Assam. Germination percent was recorded to be 31 to 88% with percent moisture varying from 11.2-14.9%. NaOH test @ 0.2% was found to be negative for bunt-infected seed. Pathogens responsible for seed discoloration were recorded to be *Aspergillus* spp., *Penicillium* spp., *Curvularia* spp., *Fusarium* spp., *Alternaria* spp. and *Drechslera oryzae* with the highest frequency of 22% by *Drechslera oryzae*. Improper storage conditions lead to a higher moisture content that favors pathogen development in seed. There is an urgent need for an awareness program among the farmers about the moisture-proof proper storage condition of paddy seed to reduce pathogen infestation and for better seed viability.

Keywords: Blotter test, ISTA, Mycoflora, Seed germination, Storage structure

Influence of Host Plants on Spodoptera litura: A Comparative Analysis of Preference, Food Consumption and Utilization

Nikhitha Gangavarapu[1*], Swarnali Bhattacharya[2] and Subhajit Pal[2]

[1]*University of Nebraska-Lincoln, Lincoln, NE (68583-0816), USA*
[2]*Visva-Bharati University, Santiniketan, Birbhum, West Bengal (731 235), India*

E-mail: nikhithachowdhary888@gmail.com

Abstract

An experiment was conducted at the PG Laboratory of Department of Agricultural Entomology, PSB, Visva-Bharati to evaluate the effect of five different host plants, *viz*., castor, cabbage, brinjal, red gram and mustard, on the host preference, food consumption and utilization, of *Spodoptera litura* at 25±2 °C and 70±5% RH. For each of the five treatments twenty larvae were taken as replications. Tender leaves of test plants were collected every day and measured amount of it was fed to larvae after cleaning and drying the leaves. The weight of the individual larva, faecal pellet and leftover feed were recorded every day. The study revealed notable variations in development of *S. litura* on different host plants. Castor was the most supportive for the highest larval weight gain (0.78 g), while red gram showed the least larval weight gain (0.23 g). High consumption was recorded on brinjal during early instars and cabbage during late instars. Castor favoured the early instars with respect to relative growth rate (RGR) (0.504 g g^{-1} bd wt day^{-1}), while red gram supported maximum RGR (0.04 g g^{-1} bd wt day^{-1}) during late instars. Early instars of castor exhibited high approximate digestibility (AD) 99.39%, but mustard had the highest AD (96.62%) during late instars. Brinjal had the least efficiency of conversion index (ECI) (5.29%) and efficiency conversion of digested food ECD (5.48%), suggesting potential toxicity inhibiting larval development. Cabbage had the highest ECI (29.7%) and castor exhibited the highest ECD (29.63%). From these studies, it was concluded that Castor proved to be the best host for laboratory purposes, whereas brinjal was the least preferred possibly due to potentially toxic compounds in the host plants inhibiting the larval development.

Keywords: Food consumption, Host plants, *Spodoptera litura*, Utilization

Effect of Bioformulations against Root-Knot caused by *Meloidogyne incognita* in the Management of Okra

Angshuman Hazarika* and D. Das

Dept. of Nematology, Assam Agricultural University, Jorhat, Assam (785 013), India

E-mail: angshuman.hazarika.amj21@aau.ac.in

Abstract

An experiment was carried out during *Kharif* 2022 in the Net House of Department of Nematology, AAU, Jorhat-13 to evaluate the efficacy of five AAU developed bioformulations *viz.*, Bio-Veer, Bio-Monas, Biofor-Pf2, Biogreen and AAU Bioguard against *Meloidogyne incognita* in okra under Net house condition. 2000 cc capacity pots were filled with sterilized pot mixture of soil: sand : clay @ 2:1:1. Bioformulations were applied in the pots as per the treatments *viz.*, T_1: Bio-Veer @ 20 g kg^{-1} soil; T_2: Bio-Monas @ 20 g kg^{-1} soil; T_3: Biofor- Pf2 @ 20 g kg^{-1} soil; T_4: Biogreen @ 20 g kg^{-1} soil; T_5: AAU Bioguard @ 20 g kg^{-1} soil one week prior to sowing the seeds. One untreated control was kept for comparison. Three to four leaved okra seedlings were inoculated with freshly hatched second stage juvenile of *M. incognita* 1 J_2 g^{-1} of soil. The experiment was terminated at 60 days after sowing. It was revealed that all the AAU developed bio-formulations significantly increased the growth of okra and reduced the nematode infestation. However, Biogreen exhibited the best result in increasing the plant growth parameters and reducing the nematode infestation, followed by and Biofor-Pf2.

Keywords: Bioformularions, Okra, *Meloidogyne incognita*, Root knot nematode

Evaluation of Cucumber Genotypes in Relation to Morpho-Chemical Traits to Identify Tolerant Types against Prevailing Coleopteran Pest Population under Gangetic Alluvial Plain of West Bengal, India

Ayan Das[1*], Arup Chattopadhyay[2] and Sudarshan Chakraborti[1]

[1]Dept. of Agricultural Entomology, [2]Dept. of Vegetable Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal (741 252), India

E-mail: ayandasvb@gmail.com

Abstract

A field experiment was conducted to evaluate cucumber germplasms in relation to morpho-chemical traits to identify tolerant types against the coleopteran infestation under gangetic alluvial zone of West Bengal, India. The experimental findings revealed that some of the tested local genotypes namely Priya, Baropata and IC 538137 have shown comparative higher tolerance towards major coleopteran pest populations, whereas Chollish Sha sasa, Sheetal, IC410658A and have appeared to be more susceptible. Further we have studied a population dynamics of pest population under twelve staggered sowing under two experimental seasons where a significant correlation was established against prevailing temperature (maximum and minimum), relative humidity and rainfall. The regression analysis revealed a significant contribution between 85.00-97.00% due to the prevailing meteorological determinants; meanwhile the staggered sowing revealed a higher pest load and infestation during the summer-kharif sowing months and significantly low during the winter (November) sowing. The morpho-chemical parameters like leaf thickness, phosphorus, potassium, silica, micronutrients, *viz*., Ca, Bo, Mg, Zn, tannin, flavonoids, phenol, ash content and enzyme activity had played a major role towards herbivore resistance. From principal component (PC) analysis it was revealed that first PC was responsible for a mean variation around 60.00-90.00% which can be easily explained with first five plant factors. The tolerant germplasms can be further be evaluated under the future pest-resistance breeding programmes.

Keywords: Beetle population, Cucumber, Morpho-chemical traits, PCA, Tolerance

Incorporation of Fenugreek for Enhancing Entomophages towards Increasing Pest Suppression and Resultant Yield Attributes under Mustard Cropping System

Ayan Das[1*], Gyaneswari Bindhani[2] and Sudarshan Chakraborti[1]

[1]Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal (741 252), India
[2]Dept of Agriculture & Farmers' Empowerment, Govt of Odisha, Odisha, India

E-mail: ayandasvb@gmail.com

Abstract

A study was conducted to assess the impact of the incorporation of fenugreek as a companion crop on the incidence and damage of the pests on mustard under lower gangetic alluvial zone of West Bengal; where growing fenugreek as a companion crop along with mustard produced a significant impact on the incidence and damage caused by the major insect pests on mustard, which was recorded similar level of incidence and damage in both the cropping sets. Higher population of aphid, DBM, sawfly and leaf webbers were recorded under the solo cropping set as compared to the companion cropping set and this led to higher level of damage on the main crop, mustard. It was presumed that the lower incidence and damage of aphid, diamond back moth, leaf webber and saw fly in mustard due to allelochemicals released by fenugreek grown as companion crop. In other words, fenugreek acted as a repellent crop for mustard pests, simultaneously suppressing their population build-up and subsequent damage. Further, it may be considered that the fenugreek as a better option as a companion crop of mustard, which provides a safer option for integrating with a rational pest management strategy. Field validation studies may confirm its level of effectiveness.

Keywords: Companion crop, Fenugreek, Insect-pests, Mustard

Impact of Agrochemicals on the Activity of Soil Micro-Fauna in Pomegranate Ecosystem

Ramesh M. Maradi[1*] and S.B. Jagginavar[2]

[1]Dept. of Agricultural Entomology, College of Agriculture, UAS, Dharwad, Karnataka (586 005), India
[2]Dept. of Agricultural Entomology, College of Agriculture, Vijayapur, Karnataka (586 122), India

E-mail: maradiramesh2011@gmail.com

Abstract

India is a global agricultural powerhouse and it is a central pillar of the Indian economy, employing 60% of the nation's workforce. Fertility of the soil is governed by its texture and diversified fauna present in the soil medium. Various agricultural inputs are applied with the eventual aim to achieve the highest productivity whereas hazardous effects on soil microorganisms are often ignored. Pesticides are noxious chemicals used to mitigate crop losses and are used to safeguard the crops against various threatening pests, which include insects, nematodes, mites and rodent, *etc*. The continuous use of herbicides indirectly reduces the associated arthropod communities. Insecticides cause toxic effects on most of the lower soil invertebrates and cause negative impact on their growth and development and alter the trophic structure in their habitats. Build up of synthetic pesticides in the soil cause many sublethal effects on the existing natural fauna and affects their survival. However, pesticides help in diminishing the quantitative losses caused by pests and enhance the agricultural productivity, but consequently the cost of enhanced productivity is compensated by the Earth's ecosystems. This study provides insight into the effects of pesticides on the soil micro fauna in pomegranate ecosystem.

Keywords: Pesticides, Pomegranate, Soil, Soil micro-arthropods

Evaluation of Some New Generation Insecticides against Chilli Thrips, Scirtothrips dorsalis Hood (Thysanoptera: Thripidae)

Ritwik Pal*, Laltu Mandal and Palash Mondal

Dept. of Agricultural Entomology, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: ento.rp.vb@gmail.com

Abstract

The laboratory-based bioassay was conducted under controlled conditions (25±2 °C and 75±5% r.h.) in the department of Agricultural Entomology, Palli Siksha Bhavana, Visva-Bharati, Sriniketan against chilli thrips, *Scirtothrips dorsalis* Hood, using eleven different insecticides at varied concentrations - recommended field dose, half and one-fourth of the recommended doses. Each treatment involved thirty thrips (one week old), with ten thrips replication^{-1}, subject to spraying with insecticides or water (as a control) using a Potter's tower. Observations for thrips mortality were recorded at various time intervals over 72 h. The findings revealed that certain insecticides achieved complete mortality at 6 h, while others showed delayed effects. Mortality statistics were corrected using Abbott's method and Probit analysis was employed to estimate LC_{50} and LT_{50} values of different insecticides. Among these, lambda-cyhalothrin exhibited the lowest LC_{50} value (7.60 ppm), followed by thiamethoxam, dinotefuran, imidacloprid, diafenthiuron, and profenofos. Interestingly, some insecticides displayed an increase in toxicity over time, indicated by a decrease in their LC_{50} values at later hours compared to 6 h. The toxicity enhancement ratios for imidacloprid, lambda-cyhalothrin, thiamethoxam, dinotefuran, diafenthiuron, and profenofos were 1.78, 1.79, 1.87, 2.12, 1.12 and 2.19 folds, respectively. Additionally, at recommended doses, the LT_{50} values were notably lower compared to doses at half or one-fourth recommendation. Broflanilide exhibited the shortest LT_{50} value (0.504 h), followed by spinosad, fipronil, spirotetramat, tolfenpyrad, diafenthiuron, lambda cyhalothrin, imidacloprid, thiamethoxam, dinotefuran and profenofos. These findings offer valuable insights for developing combined insecticide strategies to manage thrips resistance - a significant concern in protecting chilli crops from the substantial threat posed by this noxious pest.

Keywords: Chilli thrips, Insecticides, Median lethal concentration, Probit analysis

Host Reaction of Some Local Tomato Varieties against Root Knot Nematode, Meloidogyne incognita (Kofoid and White) Chitwood

Shanowly Mondal (Ghosh)*, Bibek Singh Sardar, Amit Gope, Niranjan Mandi and Gautam Chakraborty

Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya , Mohanpur, Nadia, West Bengal (741 252), India

E-mail: shanowly@gmail.com

Abstract

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops grown throughout the world. As compared to developed countries, the yield hectare^{-1} is still low in India due to various factors including the infestation of tomato by root-knot nematodes. For managing these nematodes use of resistant varieties is most practical because of the reduced cost of production and safety to environment and compatibility with other methods. An experiment was conducted for assessing the response of some local tomato varieties against Root-knot nematode, *Meloidogyne incognita* race 2 in earthen pots kept under net house conditions at the Directorate of Research, Bidhan Chandra KrishiViswavidyalaya, Kalyani, Nadia, West Bengal, during Rabi 2021-22. Inoculation of the second stage juveniles (J_2) of *Meloidogyne incognita* collected from pure culture was done at 15 days after sowing of seeds @ 1000 J_2 pot^{-1}. At 45 days after inoculation, whole plants were uprooted, washed and ranked for root galling on the basis of root-knot index (1-5 scales). The observations on shoot length, root length, fresh root weight, dry root weight, fresh shoot weight, dry shoot weight, root knot index (0-5 scale), egg masses plant^{-1} were taken. Out of thirty five varieties only four (Abhimanyu, HY- Rocky, HY- 1276 and HY-Red Boar) were found to be moderately resistant to the nematode having root gall index between 2.1 to 3.0. Twenty one varieties were found to be susceptible having root gall index between 3.1 to 4.0, while rest of the varieties were highly susceptible to the nematode having root gall index between 4.1 to 5.0. It was also found that tomato variety Amlan and HY-3682 (Special) had the largest gall infestation compared with the other varieties. All the varieties showed great variations in their responses or reactions to root-knot nematodes from moderately resistant to susceptible.

Keywords: Gall index, Resistant, Root knot nematode, Susceptible, Tomato, Varieties

Studies on Host Preference of Pulse Beetle, *Callosobruchus chinensis* (L.) on Different Pulses

N. Mandi* and S. Mondal (Ghosh)

Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: nirumandi.ento@gmail.com

Abstract

The laboratory experiment was conducted to study the host preference of pulse beetle, *Callosobruchus chinensis* (L.) on different seven pulses, *viz*., Chickpea (*Cicer arietinum* L.), Kabuli Chana (*Cicer kabulinum*), Pigeon pea (*Cajanus cajan* L.), Green gram (*Vigna radiata*), Cowpea (*Vigna unguicultata*), Black gram (*Lens culinaris*) and Soybean (*Glycine max*) at Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia during 2022 and 2023. Among tested hosts except soybean the significant shortest development period was recorded in green gram and chickpea with 28.17 and 29.17 days while the longest 33.17 days was recorded on pigeon pea. There is no development occur in soybean because there was no emergence of grub from eggs. The adult emergence, percent seed damage and percent seed weight loss were highest (85.56%, 92.00% and 49.29%) on chickpea and green gram (83.33%, 91.33% and 48.49%) and lowest on black gram (16.11%, 30.67% and 9.43%). The maximum fecundity (77.00) and minimum ovipositional period (6.06 days) was recorded in green gram and minimum fecundity (38.67) on soybean and maximum ovipositional period (7.72 days) on pigeon pea. However, the preference of different pulses to pulse beetle on the basis of adults per cent adult emergence, percent seed damage and seed weight loss in descending order was Chickpea > green gram > cowpea > kabuli chana > pigeon pea and black gram, respectively.

Keywords: Adult emergence, Developmental period, Fecundity, Pulse beetle, Seed damage, Weight loss

Comparative Analysis of *Rhizoctonia solani* Isolates across Multiple Culture Media for Growth Variability Exploration

Yerakam Durga and Srabani Debnath*

Dept. of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: srabanidebnath72@gmail.com

Abstract

Maize (*Zea mays* L.) is the 3rd major cereal crop in India after rice and wheat and is affected by number of biotic stresses of which banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* is very much important. Symptoms manifest on 40-45 days old plants, showing water-soaked, straw-colored lesions on leaves and sheaths, potentially leading to the presence of sclerotia on both sheaths and tassels. Magnitude of grain loss may reach to 100% when the ear rot phase of the disease predominates. The brown shades in the mycelium, dolipore septa, right angle branching of hyphae and constriction of branch hyphae at the point of origin are distinguishing characters of the pathogen. For finding out successful strategies of this disease management a thorough study of the pathogen was done. The causal fungus of BLSB - *Rhizoctonia solani* was collected from four different locations, *viz*., Charjadubati (isolate *R.s*-01), Simulgachi (isolate *R.s*-02), Mathurapur (isolate *R.s*-03) and Kalyani (isolate *R.s*-04) areas of Nadia district in West Bengal and their rate of mycelial growth was studied on eight different types of media, *viz*., Potato Dextrose Agar (PDA), ½ Potato Dextrose Agar (½ PDA) , Corn Meal Agar (CMA), Czapek's Dox Agar (CDA), Chickpea Agar (CPA), Rice Starch Agar (RSA), Barley Starch Agar (BSA), Wheat Starch Agar (WSA) under in-vitro conditions. BSA and WSA gained full growth (9 cm) at day 3 for all the three isolates followed by CDA and CMA that showed full growth on day 4. ½ PDA proved as best for KY isolate as it gained full growth on day 3. CDA proved as best media for SG and KY with full growth on day 3 and CMA proved as best media for KY with full growth on day 3. Of all the four isolates KY has shown excellent growth in all the 8 media with full growth in all 7 media and growth of 8.27 cm in case of PDA on day 3.

Keywords: Banded leaf, Isolates, Media, *Rhizoctonia solani*, Sclerotia, Sheath blight

Combinatorial Application of Cuminaldehyde and Tobramycin: A Promising Strategy to Combat Biofilm Mediated Threats of Methicillin Resistant, *Staphylococcus aureus* (MRSA)

Ritwik Roy and Prosun Tribedi*

Dept. of Biotechnology, The Neotia University, South 24 Paraganas, West Bengal (743 368), India

E-mail: tribedi.prosun@gmail.com

Abstract

Methicillin-resistant *Staphylococcus aureus* (MRSA) is an opportunistic organism that, infect humans with a number of acute and chronic diseases by developing biofilm. However, biofilm embedded MRSA cells frequently exhibited high drug tolerance potential, constitutes an unavoidable threat towards public health. Combinatorial methods, which combine two or more antimicrobial agents to target diverse modes of action, offer the potential to overcome antibiotic resistance and reduce MRSA biofilm linked threats. The efficiency of a combinatorial strategy employing cuminaldehyde, a bioactive phytochemical, in combination with the aminoglycoside antibiotictobramycin against clinical isolates of MRSA was investigated in this study. Cuminaldehyde and tobramycin were subsequently discovered to have a strong antimicrobial effect, against the clinical MRSA isolates. The Fractional Inhibitory concentration (FIC) index of cuminaldehyde and tobramycin against those clinical isolates of MRSA was found to be < 0.5, according to the checkerboard assay, indicating a strong synergism between them. Cuminaldehyde and tobramycin at sub-MIC doses alone did not exhibit any such antibiofilm activity, but their combination may have an impact on the development of MRSA biofilm architecture. In relation to managing the MRSA biofilm, it was shown that cuminaldehyde and tobramycin might prevent biofilm development more effectively when used together than when used individually ($p=0.01$). Further observations revealed that the synergism between cuminaldehyde and tobramycin may accumulate reactive oxygen species (ROS) to inhibit the development of microbial biofilm city. As a consequence, the findings revealed that cuminaldehyde in combination with tobramycin might be used for the effective control of MRSA biofilm threats in clinical levels as well.

Keywords: Cuminaldehyde, MRSA, Patient derived sample, Synergism, Tobramycin

Synergistic Effect of Cuminaldehyde and Tetracycline towards Effective Management of the Biofilm Threat of *Pseudomonas aeruginosa*: A Study of Combinatorial Application

Moumita Malik and Prosun Tribedi*

Dept. of Biotechnology, The Neotia University, South 24 Paraganas, West Bengal (743 368), India

E-mail: tribedi.prosun@gmail.com

Abstract

Pseudomonas aeruginosa is a major Gram-negative human pathogen that causes several biofilm-linked infections in the human host. Microbial biofilm often promotes pathogenicity by either exhibiting drug tolerance or releasing several virulence factors. In this study, we explore the combinatorial approaches for the effective management of the biofilm. In this regard, a natural compound (cuminaldehyde) and an antibiotic (tetracycline) have been tested alone as well as in combination against the biofilm profile of *Pseudomonas aeruginosa.* Our experimental observation suggested that both the compounds could explore synergistic interaction against the test organism as the fractional inhibitory concentration index (FIC=0.43) was found to be lesser than 0.5. Furthermore, the sub-MIC doses of cuminaldehyde (30 µg mL^{-1}) and tetracycline (0.01 µg mL^{-1}) were able to inhibit the biofilm formation as well as disintegrate the pre-existing biofilm of *Pseudomonas aeruginosa*. Moreover, several experimental observations suggested that the compounds in combination could promote the accumulation of reactive oxygen species (ROS) by 2 folds than their single application. Besides, the membrane permeability of the test organism also got increased by 2 folds when applied on the test organism. Furthermore, the combination of cuminaldehyde and tetracycline showed efficient reduction in the virulence factors from the test organism. In this study, the sub-MIC doses of both cuminaldehyde and tetracycline did not exhibit any kind of antimicrobial activity against *Pseudomonas aeruginosa* while showing antibiofilm activity. Towards this direction, the combinatorial approach may be considered as a promising option for the management of the *Pseudomonas* biofilm linked infections.

Keywords: Membrane permeability, *Pseudomonas aeruginosa*, Reactive oxygen species (ROS), Synergistic interaction

Inhibition of Mixed Biofilm Formation by Piperine: A Potential Solution for Co-culture Infections with *Staphylococcus aureus* and *Pseudomonas aeruginosa*

Sharmistha Das and Prosun Tribedi*

Dept. of Biotechnology, The Neotia University, South 24 Paraganas, West Bengal (743 368), India

E-mail: tribedi.prosun@gmail.com

Abstract

Piperine has been identified as a potential antibiofilm agent against both Gram-positive *Staphylococcus aureus* and Gram-negative *Pseudomonas aeruginosa*. Mixed infections of these organisms could pose a serious threat to human health. Therefore, the current investigation focuses on assessing biofilm managing properties of piperine, a natural phytochemical, when confronted with a co-culture of *S. aureus* and *P. aeruginosa*. Various experiments, including cross streak assays, metabolic fingerprinting as well as Crystal violet assay, electron microscopic image analysis revealed the coexistence and proficient biofilm-forming capacity of these bacteria under in-vitro laboratory condition, respectively. Notably, piperine was observed to hinder the biofilm formation of the mixed culture without impacting microbial growth. Piperine was found to promote the accumulation of reactive oxygen species and enhancement of membrane permeability in co-cultured cells resulted in the efficient attenuation of microbial biofilm formation. Additionally, piperine exhibited the ability to disintegrate pre-existing biofilms in the co-culture by reducing extracellular DNA content within the biofilm matrix. In conclusion, piperine emerges as a promising candidate for addressing biofilm-associated infections involving the co-culture of *S. aureus* and *P. aeruginosa*.

Keywords: Antibiofilm, Co-culture, Co-existence, Piperine, *Pseudomonas aeruginosa*, *Staphylococcus aureus*

Influence of Different Sowing Dates on the Prevalence of Major Pests Affecting Blackgram in the Gangetic Alluvial Region of West Bengal

A. Banerjee[1] and Sabyasachi Ray[2*]

1AICRP on MULLaRP, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India
2Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: sabyasachiray1997@gmail.com

Abstract

Black gram (*Vigna mungo* L. Hepper) holds significant significance among various pulse crops cultivated in India due to its ability to yield good seed with high protein content while requiring minimal external inputs, thus contributing to enhance soil fertility. Notably, flower thrips (*Megalurothrips* sp.) and spotted pod borer (*Maruca vitrata* Fabr.) pose substantial threats to the crop among various sucking and borer pests, respectively. The field experiment was conducted over two consecutive summer seasons in 2019 and 2020. The Blackgram variety PU 31 was sown on three different dates, with ten days apart specifically, on the 14th of March, 24th of March and 3rd of April each year, representing early, medium and late sown crops. Incidences of flower thrips and pod borer were assessed by recording the total thrips on ten randomly selected flowers and counting pod borer larvae on five randomly selected plants. In the second year, comparatively fewer instances of both pests were recorded than in the first year. Generally, late-sown crops exhibited fewer incidences of flower thrips, while the opposite was observed for pod borer, with higher incidences in late-sown crops. Given that early and late-sown crops attract more thrips and pod borers, respectively, it is recommended to sow black gram during the last week of March, especially in the lower Gangetic plains of West Bengal.

Keywords: Blackgram, Date of Sowing, Incidence, Spotted pod borer, Thrips

Assessment of Yield Loss due to Turcicum Leaf Blight Disease of Maize in West Bengal

Srabani Debnath, Ayan Pramanik* and Sonali Biswas

All India Co-ordinated Research Project on Maize, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal (741 252), India

E-mail: ayanp7877@gmail.com

Abstract

Maize is the most versatile cereal crop in respect of adaptability, types and uses and also known as the “Queen of Cereals” for its highest yield potential. This unique cereal has diversified uses as food, feed and industrial purposes. This is the third most important cereal crop in India and presently the second most important cereal in West Bengal. Biotic stresses are major constraints of yield loss of this important crop. In West Bengal leaf blight diseases mainly Maydis leaf blight and Turcicum leaf blight are predominant. Global scenario is expressing a yield loss of 16% due to attack of plant pathogens and the ultimate objective of all types of research under plant diseases is to minimize the yield loss of crops which is not only dependent on disease severity but also on weather factors & virulence level of the pathogens. The relationship between disease and yield loss in certain pathogen-host system is liable to change from year to year and very much difficult to predict at regional as well as farmer’s level. For determining proper management strategies for diseases, estimation of yield loss is inevitable. Field experiments were conducted in District Seed Farm at Kalyani with susceptible maize hybrid, Kaveri 50 during 2021 and 2022 during *Kharif* season. The trials were laid out in paired plot technique with two treatments replicated ten times under artificial epiphytotic conditions. The fungicide Azoxystrobin 18.2 w/w + Difenoconazole 11.4% was sprayed in protected treatment for five times at weekly interval from 35 days after sowing and after initiation of first disease symptom. In protected plots there was more yield compared to unprotected plots. Mean avoidable percent yield loss was 17.68 and 16.45 respectively during 2021 and 2022 and average yield loss percentage is 17.06 due to Turcicum leaf blight disease of maize.

Keywords: Artificial epiphytotic condition, Biotic stress, Susceptible, Yield loss

Biotic Stress Avengers: Predators and Parasitoids as Eco-Friendly Solutions for Sustainable Agriculture

Kaushik Kumar Das[1*], Subrata Goswami[2] and Swarnali Bhattacharya[3]

[1]Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal (731 236), India
[2]Dept. of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India
[3]Dept. of Agricultural Entomology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: kaushikkumardas2000@gmail.com

Abstract

Global agriculture is seriously threatened by insect pests, which cause enormous yield losses and financial setbacks. Although traditional pesticides have been used extensively to manage these pests, concerns have been raised about their negative impact on the environment as well as human health. As a result, the adoption of biological control practices has gained momentum in recent years. Predatory insects and parasitoids emerge as indispensable allies in the relentless battle against plant biotic stress, wielding nature's prowess in the intricate dance of ecological balance. The dynamic roles played by these arthropod fighters in the comprehensive management of plant-affecting pests are examined here. Emphasizing the importance of these biocontrol agents in integrated pest management (IPM) strategies, we explore their potential to curtail the reliance on chemical interventions, thus mitigating environmental risks. Furthermore, it addresses the intricacies of deploying these beneficial organisms in diverse agricultural settings, considering factors such as crop type, geographical location, and ecosystem dynamics. The synthesis presented here not only highlights the promise of these "biotic stress avengers" in bolstering sustainable agriculture but also underscores their role in fostering a harmonious coexistence between cultivation and the natural world. The abstract concludes by presumably highlighting the significance of comprehending and maximizing the interactions between these beneficial organisms and their hosts or prey in order to increase their efficacy in controlling pests, and eventually, support a more adaptable and ecologically balanced agricultural system.

Keywords: Biological control, Biotic stress, Natural enemies, Sustainable Agriculture

Effects of Feeding of Myrothecium Leaf Spot Infected Mulberry Leaves on the Commercial Characters of Silkworm

S. Monir[*] and M.K. Biswas

Dept. of Plant Pathology, Palli Siksha Bhavana, Sriniketan, University of Visva-Bharati, Santiniketan, West Bengal (731 236), India

E-mail: sirajmonir007@gmail.com

Abstract

Incidence of diseases in mulberry is one of the major problems for successful sericulture in India of *Myrothecium* leaf spot caused by *Myrothecium roridium*, is very common disease in West Bengal. An attempt was made to find out effects of feeding of *Myrothecium* leaf spot infected leaves of mulberry on the quality and quantity of cocoon and silk quality. Larvae were feed with different graded of *Myrothecium* leaf spot infected leaves and their effects were measured with rearing parameters (larval duration, length, weight, single cocoon weight, single shell weight, shell ratio, ERR wt., ERR no. and mortality). It was observed that the total larval duration was increased by 2 more days due to the feeding of different graded infected leaves in comparison to 21 days in control. The highest larval weight (3.14 g) was recorded with control and lowest silk worm larvae weight 1.39 g with the feeding of Grade -IV infected mulberry leaves. While none of the silkworms survived till 5th instar when Grade-V leaves were used for feeding. Maximum average larval length (5.377 cm) was noticed in control and smaller size (2.26 cm average) was found in grade-IV infected leaves feed larvae. Similar trends with other parameters were also observed between feeding of healthy and different grades of infected leaves. It was 2.323 g to 0.653 g for single cocoon weight; 0.55 g and 0.068 g for single shell weight; 23.27% and 10.39% for shell ratio percentage; 21.27 kg and 1.510 kg for ERR wt. and for ERR no 9733.33 and 1533.33 with control and Grade-IV infected leaves respectively. The mortality percentage of was found maximum in Grade-IV feed larvae (84.66%) while it was minimum 2.667% among healthy leaf feed larvae. The reduction in quality and yield of larvae was proportional to the level of disease severity.

Keywords: *Bombyx mori*, Crop loss, Mortality, *Morus* spp., *Myrothecium* leaf spot, Sericulture

Arms Race of Melanogenic Actinobacteria *Actinoalloteichus cyano griseus* against Mulberry Root Rot Pathogens

Saratha M.[1*] and Angappan K.[2]

[1]Research Extension Centre, Central Silk Board, Gobichettipalayam, Erode, Tamil Nadu (638 476), India
[2]Dept. of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (641 003), India

E-mail: sarathaam@gmail.com

Abstract

Mulberry (*Morus indica* L.), is an astounding multipurpose woody, deciduous crop grown all over the world. Due to pathogens that cause root rot diseases in mulberry have a major impact on intensive crop cultivation and commercial cocoon production. Notably, it has been found that these pathogens affect healthy mulberry plantations regardless of their age, variety that grown in wide-ranging soil and agro-climatic conditions. To manage the pathogens, two potent melanogenic actinobacteria *Actinoalloteichus cyano griseus* isolated from mulberry rhizosphere with few extremophilic characteristics were identified in the previous study. Their antagonism towards these pathogens exhibited through a variety of phenomena. The chemical fingerprints of bioactive isolates revealed the presence of more than 30 compounds for each. Advantageously, smaller molecules were found to be the majority of them. Important bioactive inhibitory compounds including, 2,4-DTBP, binapacryl, decanoic acid groups, 1-hydroxy-6-methylphenazine, *etc*. were identified through GC-MS. In addition to evidence of antifungal metabolites there were also found traces of anti-bacterials, allelopathic compounds with other antioxidants and flavonoid compounds. The current work thus sheds light on the antifungal potency of melanogenic isolates, which has been unexplored/ poorly analyzed.

Keywords: Anti-fungal metabolites, GC-MS, Melanogenic actinobacteria, Mulberry root rot

Effect of Enhanced Cannibalism of *Spodoptera frugiperda* on Fitness Cost Analysis

Sahana M.[1*], C.P. Mallapur[1], Saleemali Kannihalli[1], Rakshitha T.N.[2], Dileepkumar N.T.[2], Ramesh Maradi[1] and Ashwini A.[1]

1Dept. of Entomology, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka (580 005), India
2Dept. of Entomology, College of Agriculture, GKVK, University of Agricultural Sciences, Bengaluru, Karnataka (560 065), India

E-mail: sahana881996@gmail.com

Abstract

Cannibalism is the process of killing and consumption of conspecifics (individuals of a same species) which is a taxonomically widespread behaviour in phytophagous insects, mostly in lepidopteran species. Cannibalism in fall armyworm, *Spodoptera frugiperda* (J.E. Smith) accounts for 40-60% mortality in laboratory culture. It may confer direct or indirect fitness benefits, in the form of survival, developmental rate or fecundity. Exploitation of cannibalism behaviour in pest management through application of sugar solution, molasses, neem oil and *Metarhizium rileyi* at different concentrations may provide information regarding whether spraying of these materials on maize affect the feeding behaviour which may induce enhanced cannibalism among *S. frugiperda* larvae. The maximum reduction in pupal weight (46.89% and 45.73%) over control was revealed among 2nd instar larvae fed on maize leaves treated with neem oil 10% (123.97 mg) and neem oil 5% (126.67 mg). Following this, the treatment involving molasses 10% (131.10 mg) recorded 43.83% reduction over control (no cannibalism). The subsequent treatment was sugar solution 10% (41.83%). Negative effect of cannibalism on the pupal weight was noticed. Use of neem oil and molasses helps in enhancement of cannibalism among early instar larvae of fall armyworm which further led to reduced pupal weight. Hence, these substances can be used effectively in IPM as they are cost effective and ecofriendly.

Keywords: Cannibalism, Cost analysis, Insect, Lepidopteran species, *Spodoptera frugiperda*

Nisin, an Antimicrobial Peptide Exerts ROS Mediated Anti-Biofilm Action: A Canonical Approach to Control the Threats Linked with MRSA

Sarita Sarkar* and Ritwik Roy

Dept. of Biotechnology, The Neotia University, South 24 Paraganas, West Bengal (743 368), India

E-mail: sarita_sarkar@yahoo.in

Abstract

Naturally microorganisms can exist in two different forms, either as planktonic form or as biofilm form. Biofilm cells are embedded inside the self-produced Extracellular Polymeric Substances (EPS), which can increase the pathogenicity of the bacteria by protecting them from being destroyed by several external treatments. Methicillin Resistant *Staphylococcus aureus* (MRSA), an opportunistic pathogen, cause several chronic and acute infections in human by developing biofilm. However, the microorganisms associated with biofilm often show drug-tolerance and pose a severe threat to public-healthcare. To this end, one antimicrobial peptide, namely nisin was used for the efficient management of biofilms of MRSA. The minimum inhibitory concentration (MIC) of nisin was found to be 150 µg mL^{-1} against MRSA. The sub-MIC dose of nisin (0, 10, 20, 30, 40 and 50 µg mL^{-1}) did not show any antimicrobial effect rather the same could affect biofilm formation of MRSA. In connection to manage the methicillin resistant Staphylococcal biofilm, nisin could effectively inhibit biofilm formation ($p<0.01$). Further investigation revealed that the effect of nisin could generate reactive oxygen species (ROS) that resulted in the increase in membrane permeability of the cell leading to the efficient inhibition of microbial biofilm formation. Apart from this, selected sub-MIC dosage of nisin also showed significant biofilm disintegration of the test organisms ($p<0.01$). Hence, the results suggested that antimicrobial peptides like nisin could be applied for the efficient management of Staphylococcal biofilm challenges.

Keywords: Biofilm, MRSA, Nisin, ROS

Exploring the Rich Biodiversity of the Eastern Himalayas

Puppala Sri Saranya[1*], Shimantini Borkataki[2], Sourav Sen[3] and Balaga Mohan Ganesh[4]

[1]*Polytechnic of Agriculture, Garikapadu, ANGRAU, Andhra Pradesh (521 175), India*
[2]*Dept. of Entomology, Assam Agricultural University, Jorhat, Assam (785 013), India*
[3]*Dept. of Agril. Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India*
[4]*SKYCAS, SSR Puram, Srikakulam, ANGRAU, Andhra Pradesh (532 403), India*

E-mail: puppala.srisaranya@gmail.com

Abstract

The Eastern Himalayas, located at the junction of two inter-continental plates, served as a decisive factor in the high rankings of biodiversity and endemism that compassed from both regions. This region is also the meeting point of three bio geographical realms videlicet, the Indo-Malayan, the Palaearctic and the Sino-Japanese realms, bearing 9 out of 10 world's loftiest peaks and appertained as "Third Pole". The Eastern Himalayan (EH) region, enwrapping 5,24,190 sq. km area, mounts the loftiest peak Mount Everest that stands out as globally important and extends from Central Nepal's Koshi Valley to northwest Yunnan in China, including southeast Tibet, Bhutan, parts of India (Sikkim, Darjeeling Hills of West Bengal and Northeast India) and northern Myanmar. The highlands are exceptionally rich in biodiversity, high endemism and have 163 globally threatened species, including the densest population of Bengal tigers, three largest herbivores: Asian elephant, greatest one-horned rhinoceros and wild water buffalo. The Eastern Himalayas are defined as crisis eco-regions, biodiversity hotspots, endemic bird areas, Cradle of flowering plants, mega diversity countries and included in Global 200 eco-regions. The region is also an ecotourism hotspot, serving as a gateway from the overpopulated axes of Asia where rich biodiversity of the highlands can be researched. However, the Eastern Himalayas hide the real extent related to the biodiversity with extraordinary new species continuing to be discovered time- on- time of that particular region.

Keywords: Biodiversity, Eastern Himalayas, Hotspot, Threatened species

A Study of Mulberry Diseases Management Behaviour of Bivoltine Sericulture Farmers in Tamil Nadu

Arasakumar, E.[1*], Vasanth, V.[2], Swathiga, G.[2], Nandhakumar, R.[2] and Moulidharshan, R.[2]

[1]Regional Sericultural Research Station, Sahaspur, Dehradun, Uttarakhand (248 197), India
[2]Dept. of Sericulture, Forest College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (641 301), India

E-mail: arasu20595@gmail.com

Abstract

The present study was undertaken to investigate the extent of adoption level of different diseases management approaches/ technologies by sericulture farmers of Tamil Nadu. More than fifty percent (58.33-55.83%) had partial adoption of mechanical control measures, chemical control measures they adopted partially more than sixty (65.00-62.50%), cultural control measures (60.00%) partially adopted to planting the resistant varieties, more than sixty of the sericulturists had partial adoption of botanical control measures against the foliar diseases and fifty percentage of the sericulturists had full adoption of botanical control measures to control the root rot disease and biological control measure (62.50-61.66%) non-adoption of biological control measures for foliar diseases and sixty percentage of the sericulturists had full adoption of biological control measures for root rot. The reason might be the partial and non adoption due the lack of awareness about different control measures, high cost of fungicides and non availability of biological control measures.

Keywords: Adoption level, Control measures, Foliar diseases, Sericulturists

Integrated Disease Management Module for Sheath Blight Management in Rice

Rini Pal[*] and Dipankar Mandal

All India Co-Ordinated Rice Improvement Project, Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology, Chiplima, Sambalpur, Odisha (768 025), India

E-mail: rinipatho@gmail.com

Abstract

Sheath blight disease of rice, earlier considered to be a minor disease, has attained the status of a major disease since last decade. Considering the importance of the disease and availability of scarce information on integrated disease management, a study was undertaken at All India Co-ordinated Rice Improvement Project, Regional Research and Technology Transfer Station, Chiplima, Sambalpur, Odisha for developing an integrated disease management strategy. Based on several components, five IDM modules (treatments) consisting of interventions in both nursery and main plots were made. The experiment was laid out in RBD with 5 modules and 4 replications. Although all the IDM practices were found to be effective in minimizing the sheath blight disease however, of the different IDM practices, Module 4was found to be the best recording lowest PDI of 17.77 for sheath blight disease. The components include: Nursery treatment, *viz*., (i) Incorporation of FYM @ 1 kg m^{-2} in the nursery bed, (ii) Seed treatment with carbendazim @ 2 g kg^{-1} seed and spraying of carbendazim @ 1 g l^{-1} seven days before uprooting, (iii) Application of DAP @ 10 g m^{-2} and MOP @ 8.5 g m^{-2}; and Main field treatment, *viz*., (iv) Application of FYM @ 1 kg m^{-2} + *Trichoderma* sp. @ 2 g kg^{-1} FYM just before transplanting, (v) Cultural practices like hand weeding, cleaning of bunds, *etc*., (vi) Application of 75% of RDF, *i.e.*, 60:30:30 kg NPK ha^{-1} + micronutrient Solution (Agromin) @ 0.5 l per 10 m^2, (vii) One blanket application of cartap 4G @ 10 kg $acre^{-1}$ at 15 DAT, (viii) One blanket application of an effective fungicide propiconazole 25 EC @ 1 ml l^{-1} or (azoxystrobin + difenoconazole) 325 SC @ 1 ml l^{-1} at booting stage and an additional dose 15 days later.

Keywords: IDM, Management, Module, Rice, Sheath blight

Fusarium Wilt: An Emerging Disease in Dalle Khorsani (*Capsicum annum*) in Sikkim Himalayas

T.L. Bhutia[1*], Abhishek Dubey[3], S.K. Dutta[1], E.L. Devi[1], Amit Kumar[1], S.K. Das[1], Boniface Lepcha[1], R. Devadas[1] and V.K. Mishra[2]

[1]ICAR-Research Complex for NEH Region, Sikkim Centre, Tadong, Gangtok, East Sikkim, Sikkim (737 102), India
[2]ICAR-Research Complex for NEH Region, Umiam, Meghalaya (793 103), India
[3]ICAR-Research Complex for Eastern Region, Patna, Bihar (800 014), India

E-mail: tl.bhutia2021@gmail.com

Abstract

Dalley Khorsani (*Capsicum annuum)* belongs to the family Solanaceae, popularly grown in Sikkim, India and its surrounding regions like Darjeeling Himalayas which has unique flavor and pungency. It is named as such for its resemblance in size and shape to fruits of cherry. It is one of the hottest chilli with a Scoville rating of 100,000 to 350,000 SHU. Recently, it has also got Geographical Indicator (GI) tag which will help the crop to have a global recognition and marketing of the product will be beyond national borders. The wide diversity of local germplasm of red cherry pepper is being maintained traditionally by tribals and other farming community of Sikkim and Darjeeling Himalayas. This crop is also one of the cash crops of Sikkim as it gives very good return to the farmers. However, recently this crop is being affected by the disease and causing a huge loss to the farmers (approx 80%). The affected plants showed wilting symptoms with upward and inward curling of leaves. The leaves then turn yellow and the entire plant dies. Soil sample from the rhizospheric region were collected for isolation of fungus. The pure cultures were subjected to morphological and molecular identification. The sequence was deposited in GenBank under accession number OR467445. This sequenced showed maximum similarity with the *Fusarium oxysporum* isolates reported from China when compared with other sequences available in the GenBank using BLASTn and MEGA X software. Fusarium wilt has been reported from several countries and states of India, however, this is the first report of *Fusarium oxysporum* causing Fusarium wilt in Dalley chilli in Sikkim, India.

Keywords: *Capsicum annum*, Dalle Khorsani, Fusarium wilt, GI crop, India, Sikkim

Field Efficacy of Fungicides against False Smut of Rice Caused by Ustilaginoidea virens

P. Madhusudhan*, Ch. Sreelakshmi, I. Paramasiva, U. Vineetha and S.K. Sameera

Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Nellore, Andhra Pradesh (524 003), India

E-mail: p.madhusudhan@angrau.ac.in

Abstract

Rice (*Oryza sativa*) plays a significant role in achieving global food security. False smut disease caused by *Ustilaginoidea virens* (Cooke) (Takahashi) was regarded as a minor disease earlier but the disease has been observed in severe form since 2001 in India. Seven different fungicides were evaluated against false smut in randomized block design under field conditions at Agricultural Research Station, Nellore during *rabi* 2022-23. Results revealed that out of seven fungicides picoxystrobin 7.05% + propiconazole 11.7% SC @ 2 ml l^{-1} recorded highest percent reduction of false smut (64.22%) with highest grain yield (5,902 kg ha^{-1}) which was at par with azoxystrobin 18.2% + difenoconazole 11.4% @ 1 ml l^{-1} and fluopyram 17.7% w/w + tebuconazole 17.7% w/w @ 1.1 ml l^{-1}. Rest of the fungicides; propiconazole 25EC @ 1 ml l^{-1}, tebuconazole 25.9% EC @ 1.5 ml l^{-1}, fluopyram 17.7% w/w + tebuconazole 17.7% w/w @ 1.1 ml l^{-1}, krysoxymethyl 44.3% EC @ 1 ml l^{-1} recorded 38.02%, 33.84%, 28.75%, 28.33% reduction of the disease respectively.

Keywords: False smut, Fungicides, *Oryza sativa*, Rice, *Ustilaginoidea virens*

Genetic Assessment for Biotic Stress Tolerance and Foliage Yield Components in Nitrate Reductase and Chalcone Synthase Segregating Clonal Population of Mulberry

Suresh, K.*, M. Goyari, H. Yallappa, Deepika K.U. and Jula S. Nair

Central Sericultural Research and Training Institute, Berhampore, West Bengal (742 101), India

E-mail: suresh4211@gmail.com

Abstract

Sericulture provides silk for fashionable clothing and plays a major role in rural employment along with foreign exchange earnings. Improvement of mulberry foliage productivity along with resistance to biotic stresses is a long term goal of mulberry breeders. The parents were contrast for nitrate reductase (KOP: 1.97 & V_1: 5.98 ΔA_{543} $g^{-1}FW\ h^{-1}$) and chalcone synthase activity (KOP: 58.6 µkat, V_1: 31.8 µkat), which are associated with leaf yield and biotic stress tolerance respectively. The segregating hybrid clonal progenies of cross Kajli OP(KOP) × V-1 were evaluated for fourteen leaf yield components, NRA and biotic stresses such as Powdery mildew and Bacterial leaf spot disease Analysis of variance revealed significant phenotypic coefficients of variations for all traits studied indicating the existence of genetic variability. NRA had positive significant phenotypic association with leaf yield, shoot length, shoots $plant^{-1}$, fresh leaf weight & moisture content indicate the usefulness as potential candidate gene for gene-specific marker for higher yield in mulberry. The principal component analysis revealed that six among the seventeen principal components were significant (eigen value > 1) and contributed to 22.7%, 17.7%, 11.6%, 10.1%, 8.5% and 6.5% of the total variance, respectively. PC_1 included the traits that were related mostly to the yield, yield attributing, and PC_2 for leaf characteristics. K-mean cluster analysis grouped hybrid progenies into four clusters where maximum (5) were grouped into cluster I and least (9) in cluster II. Cluster II showed the highest mean value for leaf traits, growth traits and yield. Genotypes from clusters II and IV can be used in the hybridization program to develop the superior hybrids by exploiting heterosis in segregating generation. The hybrid VK-119 recorded 266 g dry foliage biomass per plant along with resistance to biotic stress and high NRA may be further evaluated for mulberry improvement.

Keywords: Bacterial leaf spot, Mulberry, NRA, Powdery mildew, Leaf yield

Studies on the Biology of Pink Stem Borer, *Sesamia inferens* on Maize at Raipur, Chhattisgarh

Nadita Paul Ganguli*, Jayalaxmi Ganguli and R. N. Ganguli

Dept. of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India

E-mail: nanditapaul352@gmail.com

Abstract

Studies conducted on the biology of pink stem borer, *Sesamia inferens* (Lepidoptera: Noctuidae) on maize at Raipur, Chhattisgarh, during 2019-2020, revealed that the mean incubation period was of 6.5 days with a fecundity of 183.6 eggs. The eggs were laid in clusters within the cover of the leaf sheath and were creamy white, semi-globular and flattened on the dorsal surface. Later, before hatching colour of the eggs changed to brownish-grey to pinkish. The larval period, pupal period and duration of the total life cycle was of 33.0, 8.5 and 51.5 days respectively. The neonate larvae were dorsally pinkish-purplish and lighter ventrally with a reddish brown head, due to which it is known as the pink stem borer. The larvae passed through six instars. The pupation took place inside the stem or between stem and leaves. The pupae were stout and dark brown. Male and female pupae could be distinguished with the presence of tapering abdomen, smaller size with two small bumps in male while the female pupae were larger with broad abdomen. Adult moths were straw coloured with a mid longitudinal dark brown broad triangular streak on the fore wings. The male adult moth was slightly smaller than the female. Both male and female moths had pectinate antennae. The longevity of female and male adult moths were of 7.5 and 6.5 days respectively.

Keywords: Biology, Maize, Moth, *Sesamia inferens*, Stem borer

Impact of Brushing Schedule on Disease Incidence and Cocoon Characteristics of Tasar Silkworm, Antheraea mylitta D., Saturniidae: Lepidoptera

C. Selvaraj[1*], Bawaskar, D.M.[1], B.T. Reddy[1], Nadaf, H.S.[2], Chowdary, N.B.[2] and T. Selvakumar[2]

[1]Basic Seed Multiplication and Training Centre, Madhupur, BTSSO, Central Silk Board, Jharkhand (815 353), India
[2]Basic Tasar Silkworm Seed Organization, Bilaspur, Central Silk Board, Bilaspur, Chhattisgarh (495 112), India

E-mail: selvaarjun665@gmail.com

Abstract

The experiment was conducted to assess the impact of brushing schedule on disease incidence and cocoon characteristics of tasar silkworm. The results of the experiment revealed that brushing schedule significantly ($P \leq 0.05$) influences the disease incidence and cocoon characteristics of tasar silkworm. The early and on time brushing schedule, B_2: 24.09.22, B_3: 29.09.23 and B_1: 19.09.22 recorded higher incidence of diseases (9.67 to 9.85% of virosis and 6.65 to 6.85% bacteriosis), whereas, delayed brushing lots such as B_5: 07.10.22, B_6: 12.10.22 and B_7: 20.10.22 recorded minimum incidence of diseases (3.90 to 6.90% of virosis and 2.85 to 5.75% of bacteriosis). Moreover, cocoon yield recorded maximum (85.00 cocoons $dfls^{-1}$) in case of delayed brushing B_5: 07.10.22. However, cocoon quality parameters like cocoon weight, shell weight and shell ratio were slightly reduced in delayed brushing lot B_5: 07.10.22 (11.75 g, 1.83 g and 15.93%), when compared to on-time brushing lot B_1: 19.09.22 (12.15 g, 1.98 g and 16.49%). Moreover, cocoon colour also differed from whitish grey to dusty grey in case of delayed brushing lots and also those lots recorded a comparatively higher number of flimsy cocoons (B_7: 4.82%). However, cocoon yield was maximum in delayed brushing lots in comparison to on time brushing lots. Therefore, we are concluding that delayed brushing lots does not affect the cocoon yield. However, cocoon quality parameters may decrease slightly.

Keywords: Brushing schedule, Cocoon, Diseases, Parameter, Quality, Yield

Adoption and Assessment of Integrated Strategies for Managing Major Insect Pests in *Kharif* Green gram [*Vigna radiata* (L.) Wilczek]

A. Banerjee[1*] and Sabyasachi Ray[2]

[1]AICRP on MULLaRP, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India
[2]Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: amitavakvk@gmail.com

Abstract

For assessing the integrated strategies towards managing insect pest of green gram the concerned experiment was executed for consecutive three years using two treatments, *viz*., IPM nodule and Farmer's practice. In case of IPM module management tactics included seed treatment with fungicide (Tebuconazole 50% + Trifloxystrobin 25%) and insecticide like thiamethoxam, seed dressing with rhizobium, installation of yellow sticky traps, pheromone traps, growing border crops, applying neem based insecticides and need based application of chlorantraniliprole. In case of Farmer's practice only two round spray of chlorpyriphos + cypermethrin were given. In all the years aphid and spotted pod borer population were significantly less compared to the farmer's practice (mean aphid population of 2.53 per 10 cm apical twig in IPM plots against 29.37 in Farmer's practice while pod borer population of 0.77 larva $plant^{-1}$ in IPM and 4.8 in Farmer's practice). Natural enemy population was considerably higher in IPM module (5.23 $plant^{-1}$) compared to the farmer's practice (1.36 $plant^{-1}$). Higher incremental benefit cost ratio was also obtained from IPM modules.

Keywords: Economic return, Green gram, Insect pests, IPM, Natural enemies, Seed yield

Temperature Tolerance Level of a Native Isolate of *Steinernema surkhetense* NBAIRS81 Isolated from Chhattisgarh, India

Sonia Soni[1*], Jagadeesh Patil[2], Jayalaxmi Ganguli[1] and R.N. Ganguli[1]

[1]Dept. of Entomology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India
[2]ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka (560 024), India

E-mail: soniasoni0203@gmail.com

Abstract

Entomopathogenic nematodes (EPNs) are a group of nematodes pathogenic to insect pests particularly those inhabiting in soil and in concealed environment. Their attribute of being and obligate parasite of insects make them promising biocontrol agent for a wide range of agricultural pests. EPN strains isolated from different geographical region show adaptation to their local environment, making them more suitable to be used as biocontrol agent for pest management in that particular area. Thus, a precise knowledge of traits like host range, infectivity, reproduction and environmental stress tolerance of the isolates are essential for development of successful strategies to use these nematodes in biological control programmes. Considering this, ecological characterization of the EPN, *Steinernema surkhetense* NBAIRS81 (Rhabdtida: Steinernematidae), a recently isolated EPN reported for the first time from Chhattisgarh state of India was carried out using larvae of *Galleria mellonella* (Pyralidae: Lepidoptera) as host. The data revealed that this native EPN is a warm adapted species. When tested at different temperatures, the nematode was able to survive at the temperature range of 15-39 °C, was infective to *Galleria* larvae at a temperature range of 15-35 °C and was able to reproduce successfully inside host cadaver within a temperature range of 15-30 °C. The isolate was found to be virulent when tested against fourth instar larvae of Diamond-backed moth (*Plutella xylostella*) under laboratory condition with LC_{50} values of 31.5 IJs $larva^{-1}$. The results of this experimental study on ecological aspects of this native isolate of *S. surkhetense* NBAIRS81 should form a basis for its potential use in biological control of insect pests in Chhattisgarh.

Keywords: EPN, Insect pests, *Steinernema surkhetense*, Temperature, Tolerance

Biointensive Integrated Pest Management for Fruit Crops

Rupashree Das[1*], Thingreingam Irenaeus K.S.[1], Tridip Bhattacharjee[1], Budhachandra Thangjam[1] and Tapan Kumar Maity[2]

[1]Dept. of Horticulture, College of Agriculture, Lembucherra, Tripura (799 210), India
[2]College of Agriculture, Lembucherra, Tripura (799 210), India

E-mail: rupashreedas2q@gmail.com

Abstract

Fruits represent a vital source of phytochemicals especially antioxidants, dietary fiber, sugar, protein, carbohydrates, vitamins, minerals, carotenoids, flavonoids and other bioactive compounds that alleviate risks of the numerous chronic diseases and stimulate immune system. Therefore fruits are considered as an essential component of the human diet. Though, India is the second largest producer of fruit in the world, the per capita output and daily availability is barely 100 g. One of the main obstacles to boosting quality fruit yield is insect pests, which also contribute significantly to the challenge of reaching such a high goal. Furthermore, it is concerning that consumption of fruits that have pesticides exceeding permissible levels have carcinogenic effects in human beings. Conventional pest management practices are unsustainable under the current situations and it is critical to develop safer, lower-risk and ecologically friendly pest control methods. The biointensive integrated pest management is a sustainable approach of pest management that utilizes cultural methods, host plant resistance, biocontrol (predators, parasitoids or pathogens), biorationals, biopesticides and molecular approaches to ensure favourable economic, ecological and sociological benefits. The problems must be resolved in order to successfully switch from traditional chemical-intensive pest management programs to ecologically based biointensive integrated pest management (IPM), which has emerged as a sustainable insect pest management option that is less harmful to the environment. This study presents the potential biointensive methods which provide better efficiency for management of insect pest mediated biotic stress in fruit crop ecosystem.

Keywords: Biocontrol, Biointensive management, Fruits, Insect pest, Molecular approaches, Reduced-risk insecticides

First Record of Small Hive Beetle, *Aethina tumida*, in European Honey Bee Colonies of West Bengal, India

Lakshman Chandra Pate* and Sourav Sen

Dept. of Agricultural Entomology, College of Agriculture (Extended Campus of BCKV), Kalna Road, Purba Bardhaman, West Bengal (713 101), India

E-mail: patel123lakshman@gmail.com

Abstract

Small hive beetle (SHB), *Aethina tumida* is an important invasive parasite of bees. The sub Saharian Africa is considered as its native place. In the past few decades, it has naturally introduced and colonized countries outside its native range. Apropos said beetle, no report is made from India. Survey activity was initiated to detect a serious unknown pest problem (as per information of beekeepers) in *Apis mellifera* colonies in Gobardanga and Hansnabad of district North 24 Parganas of West Bengal in India. Samples were collected for its morphological identification. It is identified as SHB (*Aethina tumida*) and accordingly other information is generated. The present work can contribute a lot in science of apiculture as a first discovery of SHB in *Apis mellifera* colonies of West Bengal, a state of India highlighting morphological identification, areas of infestation, seasonal occurrence, damage symptom, economic loss and probable integrated management.

Keywords: *Aethina tumida*, *Apis mellifera*, Bee colonies, European honey bee, Hive beetle, Invasive

Nutritional Indices of Eco Races of Eri Silkworm Fed with Various Castor Genotypes

G. Swathiga*, P. Priyadharshini, V. Vasanth and C.N. Hari Prasath

Forest College and Research Institute, TNAU, Mettupalayam, Tamil Nadu (641 301), India

E-mail: swathiga.g@gmail.com

Abstract

Nutritional efficiency is considered as important to assess the cost benefit ratio of sericulture practices up to the level of cocoon production. The efficiency of converting the ingested and digested food into the body, cocoon and cocoon shell varies among eri silkworm races under different castor genotypes. Nutritional quality has greater impact on regulation over the quantum of ingesta, digesta and digestibility of food among silkworm. A study was undertaken to evaluate nutritional indices of eco races of eri silkworm (Barpathar, Borduar, Khanapara, Mendipathar and Titabar) with different castor genotypes (GCH 4, GCH 7, DCH 519 and TMV 5). In this regard, Nutritional indices of all selected eco races of eri silkworm revealed that the total food consumption, total food digestion and approximate digestibility were recorded to be higher in the genotype DCH 519 (34.01 g larva^{-1}, 31.05 g larva^{-1} and 91.24%) on fresh weight and (8.78 g larva^{-1}, 5.98 g larva^{-1} and 65.06%) on dry weight basis respectively. Interaction between eco races and castor genotypes, DCH 519 × *Borduar* performed better followed by GCH 4 × *Borduar* on total food consumption, total food digestion and approximate digestability on fresh and dry weight basis. Consumption index (CI) significantly differed among the eco races of eri silkworm. *Borduar* (17.94 and 14.21) revealed maximum CI followed by C2 breed (16.30 and 13.46) and *Titabar* (16.0 and 12.77) both on fresh weight and dry weight basis when reared on GCH 4 genotype. This study reveals that of the five eco races of eri silkworm, Borduar performed well when reared with DCH 519 variety.

Keywords: Castor genotypes, Eco races, Eri Silkworm, Nutritional indices

Biopriming of Tomato Seeds with Native *Trichoderma* Species for Enhanced Seedlings Vigour

Dipankar Mandal*, Rini Pal and Sanjukta Mohapatra

Regional Research and Technology Transfer Station, Odisha University of Agriculture and Technology, Chiplima, Sambalpur, Odisha (768 025), India

E-mail: dipankarpatho@gmail.com

Abstract

An investigation was conducted to know the effect of tomato seed biopriming using six native *Trichoderma* isolates under laboratory conditions. The seeds of tomato were primed in *Trichoderma* isolates and as a control treatment seeds were treated in sterile distilled water. It was observed that all the six native *Trichoderma* isolates showed good performance with respect to growth, germination percentage and vigour index of tomato seedlings as compared to control. Among the different *Trichoderma* isolates tested, T_5 isolate showed highest shoot growth (5.44 cm), root growth (3.74 cm), germination percentage (90.0%) and seedling vigour index (826.37) followed by T_4 isolate. The lowest shoot growth (4.22 cm), root growth (3.07 cm), germination percentage (56.7%) and seedling vigour index (412.70) were recorded in untreated control.

Keywords: Biopriming, Seedling vigour, Tomato, *Trichoderma*

Studies on the Biology of Pink Stem Borer, Sesamia inferens on Maize at Raipur, Chhattisgarh

Nandita Paul Ganguli*, Jayalaxmi Ganguli and R.N. Ganguli

Dept. of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India

E-mail: nanditapaul352@gmail.com

Abstract

Studies conducted on the biology of pink stem borer, *Sesamia inferens* (Lepidoptera: Noctuidae) on maize at Raipur, Chhattisgarh, during 2019-2020, revealed that the mean incubation period was of 6.5 days with a fecundity of 183.6 eggs. The eggs were laid in clusters within the cover of the leaf sheath and were creamy white, semi-globular and flattened on the dorsal surface. Later, before hatching colour of the eggs changed to brownish-grey to pinkish. The larval period, pupal period and duration of the total life cycle was of 33.0, 8.5 and 51.5 days respectively. The neonate larvae were dorsally pinkish-purplish and lighter ventrally with a reddish brown head, due to which it is known as the pink stem borer. The larvae passed through six instars. The pupation took place inside the stem or between stem and leaves. The pupae were stout and dark brown. Male and female pupae could be distinguished with the presence of tapering abdomen, smaller size with two small bumps in male while the female pupae were larger with broad abdomen. Adult moths were straw coloured with a mid longitudinal dark brown broad triangular streak on the fore wings. The male adult moth was slightly smaller than the female. Both male and female moths had pectinate antennae. The longevity of female and male adult moths were of 7.5 and 6.5 days respectively.

Keywords: Biology, Maize, *Sesamia inferens*, Stem borer

Foraging Resources of Stingless Bee, *Tetragonula iridipennis* Smith in Jorhat, Assam

S. Sen[1*], S. Borkataki[2] and P.S. Saranya[3]

[1]*Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India*
[2]*Dept. of Entomology, Assam Agricultural University, Jorhat, Assam (785 013), India*
[3]*Polytechnic of Agriculture, ANGRAU, Andhra Pradesh (521 175), India*

E-mail: souravsen561@gmail.com

Abstract

A study on the foraging resources and floral cycle of stingless bee, *T. iridipennis* S. was conducted in a calendar year of 2021 at the Jorhat campus of Assam Agricultural University (AAU), Assam, India by installing three wooden hives (15504 cc) at three different places. After complete survey for one year at the Jorhat campus for the three hives, we identified a total 48 plant species belonging to 26 families where stingless bees were busy to collect pollen and nectar. The family represented by maximum number of plant species was Asteraceae (10 species) followed by Solanaceae (4 species), Cucurbitaceae (4 species), Lamiaceae (4 species), Brassicaceae (3 species), Rosaceae (2 species), Euphorbiaceae (2 species), Convulvulaceae (2 species). The remaining 20 plant families are represented by one plant species. The maximum availability of foraging plants was observed in January, 2021 (16.96%). The most of visited plants were herbaceous in nature and had small sized flowers with yellow, white, blue and purple colours. Visual documentation of the foraging of stingless bee on the flower of the plants was also made by using camera. This study claims an important aspect in meliponiculture and pollination services in crop plants as well as wild plants.

Keywords: Floral cycle, Foraging activity, Meliponiculture, Pollination, Wooden hive

Management of Collar Rot in Chickpea var Indira Chana 1 at Raipur, Chhattisgarh

Lav Singh[*], Jayalaxmi Ganguli and R.N. Ganguli

Dept. of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India

E-mail: singhlav748@gmail.com

Abstract

The present investigation was conducted in the Instructional Research Farm, College of Agriculture, I.G.K.V., Raipur, Chhattisgarh, during the year 2022-23. Chickpea variety Indira Chana 1 was observed on pre-emergence seed rot (PESR) seven days after sowing and on post emergence seedling mortality (PESM) 30 days after sowing with three different treatments namely, seed and soil treatment with *Trichoderma harzianum*, thiram and no treatment (control). Results of pre- and post-emergence seedling mortality due to the disease collar rot caused by (*Sclerotium rolfsii*) in chickpea was significantly (5.45%) and (7.44%) respectively in seed and soil treated with *T. harzianum*, followed by 5.88% and 9.10% in thiram while it was significantly highest in control (untreated plot) 9.86% and 10.78% respectively. The total percent mortality (including both seed and seedling) in various treatments was minimum in *T. harzianum* (12.89%) followed by thiram (14.98%) and maximum in control (20.64%). Overall disease check over control was 37.5% and 27.4 % in *T. harzianum* and thiram treated plots respectively.

Keywords: Chickpea, Collar rot, Mortality, Pre-emergence seed rot, Post emergence

Biology, Morphometric Studies and Integrative Taxonomy of Litchi Fruit Borer, *Conopomorpha sinensis* Bradley, 1986: A Serious Pest of Litchi (*Litchi chinensis* Sonn.)

S. Sen[1*], S. Borkataki[2] and P.S. Saranya[3]

[1]Dept. of Entomology, [3]Dept. of Horticulture, [4]Dept. of Plant Pathology, Nagaland University, Medziphema Campus, Nagaland (797 106), India
[2]ICAR-Research Complex for Eastern Region, Farming System Research Centre for Hill and Plateau Region, Ranchi, Jharkhand (834 010), India

E-mail: pasammaheswarareddy@gmail.com

Abstract

The litchi fruit borer, *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae) is a devastating pest in litchi orchards, leading to substantial economic losses in fruit production. The present study provides a comprehensive overview of *C. sinensis*, encompassing its biology, morphometric studies, taxonomy, and phylogenetic analysis. In the initial stages, larvae bore into fruits near the stem end, creating winding tunnels. As they progress, internal rotting occurs, leading to decay and premature fruit dropping. The species identity is confirmed through dissection of male and female genitalia and molecular confirmation. The duration of developmental stages such as egg, larval, pre-pupal, pupal, male and female adult lasts for 3.45, 11.10, 2.05, 5.85, 5.55 and 9.00 days, respectively. The average fecundity was 33.10 eggs female^{-1}. The head capsule width of five larval instars was 0.11, 0.18, 0.34, 0.58 and 0.64 mm, respectively. The sequence analysis revealed that the nucleotide composition of the COI sequences was 31.88% (A), 37.95% (T), 15.67% (C) and 14.51% (G), showing strong AT bias (69.83%).The interspecific nucleotide divergence among five species ranged from zero to 11.0%, with a mean of 6%. Phylogenetic analysis revealed distinct species-groups among the fruit borer species studied: *Conopomorpha cramerella* (Snellen), *Conopomorpha litchiella* Bradley, *C. sinensis* and *Thaumatotibia batrachopa* (Meyrick). These clustering outcomes closely mirrored the existing morphological classification. Understanding *C. sinensis* life cycle and its response to environmental factors is crucial for targeted pest control. Traditional and molecular taxonomy assists in species identification, unveiling genetic factors such as insecticide resistance. This approach aids in understanding the evolutionary relationships among *Conopomorpha* species, guiding conservation efforts for predators and strategies for resistance management.

Keywords: Biology, *Conopomorpha sinensis*, Litchi, Phylogenetic analysis, Taxonomy

Exploring Resistance in Rice Landraces: A Holistic Analysis of Morphological and Biochemical Traits against Rice Leaffolder, *Cnaphalocrocis medinalis* Guenee

S.S. Dash[1*], P. Golive[2], H. Chatterjee[1], P.C. Rath[2], A.K. Nayak[2], S. Bhattacharya[1], P. Mondal[1], P. Bhavana[2] and S.D. Mohapatra[2]

[1]*Dept. of Agricultural Entomology, Palli Siksha Bhavana, Sriniketan, Visva Bharati, West Bengal (731 236), India*
[2]*Crop Protection Division, ICAR-National Rice Research Institute, Cuttack, Odisha (753 006), India*

E-mail: soumyadashshephalika@gmail.com

Abstract

The rice leaffolder, *Cnaphalocrocis medinalis* Guenee, poses a serious threat under favourable environmental conditions. Utilizing host plant resistance emerges as a cost-effective and environmentally friendly strategy for effectively managing this pest. A systematic evaluation of ninety-four germplasm lines were conducted to categorize their reactions; resistant, moderately resistant, or susceptible reaction against rice leaffolder at tillering and boot leaf stages through field and net house screening in two consecutive *kharif* seasons of 2022 and 2023, respectively. To identify resistance sources against the leaffolder, an intricate analysis of morphological traits and five biochemical constituents was carried out in the top ten rice genotypes (ARC-12163, ARC-12069, ARC-11942, ARC-12048, ARC-11951, ARC-11304, ARC-12057, ARC-11330, ARC-11246, ARC-12063) alongside standard checks (resistant check: TKM6; susceptible check: TN1). Results revealed notable negative correlations between leaffolder damage and morphological characteristics, specifically plant height ($r = -0.939$) and leaf length ($r = -0.869$), both significant at $P<0.001$. Conversely, leaf width exhibited a positive association ($r = 0.891$, $P<0.001$). Similarly, a substantial positive correlation was found between leaffolder damage and total soluble sugar ($r = 0.964$, $P<0.001$), while phenol ($r = -0.94$, $P<0.001$) and antioxidative enzymes such as catalase, peroxidase and polyphenol oxidase demonstrated a negative correlation. Upon exposure to leaffolder larval feeding, ARC-12163, ARC-12069, ARC-11942, ARC-12048 and TKM6 exhibited reduced expression of total soluble sugar; whereas, total phenol content and upregulation of antioxidative enzymes were more pronounced in these rice varieties. Inverse associations were observed between larval duration and total soluble sugars ($r = -0.89$). Similarly, total phenol content showed negative correlations with larval survival ($r = -0.94$) and a positive correlation with larval duration ($r = 0.95$). The varied responses observed among rice genotypes to leaffolder feeding offer valuable insights into the mechanisms of resistance, laying a robust foundation for the development of resilient, leaffolder-resistant rice varieties.

Keywords: Antioxidative enzymes, Germplasm, Leaffolder, Resistance, Screening

Silicon Supplementation Activate the Defence Reaction in Black Gram Plants and Reduce the Impact of Whitefly Incidence

Gouranga Saw[1,2*], Mallikarjuna Jeer[2] and R.K. Murali Baskaran[2]

[1]*Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi (110 012), India*
[2]*ICAR-National Institute of Biotic Stress Management, Raipur, Chhattisgarh (493 225), India*

E-mail: gourangasaw8612@gmail.com

Abstract

Silicon (Si) is known for mitigating biotic stresses in various crops through diverse array of mechanisms. The present study was undertaken to decipher the mechanisms of Si in suppressing the impact of whitefly incidence to black gram plants under field conditions for two consecutive seasons. For this study, we have applied Orthosilicic acid in two distinct methods, *i.e.*, soil drenching and foliar application in different concentrations in two black gram varieties separately. The effect of these Si sources on total sugars, total phenols, anti-oxidant, and defence enzymes was monitored in black gram leaves along with their impact on whitefly incidence and yield was recorded. All the Si sources significantly enhanced the activities of antioxidant and defence enzymes like peroxidase, phenylalanine ammonia lyase, polyphenol oxidase, catalase and superoxide dismutase. Enhanced activities of defence enzymes, antioxidants and higher accumulation of total sugars and phenols in black gram tissues significantly reduced the impact of whitefly incidence. The percent Si content was positively correlated with all the defence enzymes and negatively with whitefly incidence at significant levels. Our current study convincingly proved Si induced defence reaction in black gram plants in suppressing whitefly impact.

Keywords: Black gram, Defence enzymes, Orthosilicic acid, Silicon-induced resistance, Whitefly

Evaluation of Different Fungicides against Tikka Leaf Spot Disease of Groundnut under Field Condition

Rakesh Katharaju* and Ranjan Nath

Dept. of Plant Pathology, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: : k.rakesh9912@gmail.com

Abstract

Groundnut (*Arachis hypogaea*) is an important oilseed crop cultivated throughout the world for its high economic and nutritional value. Among the various reasons attributed to low productivity, diseases are major constraints. Out of different diseases tikka leaf spot and rust caused by *Cercospora* spp.and *Puccinia arachidis* respectively and caused loss of 53% pod yield and 27% kernal weight. Hence, the present study was carried out on the occurrence of tikka leaf spot disease and evaluation of different fungicides against the disease with a view to formulate an economically viable management option.

The experiment was conducted at the research farm of the Institute of Agriculture, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal, during the *Karif* season (July to November, 2022). A comparative study on the efficacy of different fungicides against tikka disease of groundnut, caused by *Cercospora arachidicola* and *Cercospora personata*, was done. Ten treatments, namely, T_1: Thiophanate Methyl 70% WP (Roko @ 500 g ha^{-1}), T_2: Carbendazim 50% WP (Bavistin @ 250 g ha^{-1}), T_3: Carbendazim 12% and Mancozeb 63% WP (SAAF @ 1000 g ha^{-1}), T_4: Difenoconazole 25% EC (Score @ 375 ml ha^{-1}), T_5: Salicyclic acid crystal @ 700 g ha^{-1}, T_6: Chlorothalonil 75% WP (Kavach @ 1000 g ha^{-1}), T_7: Myclobutanil 10% WP (INDEX @ 375 g ha^{-1}), T_8: Azoxystrobin 23% SC (Azoxy @ 500 ml ha^{-1}) and T_9: Cymoxanil 50% WP (Hydroxanil @ 500 g ha^{-1}), T_{10}: control, were taken with three replications each and applied thrice at 15 days interval starting from the first initiation of the disease.

The data on Percent disease index (PDI) was calculated and it was evident that all fungicides tested, significantly reduced disease severity (PDI) as compared to the control (53%). The lowest PDI (26%) was observed in Carbendazim 12% and Mancozeb 63% WP (SAAF @ 1000 g ha^{-1}) treatment (T_3), followed by Azoxystrobin 23% SC (Azoxy @ 500 ml ha^{-1}) (T_8) (31.07%) and Carbendazim 50% WP (Bavistin @ 250 g ha^{-1}) (31.17%). Similarly, all fungicides tested, significantly increased the yield as compared to the control (12.20 q ha^{-1}). The highest yield (27.53 q ha^{-1}) was observed in Carbendazim 12% and Mancozeb 63% WP followed by Azoxystrobin 23% SC @ 500 ml ha^{-1} (22.73 q ha^{-1}) and Carbendazim 50% WP (@ 250 g ha^{-1}) (21.46 q ha^{-1}).

Keywords: *Cercospora arachidicola*, *Cercospora personata*, Fungicide, Groundnut, Management, Percent disease index

Genetic Diversity of Gut Bacterial Microbiota of Rice Stem Borer Complex and Their *in vitro* Insecticide Degradation Capabilities

Subrata Goswami[1*], S.B. Das[2] and P.C. Rath[3]

[1]Dept. of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India
[2]Dept. of Entomology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh (482 004), India
[3]Crop Protection Division, ICAR-National Rice Research Institute, Cuttack, Odisha (753 006), India

Abstract

E-mail: subrata.kv@gmail.com

Bacterial symbionts provide numerous advantages to insects and are also reported to supplement the ability to withstand xenobiotics in many. The present study was undertaken to explore the gut bacterial diversity of three stem borers attacking rice *viz.*, *Scirpophaga incertulas*, *Sesamia inferens* and *Chilo suppresalis* and their possible role in insecticide degradation, if any. Live larva of *Scirpophaga incertulas*, *Sesamia inferens* and *Chilo suppresalis* were collected from Varsha Dhan rice variety at ICAR-NRRI farm and the larval associated gut bacteria were isolated through culture dependent approach. The isolated gut bacteria were characterized morphologically, biochemically and genetically (based on 16S rDNA gene sequence). It was perceived that different rice stem borers of same guild collected from the same host at the same time found to harbour morphologically, biochemically and genetically distinct bacterial microbiota in their guts. *In vitro* insecticide degradation ability of the bacterial isolates was probed through minimal media study. The amount of insecticide degraded, *viz.,* Chlorpyrifos, Thiamethoxam and Chlorantraniliprole, was quantified through GC-MS and HPLC respectively, which showed that Chlorpyrifos was most prone to degradation followed by Chlorantraniliprole and Thiamethoxam as compared to control (minimal media with insecticide devoid of bacteria). The differential ability of the bacterial fauna to utilise the insecticides as carbon source revealed their possible role in insecticide detoxification in the rice stem borers. These results provide insights for further study of the association between gut bacteria and insecticide detoxification in rice stem borers and their possible manipulation to disrupt symbiont mediated insecticide detoxification process and thereby develop novel pest management strategies to control the most dreaded pest of rice.

Keywords: 16S rDNA, Gut bacteria, Insecticide degradation, Minimal media study, Rice stem borers

Studies on Post Harvest Diseases in Onion Crop in Andhra Pradesh

C. Ruth[1*], K. Gopal[2] and K. Swarajyalakshmi[1]

[1]Dept. of Plant Pathology, [2]Dept. of Post Harvest Management, Dr. YSR Horticultural University, College of Horticulture, Anantharajupeta, YSR District, Andhra Pradesh (516 105), India

Abstract

E-mail: ruthbenerjee1@gmail.com

Onion (*Allium cepa* L) called as "Queen of kitchen" is one of the oldest known and an important vegetable crop grown in India.. India is the second largest onion growing country in the world. Indian onions are famous for their pungency and are available round the year. Indian onions have two crop cycles, both Kharif and Rabi. The major varieties found in India are Agrifound Dark Red, Agrifound Light Red, NHRDF Red, Agrifound White, Agrifound Rose and Agrifound Red, Pusa White Round, Red-3, Red-4, local variety Bellary Red and several private sector varieties. In onion, purple leaf blotch (36.5 PDI) damping off (6.0), smut (12.5), basal rot (9.5), stem elongation, cascuta and thrips are the major problems identified in Aluru, Aspari, Papile, Dhone, Kurnool, Gonegondla, Nandikotkuru mandals of Kurnool district. More per cent disease index (PDI) of Purple leaf blotch noticed in Kharif (36.5) than in Rabi (30.5) in onion crop cv. Bellary Red local variety. Onion is less perishable compared to other vegetables; however losses are inevitable during storage. It has been estimated that 40 to 50% of the production never reaches to the consumers due to postharvest losses. . Due to storage losses, after harvesting the crop the quality and quantity by storage rots was affected of the produce in onion crop. Among the post harvest diseases caused by different pathogens more incidence with, Rhizoctonia, *Fusariums* sp., *Rhizopus* sp., *Aspergillus* sp. and *Alternaia* sp. were recorded and identified the pathogens. Rottening of upper surface, blackening of bulb and root portion and softening of stem portion were observed.

Keywords: Alternaria, Aspegillus, Diseases, Onion, Post harvest losses

Studies on Foraging Behaviour of Non-*Apis* Insect Pollinators Visiting on Mustard and Coriander Crops

Purjeet*, Bharti Baghel and Y.K. Yadu

Dept. of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India

Abstract

E-mail: purjitsahu@gmail.com

The present experiment on foraging behaviour of non-*Apis* insect pollinators visiting on mustard and coriander crops was conducted at Instructional cum Research Farm, CARS, Bemetara (C.G.) during the academic year of 2022-2023. Among the non-*Apis* insect pollinators *Erisyrphus* sp. (13.35%), *Eristalis tenax* L. (11.84%), *Eristalinus* sp. (10.93%), and *Ceratina* sp. (9.71%) were recorded the most frequent visitors while, *Spathulina acroleuca* (0.61%) was noted as having a comparatively lower abundance. Among total abundance of the non-*Apis* insect pollinators, order Diptera (44.01%) constituted major faction of pollinator group followed by Hymenoptera (32.47%). In coriander flowers *Eristalis tenax* L. (20.50%), *Erisyrphus* sp. (19.82%), *Rhynchium* sp. (10.59%) and *Xylocopa fenestrate* Fab. (9.01%) were the most frequent visitors, while *Euploea core* (1.35%) visits the coriander flowers less frequently. Among non-*Apis* insect pollinators order Diptera was the most dominant and most frequent visitors constituted 46.85% of total abundance followed by order Hymenoptera (25.91%).

Keywords: Abundance, Dominant, Flowers, Pollinators, Visitors

Host Preference of Hadda Beetle, *Henosepilachna vigintioctopunctata* Fab. (Coleoptera: Coccinellidae) under Net Cage Condition

Birjhu*, Lavkush Salame and Madhu Kumari

Dept. of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India

Abstract

E-mail: birjhuk68@gmail.com

Onion (*Allium cepa* L) called as “Queen of kitchen” is one of the oldest known and an important vegetable crop grown in India.. India is the second largest onion growing country in the world. Indian onions are famous for their pungency and are available round the year. Indian onions have two crop cycles, both Kharif and Rabi. The major varieties found in India are Agrifound Dark Red, Agrifound Light Red, NHRDF Red, Agrifound White, Agrifound Rose and Agrifound Red, Pusa White Round, Red-3, Red-4, local variety Bellary Red and several private sector varieties. In onion, purple leaf blotch (36.5 PDI) damping off (6.0), smut (12.5), basal rot (9.5), stem elongation, cascuta and thrips are the major problems identified in Aluru, Aspari, Papile, Dhone, Kurnool, Gonegondla, Nandikotkuru mandals of Kurnool district. More per cent disease index (PDI) of Purple leaf blotch noticed in Kharif (36.5) than in Rabi (30.5) in onion crop cv. Bellary Red local variety. Onion is less perishable compared to other vegetables; however losses are inevitable during storage. It has been estimated that 40 to 50% of the production never reaches to the consumers due to postharvest losses. . Due to storage losses, after harvesting the crop the quality and quantity by storage rots was affected of the produce in onion crop. Among the post harvest diseases caused by different pathogens more incidence with, Rhizoctonia, *Fusariums* sp., *Rhizopus* sp., *Aspergillus* sp. and *Alternaia* sp. were recorded and identified the pathogens. Rottening of upper surface, blackening of bulb and root portion and softening of stem portion were observed.

Keywords: Alternaria, Aspegillus, Diseases, Onion, Post harvest losses

Comparative Adult Male Moths of *Tuta absoluta* Meyrick (Lepidoptera: Gelechidea) Trapped by Wota T Trap in Organic and Chemically Treated Tomato Crop at Raipur, Chhattisgarh

Anjali Manhar*, Madhu Kumari, Vinita Darro, Jayalaxmi Ganguli and R.N. Ganguli

Dept. of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India

Abstract

E-mail: anjalimanhar411@gmail.com

The Tomato leaf miner *Tuta absoluta* Meyrick (Lepi: Gelechidae) is one of the most destructive insect pests that attack solaneceous crops particularly tomatoes in many tomato-growing locations all over India and in Chhattisgarh also. This insect is reported to causes losses of up to 80-100%. The present experiment was carried out with the objective to record the population of the adult moths of *T. absoluta* under field condition by using Wota T trap fitted with lure in organic and chemically treated tomato crop at IGKV, Raipur, Chhattisgarh, during the year 2021-2022. The results from the experiment revealed that the mean maximum population of adults of *T. absoluta* in organic (chemical free) and chemically treated field were seen during the 2nd fortnight of February (26.6 and 23.2 adults trap^{-1} respectively), and the lowest mean population were recorded during the 1st fortnight of January (10.4 and 5.4 adults trap^{-1}, respectively).

Keywords: Pheromone lure, Raipur, Tomato leaf miner, *Tuta absoluta*, Wota T trap

Studies on the Seasonal Incidence of Major Insect Pests of Rice at Bastar, Chhattisgarh

Vinita Darro*, Manish Kumar, Anjali Manhar, Jayalaxmi Ganguli and Yaspal Singh Nirala

Dept. of Entomology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (492 012), India

Abstract

E-mail: darrovinita2@gmail.com

A field experiment was conducted during the *kharif* season of 2021 at the Research cum Instructional Farm, Kumharawand, Jagdalpur, Bastar (Chhattisgarh) to study the seasonal incidence of major insect pests on rice. Studies on the seasonal incidence of insect pests of rice revealed fourmajor insect pests *viz*., gall midge *Orseolia oryzae*, stem borer *Scirpophaga incertulas*, leaffolder *Cnaphalocrocis medinalis* and whorl maggot *Hydrellia sasakii* were recorded. Attack of gall midge in the form of silver shoots commenced from September to October. The peak incidence was noticed during 41st SMW with 44.49%. Similarly, the peak damage of stem borer (dead hearts) were observed during 37th SMW of September and white ears were observed during 46th SMW of November with 2.08 and 12.39% damage, respectively. During the study, leaffolder and whorl maggot damage reached its peak infestation on 45th SMW of November and 36th SMW during September with 2.97 and 16.63% damage, respectively. Correlation analysis revealed that all pests, *viz*., gall midge, stem borer, whorl maggot were significantly positively correlated with maximum temperature, minimum temperature and morning relative humidity (RH-I) while, leaffolder were significantly negatively correlated with evening relative humidity (RH-II).

Keywords: Gall midge, Leaf folder, Rice insect pest, Seasonal incidence, Whorl maggot, Yellow stem borer

Field Evaluation of Rice Genotypes against Leaf Folder, *Cnaphalocrocis medinalis* (Guenee)

Paramasiva I.[1*], Srilakshmi Ch.[2], Madhusudhan P.[3], Vineetha U.[4] and Sameera S.K.[2]

[1]Dept. of Entomology, [2]Dept. of Plant Breeding, [3]Dept. of Pathology, [4]Dept. of Agronomy, Agricultural Research Station, Nellore, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh (522 034), India

E-mail: i.paramasiva@angrau.ac.in

Abstract

Field evaluation of 72 promising rice genotypes under natural field infestation of leaf folder carried out at Agricultural Research Station, Nellore, Andhra Pradesh (Acharya N.G. Ranga Agricultural Research Station, Lam, Guntur) under All India Co-ordinated Rice Improvement Project during *kharif*, 2021-22. Leaf folder incidence in terms of damaged leaves was recorded at 60 and 80 days after transplantation. Seventy two rice cultivars along with TN1 (susceptible check) and W1263 (resistant check) were sown in a single row of each line. Sowing was done on 26.08.2021 and one month old seedlings were transplanted in length of 330 cm if each line with row to row and plant to plant spacing of 20×15 cm. One seedling was transplanted hill^{-1} and susceptible check TN1 and resistant check W1263 was planted as a skip row after every ten cultivars. All recommended package of practices were adapted, but without any insecticide application. Observations on total number of leaves and total number of leaf folder damaged leaves in twenty hills in each line were recorded and mean percent damage was calculated. Across 72 genotypes screened leaf folder incidence was ranged from 4.37 to 31.02% at 60 days after transplantation (DAT) and from 9.51 to 90.28% and 80 days after transplantation. Out of 72 lines BPT 2677 (6.48%) and BPT 2984 (8.61%) recorded below 10% mean leaf damage and found to be resistant/ tolerant to leaf folder at 60 DAT, whereas, on TN1 27.76% leaf damage was recorded at 60 days after transplantation and on resistant check W1263 4.37% leaf damage was noticed. At 80 days after transplantation BPT 2677 (9.62%) and BPT 3081 (9.78%) recorded below 10% mean leaf damage and found to be resistant/ tolerant to leaf folder incidence, where as in TN1 90.28% and on W1263 9.62% leaf damage was recorded.

Keywords: *Cnaphalocrocis medinalis*, Damage, Leaf folder, Rice genotypes, Yield

Host-Pathogen Interaction of *Alternaria brassicae* and Brassica *juncea* Introgression Lines Developed from *Diplotaxis erucoides*, A Crop Wild Relative of Brassica

Anamika Kashyap[1], Shuja Ahmad[1], Pooja Garg[1], Jyoti Sharma[1], Shiv Shankar Sharma[1], Shikha Tripathi[1], Ranjeet Kushwaha[1], Sujata Kumari[1], Navin C. Gupta[1], Usha Pant[2], Ashish Kumar[1], Ramcharan Bhattacharya[1] and Mahesh Rao[1*]

[1]ICAR-National Institute for Plant Biotechnology, Pusa Campus, Delhi (110 012), India
[2]Govind Ballabh Pant University of Technology and Agriculture (GBPUAT), Pantnagar, Uttarakhand (263 145), India

E-mail: mraoicar@gmail.com

Abstract

Brassica juncea, a plant species within the Brassicaceae family, is a vital and widely cultivated oilseed crop in India. However, its potential yield is often hindered by numerous fungal diseases. One of the devastating diseases is Alternaria blight, caused by the necrotrophic pathogenic fungus *Alternaria brassicae*, which is the most common and concerning. In India, the pathogenic fungus Alternaria significantly reduces oilseed brassica productivity and quality, leading to substantial economic losses by infecting various plant tissues, *viz*., leaf and stem. This infection manifests as concentric circular, black lesions on the plant's leaves, often accompanied by a yellow halo or ring-like structures around them. The disease can spread through infected seeds or plant debris and thrives in warm and humid conditions. Genetic resistance to this disease is not reported within cultivated germplasms. However, a promising avenue exists for acquiring resistance gene(s) against such pathogens through Crop Wild Relatives (CWR). We have identified a few wild species that are immune to the *Alternaria brassicae*, and one of them, *Diplotaxis erucoides*, was used to transfer the gene(s) for *A. brassicae* resistance through wide hybridization and develop the alien introgression lines in *B. juncea*. We have developed these introgression lines by utilizing a bridge species, *i.e.*, *B. rapa*, which was first crossed with *D. erucoides* followed by the colchicine treatment for developing a transitional intermediate synthetic amphidiploid named "Erurapa". Further, the allotetraploid *B. juncea* was crossed and backcrossed with Erurapa, followed by selfing in subsequent generations to develop advanced introgression lines. After multiyear evaluation under natural hot spot locations and controlled conditions, two highly resistant and highly susceptible lines were identified and used for the host-pathogen interactions and parental lines to understand the microscopic and biochemical basis of resistance and susceptibility. We have analyzed these genotypes at different time points after inoculation under microscopic study, fluorescent and electron microscope, for different disease progression and development parameters. Also, we have analyzed the selected samples for different biochemical parameters along with gene expression analysis of the already reported gene(s) responsible for the fungal disease resistance to validate the results. The study delves into how Alternaria affects Brassica, comparing 'susceptible' and 'resistant' genotypes at various intervals.The identified resistant introgression lines will be further utilized to identify the underlying gene(s). They can be further used to develop the Alternaria blight resistance Brassica cultivars.

Keywords: *Alternaria brassicae*, *Brassica juncea*, Brassica, Crop, *Diplotaxis erucoides*, Host-pathogen

Recent Trends in Genetic Improvement of Insect Pathogens

Swagata Kota*, Vivek Kumar, Anindita Maity, Tithi Purkait Khan, Susangeeta Sahoo and Swarnali Bhattacharya

Dept. of Agricultural Entomology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: kotalswagata@gmail.com

Abstract

With the rising global population and deteriorating environmental condition, the demand for an effective and sustainable alternative to chemical pesticides is increasing. Genetic improvement is a transformative strategy in the arena of entomopathogen based pest management. They have addressed the shortcomings in traditional microbial pest control agents. Numerous research works are ongoing, which involve a detailed understanding of specific gene sequences and purposeful modification of genetic material to incorporate specific traits that aid in their efficacy in pest control. However, a significant portion of this research lacks systemisation and classification. Therefore, there is a need to analyse the existing knowledge in this field. Hence, this paper brings about a review of literature on recent genetic improvement in insect pathogens. Many research papers on this topic published between the year 1997 and 2023 have been assessed. This paper mainly evaluates recent research through citation analysis and content analysis to classify the primary areas of focus currently attracting the interest of the academic community such as use of genome editing, CRISPR-Cas9, advancement in genetic blueprint studies of insect pathogens etc. Despite the diverse route in investigation, this paper specifically reviews specific themes researched in three categories of insect pathogens: bacteria, fungi and viruses. These past few decades, research on the genomics, molecular mechanisms, genetic modifications, host- pathogen gene interaction in microbial pest control strategy is dominated by various strains of *Bacillus thuringiensis*, some commonly experimented entomopathogenic fungi like *Beauveria bassiana*, *Metarhizium anisopliae* and various strains of baculoviruses. This paper explores how they assist in host selection, infection, spread and enhanced virulence of the entomopathogens. This review paper also outlines the prospects of integrating emerging molecular technologies into present pest management strategy in consideration of growing global population and environmental sustainability.

Keywords: *Bacillus thuringiensis*, CRISPR-Cas9, Gene editing, Insect pathogens, Microbial pest, rDNA technology

Feeding and Reproductive Ecology of Rodents: A Review

K. Sindhura Bhairavi*, Ratul Kumar Borah, Badal Bhattacharyya and Shimantini Borkataki

Dept. of Entomology, Assam Agricultural University, Jorhat, Assam (785 013), India

E-mail: sindhurak111@gmail.com

Abstract

Rodents are the most populous and widespread vertebrate pest of agriculture. It is a major cause of crop losses in fields and storage grains resulting in huge economic losses annually. Despite its huge economic importance, little is known about the pest in terms of its habitat, feeding habits, reproduction patterns and population dynamics. Due to the lack of proper knowledge, rodents are one of the most difficult pests to control in the agro-ecosystems. The management practices that exist are mostly chemo-centric and are often unreliable in controlling the populations. Hence, to develop efficient management strategies, it is important to gain a better insight into the ecology of rodents, both feeding and reproductive. This paper attempts to discuss the feeding and reproductive ecology of rodents, specifically but not limited to the agro-ecosystem.

Keywords: Feeding ecology, Pest management, Reproductive ecology, Rodents, Vertebrate pest

Influence of Gamma Radiation against Disease Stress Tolerance and on Yield Attributes of Wheat

Sunita Mahapatra*, Anubhab Hooi and Sunanda Chakraborty

Dept. of Plant Pathology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741252), India

Abstract

E-mail: sunita.mahapatra071@gmail.com

Considering the importance of wheat as a staple and the need for developing elite wheat genotypes, two wheat varieties DBW 187 and K 1006 were irradiated at six different doses (200, 250, 300, 350, 400 and 450 Gy) using a Cobalt-60 source at Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, and evaluated for quality traits and disease tolerance. Seed germination, survivability and seedling length of the irradiated seeds were measured at 7 days after sowing in laboratory experiments, while plant height, disease severity (leaf rust and spot blotch), panicle length, grains panicle^{-1} and 1000 seed weight was recorded for field studies. It was observed that seed germination, survivability and seedling length declined with the increase in gamma radiation dose. The germination percentage showed significant differences among treatments (100 to 75%), while the survival percentage exhibited significant differences from 200 to 300 Gy in both the varieties. A pragmatic reduction in growth was observed in the treatments with an increase in dose of radiation. Furthermore, mutants at 200 Gy showed higher plant height as well as biotic stress tolerance (spot blotch and leaf rust). Probit analysis revealed the LD50 for DBW 187 and K 1006 to be 272.71 and 278.61 respectively, while the GR50 values were 316.22 and 346.73 for DBW 187 and K 1006 respectively under laboratory conditions. The GR50 for field observations were 341.19 Gy and 339.70 Gy for DBW 187 and K 1006 respectively. Negative correlations were established for most of the considered parameters along with a positive association with leaf rust, and spot blotch. These findings are promising tools for exploring the implication of mutation on genetic mechanisms and the transfer of complex traits on elite genotypes.

Keywords: Disease tolerance, Gamma irradiation, Quality traits, *Triticum aestivum* L.

Control of Powdery Mildew Disease of Mango (*Mangifera indica* L.) by Some Yeast Based Bio-Formulations

Ankita Roy[1]*, Debalina Majhi[1], Moumita Panda[2], Birendranath Panja[2] and Jayanta Saha[2]

[1]AICRP on Fruits, Mohanpur Center, BCKV, Nadia, West Bengal (741 252), India
[2]Dept. of Plant Pathology, Faculty of Agriculture, BCKV, Mohanpur, Nadia, West Bengal (741 252), India

Abstract

E-mail: ankipatho.roy@gmail.com

Powdery mildew disease of mango, caused by *Oidium mangiferae* Berthet., is a widespread and most important disease of mango in India which causes blossom infection and ultimately affects fruit set and causes fruit drop, resulting heavy yield loss. Experiment was conducted with the aim to reduce powdery mildew diseases of mango using healthy and environmentally safe bioformulations of two yeasts (YDP27 and YDP41). YDP27 and YDP41 were formulated with different ratio of *Aloe vera* juice along with NaCl, Sorbitol and Ascorbic acid as additives. The yeast bioformulations were sprayed @ 10 ml l^{-1} with 0.1% xanthum gum on healthy mango panicles (var: himsagar) along with fungicide treatment (Sulfex @ 2 g l^{-1}) and untreated control. Spore suspension of powdery mildew fungus has been prepared from powdery mildew infected panicle and mixed with Tween 80 and sprayed over treated panicles 18 hours after yeast bioformulation application. The yeast bioformulations successfully reduced the incidence and severity of powdery mildew of mango compared with the fungicide treatment (Sulfex @ 2 g l^{-1}). The findings of the experiment indicates the high potentiality of yeast bioformulations to minimize powdery mildew diseases and could be developed further as safe and alternative plant disease management strategy.

Keywords: Bioformulation, *Mangifera indica* L., Mango, Powdery mildew, Yeast

Host Parasitoid Interaction and Its Implication in IPM

Tithi Purkait Khan*, Swagata Kotal, Anindita Maity, Susangeeta Sahoo, Vivek Kumar and Swarnali Bhattacharya

Dept. of Agricultural Entomology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: khantithi95@gmail.com

Abstract

The intricate dynamics between host organisms and their parasitoids play a pivotal role in shaping ecological interactions within agro-ecosystems. This study explores the multifaceted relationships between hosts and parasitoids, with a specific focus on their implications for Integrated Pest Management (IPM) strategies. The parasitoid's ability to regulate host populations, influenced by factors such as host physiology, behavior and environmental conditions, underscores its potential as a key player in sustainable pest control. Understanding the mechanisms governing host-parasitoid interactions provides valuable insights into the development of targeted IPM approaches. These may include the augmentation of natural enemies, conservation of parasitoid habitats and the implementation of biological control measures. Additionally, the influence of agricultural practices on the biodiversity and abundance of parasitoids is discussed, emphasizing the importance of ecosystem-based approaches in enhancing the resilience of agro-ecosystems. In conclusion, host-parasitoid interactions help in shaping the dynamics of agro-ecosystems and advocates for their thoughtful integration into IPM strategies. By capitalizing on the inherent biological control mechanisms offered by parasitoids, agricultural systems can move towards a more sustainable and resilient future, balancing the imperatives of crop protection with environmental conservation.

Keywords: Biological control, Ecological interactions, Host Parasitoid interaction, IPM

Taxonomic Problem of Some Insect Pests of Mango

Anirban Das

Dept. of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: anirbandasbckv@gmail.com

Abstract

Mango is a very important fruit cultivated in tropical and subtropical regions of the world and so, its insect pests are of interest of farmers and scientists. There are some insect pests of mango which are suffering from the problems of identity, nomenclature or having inaccurate systematic position in the phylogeny. As taxonomy is a dynamic subject, the taxonomic status of many mango pests has been changed through time. However, some of these changes in taxonomy are either ignored or yet to be accepted and practiced by the biologists. Here current taxonomies of important mango pest species have been reviewed. There is some ambiguity in the correct scientific nomenclature of mango fruit borer. It is known by more than one name. The authorship of mango mealy bug *Drosicha mangiferae* should be Stebbing instead of Green. The higher taxonomy of *Apsylla cistellata* (Buckton) is very unstable till date. Currently it is placed in the subfamily Rhinocolinae, family Aphalaridae of super family Psylloidea. Though *Idioscopus niveosparsus* (Lethierry) is synonymous with *I. nitidulus* (Walker) former is frequently found in most literature. The great problem is with the identity of two very closely related mango hoppers, *Idioscopus clypealis* (Leth.) and *I. nagpurensis* (Pruthi). There has been a long lasting confusion of their identity for almost 100 years. All previous authors mistakenly included *nagpurensis* in the perview of *clypealis*. Till date there remain some questions regarding taxonomy of these two species among the taxonomists to solve.

Keywords: Mango fruit borer, Mango hopper, Mango pests, Systemic position, Taxonomy

Composition and Diversity of Aquatic Insects of Majuli River Island of Assam

Shimantini Borkataki[1*], Badal Bhattacharyya[1] and Ritu Ranjan Taye[2]

[1]Dept. of Entomology, Assam Agricultural University, Jorhat, Assam (785 013), India
[2]AAU, Zonal Research Station, Karimganj, Assam (788 710), India

Abstract

E-mail: shimantini.borkataki@aau.ac.in

Studies on composition of aquatic insect fauna and their diversity were carried out at the largest river island of the world, Majuli during 2016-17. Seasonal surveys conducted during pre monsoon, monsoon, post monsoon and winter covering 3 locations, 15 villages and 60 sampling sites revealed the occurrence of 48 aquatic insect species belonging to 6 orders and 20 families. At order level, Odonata (47.92%) was the most dominant with the highest numbers of species (23) followed by Coleoptera and Hemiptera (9 species with 18.75% abundance each) and Ephemeroptera (3 species, 6.25% abundance). While studying the diversity indices, the highest aquatic insect species were registered in Lower Majuli (29 species) followed by Upper Majuli (24 species) and Central Majuli (17 species). Highest Shannon-Weiner Index (H' = 3.156), Simpson Index of Diversity (1-D = 0.983) and Evenness (E_H = 0.983) were recorded during monsoon season in Upper Majuli, whereas the lowest Shannon-Weiner Index (H' = 2.341), Simpson Index of Diversity (1-D = 0.913) and Evenness (E_H = 0.860) were registered during winter in Central Majuli.

Keywords: Aquatic, Composition, Diversity, Majuli

Evaluation of Different Insecticide Treatments against *Spodoptera frugiperda* in Maize

Snigdha Samanta[1*], Tanmoy Satpati[1] and Amitava Banerjee[2]

[1]Dept. of Agricultural Entomology, School of Agriculture and Allied Sciences, The Neotia University, Sarisha, West Bengal (743 368), India
[2]Dept. of Agricultural Entomology, B.C.K.V, Mohanpur, West Bengal (741 252), India

Abstract

E-mail: snigdhamanu23@gmail.com

The fall armyworm (*Spodoptera frugiperda*; J.E. Smith) (Lepidoptera: Noctuidae) is an important economic pest of corn and other crops in the Western Hemisphere. It is recorded to feed over a broad host range which includes around 80 host plant species. Keeping in mind the prevalence of maize cultivation in the Eastern region of India, greater dependence on insecticides, wide dispersal capacity and broad-spectrum crop preference of FAW, this invasive pest has raised a concern in all the scientific and farming communities of India. In the present investigation FAW was tested against different chemicals, *viz*., Chlorantraniliprole 9.3% + Lambda-cyhalothrin 4.6% ZC @ 35 g a.i. ha^{-1}, Cypermethrin 10EC @ 50 g a.i. ha^{-1}, Chlorantraniliprole 18.5% SC @ 40 g a.i. ha^{-1}, Emamectin benzoate 5% SG @ 200 g a.i. ha^{-1}, *Bacillus thuringiensis* var. *Kurstaki* @ 2 g l^{-1}, Novaluron 5.25% + Emamectin benzoate 0.9% w/w SC @ 92 g a.i. ha^{-1} and control (water). Applications of the abovementioned insecticides were done at 30 DAS and 50 DAS. The data on larval population in term of number of larvae $plant^{-1}$ of *S. frugiperda* in various treatments was recorded one day before and 1, 3, 7 days after each application during *Rabi* 2020-21 and *Rabi* 2021-22. Evaluation of different insecticide treatment against *Spodoptera frugiperda* in *Rabi* 2020-21 revealed that after one day of first spray (30 DAS) in all treatments there was reduction in population of *S. frugiperda*. Among all the treatments the highest mean number of larvae was found in Cypermethrin 10 EC, *i.e.*, 2.13 larvae $plant^{-1}$ in 1st year and 2.20 larvae $plant^{-1}$ in 2nd year, whereas the number was highest in control plot, *i.e.*, 2.73 larvae $plant^{-1}$ in 1st year and 2.80 larvae $plant^{-1}$ in 2nd year. In both the years Chlorantraniliprole 18.5% SC and Emamectin benzoate 5% SG showed the most effective results. Hence, these insecticides can be considered effective in reducing the FAW population.

Keywords: FAW, Insecticides, Invasive, Treatments

Cordyceps: The Killer Fungi Attacking Arthropods

Nikhitha Gangavarapu, Sourin Ray* and Swarnali Bhattacharya

Palli Siksha Bhavana, Institute of Agriculture, Visva Bharati University, Sriniketan, West Bengal (731 236), India

E-mail: sourinray8@gmail.com

Abstract

Cordyceps is a fungus of the division Ascomycota (sac fungi), containing more than 400 species. Most of the species of this genus are endoparasitoids, mainly on insects and other arthropods; few are parasitic on other fungi also. This fungus is widely distributed in Asian countries having hot and humid climate. Being entomopathogenic, they can be predominantly used as biocontrol agents. Some famous species under this include *Cordyceps sinensis*, *Cordyceps javanica*, *Cordyceps fumosorosea* and *Cordyceps militaris*, which produce bioactive compounds like cordycepin, ergosterol and polysaccharide. Now *Cordyceps sinensis* have been renamed as Ophio *Cordyceps sinensis*. In Tibet and China, these are known as Winter worms, Summer grass and Caterpillar fungus, and collecting them has become an important source of earning for local households. The Ophio *Cordyceps sinensis* is one of China's most valued medicinal fungi used for strengthening the body and restoring energy. They also have compounds for immunostimulating and antitumor activity. Despite these, they can be used as mycopesticide as it has a wide range of pathogenic activity against major pest of different orders.

Keywords: Bioactive compounds, Cordyceps, Endoparasitoid, Entomopathogenic fungi

Environmental Impact of Biopesticides and Botanicals

Susangeeta Sahoo*, Swagata Kotal, Anindita Maity, Tithi Purkait Khan, Vivek Kumar and Swarnali Bhattacharya

Dept. of Agricultural Entomology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: susangeetasahoo98@gmail.com

Abstract

Pesticides are widely used in agriculture for reducing the pest population to Economic threshold level and increasing the production in the field. This indiscriminate application of pesticides highlights their detrimental effects on the environment, humans, non-target creatures, plants, *etc*. Comprehending the ecological consequences, botanicals and biopesticides is essential for developing sustainable farming methods that efficiently control pests while preserving ecosystems. Biopesticides are environmentally benign and sustainable alternatives to chemical pesticides. Biopesticide is a formulation made from naturally occurring substances that controls pests by non-toxic mechanisms. Microbial, natural enemy, biochemical and transgenic pesticides are examples of biopesticides. Even if biopesticides have their own drawbacks - they react slowly, are less effective than chemical pesticides, are more susceptible to unfavourable environmental circumstances, *etc*. - they are nevertheless thought of as sustainable because they leave behind few harmful residues. As biopesticides have no maximum residue levels, they contribute to the development of an ecosystem for agriculture that is sustainable. Sustainable agriculture fuelled by biopesticides is socially acceptable, encourages economic output and fosters environmental stewardship. These environmentally friendly substitutes are thought to be less persistent and hazardous in the environment than insecticides made of synthetic chemicals. Despite being less harmful overall, they may still impact non-target species and their frequent applications could potentially result in unforeseen ecological consequences. Land, water and energy may be needed for the development and growth of plants for botany, which could have unintended implications. Biopesticides like *Bacillus thuringiensis* have shown remarkable negative impact on non-target organisms like silkworm. We can take the example of grapefruit extract that negatively affects the cocoon quality of mulberry silkworm or we can take the example of nicotine, sabadilla, ryania dust having a significant mortality rate of Honey bees. Although botanicals and biopesticides present a viable substitute for synthetic chemical pesticides, their application must be properly controlled and included into comprehensive pest management plans to reduce any possible adverse environmental consequences.

Keywords: Biopesticides, Chemical pesticides, Environment, Sustainable

Current Status of Invasive Insect-Pest in India and Their Management

Vivek Kumar*, Swagata Kotal, Anindita Maity, Tithi Purkait Khan, Susangeeta Sahoo and Swarnali Bhattacharya

Dept. of Agricultural Entomology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: vk142371@gmail.com

Abstract

Invasive species indeed pose a significant threat to agricultural biodiversity, human and animal health and forestry. The introduction of invasive species can lead to imbalances in ecosystems, economic losses and various ecological disruptions. As on date, a total of 32 invasive insect pests reported in India. The invasion of the pests in new areas sometimes leads to the outbreak of the pest due to lack of natural enemies who find favorable conditions in their new environment. Therefore, exploration should be made in the areas of origin of the pests or efforts should be made to search some effective natural enemies in the invaded area so that the pest population could be curtailed with in Economic Threshold Level. In India, the Directorate of Plant Protection Quarantine and Storage (DPPQ&S) plays a crucial role in implementing the Destructive Insect and Pest Act (DIPA), 1914. This is achieved through the Plant Quarantine Order, 2003, which aims to prevent the entry, establishment and spread of exotic plant pests to safeguard agriculture, horticulture and forest tree plants. To address this issue, various biological control options can be considered. Biological control involves the use of natural enemies, such as predators, parasitoids and pathogens, to regulate the population of invasive species. There is a need of the hour to adopt modern technologies for detecting insect pests at various levels. There is more scope for advanced research in the use of Near-infrared spectroscopy (NIR) (rapid method, no sample preparation), E-nose technology, machine vision (Effective in detecting external insects), electrical conductance (hidden internal infestation can be identified), development of sensor systems for early detection of insects and low-cost DNA barcoding technology for easy and quick identification of insect pests. Further, there should be an international policy (other than PRA) to predict the possible invasion/ incursion of the species to different countries and also to suggest mitigation measures every year that will help to save biodiversity, crop loss/ food security thereby increasing the economy of the nation.

Keywords: Biodiversity, E-nose technology, Invasive Insect, Natural enemies

Development of Insect Resistance towards Bio-Pesticide: A Review

Anindita Maity*, Swagata Kotal, Susangeeta Sahoo, Tithi Purkait Khan, Vivek Kumar and Swarnali Bhattacharya

Dept. of Agricultural Entomology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: susangeetasahoo98@gmail.com

Abstract

Pest management is largely dependent upon synthetic insecticides. However, due to the continuous and indiscriminate use of these pesticides it has created huge selective pressure on target pests ultimately resulting in insecticide resistance. There are also numerous reports of resistance of insect-pests towards both old and new generation insecticides. Biopesticides on the other hand has opened a better platform to combat insect-pests in an environmentally safe manner. Biopesticides include a wide range of compounds occurring naturally such as micro-organisms like bacteria, fungus, nematodes, protozoa or certain plant derived products that ensure plant protection from insect-pests and diseases. Over the last decade, the use of bio-pesticides has increased to curtail chemically derived insecticide resistance and to assure human health as well as environmental safety. This review work aims to understand the possibility of development of resistance towards bio-pesticides. Bio-pesticides are naturally synthesized or derived and have a broad mode of action therefore insects take a much longer time to build resistance towards bio-pesticides. But this does not convey that they are less vulnerable to resistance. If the active ingredient present in the biopesticides has a similar mode of action to chemical toxicant then insect -pests are more prone to develop resistance through several mechanisms like metabolic, genetic, or behavioral changes or by increased excretion or altered as well as reduced binding to the target site. In contrary if the mode of action is carried through an infection, then insects are less likely to build resistance. Bt pesticides are now more popular in the market and show promising action against various lepidopteran, dipteran and coleopteran pests but now pests also show resistance towards Bt pesticides. Transgenic crops manifesting *Bt* derived delta endotoxin effective against boll worm complex is also found to exhibit resistance. Botanicals act on multiple target sites in insects as a result the chances of development of resistance is lesser. However, a better understanding of resistance development is necessary to manage the warfare against the noxious pests.

Keywords: Biopesticides, Botanicals, Insect resistance, Mechanism of resistance

Study of Inheritance for Resistance to MYMV Disease in Greengram in Segregating Populations

G. Parimala*, Shouvik Gorai, Arpita Das and Anirban Maji

Dept. of Genetics and Plant Breeding, Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, West Bengal (741 252), India

E-mail: parimalagolla1996@gmail.com

Abstract

Green gram [*Vigna radiata* (L.) Wilczek] or mung bean is a short duration grain legume crop grown for its high quality easily digestible protein. It is used as a green manure crop and cover crop for enriching soil fertility due to its high atmospheric nitrogen fixation. It is a good source of easily digestible proteins with low flatulence, which balances the staple rice diet in Asia. The major constraint for green gram cultivation in India is yellow mosaic disease which causes significant yield reduction of about 75-100%. It is caused by whitefly (*Bemisia tabaci*) and transmitted by mungbean yellow mosaic virus (MYMV). Sixty mungbean genotypes were evaluated to identify the source of resistance against MYMV. The identified resistant and susceptible genotypes were crossed and the inheritance of resistance to Mungbean Yellow Mosaic Virus (MYMV) was studied. The study revealed that the genotypes identified MYMV resistance namely, IPM-4-10-3, ML-1008, MH-421 and KM-21-109; whereas susceptible was Sonamung-2. The crosses were made with susceptible and resistant genotypes. The F_2 generations of the four crosses along with the parents were screened for MYMV resistance in natural field conditions using infector rows of MYMV susceptible variety Sonamung. Each plant in the segregating generation of both the crosses was screened for MYMV resistance according to the MYMV score proposed by Alice and Nadarajan (2007). The chi-square test confirmed the segregation ratio of 3:1 susceptible: resistant plants in the F_2 generation of four crosses. This indicates that the MYMV resistance in green gram is controlled by monogenic recessive gene.

Keywords: F_2 population, Inheritance, Mungbean, MYMV

Molecular Screening of Red Rice Genotypes to Identify Resistant Lines against Brown Plant Hopper, BPH (Nilaparvata lugens Stal)

Prajna Pati[1,2*], Swarnali Bhattacharya[2], Mayabini Jena[3], Santosh Kumar Behera[3] and Raghu S.[4]

[1]Dept. of Entomology, Institute of Agricultural Sciences (IAS), SOADU, Bhubaneswar, Odisha (751 030), India
[2]Dept. of Agricultural Entomology, Palli-Siksha Bhavana, Visva-Bharati, Srininiketan, West Bengal (731 236), India
[3]Dept. of Agricultural Entomology, Indira Gandhi Krishi Viswa Vidyalaya (IGKV), Raipur, Chhattisgarh (492 012), India
[4]Crop Protection Division, ICAR-National Rice Research Institute (NRRI), Cuttack, Odisha (753 006), India

E-mail: prajnapriyadarshinipreetimayee@gmail.com

Abstract

Brown plant hopper (*Nilaparvata lugens* Stal.) is the most destructive insect pest in all the rice growing regions of the world. The pest is very difficult to control only through the blanket application of pesticides. The development and cultivation of stable, durable BPH-resistant rice variety is the most economical and efficient strategy to manage the BPH. Land races possess numerous nutritional and stress resistant properties. In the present study, 215 red rice genotypes were evaluated for their resistance to BPH. Mass screening of 251 red rice genotypes were conducted followed by replication screening for confirmation of resistance against rice BPH, the devastating pest of rice in India and only 28 accessions found to be promising with different resistant categories. Resistant genotypes were further studied using 38 Bph gene linked SSR markers and analysis were done through different software like DARWIN, TASSEL and resistance gene responsible for Bph resistance were studied.Known gene differentials for BPH such as IR 64 (Bph1), IR 36 (bph2), ASD 7 (bph2), Swarnalata (Bph6), T 12 (bph7), Chinsaba (bph8), Pokkali (bph9) and Rathu Heenati (Bph3, þBph17) included in the study for comparison. The genotype Bavdi was moderately resistant; whereas, three others were highly resistant along with previously NRRI-identified donors of BPH such as Salkathi, Dhobnumbari. Genetic diversity analysis of all the genotypes through 38 gene-linked markers of BPH resistance categorized them into 3 major clusters. The phenotypically highly resistant genotypes were grouped together under the same major cluster III indicating their similar genetic background, but there were other resistant materials which were grouped differently showing their genetic diversity. The resistant genotypes can be utilized as efficient donors for developing rice varieties with resistance to BPH.

Keywords: Brown plant hopper, Molecular variability, Red rice, Screening

Salicylic Acid and Chitosan Dependant Defense Contributes to Resistance against Rice Sheath Blight Pathogen, Rhizoctonia solani

Raghu Shivappa[1*], Sushree Rajlaxmi Biswal[2], Jeevan B.[1], Baite M.S.[3], Pati P.[4], Prabhukarthikeyan S.R.[1], Gurupirasanna Pandi G.[1], Jambulkar N.N.[5], Bag M.K.[1] and S.D. Mohapatra[1]

[1]Crop Protection Division, ICAR-National Rice Research Institute (NRRI), Cuttack, Odisha (753 006), India
[2]Dept. of Biotechnology, Gandhi Institute of Engineering & Technology University (GIET), Gunupur, Rayagada, Odisha (765 022), India
[3]ICAR-Research Complex for NEH Region, Nagaland Centre, Medziphema, Dimapur, Nagaland (797 106), India
[4]Dept. of Entomology, Institute of Agricultural Sciences (IAS), Siksha 'O' Anusandhan deemed to be University (SOA), Bhubaneswar, Odisha (751 030), India
[5]Social Science Division, ICAR-National Rice Research Institute (NRRI), Cuttack, Odisha (753 006), India

Abstract

E-mail: raghurm531@gmail.com

Salicylic acid and chitosan are known for their antimicrobial activities against several pests and pathogens in crop plants. *Rhizoctonia solani* Khun (AG-1 IA) is the most destructive fungal pathogen causes sheath blight of rice leading to severe yield loss. Unfortunately, no cultivar is completely resistant to the disease. Application of chemical fungicide is not eco-friendly and economical. Hence, management of the disease with chemical elicitors may provide better control of the disease. To understand the effect of seed priming and foliar application of Salicylic acid and Chitosan, on plant growth, disease reduction, and yield of rice, an experiment was undertaken for two seasons in varieties Tapaswini and CR-1014. The results showed that, salicylic acid and chitosan both were significantly effective in inhibiting the pathogen growth under *in vitro* (100%). Seed priming also had significant effect on plant growth parameters with *T-3* performing ($p<0.001$) best with enhanced germination (>93%), seedling vigor and total plant biomass. Induction of systemic acquired resistance (SAR) against *R. solani* though seed priming and foliar application by significant reduction in sheath blight incidence (60.20 and 64.84% respectively in both test varieties) over control was evidenced in present study. Quantitative estimation of different defense enzymes involved disease resistance at different crop growth stages shown that, the activities of peroxidase (POD; EC 1.11.1.7), phenylalanine ammonia lyase (PAL: EC 4.3.1.24) and chitinase enhanced in elicitor treated plants compared to pathogen control. The biochemical studies were validated by histopathological study to confirm the formation of resistant structures. SDS PAGE analysis confirmed the pathogenesis related protein (PR) bands at 28.2kDa and 19.5kDa in T-3 in presence of sheath blight disease. Maximum yield (62.83 & 47.42 g pot^{-1}) was recorded in same treatment. These results suggest that, both Salicylic acid and Chitosan can induce defense response in rice against sheath blight disease and also enhance plant growth.

Keywords: Defense-related enzymes, Elicitors, Induction of disease resistance, PR proteins, rice, *Rhizoctonia solani*, Sheath blight

Revolutionizing Mosquito Control: A Sustainable Approach with Eco-Friendly Mosquito Attractant Technology

Anirban Dhar

lmions Innovations, Purbachal Kalitala Road, Kolkata, West Bengal (700 078), India

Abstract

E-mail: almightycreations36@gmail.com

In the perpetual battle against mosquitoes, traditional repellents have proven to be short-lived and environmentally harmful. The increasing resilience of mosquitoes to artificial chemicals has intensified the need for an innovative and sustainable solution. Recognizing this issue, we present a groundbreaking solution - a revolutionary mosquito attractant technology.

Our work represents a paradigm shift in mosquito control, harnessing the power of nature. Through a meticulous blend of natural juices and herbs, we have created a mosquito attractant solution that acts as an enticing energy drink for them.

However, the concoction, while energizing for mosquitoes, carries a herbal toxic mixture that proves fatal upon ingestion. As mosquitoes consume this energy concoction, they unknowingly ingest the herbal mixture that is toxic to them, leading to a sustainable reduction in their population.

This innovative approach offers a sustainable, eco-friendly solution to the longstanding mosquito problem. By addressing the shortcomings of traditional repellents and embracing the power of natural ingredients, our work aims to reduce mosquito populations effectively while maintaining harmony with environment and human health.

Keywords: Eco-Friendly, Mosquito control, Mosquito attractant technology, Sustainable approach

Impact of Iron-Modified Parthenium Biochar on Heavy Metal Uptake in Rice in an Industrial Wastewater Irrigated Soil

Sayon Mukherjee* and S.K. Singh

Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India

E-mail: sayon2808@gmail.com

Abstract

Parthenium, a noxious exotic weed has created a potential threat to agricultural practices in recent years. One of the potential ways to reduce the environmental impact of this weed is to make biochar. Toxic heavy metals are released through industrial activity, get accumulated in agricultural soil through irrigation of industrial wastewater. Rice, grown under submerged condition uptake heavy metals in higher proportions in grains leading to bioaccumulation and toxicity in human body. Biochar, due to its higher surface area and surface-active functional groups, absorbs heavy metals. Modification of parthenium biochar using $FeCl_3 \cdot 6H_2O$ has been proved to enhance the retention power of heavy metals. Thus, reduction of heavy metal uptake in rice plant has been observed in our study after application of graded dose of simple and Fe-modified parthenium biochar. Among the simple biochar (SB) and iron modified biochar (FEB), FEB performed better. Plant height, tiller no, SPAD value has been increased significantly after addition of graded dose of biochar after 90 days after transplanting. So, it can be established that use of iron modified parthenium biochar can be a promising technology to reduce heavy metals uptake and its subsequent toxicity to plant.

Keywords: Biochar, Heavy metal, Industrial wastewater, Parthenium, Rice

Salinity Stress Investigation in Different Rice Varieties: Morphological and Biochemical Analysis

Shivani Singh and A.K. Shukla*

Dept. of Botany, IGNTU, Amarkantak, Madhya Pradesh (484 887), India

E-mail: awadhesh.shukla@igntu.ac.in

Abstract

Rice (*Oryza sativa* L.) is the world's second-most-important cereal crop. It belongs to the genus *Oryza* and family Poaceae, has great economic importance. In 2022, the domestic consumption volume of rice was over 109 million metric tons in India. Roughly one-half of the world population, including virtually all of East and Southeast Asia, is wholly dependent upon rice as a staple food and 95% of the world's rice crop is eaten by humans. Abiotic stresses such as drought, temperature, flooding, metal toxicity, nutrient deficiency and salinity are believed to cause major problems in agriculture by reducing crop growth and productivity. Salinity is regarded as a major environmental constraint to crop productivity worldwide. More than 6% of the world land areas are either salinity affected. Due to the human activities and natural causes, soil salinization is increasing. The high concentration of salt in the soil makes it harder for roots to uptake water and nutrients, therefore inducing ion imbalances and water stress in plants, it also affects the morphological, physiological and biochemical characteristics of rice plants, which vary with the growth stages, including reductions in plant height, productive tiller number, biomass, grain yield, filled grain panicle^{-1}, grain weight, grain quality and photosynthetic activity. In the present study, two common varieties of rice (MTU1010 and IR 64) of Madhya Pradesh, India were taken. NaCl stress was given for 12 days at seed stage at different concentrations following with control. Morphological investigation under the laboratory conditions that is germination percentage, length of root and shoot was examined. Also biochemical parameters including chlorophyll content, water relation studies and antioxidant activities were analysed. As the concentration was increased the germination percentage decreases following the root and shoot growth. Apart from this, the biochemical analysis showed variations in both varieties.

Keywords: Abiotic Stress, Antioxidant, Biochemical analysis, Rice, Salinity

Assessing Fe-Deficiency Tolerance in Rice Genotypes and Strategies for Mitigation in Aerobic Cultivation

Pooja Tamuk* and Tapan Jyoti Purakayastha

Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi (110 012), India

E-mail: tamukpooja09@gmail.com

Abstract

Fe deficiency is a critical nutritional disorder in aerobic rice cultivation on alkaline and calcareous soils. It directly affects grain quality, productivity and indirectly, human health. Rice genotypes exhibit varying degrees of tolerance to Fe deficiency. Therefore, it becomes essential to identify tolerant genotypes, especially under Fe-deficient soil conditions. In a pot experiment, ten rice genotypes were grown in both Fe-deficient (~2.1 ppm Fe) and Fe-sufficient (~10 ppm Fe) soils under aerobic conditions. Fe Deficiency Tolerance Index (FeDTI) was calculated based on various growth and physiological attributes, as well as Fe uptake and accumulation, to distinguish between Fe-deficient tolerant and sensitive rice genotypes. A second pot experiment was conducted using two rice genotypes identified as Fe-deficient tolerant (Danteshwani) and Fe-deficient sensitive rice genotype (Sona Mahsuri) under both Fe-deficient (FeDS) and Fe-sufficient soil (FeSS) conditions in an aerobic condition. Overall, Danteshwani outperformed Sona Mahsuri in both soil conditions. Among the treatments, seed treatment with a consortium of *Pseudomonas plecoglossida* and *Panteo agglomerans* proved to be the most promising strategy, resulting in higher leaf greenness, grain Fe content and grain yield.

Keywords: Aerobic condition, Biological intervention, FeDTI, Fe uptake, Rice genotype

Breeding for Abiotic Stress Resistance in Flower Crops

Shreedhar Beese*, S.R. Dhiman, Puja Sharma and Neha Grace Angel Kisku

Dept. of Floriculture and Landscape Architecture, Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh (173 230), India

E-mail: shridhar.rb38@gmail.com

Abstract

Abiotic stress is a significant issue affecting vast regions of India, arising from factors like extreme temperatures (both low and high), drought and salinity. These stressors impose substantial limitations on crop growth and overall productivity. While considerable attention has been devoted to addressing these challenges in staple crops, ornamental crops have received relatively limited focus. However, ornamental crops now emerge as a potential source of higher income in comparison to traditional crops and play a crucial role in the national economy. One of the contemporary challenges is to breed ornamental varieties that can thrive in stressful environments. Several strategies have been developed to enhance abiotic stress tolerance in plants, yet only a few have shown promise in the context of ornamental crops. Wide distant hybridization, involving crosses between different species and genera, has emerged as a fundamental approach with significant potential. This strategy aims to enhance drought tolerance in certain crops by introducing abiotic stress-tolerant traits from their wild relatives into cultivated ornamental varieties. Another vital technique is in vitro mutagenesis, which combines tissue culture methods with induced mutation strategies to improve stress tolerance and enhance crop yield and quality. Genetic engineering stands out as the latest technology employed in breeding programs. It offers a relatively straightforward means to introduce novel traits such as new colors, as well as enhanced tolerance to both biotic and abiotic stresses in ornamental crops. Unlike conventional breeding, genetic transformation can facilitate the achievement of these desired characteristics. In summary, addressing abiotic stress in ornamental crops is a crucial challenge in India and various strategies, including wide distant hybridization, *in vitro* mutagenesis and genetic engineering, offer potential solutions to enhance stress tolerance and overall crop quality.

Keywords: Abiotic stress, Crop breeding, Genetic engineering, *In vitro* mutagenesis, Novel traits, Stress tolerance

Effect of Boron on Physiological and Biochemical Changes in Darjeeling Mandarin Seedlings (*Citrus reticulata* Blanco.) under Aluminium Toxicity

Novin Chamling* and Nilesh Bhowmick

Dept. of Pomology and Postharvest Technology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal (736 165), India

E-mail: novinchamling354@gmail.com

Abstract

Darjeeling Mandarin also known as "Suntala" is one of the commercial fruit crops grown in Darjeeling and Kalimpong regions of West Bengal. But in recent past years, the production has been declined drastically due to some of the underlying biotic and abiotic factors. The soil condition in this region are mainly acidic in nature that has a complex interaction of growth limiting factors that can restricts growth by inducing stress on plants through triggering aluminium stress and micronutrient deficiency. Aluminium (Al) toxicity which is one of the most important soil constraints for plant growth and development in acid soils (pH<5.5) triggering the deficiency of micronutrients in plants. Boron (B) is an essential micronutrient for the growth and development of higher plants. Alleviation of aluminium toxicity by boron has been well discussed by many researchers. Various studies have been conducted to explore the cause behind mandarin orange declination. However, none of the studies have been investigated in Darjeeling mandarin in response to boron under aluminium stress condition. Keeping this in view, the current experiment was undertaken to investigate the effect of boron on physiological and biochemical changes in Darjeeling mandarin seedlings (*Citrus reticulata* Blanco.) under aluminium toxicity. The mandarin seedlings were grown in pot containing sand media and fertilized with Hoagland solution containing four levels of boron (*i.e.*, 0 µM, 5 µM, 10 µM and 25 µM H_3BO_3) and two level of aluminium (*i.e.*, 0 µM and 1200 µM $AlCl_3 \cdot 6\ H_2O$). Mandarin seedlings grown without boron and aluminium were treated as the control. Characters such as relative water content, photosynthetic parameters, ascorbic acid, protein content, proline content were directly affected negatively under aluminium stress condition. Whereas the application of boron played an important role in improving the following characters of mandarin seedlings under aluminium stress resulting in overall better performance of mandarin seedlings.

Keywords: Aluminium toxicity, Boron, *Citrus reticulata* Blanco., Mandarin Orange, Mitigation, Toxicity

Deep Water Rice of Assam - A Review

Manjilika Rajkhowa and Dharitri Borgohain*

Dept. of Botany, North Lakhimpur College (Autonomous), Lakhimpur, Assam (787 031), India

E-mail: dharitri.48@gmail.com

Abstract

Rice is the most important food crop which is consumed by half of the world's population everyday as a primary food source which provides 20% of the world's dietary energy supply. Although Assam is bestowed with varieties of rice strains, however it suffers from heavy rainfall from the month of April to September. During that time of the year, most of the regions get submerged due to flood and cultivation of the rice varieties is not feasible. Deep water rice varieties are basically grown in lowland and flood-prone conditions and serve as a blessing to the local communities and only means of subsistence for most of the people. Therefore, deep water rice has great agronomic importance in many densely populated areas where no other crop can be grown during monsoon or heavy rainfalls. This review focuses on the various directions in which different studies such as physiological, molecular, as well phytochemical investigations that were carried out on deep water rice in different parts of the world to study the flood tolerance properties as well as nutritional values.

Keywords: Deep water rice, Molecular, Physiological, Water stress tolerance

Influence of Mulch and Irrigation Schedules on Grain and Water Productivity in Spring Sunflower

Rakesh Dawar[1*], M.S. Pal[2], R.S. Bana[1], Deepak Kumar Meena[1] and Shital Kumar[1]

[1]Division of Agronomy, ICAR-Indian Agricultural Research Institute (IARI), New Delhi (110 012), India
[2]Dept. of Agronomy, G.B. Pant University of Agriculture and Technology, Pantnagar, US Nagar, Uttarakhand (263 145), India

E-mail: dawarrakesh601@gmail.com

Abstract

This field experiment, conducted during the spring season (March-July) of 2019 at GBPUAT, Pantnagar, Uttarakhand, India, aimed to assess the combined impact of mulching and irrigation scheduling on crop yield and water use efficiency (WUE). The study conducted in a split-plot design, evaluating three mulch levels (control, straw mulch at 6 tons ha^{-1}, and black polythene mulch) and four irrigation schedules (critical stages, 0.8, 1.0, and 1.2 IW/CPE ratios). Results indicated that polythene mulch significantly increased grain and stover yield, with comparable results to straw mulch, while the control exhibited the lowest yield. Polythene mulch also showed significantly higher water use efficiency compared to both the control and straw mulch. Irrigation at a 1.2 IW/CPE ratio resulted in the highest seed yield, surpassing yields from 1.0, 0.8 IW/CPE ratios, and critical stages by 5.4%, 11.1% and 14.8%, respectively. Similar trends were observed for total biological yield and harvest index. Water use efficiency was significantly highest when irrigation occurred at critical stages, while 0.8 and 1.0 IW/CPE ratios exhibited comparable efficiency. The lowest water use efficiency was recorded at a 1.2 IW/CPE ratio. In conclusion, the combination of polythene mulch with a 1.2 IW/CPE ratio demonstrated improved yield attributes (grain yield, stover yield, harvest index) and water use efficiency in the Tarai region of northern India. These findings underscore the potential for optimizing crop management practices to enhance agricultural productivity in similar agro-climatic regions.

Keywords: Crop yield, Irrigation. Mulching, Productivity, Water use efficiency

Agro-Physiological Traits based Selection of Wheat (*Triticum asetivum* L.) Cultivars for Tolerance against Terminal Heat Stress

J. Raj, S.K. Pathak, A.R. Chowdhury*, M. Ghosh, S.S. Acharya, S.B. Choudhary and Bhavya

Dept. of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, Bihar (813 210), India

E-mail: arnabuas@gmail.com

Abstract

The study aims at assessment of agro-physiological traits such as leaf area index (LAI) and Relative Water Content (RWC) to screen out tolerant wheat cultivar(s) against terminal heat stress and minimise yield penalty. Hence, a field experiment was laid out in split-plot design during *rabi* season of 2022-2023 at Sabour, Bhagalpur, Bihar to compare seven wheat cultivars (HD 3388, HD 3249, HD 3086, HD 2967, DBW 222, DBW 187 and PBW 826) for its dynamics of leaf area index and flag leaf relative water content under two different sowing windows *i.e.*, normal (3rd week of November) and late sown (3rd week of December) condition. Late sowing exposed the post-anthesis stage of wheat towards 4-5 °C higher temperature over normal sowing and led to reduction in LAI (15-16%) and RWC (12-16%) for all the cultivars in general (under late sown condition) which ultimately reduced grain yield to 34.17%. HD 3249 registered maximum yield (3.7 t ha^{-1}), irrespective of sowing windows even under higher intensity of terminal heat stress. HD 3249 was able to maintain significantly higher LAI over rest of the cultivars during flowering to 10 days after flowering under higher degree of terminal heat stress (delayed sowing). Lowest reduction of LAI was recorded for the cultivar HD 3249 during the interval. Maximum RWC in the flag leaf was also retained by cultivar HD 3249 during flowering to 10 DAF. This indicates HD 3249 could surpass other cultivars in intercepting solar radiation effectively with higher LAI and retained favourable water balance in its canopy. This ultimately leads to significantly higher grain yield (3.7 t ha^{-1}) of this cultivar over others. This study indicates a cultivar with higher retention of LAI during post anthesis period and favourable water balance are effective agro- physiological traits for selection of high performing cultivars under terminal heat stress.

Keywords: Terminal heat stress, Traits, *Triticum asetivum*, Wheat, Yield

Influence of Abiotic Factors on Pest Dynamics in Rapeseed Mustard

Pradip Kumar Patel and Sameer Kumar Singh*

Dept. of Entomology, College of Agriculture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh (224 229), India

E-mail: drsameerent@nduat.org

Abstract

The study highlighted four major insect pests; Mustard sawfly (*Athalia lugence proxima*), Mustard aphid (*Lipaphis erysimi*), Cabbage butterfly (*Pieris brassicae*) and Painted bug (*Bagrada hilaris*) known for inflicting significant damage during various growth stages of the crop. The highest incidence of Mustard sawfly was observed at 47th SMW (2.10 grubs plant^{-1}) during the crop's vegetative stage, showed a positive correlation with minimum temperature (0.325) and negative correlation with minimum RH and rainfall (-0.317 and -0.302); whereas significant positive correlation with maximum temperature (0.460*) and significant negative correlation with maximum RH (-0.568*). The maximum aphid population was recorded during the 5th SMW (126.90 aphids per 10 cm central twig plant^{-1}) at the silique formation stage, demonstrated a non-significant negative correlation with minimum and maximum temperature and rainfall (r = -0.358, -0.348 and -0.222, respectively), while displayed a non-significant positive correlation with minimum and maximum RH (r = 0.410 and 0.240, respectively). Notably, it exhibited a significant positive correlation with *Coccinella* spp. and syrphid fly (0.780** and 0.805*, respectively). The peak intensity of Cabbage butterfly was recorded during the 6th SMW (2.40 larvae plant^{-1}), displayed a significant negative correlation with maximum temperature (-0.632*) and significant positive correlation with minimum and maximum RH (r = 0.721** and 0.455*). However, it exhibited non-significant correlations with rainfall (-r = -0.015), minimum temperature (r = -0.437) and maximum RH (0.229). The highest incidence of the Painted bug was noticed during the 8th SMW (3.00 bugs plant^{-1}), exhibited a non-significant correlation with weather factors.

Keywords: Abiotic factors, Aphid population, Insect pests, Pest dynamics, Rapeseed mustard

Assessment of Carbohydrate Alteration in Chickpea under Terminal Drought Stress

Kinjal Mondal[1]*, Kamal Dev Sharma[2], Surender Singh Chandel[2], Shaik Munnysha[3] and Sukanya Dutta[4]

[1]*Dept. of Molecular Biology and Biotechnology,* [3]*Dept. of Plant Pathology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan (313 001), India*

[2]*Dept. of Agricultural Biotechnology, College of Agriculture, CSK Himachal Pradesh Agriculture University, Palampur, Himachal Pradesh (176 062), India*

[4]*Dept. of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal (741 252), India*

E-mail: kinjalmondal.cskhpkv2017@gmail.com

Abstract

A cool-season annual self-pollinated diploid (2n=2x=16) legume with a genomic size of about 740 Mbp, chickpeas (*Cicer arietinum* L.) are well-known for their superior resistance to drought. In order to better understand how the regulation of carbohydrate metabolism functions in chickpea under drought stress, alteration in the carbohydrate pool, the expression of genes involved in carbohydrate metabolism, and the relative water content (RWC) in the leaves of both drought-tolerant (ICC 8950) and drought-susceptible (ICC 3776) genotypes were investigated. Seven genes (*ADP-glucose pyrophosphorylase*, *Phospho-glucandikinase*, *Iso-Amylase3*, *Starch synthase4*, *Beta-amylase1*, *Beta-amylase3* and *Granule-bound starch synthase2*) involved in starch metabolism and three genes (*Sucrose-phosphate synthase2 like*, *UDP-glucose pyrophosphorylase* and *Cell wall invertase3LX2*) involved in sucrose metabolism were studied. Plant vulnerability to drought was shown by a decrease in RWC in the leaves of ICC 3776 compared to ICC 8950. Both genotypes exposed to terminal drought had considerably larger amounts of total sugars, reducing sugars, non-reducing sugars, and sucrose; however, the susceptible genotype showed a greater spike in each of these cases. In ICC 3776, the starch content rose, whereas in ICC 8950, it stayed same. Even though *Beta-amylase1* and *Iso-Aamylase3* were upregulated in the susceptible genotype, the main starch-degrading enzyme, *Beta-amylase3*, was downregulated while *starch synthase4* was simultaneously upregulated, contributing to the rise in starch. In ICC 8950, starch synthesizing as well as starch degradation enzymes with the exception of *Phospho-glucandikinase* downregulated. Increased accumulation of sucrose content in susceptible genotype compared to tolerant one under induced drought can be attributed to lower expression of *Cell wall invertase3LX2* in the susceptible genotype. The study provided insights into sugar metabolism in chickpea under terminal drought.

Keywords: Chickpea, ICC 3776, ICC 8950, RWC, Terminal drought

Application of Nanoparticles and Nano Sensors in Abiotic Stress Management

Aishik Sadhukhan

Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: sadhukhanaishik@gmail.com

Abstract

Abiotic stress has become one of the biggest threats to the farming community for the last few decades. Heavy metals toxicity, drought, salinity, cold stress and heat stress are the major abiotic stresses that adversely affect plant growth and drastically reduce the yield. Traditional approaches are not enough to fulfill the demand of the increasing human population. Some sustainable strategies are therefore necessary to overcome this problem and application of nanotechnology can prove to be promising in this context. Nanoparticles (NPs) can play an important role to combat against nutrient deficiencies, promote stress tolerance and improve the yield and quality of crops. In many cases nanoparticles keep some positive impact on plant performance under stress conditions. Nano sensors can be applied in agricultural field for identification of heavy metal ions, pollutants, temperature and humidity monitoring. Small size, compactness, effectiveness, uniqueness, sensitivity and low cost are the unique properties which make the nano sensors useful in the agricultural industry. Plants use hydrogen peroxide (H_2O_2) inside their leaves for communication. Nano sensors are made up of nanoscale particles such as nanoscale wires (high sensitivity to detection), thin films, carbon nanotubes (high surface area), nanoparticles and nanomaterials from polymers. When these sensors are placed on the plant leaf, they can easily detect the hydrogen peroxide signaling waves. There are a few recent works pertaining to use of nanoparticles in different sectors of agriculture. It is predicted that large scale use of nanoparticles will lead to precision farming and ultimately enhancing the productivity of crops with minimum input costs. This review article thus envisages to study the role and risk associated with the use of nanoparticles and nano sensors in agriculture.

Keywords: Abiotic stress, Nanoparticles, Nano sensors, Stress tolerance, Sustainable strategies

Phytochemical Characterization and Antioxidant Evaluation of Aqueous Extracts of *Parthenium hysterophorus* L.

Heena Choudhary and Ravindra Shukla*

Bioresource Technology Laboratory, Indira Gandhi National Tribal University, Amarkantak, Madhya Pradesh (484 887), India

E-mail: ravindra.shukla@igntu.ac.in

Abstract

Parthenium hysterophorus L. is an unwanted weed of the family Asteraceae. The plant is vigorous and invasive in cosmopolitan habitats. It was unintentionally brought to India and spread quickly throughout the nation. The plant was found to be tolerance to biotic and abiotic stresses. Over exposure of people and cattle to *P. hysterophorus* causes allergic responses, including mouth ulcers, asthma, dermatitis, fever, skin-burning and blisters around the eyes. Various ethnic communities of India are utilizing the plant in a variety of medical purposes, *i.e.*, treating fever, neurological conditions, diarrhea, dysentery, malaria, urinary tract infections and allergic respiratory issues. There are several kinds of allelochemicals in this herb that have negative effects. However, parthenium is a fascinating subject for study as it contains remarkable bioactive components such as polyphenols, alkaloids, terpenes, pseudoguaianolides and histamines. An imbalance in the synthesis and deposition of reactive oxygen species (ROS) in cells and tissues is known as a state of oxidative stress. Now-a-days, a number of natural antioxidant sources are in raising demands because of their lower cost and less adverse effects. Exhaustive research is required to explore further medicinal aspects of Parthenium for its antioxidant potential. It is much relevant as the need for safer and cost-effective substitutes for synthetic antioxidants. The present work investigates the phytochemical contents, antioxidant properties and quantitative analysis of *P. hysterophorus* extracts prepared from the stem, roots leaves and flowers. The varying aqueous concentrations of flower, stem and root extracts have shown moderate antioxidant activity. However, different concentrations of the leaf extract have showed strong antioxidant activity as compared to control.

Keywords: Antioxidants, Aqueous extracts, Medical uses, *Parthenium hysterophorus* L., Weed

Chemical Weed Management on Baby Corn (*Zea mays* L): A Review

Suhrid Teli*, Abhijit Saha and Bobilan Debbarma

Dept. of Agronomy, College of Agriculture-Tripura, Lembucherra, West Tripura (799 210), India

E-mail: agrisuhrid@gmail.com

Abstract

Baby corn is a dehusked maize ear harvested within 2-3 days of silk emergence, but prior to fertilization. Baby corn provides a viable option for crop diversification owing to its multi-uses such as vegetables for delicious human food, green fodder for quality livestock feed, raw material for canning and pickling food processing industries and enhancing profitability particularly in peri-urban areas. It also has massive potential for revenue generation and exports. Additionally, weed management has become increasingly important in modern intensive farming due to the ever-increasing use of fertilizer and irrigation water. This is because weed infestation during the summer season results in a 40-50% reduction in baby corn yield and farmers suffer a greater financial loss when their crop yields are lost entirely. The type of weed flora, the length of time and intensity of crop-weed competition and the size of losses are all important factors to reduce the harmful impacts of weeds on baby corn. The critical period of weed competition begins 17 to 29 days after baby corn is planted, with a 5% to 10% yield loss considered acceptable. A particular application of herbicides can't control all the community of weeds. The majority of researchers have reported that the pre-emergence and post-emergence application or either tank mix pre-emergency and post-emergence are most effective for weed control and greater yield of baby corn, as evidenced by considerably decreased dry weight of weeds and maximum weed control efficiency. Pre-emergence and post-emergence herbicide applications initially had a negative impact on the number of microorganisms in the soil shortly after they were applied. However, regular use of similar herbicides can lead to herbicide resistance, so it's important to investigate new herbicide options.

Keywords: Herbicides, Herbicides resistant, Soil microflora, Weed flora

Efficacy of Pre-Emergence Herbicide in Chickpea in Red and Laterite Soil of West Bengal

Sanij Ikbal[1], Anannya Mondal[2*], Mahua Banerjee[1] and Ganesh Chandra Malik[1]

[1]Dept. of Agronomy, Palli Siksha Bhavana, Visva-Bharati University, Sriniketan, Bolpur, West Bengal (731 236), India
[2]Dept. of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: ananyaagro5@gmail.com

Abstract

Chickpea (*Cicer arietinum* L.) also known as the gram, is the third most important food legume of the Fabaceae family. Weeds pose a serious threat to chickpea production by inflicting severe crop-weed competition for resources such as light, moisture, space and nutrients, leading to substantial crop yield losses. Keeping this in view, a field experiment was conducted at the Agricultural farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan during *rabi* season of 2018-19 to evaluate the efficacy of pre-emergence herbicides in Chickpea. Seven treatments namely, T_1: Flumioxazine 50% SL 75 g ha^{-1} at 3 days after sowing (DAS), T_2: Flumioxazine 50% SL 100 g ha^{-1} at 3 DAS, T_3: Flumioxazine 50% SL 125 g ha^{-1} at 3 DAS, T_4: Flumioxazine 50% SL 150 g ha^{-1} at 3 DAS, T_5: Pendimethalin 30% EC 750 g ha^{-1} at 3 DAS, T_6: Untreated control, T_7: Hand weeding at 20 and 40 DAS were laid out in a randomized block design with 3 replications. Results showed that following two hand weedings 20 & 40 DAS Flumioxazine 50% SL applied at 125 g ha^{-1} and 150 g ha^{-1} led to considerably higher weed control efficiency along greater yield attributes and yields. Besides Flumioxazine 50% SL 150 g ha^{-1} resulted in highest net returns of 92,832.00 INR ha^{-1} followed by Flumioxazine 50% SL 125 g ha^{-1} which, however, led to the highest benefit-cost ratio of 3.35. So, effective and economically viable weed management in chickpea under lateritic soil of West Bengal can be achieved by application of Flumioxazine 50% SL 125 g ha^{-1} at 3 DAS and also by adopting two hand-weeding at 20 and 40 DAS according to the availability of labours.

Keywords: Chickpea, Crop, Flumioxazine, Herbicide, Yield

Effect of Integrated Weed Management on Economics of Different Cultivars of Black Rice

H.M. Chishi*, D. Nongmaithem, L. Yosung, T. Malemnganbi, K.V. Awomi and G. Zion

Dept. of Agronomy, School of Agricultural Sciences, Nagaland University, Medziphema, Nagaland (797 106), India

E-mail: hillelchishihillel@gmail.com

Abstract

Field experiment was conducted to study the "Effect of integrated weed management on different cultivars of black rice and its economics" at the experimental farm of School of Agricultural Sciences (SAS), Nagaland University, Medziphema campus during *kharif* season of 2021 and 2022. The experiment was laid out in split plot design with four integrated weed management *viz.*, W_1: Weedy check (Control), W_2: Hand weeding (15 and 30 DAS), W_3: Pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS and W_4: Pretilachlor @ 1.0 kg ha^{-1} (PE) + Bispyribac sodium @ 25 g ha^{-1} (PoE) at 20 DAS in the main plots and four cultivars *viz.*, C_1: Chakhao Poireiton, C_2: Chakhao Amubi, C_3: Wairi Chakhao and C_4: Khurukhul Chakhao in the sub-plots and were replicated thrice. Based on the findings it was revealed that among the weed management practices minimum dry matter (9.08 g m^{-2}) and weed control efficiency of (78.69%) was recorded with hand weeding at 15 and 30 DAS and among the cultivars cultivar Chakhao Poireiton recorded the minimum dry matter (13.15 g m^{-2}) as well as weed control efficiency of (54.82%). The highest net return (Rs. 1,06,772.70) was also recorded with two hand weeding at 15 and 30 DAS however, highest B:C ratio (2.26) was recorded with application of pretilachlor @ 1.0 kg ha^{-1} (PE) *fb* HW at 40 DAS along with cultivar Chakhao Poireiton.

Keywords: Black rice, Cultivars, Dry matter, Pretilachlor, Weeding

Impact of Organic Mulching in Weed Suppression and Yield of Sesame (*Sesamum indicum* L.)

K.V. Awomi*, A.P. Singh, L. Yosung and H.M. Chishi

Dept. of Agronomy, School of Agricultural Sciences, Nagaland University, Medziphema, Nagaland (797 106), India

E-mail: kilivawomi00@gmail.com

Abstract

A field experiment entitled "Impact of organic mulching in weed suppression and yield of Sesame (*Sesamum indicum* L.)" was carried out at the Agronomy Research Farm, School of Agricultural Sciences, Nagaland University, Medziphema campus, during the summer season of 2021 in randomized block design (RBD) with three replications to evaluate the effectiveness of organic mulches in weed suppression and yield of sesame (*Sesamum indicum* L). Locally available materials were sourced for the experiment and treatments were made *viz*., T_1 (weedy check), T_2 (Hand weeding at 20 and 40 DAS), T_3 (Cardboard mulching), T_4 (Paddy straw mulching @ 5 t ha^{-1}), T_5 (Farmer's practice), T_6 (Wood chips mulching @ 5 t ha^{-1}), T_7 (Live mulch with legume (black gram) and T_8 (FYM mulching @ 10 t ha^{-1}). Result showed that the weed dynamics were significantly affected with T_6 (wood chips mulching @ 5 t ha^{-1} g) having the lowest weed dry weight of (3.03 g, 6.62 g) at 25 and 50 DAS, respectively and highest weed control efficiency (WCE) of (87.18%, 79.34%) respectively. However, among the organic mulch materials, the highest seed yield of (634.58 kg ha^{-1}) and a Stover yield of 1903.82 kg ha^{-1} was recorded in T_3 (cardboard mulching). The harvest index for the same was calculated as 25.03%.

Keywords: Cardboard, Live mulch, Mulching, Woodchips

Influence of Herbicides on Weed Dynamics and Wheat Performance

M.H. Shah*, B. Mandal and D. Mukherjee

Dept. of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: maksudhasanshah@gmail.com

Abstract

Wheat holds a prominent position among the world's major cereal crops due to its significant contributions to global food security. Nevertheless, wheat production faces numerous challenges, with weed interference emerging as a primary impediment. Uncontrolled weed growth during entire growing season of wheat causes significant yearly losses that can vary from 17% to 30%, based on the diversity and density of the weeds. Manual weeding is costlier and involves risk of mechanical injury to roots. Chemical control is favoured for its speed, effectiveness, and labour-saving attributes in combating wheat weeds. A two-year field experiment was conducted during consecutive rabi seasons under humid climatic conditions to investigate the influence of herbicides on weed dynamics and wheat performance. The findings indicated that among the herbicidal treatments, the most effective approach was the application of pendimethalin 30% EC @ 1.0 kg ha^{-1} pre-emergence, followed by a post-emergence application of metribuzin 70% WP @ 0.2 kg ha^{-1}. This treatment demonstrated superior weed control efficiency (91.79%), crop resistance-index and herbicide efficiency-index, while maintaining a low weed-index (1.23%) compared to other herbicides. Furthermore, it significantly increased various growth parameters, including plant height (99.18 cm), crop dry matter accumulation (515.93 g m^{-2}), crop growth rate (10.32 g m^{-2}day^{-1}), leaf area index (3.46), net assimilation rate, spike length (8.06 cm), grains spike^{-1} (38.18), grain yield (4.34 t ha^{-1}), and straw yield (7.16 t ha^{-1}), outperforming the weedy check plot. The treatment with pendimethalin 30% EC @ 1.0 kg ha^{-1} *fb* by one hand weeding also yielded comparable results, except for the number of grains spike^{-1}. In addition, the application of sulfosulfuron 75% + metsulfuron 5% WG @ 32 g ha^{-1} resulted in higher net returns and the maximum benefit-cost ratio. These findings underscore the importance of herbicide selection and application in optimizing wheat crop performance while effectively managing weed populations.

Keywords: Cereal crops, Effectiveness, Herbicides, Weed dynamics, Wheat

Effect of Post-Emergence Herbicides on Late-Sown Direct-Seeded Herbicide-Tolerant Rice Varieties in New Alluvial Zone of West Bengal

Saptashree Das*, Priotosh Adhikary and Manabendra Ray

Dept. of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: saptashree77@gmail.com

Abstract

Weeds are the silent unwanted and undesirable plants but virulent robbers of plant nutrients, which can be effectively controlled by herbicide. DSR seems to be a viable option under water stress condition. Weeds remain the most important biological barrier in DSR despite its many benefits. In view of that a field experiment "Effect of post-emergence herbicides on late sown direct seeded herbicide-tolerant rice varieties in New Alluvial Zone of West Bengal", was conducted at Central Research Farm, Gayeshpur, B.C.K.V., Nadia, West Bengal in 2022 by using two herbicide tolerant rice varieties SAVA 127 and SAVA 134. The experiment was laid out in split plot design with 4 replications comprising 2 main plot factors (2 variety - V_1: SAVA 127; V_2: SAVA 134) and four subplot factors (4 Weed control methods - T_1: Weed-free check (2 times hand weeding); T_2: Untreated control (weedy check); T_3: Bispyribac Na 10% SC @ 200 ml ha^{-1}; T_4: Imazethapyr 10% SL @ 1000 ml ha^{-1}. Different rice varieties don't have much influence on the weed population and weed growth, but crop growth and yield are highly influenced by the varieties. Maximum plant growth, number of tillers m^{-2} (189.80), number of panicles m^{-2} (179.76), yield (2.26 t ha^{-1}) and net return (Rs. 13,734.00) and B:C (1.34) were recorded in V_1 (SAVA 127); whereas T_1 (Weed free check) recorded the maximum WCE. Maximum net return (Rs. 18,810.00) and B:C (1.49) were obtained from T_4 (Imazethapyr 10% SL @ 1000 ml ha^{-1}) due to the low cost of cultivation. Thus, it is concluded that, the herbicide-tolerant rice variety 'SAVA 127' is suitable under late sown direct seeded conditions and the time-consuming, costly hand-weeding method can be replaced by application of Imazethapyr 10% SL which has been found most cost-saving and a safe weed control treatment.

Keywords: DSR, Herbicide tolerant rice, Imazethapyr, Weed population

Weed Management in Jute (*Corchorus olitorius*) Fibre Production under Terai Region of West Bengal

S. Dutta[1*], S. Kheroar[2], K. Mandal[2] and S. Rai[2]

[1]*Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India*
[2]*Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal (736 165), India*

E-mail: sukanyadutta74@gmail.com

Abstract

Field experiment was conducted in the sandy loam soil of Instructional Farm (26°34′19″ N, 88°08′51″ E and 9.75 m above MSL) of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar during pre-*kharif* season of 2018 and 2019 to evaluate the effect of different weed management strategies on weeds associated in tossa jute (JRO 204) and the growth and yield of jute. The field trial was laid in a randomised block design (RBD) with ten treatments replicated thrice. During experiment grassy weeds were most predominant as compared to sedge and broad leaved weeds. The highest weed control efficiency (WCE) of 90.7% was recorded with two hand weeding (15 and 21 DAE) followed by quizalofop ethyl 5% EC @ 60g a.i. ha^{-1} and ethoxysulfuron @ 100 g ha^{-1} at 15 DAE + hand weeding at 21 DAE (85.4%). Among the various agronomic indices, highest agronomic management index (AMI), weed management index (WMI) and integrated weed management index (IWMI) and best weed index (WI) value (1.78%) observed in quizalofop ethyl 5% EC @ 60 g a.i. ha^{-1} and ethoxysulfuron @ 100 g ha^{-1} at 15 DAE + hand weeding at 21 DAE.

The outcome of the experiment suggests that application of quizalofop ethyl 5% EC @ 60 g a.i. ha^{-1} and ethoxysulfuron @ 100 g ha^{-1} at 15 DAE along with one hand weeding at 21 DAE in tossa (JRO 204) jute can effectively control the weeds and increase the fibre yield (3.68 t ha^{-1}) with higher net return (Rs. 88,397.00) and benefit-cost ratio (1.55).

Keywords: AMI, Fibre yield, IWMI, WCE, Weed density

Integrated Nutrient Management for Enhancing Growth and Yield of Sali Rice (*Oryza sativa* L.)

Ipsita Ojah[1*], Britan Rahman[2] and Debasish Borah[3]

[1]*Krishi Vigyan Kendra, Udalguri, Assam Agricultural University, Lalpool, BTR, Assam (784 514), India*
[2]*Dept. of Soil Science, Assam Agricultural University, Jorhat, Assam (785 013), India*
[3]*Assam Agricultural University, Jorhat, Assam (785 013), India*

E-mail: ipsita.ojah@aau.ac.in

Abstract

Udalguri district of Assam has a sizeable area under rice cultivation, but the productivity is very low. The reasons of low productivity have been identified as the poor knowledge about the new technologies by the farmers. Therefore, a series of demonstrations have been conducted on popular Sali Rice varieties Ranjit using Integrated Nutrient Management (INM) with the objective to increase crop productivity and soil-plant health. In this regard, the present study entitled "Integrated nutrient management for enhancing growth and yield of Sali rice (*Oryza sativa* L.)" was conducted by Krishi Vigyan Kendra, Udalguri under Assam Agricultural University, Assam. The demonstrations were conducted at farmer's field at different villages of Udalguri district during Kharif seasons of 2014 and 2015 to assess the impact of continuous use of inorganic fertilizers and organic nutrients on crop productivity, economics, soil fertility and plant health. From the experiment it was found that the use of INM package (using Microbes *Azospirillum* and PSB @ 4 kg ha^{-1} each, FYM @ 1 t ha^{-1}, 56 kg ha^{-1} of rock phosphate as phosphatic fertilizer and 67 kg MOP ha^{-1} as potassic fertilizer) was superior over control in terms of growth and yield parameters resulting a grain yield of (48 q ha^{-1}), improved soil fertility status (N:P:K 252:24:148 kg ha^{-1}) and net profit (Rs. 43,050.00 ha^{-1}) over the control which produce only (34.7 q ha^{-1}) with a net profit of (Rs. 28,000.00).

Keywords: Integrated nutrient management, *Oryza sativa* L., Ranjit, Sali Rice, Yield

Assessment of Soil Fertility in Mulberry Cultivation Areas of Tamil Nadu, India

Devamani M.[1*] and Dhahira Beevi N.[2]

[1]*Centre for Higher Studies in Botany and Sericulture, Periyar University, Salem, Tamil Nadu (636 011), India*
[2]*Regional Sericultural Research Station, CSB, Vaikkalpattarai, Salem, Tamil Nadu (636 017), India*

E-mail: devikattani@gmail.com

Abstract

The available nutrient status of surface layer (0-30 cm) soils of mulberry growing 26 clusters and non-captive areas of Tamil Nadu, were evaluated. Samples were collected and analyzed for 12 chemical parameters. Of the 2630 soil samples tested, 83.27% of soil found under the alkaline in pH category (>7.8) and non-saline EC (<1 mmhos cm^{-1}). Organic carbon content was low in 64.33% of the soils (<0.65%) and 30.22% found under a medium (0.65-1.00%). 38.75% and 35.1% of the samples were found medium (260-560 kg ha^{-1}) to high (>560 kg ha^{-1}) and 26.16% soil found low in available nitrogen. Available phosphorus (P_2O_5) were low (<15 kg P_2O_5 ha^{-1}) in 34.67% and high (>25 kg P_2O_5 ha^{-1}) in 45.01% of the samples. Similarly, available potassium (K_2O) content was medium in 31.48% (120-240 kg K_2O ha^{-1}) and high in 59.43% (>240 kg K_2O ha^{-1}) of the samples. Available sulphur were low (<10 ppm) 38.52% to medium (10-20 ppm) 29.35% and high (>20 ppm) in 29.39% of the samples. While DTPA extractable micronutrients were found in low to sufficient category such as Mn low in 23.19% (<2 ppm) to sufficient in 23.8% (2-4 ppm) and high (>4 ppm) in 53% of the soil samples, B found low in 79.20% (<0.5 ppm) and sufficient in 16.5% (>0.5-1.0 ppm) of the samples. 7.90% and 84.71% of the samples found as sufficient (4.5-9.0 ppm) to low in Fe (<4.5 ppm). 57.52% of the soil samples are deficient (<0.6 ppm) and sufficient (0.6-1.2 ppm) in available Zn and 89.88% of the soil samples found high (>0.4 ppm) in Cu content in mulberry cultivated areas of Tamil Nadu. Hence, maintenance of optimum level of organic carbon content in the soil through application of optimum quantities of organic manures is recommended. Use of S containing fertilizers and FYM, green manuring is suggested to reduce the pH.

Keywords: Chemicals, Macronutrients, Micronutrients, Mulberry cultivation, Soil

A Comprehensive Study on Nitrogen Management and Plant Spacing Methods for Optimizing Buckwheat (*Fagopyrum esculentum* Moench) Production in the Eastern Himalayan Region

Narmi Tatak[1] and Bharati Lap[2*]

[1]Dept. of Agronomy, [2]Dept. of Genetics and Plant Breeding, Faculty of Agricultural Sciences, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh (791 112), India

E-mail: bharatilap05@gmail.com

Abstract

Buckwheat (*Fagopyrum esculentum* Moench) is a highly nutritious, gluten-free pseudocereal belonging to the family polygonaceae. Common Buckwheat (*Fagopyrum esculentum*) and Tartary Buckwheat (*Fagopyrum tataricum*), both integral for consumption, represent the two species of Buckwheat. Cultivation of *Fagopyrum* spp. is prominent in the states of Sikkim, Meghalaya, Arunachal Pradesh, Assam, Manipur and Nagaland in the North-eastern region. Optimal plant spacing plays a crucial role in promoting root growth and enhancing nutrient uptake efficiency. The application of organic manures, such as compost, contributes to a sustainable soil nutrient balance, increased soil aggregation, improved moisture retention capacity and enhanced soil fertility. Therefore, the study aimed to analyse the impact of nitrogen and spacing on Buckwheat cultivation, utilizing vermicompost and compost as nitrogen sources and employing four spacing levels: broadcasting, line sowing at 20 cm, 30 cm and 40 cm, respectively. The experiment involved 8 treatment combinations, assessed through a Factorial Randomized Complete Block Design (FRBD). Statistical analysis, including Analysis of Variance and F-test (significance level $P \leq 0.05$), was conducted on all data. Vermicompost (4 t ha^{-1}) outperformed compost (4 t ha^{-1}) as a nitrogen source. Notably, a spacing of 40 cm between rows significantly influenced agronomic parameters. The interaction between nitrogen (vermicompost) and spacing (40 cm) demonstrated a substantial increase in growth and yield parameters. Specifically, the combined application of 4 t ha^{-1} vermicompost and line sowing at 40 cm (N_1S_4) significantly enhanced plant height, number of branches, number of leaves, seed and stover yield and harvest index. This suggests that N_1S_4 represents the optimal combination of nutrient and spacing for maximizing Buckwheat production in the Eastern Himalayan region of India.

Keywords: Buckwheat, Growth, Nitrogen, Spacing, Yield

Agronomic Intervention of Zinc Biofortification for Improving Yield and Nutrient Content of Chickpea Varieties

Narendra Kumar Bhinda*, Prakash Chand Chaplot and Ashok Samota

Dept. of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan (313 001), India

E-mail: narendrabhinda@gmail.com

Abstract

A field experiment was conducted at Maharana Pratap University of Agriculture and Technology, Udaipur during 2022-23 to studying the performance of chickpea varieties under different agronomic methods of zinc biofortification. The experiment was laid out in split plot design comprised four chickpea varieties *viz.*, Pratap Chana 1, GNG-2144, GNG-1958, RVG-203 and six agronomic zinc biofortification methods *viz.*, Control, seed priming with $ZnSO_4$ @ 0.05%, soil application of $ZnSO_4$ @ 25 kg ha^{-1}, foliar application of $ZnSO_4$ @ 0.5% $ZnSO_4$ at flowering and pod development stage, seed priming with $ZnSO_4$ @ 0.05% + foliar application of $ZnSO_4$ @ 0.5% $ZnSO_4$, soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar application of $ZnSO_4$ @ 0.5% $ZnSO_4$. The chickpea variety GNG 2144 recorded significantly higher seed yield and biological yield over variety GNG 1958, RVG 203 and Pratap Chana 1. However, highest haulm yield was registered with variety GNG 1958 which was found at par with variety GNG 2144 and both these varieties significantly increased haulm yield over variety RVG-203 and Pratap Chana-1 during both years. Under zinc biofortification methods, soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar application of $ZnSO_4$ @ 0.5% $ZnSO_4$ produced highest seed yield, haulm yield and biological yield which was significantly higher over rest of zinc biofortification methods. The chickpea variety GNG 2144 recorded highest nitrogen and zinc content in seed which was significantly higher over rest of varieties. Amongst zinc biofortification methods, highest nitrogen and zinc content in seed was recorded with soil application of $ZnSO_4$ @ 25 kg ha^{-1} + foliar application of $ZnSO_4$ @ 0.5% $ZnSO_4$ over rest of zinc biofortification methods.

Keywords: Biofortification, Foliar application, Nutrient content, Soil application, Yield, Zinc

Impact of VAM and PSB on Growth and Yield of Radish Cultivars in Phosphorus-Deficient Soil of Arunachal Pradesh

Firdusur Rahman, Taj Yam, Takhe Soniya, Takar Sonam, Lungdoi Dokkam, Liang Yangfo, Ashim Debnath and Bharati Lap*

Dept. of Genetics and Plant Breeding, Faculty of Agricultural Sciences, Rajiv Gandhi University (A Central University) Rono Hills, Doimukh (Itanagar), Arunachal Pradesh (791 112), India

E-mail: bharatilap05@gmail.com

Abstract

Radish (*Raphanus sativus*) belonging to the *Brassicaceae* family is an important annual vegetable *rabi* season crop. Field experiment was conducted by B.Sc. (Agriculture) final year RAWE students in the farmers' field of Emchi village, Papumpare district, Arunachal Pradesh. Split plot design was employed with three replications. Vesicular Arbuscular Mycorrhiza (VAM) and Phosphate-Solubilizing Bacteria (PSB) were allotted to main plot, while six cultivars (White long, Bombay Red, H. Red, Pusa Chetki, Long Chetki, Khasi Kata) were assigned to sub plots. The soil of Arunachal Pradesh is highly acidic in nature which makes the soil deficient in phosphorous (P-deficient). Therefore, the current study was undertaken to assess the effects of biofertilizers on the growth and yield attributes on radish under P-deficient soil condition. Result on qualitative and quantitative data showed significant variability among the cultivars. Cultivar Bombay Red showed the maximum number of leaves, root weight, root diameter, root length, yield plot^{-1}, biological yield under the influence of VAM in comparison to control and PSB treatment, suggesting the application of VAM for optimizing the yield of radish under P-deficient soils of Arunachal Pradesh. However, future research possibilities may be explored for optimal combinations and application methods for maximizing the agricultural benefits of VAM and PSB.

Keywords: Growth, P-deficient, Phosphate-Solubilizing Bacteria, Radish, Vesicular Arbuscular Mycorrhiza, Yield

Effect of Iron Slime Waste on Growth and Yield of Kharif Onion in Lateritic Soil

Nafisa*, Santanu Sarkar, Sudipta Kr. Ghosh and Prasanta Kr. Patra

Dept. of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: missnafisa444@gmail.com

Abstract

Iron ore-based steel marketing generates huge amounts of by-products *viz*., slag, sludge, dusts, scales and fines. Among these by-products iron slime is considered to be used as potential input in agricultural fields. A field experiment was conducted at the teaching farm of College of Agriculture, Chhatna, B.C.K.V. with the best combination of these factors *viz*., iron ore slime waste and organic manure on *Kharif* season during 2021 to analyse the nutrient concentration of bulb and haulm after harvest. The dosage of NPK was kept constant in all experiments. The experiment was laid out in Randomized Complete Block Design with three replications. Light texture acidic soil was treated with iron ore slime waste @ 100, 200, 300, 400, 500, 600, 700, 800 kg ha^{-1} in combination with organic manure (FYM) @ 10 t ha^{-1}. Plant growth parameters such as bulb weight was taken and plant yield were recorded. Finally, the produce (Bulb and haulm) was analysed for finding out nutrient contents. There was significant difference between the treatments in plant parameters such as total N, total P and total K. The present findings of the experiment indicated that highest nutrient concentration of N, P and K (%) in both onion haulm and bulb obtained with the application of iron ore slime waste @ 800 t ha^{-1} and 10 t ha^{-1} organic manure (FYM) with recommended doses of NPK fertilisers. The total N content, total P, total K content in bulb and haulm increased progressively with respect to treatments. The findings will pave the way for using a huge amount of hitherto considered industrial waste as a valuable resource for agriculture.

Keywords: Growth, Iron ore, Onion, Waste, Yield

Effect of Different Sources of Sulphur on Growth and Productivity of Safflower (*Carthamus tinctorius* L.) in the Red Lateritic Zones of West Bengal

Shreyasi Das* and Narayan Chandra Sarkar

Dept. of Agronomy, Palli Siksha Bhavana, Visva-Bharati University, Sriniketan, Bolpur, West Bengal (731 236), India

E-mail: shreyasiagro@gmail.com

Abstract

A field experiment was carried out during the Rabi season of 2018-19 at the Agricultural farm of Palli-Siksha Bhavana (Institute of Agriculture), Visva-Bharati University, Sriniketan, Birbhum, West Bengal to study the effect of different sources and levels of sulphur on growth and yield of safflower cultivation in the red-lateritic zones of West Bengal. Different doses of sulphur were applied in the way, T_1: Control (No sulphur application), T_2: SSP @ 20 kg ha^{-1}, T_3: SSP@ 40 kg ha^{-1}, T_4: SSP @ 60 kg ha^{-1}, T_5: Zinc sulphate @ 20 kg ha^{-1}, T_6: Zinc sulphate @ 40 kg ha^{-1}, T_7: Zinc sulphate @ 60 kg ha^{-1}, T_8: Elemental sulphur @ 20 kg ha^{-1}, T_9: Elemental Sulphur @ 40 kg ha^{-1}, T_{10}: Elemental Sulphur @ 60 kg ha^{-1} along with the recommended dose of fertilizer for safflower cultivation. From the findings, it was concluded that application of 40 kg sulphur ha^{-1} applied through zinc sulphate had resulted the tallest plant, highest number of branches plant^{-1} (17.3), maximum number of capitula plant^{-1} (15.8) and seeds capitula^{-1} (23.9), maximum seed yield (810 kg ha^{-1}), stover yield (2664 kg ha^{-1}), biological yield (3474 kg ha^{-1}) and maximum oil yield (227.7 kg ha^{-1}).

Keywords: *Carthamus tinctorius* L., Growth, Red lateritic zones, Productivity, Safflower

Productivity of *Kharif* Rice under Different Levels of Nitrogen and Silicon in Red and Laterite Soil

Sujay Kumar Paul*, Ganesh Chandra Malik and Mahua Banerjee

Dept. of Agronomy, Palli Siksha Bhavana, Visva-Bharati University, Sriniketan, Bolpur, West Bengal (731 236), India

E-mail: sujaykumarpaul.rs@visva-bharati.ac.in

Abstract

A field experiment was conducted at Agriculture Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal during *kharif* season of 2021, in order to assess the productivity of kharif rice under various levels of nitrogen and silicon in red and laterite soil of West Bengal. The experiment was laid out in split plot design with three levels of nitrogen in main plots and five levels of silicon in sub plots. The levels of nitrogen were N_1 (Control nitrogen 0 kg ha^{-1}), N_2 (Nitrogen @ 80 kg ha^{-1} as 1/4th nitrogen as basal, 1/2th nitrogen at active tillering stage, 1/4th nitrogen at panicle initiation stage) and N_3 (Nitrogen as urea @ 20 kg ha^{-1} as basal + LCC-3 at 20 kg N ha^{-1}). The five levels of silicon were S_1 (Control *i.e.*, no silicon fertilizer), S_2 (Calcium Silicate as SiO_2 @ 100 kg ha^{-1}), S_3 (Calcium Silicate as SiO_2 @ 200 kg ha^{-1}), S_4 (Calcium Silicate as SiO_2 @ 300 kg ha^{-1}), S_5 (Calcium Silicate as SiO_2 @ 400 kg ha^{-1}). Recommended doses of fertiliser followed were 80 kg of nitrogen, P_2O_5 at 40 kg ha^{-1}, K_2O at 40 kg ha^{-1}. Nitrogen management was done as per treatments and full phosphorus & potassium fertiliser will be applied as basal. Among the main plots, treatment N_3 plots with nitrogen applied as urea @ 20 kg ha^{-1} as basal + LCC-3 at 20 kg N ha^{-1} had the highest rice grain and straw yield. Among the sub plots, treatment S_3 plots revealed highest rice grain and straw yield, where silicon was applied in the form of calcium silicate as SiO_2 @ 400 kg ha^{-1}. Interaction effect of treatments N_3 and S_3 showed highest results of yield of grain and straw of rice.

Keywords: Kharif, LCC, Nitrogen, Productivity, Rice, Silicon

Enhancing the Degradation of Low-Density Polyethylene (LDPE) in Soil through the Bioaugmentation of Enterobacter cloacae AKS7 Emerges as a Promising Strategy for the Sustainable Handling of LDPE Waste

Ranojit Kumar Sarker* and Prosun Tribedi

Dept. of Biotechnology, The Neotia University, South 24 Paraganas, West Bengal (743 368), India

E-mail: ranojitkumar.sarker@tnu.in

Abstract

Enterobacter cloacae AKS7 has previously demonstrated enhanced efficiency in degrading UV-treated low-density polyethylene (LDPE) compared to its untreated counterpart. However, the ability of AKS7 to degrade LDPE in contaminated soil has not been addressed. To fill this research gap, we constructed soil microcosms with equal amounts of UV-treated or untreated LDPE, either augmented with AKS7 or left non-augmented. Our findings revealed a notable twofold increase in polymer degradation in bioaugmented microcosms compared to non-bioaugmented counterparts. Further investigation unveiled a five-fold rise in the abundance of LDPE-degrading organisms in bioaugmented microcosms. Additionally, microbial biomass carbon and nitrogen content exhibited approximately twofold enhancement in bioaugmented microcosms compared to non-bioaugmented ones. Moreover, bioaugmented microcosms demonstrated nearly twofold increases in dehydrogenase and fluorescein diacetate (FDA) hydrolyzing activity compared to non-bioaugmented microcosms. The assessment of microbial richness and evenness using the Shannon-diversity index and Gini coefficient, based on the carbon source utilization pattern of BiOLOG ECO plates, indicated a ~30% higher functional richness and ~30% enhanced functional evenness in bioaugmented microcosms. These results suggest the development of an enriched ecosystem with diverse functionalities, including polymer degradation. Thus, our study reveals *Enterobacter cloacae* AKS7 as a promising bioaugmenting agent for the sustainable degradation of LDPE waste at contaminated sites. This research contributes valuable insights into the potential applications of AKS7 in addressing environmental challenges associated with plastic waste.

Keywords: Bioaugmentation, Bioremediation, *Enterobacter cloacae* AKS7, Functional diversity, Low density polyethylene (LDPE)

Spacing Variations: Impact on Biochemical Parameters in Mulberry Tree Varieties V1 and G4

Vijay S.[1*] and Susikaran S.[2]

[1]*Silkworm Seed Production Centre, National Silkworm Seed Organization, Central Silk Board, Dakshin Bhawanipur, West Bengal (733 132), India*

[2]*Directorate of Open and Distance Learning, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (641 003), India*

E-mail: vijayseri98@gmail.com

Abstract

The investigation assessed the impact of three spacing such as 5 ft × 5 ft, 6 ft × 6 ft, 7 ft × 7 ft on the biochemical parameters in two tree types of mulberry, V1 and G4. The findings demonstrated variations in mulberry biochemical parameters based on the spacing configurations. Specifically, in the 6 ft × 6 ft spacing of the V1 variety, the biochemical parameters including chlorophyll-a (1.96 mg g^{-1}), Chlorophyll b (0.81 mg g^{-1}), Total chlorophyll (1.77 mg g^{-1}), Carotenoids (0.80 mg g^{-1}), crude protein (23.16%), total sugars (15.61%), moisture content (78.34%), moisture retention capacity (64.14%), soluble protein (28.49 mg g^{-1}), total carbohydrate (19.84 mg g^{-1}), as well as macronutrients such as nitrogen (4.16%), phosphorus (0.32%) and potassium (1.77%), exhibited the highest values in comparison to other spacing arrangements for the G4 variety.

Keywords: Biochemical, Nutrients, Spacing, Tree mulberry

Effect of Organic Nutrient Management on Yield and Nutrient Uptake of Lowland Black Rice

L. Yosung*, D. Nongmaithem, T. Gohain, H.M. Chishi, K.V. Awomi and T. Malemnganbi

Dept. of Agronomy, School of Agricultural Sciences, Nagaland University, Medziphema, Nagaland (797 106), India

E-mail: ylenmem@gmail.com

Abstract

A field experiment was carried out during the *kharif* season of 2019 in the experimental farm, Department of Agronomy, SAS, NU: Medziphema campus to evaluate the "Effect of organic nutrient management on yield and nutrient uptake of lowland black rice". The experiment was carried out with nine treatments *viz*., T_1: Control, T_2: 100% RDF, T_3: 75% RDF + 25% N from FYM, T_4: 75% RDF + 25% N from Pig manure, T_5: 50% RDF + 50% N from FYM, T_6: 50% RDF + 50% N from Pig manure, T_7: 25% RDF + 75% N from FYM, T_8: 25% RDF + 75% N from Pig manure, T_9: 50% N from FYM + 50% N from Pig manure and was replicated thrice in completely randomized block design. The result revealed that 75% RDF + 25% N from FYM recorded the highest grain yield (2.52 t ha^{-1}) and straw yield (6.83 t ha^{-1}) while the highest harvest index (27.46%) was recorded in 50% RDF + 50% N from FYM. The results further revealed that 75% RDF + 25% N from FYM recorded the highest N uptake for grain, straw and K uptake for grain. However, 75% RDF + 25% N from Pig manure recorded the highest P uptake for grain, straw and K uptake for straw.

Keywords: Black rice, FYM, Nutrient management, Organic, Pig manure

Heavy Metal Contamination in Different Parts of Paddy Grown on Sewage Irrigated Soils

Susmit Saha[1*] and Enamul Pailan[2]

[1]College of Agriculture, BCKV, Burdwan Sadar, West Bengal (713 101), India
[2]Dept. of Agricultural Chemistry and Soil Science, BCKV, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: susmit.bckv@gmail.com

Abstract

Cereals and vegetables are extensively grown around the land-filling site of Dhapa, Kolkata as well as on the banks of sewage canals. A significant amount of heavy metal (HM) contamination in agricultural soil as well as in cultivated crops is obvious by the long-term usage of sewage water as irrigant along with compost made of dumping waste (sludge). In order to determine the health risks associated with consuming HM-contaminated cereals in sewage irrigated peri-urban areas of Kolkata, a thorough survey has been conducted during post-monsoon season of 2022-23. Soil samples as well as different parts of paddy, *viz*., root, shoot and grains were collected at maturity stage of crop from different locations of Dhapa, Kolkata. The collected plant samples were digested with di-acid mixture for analysis of heavy metals, *viz*., Pb, Cd, Cu, Cr, Zn and Ni using Atomic Absorption Spectrophotometer. The relative abundance of HMs in de-husked paddy grain were found to be in the order of Zn > Cu > Pb > Cd > Ni > Cr. Roots of collected paddy crop sequestered more heavy metals from soil as compared to shoot and harvested grain. Therefore, transfer co-efficient from root to shoot and shoot to grain for those six heavy metals were calculated to assess the inherent physiological barrier of plant to prevent heavy metal contamination.

Keywords: Cereal, Grain, Root, Shoot, Transfer-coefficients

Efficiency of a *de novo* Synthesized Nanocrystalline Metal Ferrite to Harvest Microalgal Biomass for Industrial Applications

Chandra Mukherjee* and Debabrata Misra

Dept. of Basic Sciences, School of Science and Technology, The Neotia University, Diamond Harbour Road, 24 Parganas (S), West Bengal (743 368), India

E-mail: chandra.mukherjee@tnu.in

Abstract

Metal nanoferrites (MNF) have shown a promising application in a wide range of projects in the areas of biogas technology, biomass energy, waste-to-energy, recycling and waste management. Microalgae have been extensively investigated over the past decades as a source for biofuel production due to their high lipid and carbohydrate yields as well as being a natural source of high value-added bioactive compounds such as polyphenols, carotenoids, fatty acids and antibiotics. Of the several major production steps of microalgae components, harvesting is both energy and time demanding. It is estimated that microalgae biomass harvesting is responsible for 20-30% of the total biomass production cost. However, due to the low concentration (~5 g L^{-1}) in culture, small size (~5 µm) and negative surface charge (~ -20 mV) of algal cells, external energy and/or chemicals are generally required to accelerate their recovery from base water. The present work aims to study the efficiency of a novel MNF in the recovery of microalgae for the downstream processing of algal biomass to bio-products. In this study, nanocrystalline nickel zinc ferrite (NZF) $Ni_{1-x}Zn_xFe_2O_4$ (where, x = 0.3, 0.5 and 0.7) with varied proportions were synthesised through cost effective and economically feasible coprecipitation technique at regulated spin and controlled temperature. The structural and surface morphological characterizations, porosity and surface activity of the prepared NZFs have been analysed by Powder X-ray Diffraction (PXRD) and Field Emission Scanning Electron Microscopy (FESEM). The magnetic properties of nickel zinc ferrite nanoparticles could potentially be used to disrupt microalgae cells, facilitating the release of intracellular compounds. Study of NZFs revealed that the harvesting efficiency of a *Chlorella* sp. reaches upto 98.9% at pH 10 for biomass concentration of 3-3.5 g L^{-1} at ambient temperature within a reaction time of 50-60 min. The supermagnetic NZF nanoparticles demonstrated an excellent separation capability to microalgae with external magnetic devices.

Keywords: *de novo* Synthesize, Harvest, Industrial applications, Metal Ferrite, Microalgal biomass, Nanocrystalline

Effect of Micronutrient Priming with Zinc and Boron on Root Characteristics of Lentil with Various Irrigation Regimes in the Lateritic Belt of the of Sub-Humid Tropical Region

Sananda Mondal[1]*, Kalipada Pramanik[2] and Debasish Panda[1]

[1]Dept. of Crop Physiology, [2]Dept. of Agronomy, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal (731 204), India

E-mail: mondalsananda@gmail.com

Abstract

Micronutrient deficiencies resulting from unbalanced use of fertilizer application is a major bottleneck in growth and productivity of pulse crops in the lateritic belt of the subtropical region. Application of zinc and boron through seed priming not only overcome the deficiency problem but also enhance growth and yield of lentil in lateritic soil. Lentil is a moisture sensitive crop; therefore, maintaining appropriate irrigation regimes may further enhance the productivity of lentil. In an experiment between 2014-15 and 2015-16 in lateritic of West Bengal, India, the main plots represented irrigation regimes: irrigation at 75% CPE (I_{75}), irrigation at 100% CPE (I_{100}) and irrigation at 125% CPE (I_{125}); while subplots represented nutripriming: control (P_1; without seed priming), hydropriming (P_2), Zn sulphate heptahydrate (2 mM) priming (P_3), boric acid (4 mM) priming (P_4) and Zn sulphate heptahydrate + boric acid (2 mM + 4 mM) priming (P_5) in a split-plot design with three replications. Root length, root area, root volume and root diameter were evaluated. Root characteristics were influenced by irrigation regimes, and seed priming with zinc and boron. The results suggest that the combination of irrigation at 100% CPE (I_{100}) with Zn sulphate heptahydrate + boric acid (2 mM + 4 mM) priming (P_5) plant's characterization of roots need further studies in future to find climate-smart management techniques in lentil crop.

Keywords: Boron, Lentil, Micronutrient, Root, Zinc

Mixture Effects of Arsenic and Chromium on Zebrafish (*Danio rerio*) Brain at Environmentally Relevant Concentrations: Expression of Antioxidant, DNA Repair and Tumor Suppressor Genes

Sreejata Kamila* and Ansuman Chattopadhyay

Dept. of Zoology, Visva-Bharati, Santiniketan, West Bengal (731 235), India

E-mail: kamilasreejata23@gmail.com

Abstract

Nuclear factor (erythroid-derived 2)-like 2 or Nrf2 is a very important transcription factor involved in the expressional regulation of enzymes needed for maintaining cellular redox homeostasis. Arsenic (As) and chromium (Cr) are harmful toxicants that are reported to induce Nrf2. Co-exposure of these two contaminants is seen mainly in industrial effluents and leads to mixture effects in animals including fish. This study reported the expressional pattern of Nrf2 and associated xenobiotic metabolizing enzyme Nqo1 and other markers of oxidative stress such as reactive oxygen species and reduced glutathione level, lipid peroxidation and catalase activity in zebrafish brain after exposure to environmentally relevant concentrations of As and Cr for 15, 30 and 60 days individually and in combination. MDA content, increase in GSH level, and catalase activity indicated the occurrence of oxidative stress in exposed groups. In addition to these, this study included the expression of DNA repair (*ogg1*, *apex1*, *creb1*, *polb*, *mlh1*, *msh2* and *msh6*) and tumor suppressor (*p53*, *brca2*) genes. Results of ROS generation, MDA level, histological analysis, gene expression and immunofluorescence study confirmed that As and Cr did not show antagonistic effects in combination, rather indicated additive effects. Here it can be hypothesized that both As and Cr induced neurotoxicity in zebrafish is dose-dependent but not always linear.

Keywords: Arsenic, Chromium, *Danio rerio*, DNA repair, Tumor suppressor genes, Zebrafish

Response of Various Sources of Sulphur on Growth and Yield of Sunflower (*Helianthus annuus* L.)

Nirmala Patel[1], Debasmita Das[2] and Sumana Balo[3*]

[1]Dept. of Agronomy, [2]Dept. of Agricultural Meteorology, [3]Dept. Soil Science and Agricultural Chemistry, School of Agriculture, GIET University, Gunupur, Odisha (765 022), India

E-mail: balosumanaagri@gmail.com

Abstract

A field experimentation was conducted during rabi season, 2020-21 at Instructional farm, School of Agriculture, GIET University, Gunupur, Odisha, to analyze the impact of various sources of sulphur on growth parameters and yield of sunflower under red and lateritic soils of Odisha. The experiment design was Randomized Block Design (RDB) and replicated thrice with seven treatments, *i.e.*, T_1: Control, T_2: 20 kg sulphur ha^{-1} through ammonium sulphate, T_3: 20 kg sulphur ha^{-1} through elemental sulphur, T_4: 0 kg sulphur ha^{-1} through gypsum, T_5: 20 kg sulphur ha^{-1} through ammonium sulphate + 20 kg sulphur ha^{-1} through elemental sulphur, T_6: 20 kg sulphur ha^{-1} through elemental sulphur + 20 kg sulphur ha^{-1} through gypsum, T_7: 20 kg sulphur ha^{-1} through gypsum + 20 kg sulphur ha^{-1} through ammonium sulphate. The outcome revealed that combined application of 20 kg sulphur ha^{-1} through gypsum and 20 kg sulphur ha^{-1} through ammonium sulphate (T_7) recorded higher growth attributes and yield of sunflower over other treatments.

Keywords: Ammonium sulphate, Growth, Oil yield, Sulphur, Sunflower

Effect of Methods of Irrigation and Silicon on Yield Attributes and Yields of Summer Maize under Different Irrigation Regimes

Subhajit Barat*, Binoy Kumar Saren and Kalipada Pramanik

Dept. of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal (731 236), India

E-mail: subhajitindas@gmail.com

Abstract

In India, maize (*Zea mays* L.) is the third most important food crop after rice and wheat. At present, its production faces great challenges through increasing or maintaining its yield based on severe abiotic stresses mainly due to climate change. The most severe abiotic stress restricts maize yields due to water deficit situations. To decrease water deficit-induced damage in agricultural crops, an option is the use of silicon along with judicious application of irrigation water, especially for *Poaceae* species such as maize. Keeping the above facts in view, the experiment was carried out at the Agriculture Farm (23°67'19" N latitude and 87°66'13" E) of Palli Siksha Bhavana, Visva-Bharati, Sriniketan during the summer season of 2023 to know the best practices for summer maize crop under reduced water use in this drought-prone, red and lateritic soil of West Bengal. The experiment was conducted in a split-plot design with nine main plots and two sub-plots which were replicated thrice. Three irrigation regimes, *viz.*, irrigation applied at an interval of 40, 50 and 60 mm cumulative pan evaporation (CPE) combined with three methods of irrigation, *viz*., farmers practice (border strip), ridge and furrow (every furrow) and alternate furrow (skip furrow) were evaluated in main plots and two foliar application of silicon, *i.e*., control (no spray) and Si spray @ 2 mM L^{-1} (Na_2SiO_3) in sub-plots. Irrigation applied at 40 mm CPE under the ridge and furrow method with Si spray resulted in significantly higher grain and stover yield than other treatment combinations; however, the effect was at par with that of 50 mm CPE under the ridge and furrow method with Si spray. The lowest yield was observed under the treatment combination of 60 mm CPE and alternate furrow irrigation with no Si spray. Moreover, 40 mm CPE combined with skip furrow was found at par with the effect of 60 mm CPE and irrigation applied with ridge and furrow method. The results indicated that Si application showed better performance than that of without Si application.

Keywords: Irrigation methods, Irrigation scheduling, Maize, Silicon, Yield

Effect of Nano Zinc on Summer Maize (*Zea mays* L.) under Drip Fertigation in Lateritic Soil of West Bengal

Sandip Kumar De* and Kalipada Pramanik

Dept. of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal (731 236), India

E-mail: sandipshakede@gmail.com

Abstract

A field experiment was conducted during *summer* season of 2022-2023 at Agricultural Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal, to study "Effect of nano zinc on summer maize (*Zea mays* L.) under different drip fertigation methods in lateritic soil of West Bengal". The soil of the experiment site was sandy-loam in texture. Soil contains high percentage of sand and low percentage of clay. The soil was slightly acidic, low in soil organic carbon, available nitrogen, phosphorus and medium in potassium. The field experiment was carried out in Split-plot design with three replications in which four main plots and four sub plots were there. Main Plots consist of four Drip-fertigation practices (DF_1: Farmers' practice with 100% RDF, DF_2: Drip irrigation with 50% RDF, DF_3: Drip irrigation with 75% RDF and DF_4: Drip irrigation with 100% RDF) and Sub plots consist of four Nano zinc applications (Zn_1: Control, Zn_2: Seed priming of ZnO NP at 50 ppm, Zn_3: Seed coating of ZnO NP at 50 ppm, Zn_4: Foliar application of ZnO NP at 50 ppm). The results showed that Drip-fertigation practices exerted significant influence on all the growth parameters and productivity of maize. The DF_4 recorded maximum plant height and number of leaves and it is at par with DF_3. The DF_4 recorded higher number of grains cob^{-1} and highest grain yield in comparison to other fertigation treatments and it is also at par with DF_3. The different Nano zinc applications also showed positive and favourable influence on improving almost all growth and yield parameters of maize under study. Zn_3 recorded maximum plant height and number of leaves, yield attributes such as number of grains cob^{-1} and highest grain yield over other nano zinc applications and it is at par with Zn_2.

Keywords: Drip fertigation, Maize, Nano zinc oxide, Yield

Effect of Planting Time on Yield Components of Bio-fortified Cauliflower (*Brassica oleracea* var. *carotena* and *valentena*) in Undulating Topography of Tripura

Debasmita Sil*, Tridip Bhattacharjee, Manish Debnath, Thingreingam Irenaeus K.S. and T.K. Maity

College of Agriculture Tripura, Lembucherra, West Tripura, Tripura (799 210), India

E-mail: debasmitasil647@gmail.com

Abstract

Cultivation of bio-fortified Cauliflower at the right time is one of the most important means of maximizing yield in hilly region especially planting time. The experiment was conducted at the Farm of College of Agriculture Tripura, Lembucherra, West Tripura, during the period from October 2022 to March 2023 to determine the effect of planting time on the growth and yield of cauliflower. The experiment consisted factors: Planting Time - 4 levels such as P_1: Planting at October, P_2: Planting at November, P_3: Planting at December, P_4: Planting at January. In case of planting time in carotena highest plant height at harvest (78 cm) was produced by 14/11/22 planting, highest curd weight (1.1 kg), was recorded from 14/11/22 planting and the lowest (210 g) was recorded from 14/01/23 planting. In case of planting time in valentena highest plant height at harvest (52 cm) was produced by 14/12/22 planting, highest curd weight (585 g) was produced by 14/11/22 planting and the lowest (290 g) was recorded from 14/12/22 planting.

Keywords: Carotena, Cauliflower, Planting time, Valentena, Yield

Optimizing Water Productivity in Sweet Corn (*Zea mays* L. var. *saccharata*) through Different Mulching and Irrigation Methods

Arif Mohammad[1*], Ratneswar Poddar[1] and Sanmay Kumar Patra[2]

[1]Dept. of Agronomy, [2]Dept. of Soil Science, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 234), India

E-mail: arif14705@gmail.com

Abstract

Water is a limited natural resource that must be used wisely to increase crop and water output. During Rabi 2019-20, an experiment was carried out at CR farm, Gayeshpur, BCKV, Nadia to evaluate the influence of various irrigation systems and mulch conditions on sweet corn. The goal was to determine the variation in crop water use and WUE. The experiment had two factors: three irrigation methods (furrow irrigation, alternate furrow irrigation and flatbed irrigation) in the main plot and four mulch conditions (paddy straw mulch, black polythene mulch, jute textile mulch and soil mulch) in the sub-plot treatment. The experiment was set up in a Factorial RBD design and replicated three times. The experiment results showed that all growth parameters, except RGR, were maximum with furrow irrigation when combined with black polythene mulch, including plant height, dry matter accumulation, CGR and LAI. Furrow irrigation produced a 5.7% and a 12.7% higher crop production than flood and alternate furrow irrigation, respectively. The use of several types of mulches other than soil mulch resulted in a 7.7-16.1% increase in fresh cob production in sweet corn growing. Furrow irrigation combined with black polythene mulch produced the highest cob yields (173.95 q ha^{-1}), biological yields (530.54 q ha^{-1}) and harvest index. Flood irrigation with soil mulch used the most water overall, whereas alternate furrow irrigation with black polythene mulch had the best water use efficiency (8.86 kg $ha^{-1}cm^{-1}$). The current study's results show that, in the instance of sweet corn, furrow irrigation combined with black polythene mulch may be the optimum management strategies for achieving increased crop production and water use efficiency.

Keywords: Irrigation method, Mulch, Sweet corn, Water use efficiency, Yield

Response of Minimum Tillage and Integrated Nutrient Management on Rice Yield in Rice-Lentil Cropping System

Urjashi Bhattacharya[1*] and Smritikana Sarkar[2]

[1]The Neotia University, 24, Diamond Harbour Road, Parulia, West Bengal (700 104), India
[2]Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal (741 252), India

E-mail: urjashibhattacharya@gmail.com

Abstract

Conserving natural resources has become imperative in the current global scenario. Practising conservation tillage like minimum tillage along with integrated nutrient management is one such alternative to restrict the degradation of soil health. Keeping in view, the absolute need to fulfil food security and sustainability, an experiment was conducted to study the growth and yield attributes of rice as affected by conservation tillage and integrated nutrient management schedules. The experiment was laid out in split plot design having, 4 randomly arranged main plots (CT Direct seeded rice-lentil, MT Direct seeded rice-lentil, CT Transplanted rice-lentil and MT Transplanted rice-lentil). and 5 randomly arranged subplots of Control - lentil, 100% RDF - lentil, 75% Nitrogen + FYM (10 t ha^{-1}) - lentil, 75% Nitrogen + FYM (10 t ha^{-1}) + *Azospirillum* sp. (2 kg ha^{-1}) - lentil and 75% Nitrogen + FYM (10 t ha^{-1}) + *Azospirillum* sp. (2 kg ha^{-1}) + Zinc Sulphate Heptahydrate ($ZnSO_4 \cdot 7H_2O$) @ 20 kg ha^{-1} - lentil. After two years of study it was observed that conventionally tilled direct seeded rice-lentil system recorded highest dry matter accumulation (657.96 g m^{-2}) and yield (4.81 t ha^{-1}) which was closely followed by minimally tilled direct seeded rice-lentil system. Among the nutrient schedules 75% Nitrogen + FYM + Azospirillum + Zinc Sulphate-lentil showed highest dry matter accumulation (687.77 g m^{-2}) and yield (5.15 t ha^{-1}). However minimally tilled direct seeded rice system having nutrient schedule of 75% Nitrogen + FYM + Azospirillum + Zinc Sulphate proved to be the best treatment having highest crop yield (5.26 t ha^{-1}) and B:C ratio (2.034).

Keywords: Cropping system, Integrated nutrient management, Minimum tillage, Rice-Lentil, Yield

Breeding Approaches for Improving Plant Health: A Pathway to Sustainable Agriculture

Khushboo Chandra* and Ashok Kumar

Faculty of Agricultural Science, Shree Guru Gobind Singh Tricentrenary University, Gurugram, Haryana (122 505), India

E-mail: drkhushboochandra@gmail.com

Abstract

Ensuring the food security and sustainable agriculture in the face of escalating global concerns including climate change, developing diseases and rising food demand, it is critical to improve plant health. Breeding techniques have become effective weapons in the fight against these issues, with the goal of creating durable, disease-resistant and ecologically sustainable crops. To produce plants with desired features, conventional breeding techniques like crossbreeding and selection have long been used. The breeding environment has been completely transformed by Marker-Assisted Selection (MAS) and genomic technologies, which allow for the exact identification and modification of genes linked to disease resistance. The introduction of genetic variety through mutagenesis and hybridization expands the genetic pool available for breeding. Through genetic engineering, transgenic techniques provide a means of introducing genes from many sources to improve a plant's resistance to diseases and pests. Furthermore, plant genomes may be modified with previously unheard-of accuracy using genome editing methods like CRISPR-Cas9, enabling specific increases in disease resistance. In addition to technology improvements, participatory methods have become more popular and include farmers in the breeding process. Their practical insights and traditional knowledge play a major role in the creation of crop types that are resistant to disease and well adapted to the local environment. Moreover, the notion of biofortification prioritizes the improvement of nutritional content in addition to disease resistance, taking into account the health of both humans and plants. To sum up, the combination of various breeding strategies offers a viable way to enhance plant health. Breeders can produce robust crops that defy disease, adjust to changing climates and support sustainable agriculture by fusing traditional knowledge with cutting-edge technologies. To fully realize the promise of these strategies and provide a more sustainable and healthy future for agriculture and the world's population, cooperation between scientists, breeders, farmers and policymakers is imperative.

Keywords: Conventional, CRISPR, Environment, Genome editing, Marker, Transgenic

Evaluation of Maize Hybrids under Rainfed Condition in New Alluvial Zone of West Bengal

S. Biswas[1*] and A. Saha[2]

[1]Dept. of Agronomy, Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India
[2]Dept. of Agronomy, College of Agriculture, Lembucherra, West Tripura, Tripura (799 210), India

E-mail: sonali.saha80@gmail.com

Abstract

A field experiment was conducted during *Kharif* season of 2020 at District Seed Farm (AB-Block) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal to study the performance of maize hybrids under rainfed condition and to study crop yield and adaptability of maize hybrids under rainfed condition. The experiment was laid down in Randomized Block Design with four replications and six maize hybrids (DKC 9144, DKC 7204, DKC 8181, P3396, Kaveri 50 and Yuvraj). Results of the experiment indicated that the maize hybrid DKC 9144 recorded the highest growth attribute like plant height (252.67 cm) and yield attributing characters like grain rows cob^{-1} (13.97), grains row^{-1} (43.00) and 100 seed weight (41.67 g). Highest grain yield (9.06 t ha^{-1}), stover yield (10.99 t ha^{-1}) and harvest index (47.80) were obtained by maize hybrid DKC 9144 than other maize hybrids. Lowest growth character (plant height), yield attributing characters (Grain rows cob^{-1}, Grains row^{-1} and 100 seed weight), yields (Grain yield and Stover yield) and harvest index of maize were recorded by Kaveri 50 hybrid. From the experimental results, it can be concluded that cultivation of maize hybrid DKC 9144 is a recommendable option for achieving higher yield under rainfed condition in new alluvial zone of West Bengal.

Keywords: Hybrids, Maize, Rainfed condition, West Bengal, Yield

Exploring Radish Genotypes: A Morphological Study to Identify Superior Performers in Papumpare District of Arunachal Pradesh

Nyagem Wangsa, Nancy Briangjo, Teresa Nuski Taruk, Meena Ragyor, Sakimumdi Gao, Diana Moyong, Bharati Lap and Ashim Debnath*

Dept. of Genetics and Plant Breeding, Faculty of Agricultural Science, Rajiv Gandhi University (A Central University), Rono Hills, Doimukh (Itanagar), Arunachal Pradesh (791 112), India

E-mail: ashim.debnath@rgu.ac.in

Abstract

Radish (*Raphanus sativus*) is one of the most popular root vegetable crops cultivated for its enlarged edible roots. The experiment was conducted by B.Sc. (Agriculture) final year RAWE students in the farmers' field of Emchi village, Papumpare district, Arunachal Pradesh, under the supervision of Department of Genetics and Plant Breeding, RGU.A total of six different cultivars, namely Radish White Long (G1), Bombay Red (G2), H. Red (G3), Pusa Chetki (G4), Long Chetki (G5) and Bombay Red Khashi Kata (G6)were used which were planted in split-pot experimental design in three replicates. Vesicular Arbuscular Mycorrhiza-VAM, Phosphate-Solubilizing Bacteria-PSB along with control were used as main plot treatments and cultivars as sub-plots treatments. Five plants plot^{-1} were randomly selected, tagged and observations on morphological characteristics on these plants were recorded for various parameters related to plant growth and root yield. Parameters such as leaf length and width were measured at 30 DAS (days after sowing), while other parameters, such as vein colour, leaf incision, apex shape and foliage base, were recorded at 40 DAS. On the basis of phenotypic data, genotype G2 (Bombay Red) exhibited the maximum leaf area, largest root diameter and length, while genotype Bombay Red Khashi Kata (G6) performed the poorest among all the cultivars. If consistent results are obtained upon repeating the experiment, this superior-performing genotype (G2), together with VAM, can be economically grown in different areas of Arunachal Pradesh for commercial production.

Keywords: Crop growth, Crop yield, Morphological trait, Phosphate solubilizing bacteria, Radish (*Raphanus sativus*), Vesicular Arbuscular Mycorrhiza

Gene Pyramiding of Hulless and Blue Aleurone Traits in Barley (*Hordeum vulgare* L.)

Sajal Saha

Dept. of Genetics and Plant Breeding, School of Agricultural Sciences, Nagaland Central University, Medziphema, Nagaland (797 106), India

E-mail: sajalsaha169@gmail.com

Abstract

Barley (*Hordeum vulgare* L.) is considered one of the top five cereal grains in the world it is mainly used for animal feed, in the last decade an increased interest has been witnessed for naked barley and blue grains as preferred and healthy food for human consumption. The molecular screening was done using six different molecular markers linked with hulless and blue aleurone traits. The hulless trait in barley is controlled by a single recessive nud gene located on chromosome 7HL. However, blue aleurone seed colour is due to the accumulation of anthocyanin in the aleurone layer due to the presence of five *Blx* genes located on chromosomes 4HL and 7HL. All the Parental Cultivars and their nine (BC_1F_1) hybrids were characterized using linked molecular markers *sKT3* for hulless phenotype and *Bmac0187* for blue aleurone phenotype. Molecular marker *sKT3* located on the chromosome 7HL showed polymorphism among IITR-39 hulless and other barley cultivars. However, *Bmac0187* molecular marker located on 7HL also showed polymorphism among IITR-38blue aleurone and other barley cultivars. The BC_1F_1 seeds are separated manually on the basis of their morphological characteristics and sown in the research field. The BC_1F_1 plants were also screened using polymorphic linked molecular markers *sKT3* and *Bmac0187* and found true. All the BC_1F_1 Plants will be advanced in F2 generation and the seeds of recombinants for naked barley along with blue aleurone will be screened.

Keywords: Gene pyramiding, Markers, Molecular screening, Polymorphism

Varietal Effect of Baby Corn (*Zea mays* L.) under Varied Nitrogen Levels: A Review

Bobilan Debbarma*, Abhijit Saha and Suhrid Teli

Dept. of Agronomy, College of Agriculture-Tripura, Lembucherra, West Tripura (799 210), India

E-mail: bobilan50@gmail.com

Abstract

Maize is the third most important crop among the cereal which gives highly nutritional value food and fodder. Baby corn is immature maize which is harvested at 3-4 cm long silk, which is a highly nutritive and delicious vegetable that may be eaten as a natural food source. It offers minerals, vitamins, carbs, protein, fat and sugar in a form that is palatable, nutritious, hygienic and digestible. Baby corn, being a relatively recent introduction to our country, thus needs to have production technology developed, including identification of suitable cultivars and nitrogen dose to realise the higher baby corn yield and financial benefits, before it can be widely adopted by farmers. In Indian soils, nitrogen (N) insufficiency is a widespread problem and correct management is crucial from an environmental and economic standpoint. Combined approach nitrogen level and superior variety enhance the quality of growth and yield attribute of baby corn. The majority of researchers have reported that an increase in dose of nitrogen helps to improve baby corn growth, yield parameters and quality characteristics. However economic optimum nitrogen dose may vary on soil and climatic condition with seasonality. It has been also indicated that the single cross hybrid variety influences growth and yield attributes more than local variety and a location wise interaction between hybrid variety and proper nitrogen level is good strategy which helps to increase yield and more profitable to farmers.

Keywords: Baby corn, Cultivar, Nitrogen, Yield

Viability Loss of Bamboo Seeds of Three Species Associated with Membrane Phase Behaviour and Enzyme Analysis during Storage

Geetika Singh*, Richa Puri and M.L. Sharma

Dept. of Botany, Panjab University, Chandigarh (160 014), India

E-mail: geetika_phd@yahoo.com

Abstract

The aim of the study was to correlate membrane integrity and enzyme analysis with seed viability or physiology during storage for upto 18 months in 3 species of bamboo seeds, *i.e.*, *Dendrocalamus strictus*, *Bambusa bambos* and *Dendrocalamus hamiltonii.* Flowering of bamboos takes a long interval and generally flowering is sporadic. However seeds are hardly available and also their viability is for short time of 2-3 months. Mostly the seeds are stored under controlled condition of 4 °C in desiccators along with anhydrous calcium chloride so as to maintain viability for longer time. When seeds are stored, deterioration increases with time interval. Biological membranes with a normal composition and organisation generally regulate the transport of material into and out of the cell. Seed deterioration can be explained due to damage caused to the organisation of cell membrane. Activity of α-amylase, β-amylase and catalase was assessed of all the three species of bamboos *Dendrocalamus strictus*, *Dendrocalamus hamiltonii* and *Bambusa bambus* till period of 18 months in both naturally and controlled aged seeds. Content of α-amylase increases in both naturally and controlled aged seeds with increase in time interval maximum content of α-amylase was found in *Dendrocalamus strictus* 93.24 in freshly aged seeds and β-amylase was maximum in 107.8 in *Dendrocalamus hamiltonii* and Catalase in 411.12 in *Bambusa bambos*. The study demonstrates that the lower selectivity with time is due to damage caused to the membrane during storage and hence increase in the leakage of solutes to the environment is one of the main reason behind the decline in the physiological quality of seeds and catalase enzyme is present in major amount compared to other enzymes which continuously decreases with increasing interval of time.

Keywords: Desiccators, Deterioration, Membrane integrity, Organisation, Viability

Biochemical Characterization of Maize (*Zea mays* L.) Hybrids under Excessive Soil Moisture Stress

Sri Sai Subramanyam Dash[1*], Devraj Lenka[1], Jyoti Prakash Sahoo[2], Swapan Kumar Tripathy[2], Kailash Chandra Samal[2], Devidutta Lenka[1] and Rajendra Kumar Panda[3]

[1]Dept. of Plant Breeding and Genetics, [2]Dept. of Agricultural Biotechnology, [3]Dept. of Plant Physiology, Odisha University of Agriculture and Technology, Bhubaneswar, Odisha (751 003), India

E-mail: saidash69@gmail.com

Abstract

A set of 32 maize hybrids were evaluated under excessive soil moisture (ESM) stress. The plants were subjected to water-logging for 12 days at the flowering stage by maintaining 3-5 cm water level. Physiological and biochemical traits were examined to analyze plants' response to water-logging stress. The chlorophyll a, b and total chlorophyll content declined due to ESM stress, and the decrease was relatively higher in the case of susceptible hybrids. The decrease in chlorophyll content had shown a significant impact on total carbohydrate content, but the tolerant hybrids thrive better under stress with a capacity to maintain higher carbohydrate concentration. Proline accumulation was enhanced in all hybrids in response to the above stress, but it was tremendously increased in tolerant hybrids to offer osmotic protection compared to the sensitive genotypes. Total chlorophyll, chlorophyll-a, carbohydrate, proline as well as an increase in proline content in response to stress, revealed a significant positive association with seed yield, while percentage decline in chlorophyll, decrease in carbohydrate and senescence percentage maintained the reverse trend. Further, the chlorophyll 'a' followed by an increase in proline content can be considered as important parameters for assessing tolerance to ESM stress owing to their high positive direct effects on seed yield.

Keywords: Excess soil moisture stress, Hybrids, Maize, Physiological and biochemical analysis

Genome Wide Association Study for Brown Plant Hopper Resistance in Rice

A. Shanmugam[1], R. Suresh[1], A. Ramanathan[2], P. Anandhi[3] and D. Sassikumar[4*]

[1]Dept. of Genetics and Plant Breeding, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (641 003), India
[2]Agricultural Research Station, Kattuthottam, Thanjavur, Tamil Nadu (613 501), India
[3]Tamil Nadu Rice Research Institute, Aduthurai, Thanjavur, Tamil Nadu (612 101), India
[4]Sugarcane Research Station, Cuddalore, Tamil Nadu (607 001), India

E-mail: sassikumar@tnau.ac.in

Abstract

Rice (*Oryza sativa*) is the leading food crop for nearly half of the world's population and it has rich genetic diversity, with thousands and thousands of varieties grown throughout the world. Although 90% of rice are produced in Asian countries, rice production and security in these areas are threatened by several biotic and abiotic stresses. An approximately 52% of the total global production of rice is lost annually owing to the damage caused by biotic factors, of which nearly 21% is attributed to the attack of insect pests. The brown planthopper *Nilaparvata lugens* (Stal) (BPH) is a monophagous, phytophagous insect which causes severe damage to the rice industry in many areas of Asia, with millions of tons lost each year. Deciphering the host plant resistance of the traditional landraces through precise phenotyping is the first step to develop BPH resistant varieties. The present study examined the panel of 120 genotypes against BPH using modified seed box seedling screening test (MSST) method. Five traditional landraces were identified namely, *Adukkan*, *Edakkal*, *Pal Kichadi*, *Onamuttan* and *Manvilayan* as "highly resistant" landraces against BPH on both years with damage score of 0.33 to 1.0. Landraces namely, *Karuppunel*, *Norungan*, *Pisini*, *Kudavaraghai*, *Chenell*, *Gandakasala*, *Sembalai* and *Altera* were identified as "resistant" genotypes as it possessed damage score of 1.01 to 3.00. Genome Wide Association Study (GWAS) is an efficient tool for unveiling genotypic variation linked to complex phenotypic traits. Population structure of studied 120 landraces was analysed by model based approach using 174 polymorphic simple sequence repeat (SSR) markers and identified optimum K value as two. GWAS study revealed that four consistent and significant markers *viz*., RM 3808, NBS 4, Ind2 and RM 25694 based on GLM and MLM models were identified for BPH resistance. Of which, marker RM 3808 was identified as major QTL (R^2>10%), except InD2 marker, all other markers were reported to be novel association with BPH resistance. Thus, resistant landraces identified in this study could be a potential donor in future breeding programmes and linked markers would be useful for molecular breeding to develop resistant varieties though MAS.

Keywords: Genome wide association, Plant hopper, Rice, Resistance

Elucidation of Genetic Variability and Character Association in Tossa Jute

Sourav Hazari*, Sri Sai Subramanyam Dash and Anita Roy

Dept. of Genetics and Plant Breeding, Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia, west Bengal (741 252), India

E-mail: souravhazari@gmail.com

Abstract

Jute (2n=14), often regarded as the "golden fibre" and one of the most important bast fibre crop of the world, is extensively grown in India and Bangladesh due long and shiny fibres that caters to many diversified product-manufacturing companies, including textile and paper. A set of 22 *Corchorus olitorius* (tossa jute) genotypes were examined for all yield and quality characteristics. Significant variations were observed in traits like plant height, basal diameter, mid diameter, top diameter, number of nodes per plant, base internode length, mid internode length, top internode length, bark thickness, green weight, dry fibre weight, stick weight, fibre percentage, fibre fineness and tensile strength. The genotypic coefficient of variation (GCV) was high to moderate for green weight, fibre weight, stick weight and fibre fineness. These parameters also showed high to moderate heritability along with considerable genetic advance over percentage of mean, depicting that selection based on these traits could be rewarding in future breeding strategies. Several genotypes exhibited high fiber yield were identified, including BCCO 105, BCCO 107, BCCO 115, OIN 95, OIN 123 and OIN 127. Notably, genotypes with fine fiber characteristics include OIN 120, OIN 95, OIN 121, BCCO 104 and BCCO 120. It was observed that there were positive relationships between fibre weight and various plant characteristics like plant height, node number, basal diameter, green weight, stick weight and fibre fineness at the genotypic level. The outcomes of path coefficient study showed a significant and favourable direct effect of stick weight on fibre yield. Further, mid diameter, mid internode length, top internode length, fibre fineness, green weight and stick weight were determined to play crucial roles in yield. There was positive connection between base diameter and fibre yield. So, basal and mid diameter could be jointly used in future to increase the efficiency of selection.

Keywords: Character association, Genetic variability, Path coefficient, Tossa jute

Development of Low GI Rice Varieties through Genomic Assisted Breeding

Sk. Sameera*, Ch. Sreelakshmi, I. Paramasiva, P. Madhusudhan and U. Vineetha

Agricultural Research Station, Nellore, Acharya NG Ranga Agricultural University, Lam, Guntur, Andhra Pradesh (524 003), India

E-mail: s.sameera@angrau.ac.in

Abstract

Rice (*Oryza sativa* L.) constitutes 80% starch as a staple food, with increased consumption posing a risk of type II diabetes, predicted to affect nearly 330 million people by 2030. Rice varieties with slowly digestible starch, particularly those high in amylose, show promise for managing type II diabetes by contributing to a lower glycemic index. Understanding the genetic mechanisms underlying starch biosynthesis and metabolism in cooked rice is crucial for developing efficient breeding strategies that combine high grain yield with a low glycemic index. The utilization of rice genome sequence information, especially encoding key enzymes involved in amylose biosynthesis, can reveal novel alleles through single nucleotide polymorphisms (SNPs). The multi-allelic waxy gene (Wx), specifically encoding Granule-Bound Starch Synthase I (GBSS I), determines amylose content in rice endosperm. Molecular markers are now available to detect GBSS I alleles (SNPs) associated with different amylose classes (waxy: 0-5%, very low: 5-12%, low: 12-20%, intermediate: 20-25% and high: 25-33%). Superior donors identified through haplopheno analysis, featuring advantageous haplotype combinations, will be employed in Haplotype-based breeding. This approach aims to develop next-generation, tailor-made, high-quality and healthier rice varieties aligning with consumer preferences and market demand. The global shift in food consumption patterns, coupled with a sedentary lifestyle, is driving the surge of non-communicable diseases, anticipated to persist as a global health challenge. A multidisciplinary approach, integrating low to moderate glycemic index rice varieties through efficient phenotyping techniques, enables the selection of molecular markers and breeding lines with lower glycemic index and enhanced palatability. Genomic-assisted breeding and diet-based diversification solutions offer a sustainable pathway to address the growing nutritional challenges posed by shifting dietary patterns.

Keywords: Genomic assisted breeding, Low GI rice, *Oryza sativa* L., Yield

Entrepreneurship Development for Rural Youths through Agro-Processing

S.K. Goyal[1*], Jai P. Rai[1], Durga Shankar Bunkar[2] and S.R. Singh[1]

[1]BHU-KVK, Institute of Agricultural Sciences, RG South Campus, Barkachha, Mirzapur, Uttar Pradesh (231 001), India
[2]Dept. of Dairy Science and Food Technology, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh (221 005), India

E-mail: skgoyal@bhu.ac.in

Abstract

Agriculture, agriculture education and agro-processing are the backbone of agricultural and rural development in the country. Thus, it is necessary to build practical skills and entrepreneur spirit to rural youths by imparting hands on training in the area of agro-processing. BHU-KVK, Mirzapur has created the facilities for practical learning to rural youths in order to fulfill the growing demands of the private sector. Also, rural youths are pursuing self-employment in agro-processing areas in Vindhyan region. Entrepreneurship development for rural youths through agro-processing is exceptionally significant to create facilities for "*Hands on Training*" to the skill development of rural youths as entrepreneur and transfer of technology for development of various food products by utilizing locally grown raw material and providing "*Hands on Experience*" at such agro-processing cum training centre, while according priority to rural youths, farmers and farm women of Vindhyan region. The funds are provided by BHU-IoE for creating these facilities as agro-processing Centre at KVK, Mirzapur. The main objective of this centre is to address the issue of unemployment by creating employment opportunities and entrepreneurship development in Vindhyan region through agricultural processing specially fruits and vegetables, develop new value-added processed food products and supply whole-some, safe, nutritious and acceptable food to consumers throughout the year.

Keywords: Agro-processing, Employment opportunities, Entrepreneurship, Rural youths

Bio-Extract as an Alternative to Chemical Preservatives to Extend the Shelf-Life of Papaya

Prerna Baraily[1*] and Chinmoy Mondal[2]

[1]Dept. of Pomology and Post Harvest Technology, College of Agriculture (Extended Campus), UBKV, Majhian, Dakshin Dinajpur, West Bengal (733 133), India
[2]Dept. of Fruit Science, UBKV, Pundibari, West Bengal (736 165), India

E-mail: prernabaraily@gmail.com

Abstract

Papaya (*Carica papaya*) is a very popular fruit belonging to Caricaceae family and believes to have originated from Tropical America. It is an economically significant fruit crop in many tropical and subtropical countries. Although, it is popular fruit crop and has huge market value, the post harvest losses have a major drawback during storage and distance transportation due to it high perishable nature. Papaya fruits tend to loss the quality of fruit as it is very susceptible to moisture loss and many fungal infections. Some reports claim that about 30-50% of the harvested papaya never reaches the consumers mainly due to postharvest spoilage. Therefore, to minimize the postharvest losses and to retain the quality of fruits several methods have been utilized, but most of them are chemical based and thus pose health concerns owing to their residual toxicity, environmental pollution and their side effects on human health. So, keeping both these losses and consequences in view, the best alternative will be the application of bio- or plant-based extract as they are non-hazardous to both human health and environment. These extracts have promising result not only on the moisture loss, respiration, fungal contamination and overall fruit quality retention but also in extending the shelf-life of the fruit.

Keywords: Bio-extract, Papaya, Post-harvest losses, Shelf-life, Toxicity

Performance of Different King Chilli Ecotypes Grown in Nagaland

C. Apon, S. Jamir and T. Longkumer*

Dept. of Horticulture, SAS, Nagaland University, Medziphema Campus, Nagaland (797 106), India

E-mail: tasenlongkumer@gmail.com

Abstract

A field experiment was conducted in the Research Farm, Department of Horticulture, School of Agricultural Sciences, Nagaland University, Medziphema Campus, Nagaland during the year 2021 with an objective to study the performance of different ecotypes of King Chilli grown in Nagaland. The experiment was laid out in Randomized Block Design with three replications. A total of 21 ecotypes of King Chilli were used for the experiment. Among all the ecotypes, NUKC-7 was observed to have the maximum plant height (66.77 cm) while the ecotype NUKC-1 recorded the minimum plant height (43.16 cm). The maximum leaf area index was recorded in NUKC-16 (0.525) and the ecotype NUKC-12 (0.449) recorded the lowest leaf area index. For number of primary branches plant^{-1}, the ecotype NUKC-9 (4.22) recorded the highest while ecotypes NUKC-3, NUKC-5, NUKC-6, NUKC-18, NUKC-19, NUKC-20 and NUKC-21 were observed to have the minimum number of primary branches plant^{-1}, *i.e.*, 2.00. The maximum days taken to 1st flowering was shown in ecotypes NUKC-20 (131.33) and the minimum days to 1st flowering was shown in ecotype NUKC-12 (103.00). The maximum days taken to marketable maturity was recorded for ecotype NUKC-14 (26.67) and the minimum days taken to marketable maturity was recorded for the ecotype NUKC-6 (15.44). The ecotype NUKC-9 resulted superior in yield (6420.9 q ha^{-1}) followed by ecotype NUKC-7 (5249.87 q ha^{-1}). The minimum recorded yield was in ecotype NUKC-5 (1049.80 q ha^{-1}). The result shows that ecotype NUKC-9 and NUKC-7 are potential yielders and can be utilized for further breeding programs.

Keywords: Ecotype, King chilli, NUKC-9, Performance, Yield

Unravelling the Impact of Micronutrient Stress on the Physiology and Photosynthetic Pigments of Acid Lime (Citrus aurantifolia Swingle) Seedlings

Payel Das* and Prahlad Deb

Dept. of Horticulture and Post-Harvest Technology, Palli-Siksha Bhavana, Visva-Bharati, Sriniketan, Bolpur, West Bengal (731 236), India

E-mail: payeldas.02.96@gmail.com

Abstract

The growth of plants is markedly influenced by the presence of essential micronutrients, notably zinc (Zn) and boron (B), which plays pivotal roles in the production of chlorophyll and the synthesis of growth-promoting hormones. These micronutrients also serve as activators for a diverse range of enzymes and contribute to protein synthesis. Elevated concentrations of these micronutrients significantly impact plant growth comprehensively. To investigate the physiological effects of Zn and boron stress and toxicity, 8-month-old acid lime seedlings were cultured in virgin sand media, subjected to varying Zn concentrations (2.5, 5.0, 7.5, 10, 12.5 and 15 mM) and Boron concentrations (0.5, 1.0, 1.5, 2.0 and 2.5 mM) at 15-day intervals. Plant biomass exhibited an incremental trend with increasing concentrations, reaching a peak at the optimum concentration before diminishing under excessive levels. Young leaves demonstrated greater susceptibility compared to their mature counterparts. Zinc deficiency manifested as irregular green spots along the midrib and with prolonged deficiency, leaves exhibited reduced size and extreme thinness. Conversely, excess boron, as opposed to deficient supply, resulted in a more pronounced reduction in photosynthetic pigments. Understanding the ramifications of Zn and B stress on acid lime is imperative for the development of sustainable agricultural practices and effective nutrient management strategies. This research offers valuable insights into the optimal concentration ranges of zinc and boron for acid lime cultivation, empowering farmers to make informed decisions aimed at enhancing crop productivity while mitigating the risk of nutrient-related stress and toxicity.

Keywords: Acid lime, Boron, Stress, Toxicity, Zinc

Study on Different Jackfruit (*Artocarpus heterophyllus* Lam.) Genotypes and Their Characterization in Northern Tripura

A. Debnath[1*] and P. Deb[2]

[1]*Krishi Vigyan Kendra-Dhalai, Salema, Tripura (799 278), India*
[2]*Visva Bharati, Sriniketan, West Bengal (731 235), India*

E-mail: abhijitdebnathhorticulture@gmail.com

Abstract

The present experiment was undertaken, during 2019-21, for the purpose of evaluation is to find out the genetic variability existing among various locally available jackfruit (*Artocarpus heterophyllus* Lam.) germplasm at North Tripura. A total of 50 (fifty) genotypes were evaluated for characterization based on the extent of variation in quantitive and qualitative traits and genetic variability estimates. The Individual fruit weight, number of fruit tree^{-1}year^{-1} and Yield were documented as the maximum of 11.40 kg, 168.00 and 1915.00 kg tree^{-1}year^{-1} in the case of the genotype JF-21 and all these parameters showed the minimum values for the accession JF-48. The parameter TSS content was recorded as the highest in genotype JF-12 (32.10 °Brix) and it was the lowest in JF-9 (15.80 °Brix). Genotypic coefficient of variation was found as the maximum for yield (80.96%), followed by fruit productivity (74.34%), fruit stalk length (62.65%), number of fruits cluster^{-1} (62.08), flake (bulb)/ seed ratio (52.56%), fruit core weight (48.76%), number of fruit tree^{-1}year^{-1} (46.96%) and fruit weight (46.92%); whereas this parameter was found as the minimum for the parameter fruit acidity (12.01%). The highest value for Phenotypic co-efficient of variation was recorded for fruit core weight (108.12%), followed by yield (81.80%), fruit productivity (74.65%), flake (bulb)/ seed ratio (52.73%), number of fruits cluster^{-1} (69.037%), fruit stalk length (63.67%). On the other hand, the least value for this of 14.38% was obtained in case of reducing sugar content of fruit, preceded by total sugar content of fruits (15.56%). Environmental co-efficient of variation the highest value had been revealed as 96.50% for fruit core weight and the least had been seen for total sugar content of fruit (2.90%). High magnitudes for G.C.V., heritability, genetic advance and genetic advance as percentage of mean were observed for yield, fruit productivity, fruit stalk length and fruit core weight, which might have more role in improvement of these traits through proficient selection process.

Keywords: G.C.V., Genetic advance, Genetic variability, Heritability, Jackfruit, P.C.V.

Potentiality of a Few High Yielding and Regular Bearing Newly Released Mango Hybrids Suitable for West Bengal

Debalina Majhi[1*], Ankita Roy[1] and Urmila Tudu[2]

[1]*ICAR-AICRP on Fruits, BCKV, Mohanpur, West Bengal (741 252), India*
[2]*Dept. of Fruit Science, Faculty of Horticulture, BCKV, Mohanpur, West Bengal (741 252), India*

E-mail: drdebalina.bckv.fruits@gmail.com

Abstract

Mango (*Mangifera indica* L.), the 'King of Fruit' and Native to Indo-Burma region, is the most important economic fruit crop in India as well as Bengal for its exquisite taste, flavour, attractive colour, nutritional value, diverse end uses and availability. In India, West Bengal ranks 7th with share of 4.38% producing total 889.69 thousand MT mango from 65.4 thousand Ha area. A number of leading varieties and hybrids (*e.g.*: Himsagar, Langra, Amrapali, *etc*.) are being commercially cultivated throughout Bengal having a wide genetical diversity but, quality production of mango facing difficulties due to constrains like, irregular/ alternate bearing, low productivity and pest and disease incidence, *etc*.

Recently a bunch of hybrids were collected from different research institutes of India and planted at research station of ICAR-AICRP on Fruits BCKV which offer better quality traits like regularity in bearing, good production, attractive colour, low disease and pest incidence with longer keeping quality. A few hybrids have shown very strong quality traits as compared with Himsagar and Amrapali, *viz*., good vegetative and reproductive growth, from Pusa Shrestha, Arka Udaya and Pant Sundari; bigger fruit size from Vanraj (10.08 cm × 9.29 cm, 445.61 g) and Arka Udaya (10.95 cm × 7.52 cm, 393.39 g); sweeter fruits from Arka Udaya (TSS 24.67 °B) and Pant Sundari (24.27 °B) than Himsagar (21.17 °B) and Amrapali (20.07 °B). These hybrids also showed regularity in bearing, with a very attractive peel colour and almost no pest and disease infestation, which makes them very potential for commercial cultivation as compared to the leading varieties and hybrids of West Bengal and have potentiality of being popularized among growers of Bengal.

Keywords: High yield, *Mangifera indica* L., Mango hybrid, Pest-disease incidence

Kharif Onion Cultivation: An Opportunity to Improve the Economic Status of Rural Farming Community of Tripura

Abhinaba Das*, Tridip Bhattacharjee, Dyoti Ballav Bhuiya, Sayan Saha and T.K. Maity

College of Agriculture Tripura, Lembucherra, West Tripura, Tripura (799 210), India

E-mail: abhinabadas98@gmail.com

Abstract

Onion (*Allium cepa* L.) is an important cool season bulb crop belongs to family Alliaceae, which have an extensive culinary, dietary, therapeutic value. It is the most important and paramount item in the worldwide kitchen as a condiment, vegetable and is enriched with medicinal properties too. Bulb contains a volatile oil known as allyl-propyl disulphide, that accounts for its distinctive pungent flavour. It contains anti-fungal property viz. catechol. It lowers the bad LDL, cholesterol and triglycerides and increases the good HDL cholesterol in blood. Quercetin is one of the important flavonoids found in onion which helps to prevent high blood pressure. The production status of onion in Tripura is area coverage 160 ha with production of 1050 MT with very less productivity. The estimated per capita consumption of onion in India is about 9.37 kg year^{-1}. So, demand for onion in Tripura may be estimated as 38.42 thousand metric tons year^{-1} against which production was to the tune of 1050 metric tons during 2020-2021. Importantly, Tripura is blessed with favourable climatic condition for kharif onion cultivation. So, to meet the demand and supply and to minimize the dependency on other states for onion, we need to promote kharif onion cultivation in Tripura.

Keywords: Cultivation, Demand and supply, Kharif, Onion, Prospects

Hot Air Drying of Jackfruit Seed for Production of Low Glycemic Index Flour

Anurupa Mandal[1], Arpita Banik[1], Sukanya Santra[1], Sweta Malakar[2], Prodyut Kr Paul[2], Himadri Shekhar Konar[1*]

[1]Faculty of Technology, Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal (736 165), India
[2]Dept. of Pomology and Post Harvest Technology, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal (736 165), India

E-mail: hskonar@gmail.com

Abstract

Jackfruit seed flour has a good potential to be mixed with wheat flour or millet flour as an ingredient of composite flour for production of various bakery products having low glycemic index. In the present study, the effects of drying time and temperature were studied on the quality of jackfruit seed flour. Quartered jackfruit seed were dried in tray dryer at different air temperature (50, 60 and 70 °C) for 15, 20 and 25 h following a full factorial experimental design and ground into fine powder. Moisture content of dried product decreased with the increase of drying time and temperature. Oil absorption capacity and water absorption capacity of the dried jackfruit seed flour has increased at higher temperature and longer drying time. Glycemic index of the product was lower at higher drying temperature. Optimization of drying parameters was done using Design Expert software. Hot air drying at 70 °C for 25 hours produces the best quality of jackfruit seed flour with minimum moisture content (11.24%) and Glycemic index (41.63) and maximum oil absorption capacity (115.62%) and water absorption capacity (242.34%).

Keywords: Glycemic index, Hot air drying, Jackfruit seed, Oil absorption capacity, Water absorption capacity

Plant Growth Regulators Impact on Fruit Crops: A Review

Duanaliu Kamei* and Yumnam Somi Singh

Dept. of Horticulture, North Eastern Hill University, Tura Campus, Meghalaya (794 002), India

E-mail: kameidonna@gmail.com

Abstract

Plant growth regulators (PGR's) are organic compounds other than nutrients that are applied on plants to cause any physiological response. These PGR compounds have a role in the control of a number of physiological processes, which includes the growth of plant cells, tissue differentiation and organs, in addition to other processes like flowering, dormancy, senescence, fruit set, germination of seeds, fruit drop reduction, fruit retention, yield and quality. When utilized in modest quantities, organic chemical substances, plant growth regulators can significantly change or regulate a variety of physiological processes in a plant. For the majority of cultivated plants, especially fruit plants, these plant growth regulators are now an essential part of agro-technical processes. Due to their considerable contribution to the growth of the national economy and their vital role in offering several health advantages, fruits are considered a highly valuable crop. The influence on fruit production by the growth regulators are numerous and are employed in a wide range of circumstances varying from tissue culturally propagated plants to enhancing post-harvest storage life through almost all stages of plant life in between. Thus, in this review, the most recent developments in PGR application are covered and how they affect fruit crops.

Keywords: Fruit crops, PGR application, Physiological processes, Plant growth regulators

Artificial Intelligence a New Vista for Indian Horticulture

Sayan Saha*, Tridip Bhattacharjee, Debasmita Sil, Abhinaba Das and T.K. Maity

College of Agriculture, Lembucherra, Tripura (799 210), India

E-mail: sayansaha35ss@gmail.com

Abstract

The Agricultural scenario of the world is changing rapidly to feed the ever increasing population using new technologies. Based on new technologies and data analysis methods, the development of intelligent systems has improved the scope to enhance the cultivation and management aspects of horticultural crops. AI helps in the disease diagnosis, insect pest attack, fertilizer application timings, driverless tractors, produce maturity indices, field management, automated irrigation systems, grading of fruits. In AI various data are being incorporated in the system based on which system processes the data by using machine languages and gives the result and performs the operation. By using AI, the cost of cultivation can be minimized and the output can be maximized. The application of AI in all application domains will also bring an ideal shift in the way we do research and development in horticulture now. AI will help to do a precise form of farming in this new era where the resources and man powers are getting limited.

Keywords: Automatons, Drones, Quad duster systems, Smart irrigation, USN

Enhancing Soil Health and Fruit Yield in Rainfed Guava (*Psidium guajava* L.) Orchards using under Rainfed Uplands of Jharkhand

Abeer Ali[1,3*], Bikash Das[2], Mahesh Kumar Dhakar[3], Sushanta Kumar Naik[3], Adarsh Divyadarshan[4,3] and Akshay[1]

[1]Division of Fruits and Horticultural Technology, [4]Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi (110 012), India
[2]ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar (842 002), India
[3]ICAR-Research Complex for Eastern Region, Farming System Research Centre for Hill and Plateau Region, Plandu, Ranchi, Jharkhand (834 010), India

E-mail: abeerali8281@gmail.com

Abstract

Tephrosia candida, a leguminous green manuring crop, exhibits superior biomass production and notably higher concentrations of carbon, nitrogen, phosphorus, potassium and essential micronutrients. The research was undertaken to standardize biomass mulching on guava orchard using *Tephrosia candida* and to know its effect in plant growth and yield and soil parameters. Four treatments were tested: T_1 (3.0 kg of *Tephrosia candida*'s dry biomass m^{-2} of the plant basin), T_2 (2.0 kg m^{-2}), T_3 (1.0 kg m^{-2}) and T_4 (control without mulching). The experiment was conducted in a 12-year-old guava (cultivar: Allahabad safeda) orchard with a spacing of 1.0 m × 2.0 m, accommodating 5000 plants ha^{-1}, using a Randomized Block Design with each treatment was replicated five times. Mulching with 3 kg of biomass m^{-2} hastened the winter bud stage by 29.17 days, trunk diameter increased by 50.47%, fruit yield of winter crop by 42.25%, fruit weight by 11.00%, number of leaves $shoot^{-1}$ increased nearly three times, while the specific leaf area showed an increase of nearly 18% over the control. Moreover, there were notable increases in the levels of leaf total chlorophyll, total nitrogen, total phosphorus, total potassium, total iron, total zinc and total manganese. Additionally, there was a marked reduction in total anthocyanin content of the leaves. Biomass mulching at rates of 3.0 kg m^{-2} or 2.0 kg m^{-2} significantly improved soil properties, including EC, available nitrogen, available phosphorus, exchangeable potassium, DTPA extractable micronutrients (Fe, Zn, Cu and Mn) and increased total organic carbon (TOC), soil organic carbon (SOC), organic carbon fractions and microbial biomass carbon within 0 to 15 cm and 15 to 30 cm soil depths. FDA and dehydrogenase activity peaked in April 2022 and reached minimum values in January 2022, in both soil depths.

Keywords: Biomass mulching, Microbial biomass carbon, Nutrients, Organic carbon fractions, Phenology, *Tephrosia candida*

Survival Potential and Growth of Fingerlings of *Ompok pabo* Related to Competent Feed: A Step towards Conservation

R. Banik[1], P. Bhattacharjee[2] and S. Banik[2*]

1Dept. of Molecular Biology & Bioinformatics, 2Dept. of Zoology, Tripura University (A Central University), Suryamaninagar, West Tripura (799 022), India

E-mail: sukbanik@gmail.com

Abstract

Captive bred stock of embryonic population of *Ompok pabo* has been reared successfully for the first time in India in general and North-East India in particular. To evaluate the escalation of survival and growth of fingerling stage, an *ex-situ* captive breeding experiment has been carried out for about two weeks. During the experiment some protein rich feeds have been provided to the fingerling stage. To understand effectiveness of feed digestive enzyme activities as well as apparent digestibility coefficient of protein are analysed through analysis of faeces from the digestive tract of the fingerling. Water quality of the experiment is maintained with the manipulation of physico-chemical characters of water at a suitable level where water velocity = 0.92-1.86 m s^{-1}, DO_2 = 4.6-5.4 ppm, pH = 7.3-7.8, CO_3 = 20.0-30.0 ppm, HCO_3 = 160.0-166.0 ppm and DOM = 0.82-1.6 ppm as well. During the experiment continuous flow of water is being sustained with a particular cyclic water-flow system in order to reduce faecal suspension in the water. Results indicate that the preparation of effective feed along with streaming of standard level of water quality seems to be suitable for effective rearing of fingerlings of *Ompok pabo*.

Keywords: Embryo, Feed, *Ompok pabo*, Survival, Water quality

Expression of Stress of Papaya (*Carica papaya* L.) Seedlings as Influenced by Foliar Application of Zinc and Boron

Prahlad Deb*, Kumar Abhishek and Payel Das

Dept. of Horticulture and Post-Harvest Technology, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731236), India

E-mail: debprld@yahoo.com

Abstract

Papaya is one of the most important nutrient rich tropical fruit that is preferred and cultivated almost majority of the states of India. Choice of variety and proper nutrition management and disease management are the key operations for successful commercial papaya cultivation. Micronutrient deficiency starting from the early stage of growth can cause poor growth and reduced yield in papaya. Thus a pot experiment has been conducted to study the influence of zinc and boron as foliar application on seedling growth of papaya. The experiment was laid out in Completely Randomized Design (CRD) with nine treatments comprising zinc sulphate @ 0.2%, 0.4% and borax @ 0.2%, 0.4% and their combinations along with a control treatment (only distilled water). The seedlings were raised in polythene bags filled with growing media (soil: sand: FYM @ 4:2:1) and sprayed with the above mentioned treatment combinations of micronutrients adjusting neutral pH at 15 days interval after germination. The application of zinc sulphate @ 0.4% along with borax @ 0.2% resulted higher leaf chlorophyll content (a, b and total) and thereby increased photosynthates (soluble sugar) along with higher relative leaf water content available for all metabolic processes. Increased zinc and boron application also reduced the stress expression of the papaya seedlings by reducing the proline content, superoxide dismutase enzyme as well as phenol content. The lipid peroxidation in leaf was also minimum in higher rate of zinc application along with moderate boron application as indicated by lower malondialdehyde content. Thus the foliar application of zinc sulphate @ 0.4% and borax @ 0.2% can be recommended for better seedling growth of papaya with respect to less stress and high metabolic activity.

Keywords: Zinc, boron, papaya seedlings, SOD, proline, MDA, phenol

Impact of Organic Mulching after Sulfuric Acid Scarification on the Growth and Development of Papaya Seedlings in Pot Culture

Serma Saren and Ankan Das*

Dept. of Horticulture, Institute of Agricultural Science, University of Calcutta, 51/2 Hazra Road, Kolkata, West Bengal (700 019), India

E-mail: ankandas660@gmail.com

Abstract

Papaya seeds have a significant barrier to growth because of the sarcotesta, or aril, which causes slow and poor germination. Therefore, sawdust, wood chips and rice bran were utilised as natural mulching material to further aid in the act of seed germination and sulfuric acid was incorporated prior to assess its scarifying impact. There were three replications of each of the seven treatments that made up the experiment. The treatments were applied in combination of sulphuric acid duration (for scarification) and above mentioned mulching material in the pot. The entire experiment was conducted in a completely randomised manner (CRD). The criteria that were observed at regular intervals during the growth of the seedlings were plant based physical parameters and chlorophyll content. Based on the complete experiment, it can be concluded that the development of papaya seedlings was positively impacted by acid scarification and the usage of organic mulches. The most effective treatment, according to the findings of the various attributes, was sulfuric acid scarification for one minute while using wood chips as an organic mulch material.

Keywords: Acid, Mulch, Organic, Papaya, Seeds, Study

Revolutionizing Indian Agriculture: Unleashing the Power of Secondary Farm Mechanization

Priyanka Roy[1], Saikat Maji[2] and Prashish Singh[1*]

Dept. of Extension Education, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India

E-mail: prashishext@bhu.ac.in

Abstract

The Indian agriculture sector, long the backbone of the economy, faces challenges like diminishing land resources, labor shortages and unpredictable weather patterns. Emphasizing secondary agriculture and farm mechanization has emerged as a game-changer to address these issues. Small and marginal farmers, who make up 86% of landholders, often struggle to invest in costly farm machinery and rely on hiring implements for agricultural work. Mechanization brings efficiency, reduces drudgery and enhances sustainability. Mechanization's role in secondary agriculture is crucial, streamlining processes, boosting productivity and ensuring product quality. Government interventions and stakeholder efforts have mechanized various agricultural processes. However, challenges persist, such as the limited scale of mechanized transplanting and harvesting and the lack of mechanical drying facilities. The benefits of secondary farm mechanization are evident, including increased productivity, quality assurance, reduced losses, income diversification, labor shortage mitigation and sustainability. Initiatives like SMAM, food processing units, agri-startups and mandi modernization aim to promote mechanization. Challenges like affordability, awareness, inadequate infrastructure and environmental impact need addressing. Collaboration between the government, private players and NGOs is crucial to provide subsidies, training and market linkages. In summary, secondary farm mechanization holds immense potential to transform Indian agriculture, improve livelihoods and ensure sustainable and efficient food production.

Keywords: Agri-Startups, Government, Mechanization, Secondary agriculture, Sustainable

Strategies for Addressing Climate Change Impacts on Agriculture: Adaptation and Mitigation Approaches

Anil Kumar S.

ICAR-Krishi Vigyan Kendra, Kolar, Karnataka (563 101), India

E-mail: anilkumar.s@uhsbagalkot.edu.in

Abstract

Climate change is expected to exert significant impacts on crop yields by altering temperatures and water availability. Mitigation and adaptation efforts aim to counteract these effects gradually while sustaining development. Effective strategies encompass various practices that fall into three main categories: crop and cropping system-based technologies, resource conservation-based technologies and socio-economic and policy interventions. In the context of India, it is crucial to explore these measures and identify the most suitable strategies for combatting climate change. Crop and cropping system-based technologies involve the adoption of climate-resilient crop varieties and optimized planting practices. Utilizing drought-resistant seeds, implementing precision agriculture techniques and adjusting planting calendars can enhance resilience to changing climatic conditions in India. Resource conservation-based technologies encompass sustainable water management and soil conservation practices. Implementing efficient irrigation methods, such as drip irrigation and rainwater harvesting, can help preserve precious water resources. Soil health improvement through organic farming, reduced tillage and agroforestry can enhance soil fertility and mitigate climate-related risks. Socio-economic and policy interventions play a critical role in climate resilience. Promoting farmer education and awareness on climate-smart agriculture practices can empower rural communities to adapt effectively. Additionally, government policies that incentivize sustainable agriculture, provide insurance against climate-related crop losses and support research and development of climate-resilient technologies are essential for long-term climate adaptation in India.

Keywords: Agroforestry, Carbon, Food insecurity, Intercropping, Rice fields, Zero tillage

Weed Management in Conservation Agriculture System

Shubhamay Dey[1*] and Sonali Biswas[2]

[1]Dept. of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India
[2]AICRP on Maize, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: shubhamaydey@gmail.com

Abstract

Conservation agriculture (CA) is a holistic approach towards increased productivity and improved soil health having several advantages over conventional tillage (CT) in terms of soil health parameters. However, weeds are the major biotic constraint in CA, posing as a great challenge towards its adoption. Presence of weed seeds on upper soil surface, due to no tillage operation, leads to higher weed infestation in CA and so far herbicides are the only answer to deal with this problem. Overreliance on herbicide use showed its consequence in terms of environmental pollution, weed shift and herbicide resistance development in weeds. Growing herbicide tolerant crops using non-selective herbicides is a broad spectrum weed management technique to tackle weed shift, but the same has resulted in evolution of more problematic super weed. These observations indicate the need of IWM technologies involving the time tested cultural practices, *viz.*, competitive crop cultivars, mulches, intercrops with allelopathic potential, crop diversification, efficient nutrient and water management, *etc.*, along with limited and site specific herbicide application. `Happy Seeder' technology, that helps in managing weeds through retention of crop residues as mulches, besides providing efficient seeding and fertilizer placement, holds the promise of becoming an integral part of CA system. The benefits of CA can well be taken in black cotton soils with rice-wheat-moong bean system as weed menace under this system can be managed by integrating suitable herbicides in the weed management programme. However, it's very basic principles of sowing seeds in an un-tilled land and without removing crop residues are in sharp contrast to the traditional belief, tremendous amount of efforts will be needed to pursue the farmers' for adoption of this technology. Further, lack of availability of suitable machineries and timely availability of herbicides could be other bottlenecks towards the popularization of CA, which requires administrative intervention.

Keywords: Agriculture, Conservation agriculture, Environment, Productivity, Weed management

Agroforestry: An Effective Tool to Improve Soil Quality and Food Security under Changing Climate

Kaberi Mahanta[1*], Kusum Deka[1], Naseema Rahman[1] and D.J. Rajkhowa[2]

[1]AAU-HRS, Kahikuchi, Guwahati, Assam (781 017), India
[2]ICAR Research Complex for NEH Region, Nagaland Centre, Nagaland (797 106), India

E-mail: kaberi.jorhat@gmail.com

Abstract

The global population will reach 11 billion by 2050; hence achieving food security without hampering environmental quality is a global challenge. Climate and soil are the major determinants of agricultural productivity, profitability and human well-being. Climate adversities had a negative impact on crop productivity, natural resources and eventually food security and environmental health. Moreover, the burgeoning population causes serious pressure on land to fulfil the increasing food demand, animal feed, fiber and fuel, leading to adopting practices such as intensive tillage, monoculture, excessive and improper use of inorganic fertilizer, use of agro-chemicals, deforestation, over-grazing, among others. These modern practices of agriculture are considered to be the major unsustainable practices leading to soil health degradation. Some of these practices lead to climate change, which in turn accelerates the rate of soil health degradation. Planting trees in agricultural landscapes not only generates income in the form of timber and non-timber produce but also performs valuable ecosystem services. Agroforestry has an important role in reducing vulnerability, increasing the resilience of farming systems and buffering households against climate-related risks. It can also maintain or increase the supply of ecosystem services - water, soil health and biodiversity, especially under a changing climate, that will continue to support social, industrial and ecosystem services needs. The planting of trees are integral to our traditional farming systems, because of the innumerable direct and indirect benefits that they provide subsistence of farmers. So these agroforestry systems act as a source of different tree-based products, such as gums, resins, floss, fibers, fodder, brooms, fruits, *etc*., for the subsistence of farmers. Therefore, agroforestry is considered to be the backbone of marginal farming for self-reliant and sustainable agriculture. Achieving food security and environmental security is a prime benefit of agroforestry systems. The varied agroforestry systems in India form a strong feasible option to counter climate change.

Keywords: Agroforestry, Climate change, Food security, Soil quality

The Role of Forest and Forestry in Reducing Poverty among PVTGs in Chhattisgarh

Devjit Nandi* and Debashis Sarkar

Dept. of Agricultural Economics, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: devjeetn@gmail.com

Abstract

The potential of Forest Rights Act (FRA), has the potential to reduce poverty among the PVTGs, which has not been implemented properly. The forest dependence and the relationships are important and have been studied in details in Achanakmar Sanctuary and its implications on poverty reduction policies have been analyzed. The major income is from forest, and various bio diverse trees have specific importance for increase the income of the community and the management by the people will further up-scale the forest income as envisaged under FRA. The land entitlement provided in the devolution process and agriculture income can also be major contribution. Using data by survey from Core and Buffer area of Achanakmar Tiger reserve in Chhattisgarh, we derive the counter factual of what Baiga household's income, poverty and inequality would be without forest and forest income. Results disparagingly show that in absence of forest income; poverty would have been deeper and income inequality would be more. We find that land ownership, awareness, education and way of life are very pivotal in helping household gain access to their devolution gains. We also find that those who are entirely dependent on forests have unique non-observable attributes that make them more innovative and productive NTFP collectors, implying positive selection on their attributes. Moreover, engagements in village activities have a positive spill over effect on household income.

Keywords: Agriculture, Biofortification, Micronutrients, Nutrition

Bioactive Compounds from Mangroves and Their Effect on Shrimp Health

Suchita Mukherjee and Tapti Sengupta*

Dept. of Microbiology, West Bengal State University, Barasat, 24 Pgs(N), Kolkata, West Bengal (700 126), India

E-mail: tapti.sg@wbsu.ac.in

Abstract

Mangroves are the backbone of our ecosystem and they are halophytic. Around twenty five percent of the world's coastline is occupied by mangroves. Around eighty four species of mangrove plants are present in the world. Out of them, seventy are true mangroves. Thirty four true mangrove species are present in the Indian Sundarban's bioreserve. This unique vegetation is rich in bioactive compounds having antibacterial and antiviral activity. Nowadays, shrimp culture is growing fast because of their high demand in the global market. Shrimp aquaculture faces many problems due to the outbreak of bacterial and viral diseases. Bacterial pathogens such as *Vibrio parahaemolyticus*, *Vibrio alginolyticus*, *Aeromonas hydrophila*, *E. coli*, *Salmonella* spp., *Pseudomonas* spp. and viral pathogens such as white spot syndrome virus (WSSV) cause mass mortalities and loss of revenue for shrimp farms along the Indian coastal line. For the control of such bacterial and viral infections and to prevent morbidity, excessive antibiotics and antiviral agents are used which when drained to the aquatic systems cause serious harmful effects on the environment as well as on human health as it increases the antimicrobial resistance (AMR) of inherent pathogens. Dietary supplementation using bioactive components can increase the survival rate of shrimps and reduce disease occurrence. Mangrove species like *Acanthus ilicifolius*, *Avicennia alba*, *Bruguiera* spp., *Rhizophora* spp., *Excoecaria* spp., *Xylocarpus granatum*, *Sonneratia* spp. are rich in several secondary metabolites like saponins, terpenoids and many phenolic compounds such as alkaloids, tannins, glycosides which act as active phytocompounds having antibacterial and antiviral effects. Fortification of shrimp feed with these extracts can be economical and sustainable. The current study deals with the importance of Sundarban mangroves, their sustainable and economic utilization and use of active phytoextracts to enhance the efficacy of shrimp feed in brackish water aquaculture systems.

Keywords: AMR, Bioactive compounds, Mangroves, Shrimp feed, Sundarban

Exploring the Variations in Oleic Acid Content of Pre-Treated Rubber Seed Oils and Their Comparison with Commercially Available Edible Oils

Abhijit Bhattacharjee*, Bipul Das Chowdhury and Bimal Debnath

Dept. of Forestry and Biodiversity, Tripura University, Suryamaninagar, Tripura (799 022), India

E-mail: abhimonish@gmail.com

Abstract

Oleic acid (cis-9-octadecenoic acid) is an omega-nine fatty acid found in almost all lipids. It is a natural fatty acid widely distributed in 10% to 40% concentrations of edible oils. In preliminary studies, Rubber Seed Oil (RSO) has shown promising results in commercial applications as skin creams and drugs that can inhibit Glucosyl transferase and Cholesterol Synthesis. It is also used as an excipient for producing emulsions due to its ability to react with alkali-forming soaps with emulgent properties. Various pre-treatment methods were evaluated to provide clear and concise information about RSO and its uses for the diverse needs of a vast population. The oleic acid content (as FFA %) of a few commercially available refined edible oils, such as Sunflower (SunO), Olive (OliO) and Peanut oils (PEO) with various pre-treated RSO subjected to temperatures of 45 °C for 48 hours, 60 °C for 72 hours and 75 °C for 48 hours. The total titratable acidity was determined by the AOCS method for all samples. Free Fatty Acid (FFA) analysis showed that SunO, OliO and PEO had oleic acid values of 0.71, 1.41 and 13.40, respectively. FFA % was found to be highest at 33.14% in the RSO sample (extracted at 75 °C, 45 °C - 48 h pre-treatment) followed by 14.10% (extracted at 120 °C, 60 °C - 72 h pre-treatment) and 12.69% in RSO sample (extracted at 160 °C, 75 °C - 48 h pre-treatment). The present study showed that the pre-treated RSO samples had higher oleic acid content than other experimental edible oils. These findings would provide insights into the various aspects of edible oils' FFA content (oleic acid) and the impact of pre-treatment temperature and duration on these values. The high oleic acid content in RSO makes it a suitable candidate for its use in the cosmetic industry. Pre-treatment and storage can reduce its harmful contents, making this resource utilization possible.

Keywords: Cosmetic industries, Oleic acid, Pre-treatment, Rubber Seed Oil (RSO)

Role of Soil Phosphorus as Macronutrient in Agar Wood Formation

Bipul Das Chowdhury*, Abhijit Bhattacharjee and Bimal Debnath

Dept. of Forestry and Biodiversity, Tripura University, Suryamaninagar, Tripura (799 022), India

E-mail: bipuldasmbbc@gmail.com

Abstract

Agar wood-producing trees have been observed to host a variety of endophytic microbes, including fungi, which have been found to produce similar or even higher amounts of bioactive substances compared to their healthy host counterparts. Endophytes alter the phytoconstituents of the host plant, forming more sesquiterpene and chromone derivatives that can act as a defense mechanism against stresses. Endophytes produce a wide range of secondary metabolites that can significantly improve a plant's defense system. Endophytes assist host plants in combating unfavorable conditions through biofertilizers, bio-control, and phytostimulation. Root-soil interactions in the rhizosphere can significantly affect phosphorus availability to plants. Our objective was to examine the variation in available phosphorus in soil due to endophytic associations and observe the variation between healthy and infected Agar wood plants' rhizospheric soil. Three sites were selected from three areas in North Tripura for soil sampling. Samples were collected at three depths from each sampling site. Available phosphorus was quantified using the colorimetric Bray's phosphorous method. The result showed a significant increase in phosphorus content (P=0.0246) with soil depths in healthy and infected plant sites. The healthy plant site had higher available phosphorus content (25.711-59.770 kg ha^{-1}) at all depths. In contrast, infected Agar wood plant sites showed lower content (11.845-27.408 kg ha^{-1}). This may be due to the excessive uptake of minerals by infectious microorganisms. The study highlights the critical role played by soil phosphorus in enhancing plant resistance to disease, strengthening plant stems, and ultimately helping in resinous Agar wood formation. It is essential to note that the available phosphorus content in the soil of infected plants was lower than that of healthy plants.

Keywords: Agarwood, Available phosphorus, Defense mechanism, Phytoconstituents

Yield Response and Nutrient Uptake of Utera (Relay) Rapeseed-Mustard Varieties in Rice-Fallow as Influenced by Foliar Spray of Nutrients in Alluvial Soils

Somnath Saha*, Arun Kumar Barik and Basant Kumar

Dept. of Agronomy, Palli-Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal (731 236), India

E-mail: zdsom@live.com

Abstract

A field experiment was conducted during winter season (November to February) of 2020-21 and 2021-22 to evaluate performances of different rapeseed-mustard varieties under foliar spray of nutrients on seed yield, oil yield and nutrient uptake of utera (relay) rapeseed-mustard grown in rice-fallow. The experiment was laid out in a splitplot design keeping varieties, *viz*., Anushka, Binoy and PM-28 in main plots and eight different foliar spray of nutrients in sub-plots. Mustard variety PM-28 achieved significantly higher seed yield (1198.5 kg ha^{-1}), stover yield (3300.4 kg ha^{-1}) and biological yield (4498.8 kg ha^{-1}), oil yield (404.1 kg ha^{-1}) and protein yield (194.7 kg ha^{-1}) as well as significantly higher N, P and S uptake over other two varieties. Foliar spray of N:P:K (19:19:19) @ 2% twice at 30 DAS and 45 DAS + $ZnSO_4$ @ 0.05% at 40 DAS + Boron (20%) @ 0.1% at 50 DAS was found significantly superior to all other foliar sprays with respect to seed yield (1233.2 kg ha^{-1}), stover yield (3109.9 kg ha^{-1}) and biological yield (4343.2 kg ha^{-1}), oil yield (479 kg ha^{-1}) and nutrient uptake irrespective of the varieties over others. The study revealed that, relay cropping with rapeseed-mustard along with foliar application of nutrients in rice-fallow was a better option to enhance productivity, oil yield and nutrient uptake of relay rapeseed-mustard in alluvial soils.

Keywords: Foliar spray, Nutrient uptake, Oil yield, Rapeseed-mustard, Rice-fallow, Utera crop

Degradation of Low Density Poly-Ethylene (LDPE) by *Enterobacter cloacae* AKS7 (A Soil Isolate): A Potential Strategy for Environment Cleanup

Poulomi Chakraborty* and Tapti Sengupta

Dept. of Biotechnology, The Neotia University, South 24-Paraganas, West Bengal (743 368), India

E-mail: poulomi.chakraborty@tnu.in

Abstract

Plastic materials, especially polyethylene are apparently non-biodegradable and exhibit a major threat due to their long persistence in environment. Recent literatures showed that microbial degradation of polyethylene is quite slow and insufficient. Moreover, the underlying mechanism of microbial degradation of plastic material is yet to be explored. Thus, in the current study, efforts have been made to degrade low density polyethylene (LDPE) by an isolated bacterium, *Enterobacter cloacae* AKS7. Scanning electron microscopic (SEM) image analysis, Tensile strength and weight loss analysis showed that the isolated organism AKS7 can degrade LDPE considerably. Ribotyping and biochemical tests also carried out and the results showed that AKS7 is a new strain of *Enterobacter cloacae*. During the course of incubation of AKS7 with LDPE, the organism gradually increases the degree of adherence to LDPE indicating the formation of microbial biofilm on LDPE surface. It was also observed that the bacteria AKS7 significantly increase the secretion of extracellular polymeric substances (EPS) while growing with LDPE. The secretion of EPS validates the development of microbial biofilm over the LDPE surface. The result established a direct correlation between microbial biofilm and LDPE degradation suggesting that microbial biofilm causes enhanced degradation of LDPE by AKS7. In order to examine the mechanism of biofilm formation over the LDPE surface, microbial cell surface hydrophobicity assay was performed. The result demonstrated that cell surface hydrophobicity got increased which indicates the promotion of better colonization of AKS7 on LDPE surface that leads to enhance the degradation of LDPE by AKS7. Thus, this organism holds a promising bio-remediating agent for the sustainable degradation of polythene-based hazardous waste.

Keywords: Cell surface hydrophobicity (CSH), *Enterobacter cloacae*, Extracellular polysaccharides (EPS), Low density poly-ethylene (LDPE), Microbial biofilm

Exploring the Brassica Wild Relatives and U-Triangle Species to Identify the Glyphosate Tolerant Genotypes at Pre- and Post-Emergence Stages

Ranjeet Kushwaha[1*], Anamika Kashyap[1], Sujata Kumari[1], Pooja Garg[1], Shikha Tripathi[1], Jyoti Sharma[1], Navin C. Gupta[1], Rajeev Ranjan Kumar[2], Harinder Vishwakarma[3], Ramcharan Bhattacharya[1], Rashmi Yadav[3], Jai Chand Rana[4] and Mahesh Rao[1]

[1]ICAR-National Institute for Plant Biotechnology, Pusa, New Delhi (110 012), India
[2]ICAR-Indian Agricultural Statistics Research Institute, New Delhi (110 012), India
[3]ICAR-National Bureau of Plant Genetic Resources, New Delhi (110 012), India
[4]Bioversity International, India Office, New Delhi (110 012), India

E-mail: mraoicar@gmail.com, ranjeet1998@yahoo.in

Abstract

Brassica crop wild relatives (CWRs) play a crucial role in enhancing cultivated *Brassica* species due to their substantial genetic variation. Although their contributions are noteworthy, their tolerance to the widely used herbicide glyphosate remains unknown. This study focuses on the wild counterparts alongwith the genotypes within the U triangle, examining how 20 Brassicaceae family genotypes respond to glyphosate. For the treatment, Roundup Monsanto (Bayer, India) (41% glyphosate), was used to prepare a 100 mg L^{-1} solution and applied for the evaluation at pre-emergence as well as post emergence stage. The evaluation was done on the basis of morpho-biochemical reactions, specifically germination percentages, root length, survival rates, protein estimation and *ascorbate peroxidase* (APX) activitiy at pre- and post germination stages. The genotypes are categorized into three groups based on mean membership function values (MFV) that indicate their response to these traits: susceptible, somewhat tolerant, and tolerant. *Crambe abyssinica* genotypes EC400058 and EC694145 along with *Brassica carinata* (PC6) and *B. rapa* (NRCPB rapa 8) grouped as the highly tolerant while 13 and 3 species were grouped as moderately tolerant and sensitive for the Glyphosate treatment. The diverse results underscore the varying responses of different genotypes to glyphosate, emphasizing notable tolerance in certain species. This study underscores the importance of utilizing phenotypical and biochemical indicators for assessing herbicide tolerance and offers treasured visions into the herbicide tolerance of *Brassica* wild relatives.

Keywords: Crop wild relatives, Herbicide tolerance, Membership function value, Morpho-biochemical

Diversification of Potato based Cropping System for Higher Productivity and Profitability in Red and Lateritic Soils of West Bengal

Basant Kumar*, Arun Kumar Barik, Biswajit Saha, Somnath Saha, Siddharth Patre and Nirmala Patel

Dept. of Agronomy, Palli Siksha Bhavana, Visva Bharati University, Santiniketan, West Bengal (731 236), India

E-mail: bkmips0725@gmail.com

Abstract

A field experiment was conducted to identify the best potato based diversified cropping system during rabi and summer seasons of 2020-21 and 2021-22 under red and lateritic soils of West Bengal. The present study, comprised of seven diversified potato based cropping systems namely, potato-sesame; potato-greengram; potato-babycorn; potato-okra; potato-groundnut; potato-blackgram and potato-vegetable cowpea, was laid out in randomized block design with three replications. The results obtained from the study showed that the system productivity (47.47 t ha^{-1}) was significantly highest in cropping sequence with potato-vegetable cowpea followed by potato-babycorn (43.13 t ha^{-1}) and potato groundnut sequence (42.34 t ha^{-1}). The potato-vegetable cowpea sequence also fetched highest gross return (493×10^3 Rs. ha^{-1}), net return (365×10^3 Rs. ha^{-1}) and return per rupee invested (Rs. 3.86) which was statistically at par with potato-groundnut sequence. The system production efficiency (130.05 kg $ha^{-1}day^{-1}$) and system economic efficiency (1017.34 Rs. $ha^{-1}day^{-1}$) was also significantly higher under potato-vegetable cowpea sequence on pooled data basis. Cropping system having potato-blackgram sequence registered lower system productivity and economics on the above parameters. The present findings revealed that inclusion of vegetable cowpea in potato based cropping system will not only lead to increased productivity but also higher profitability as compared to other potato based cropping systems in red and lateritic soils of West Bengal.

Keywords: Cropping sequence, Potato, Productivity, Profitability and system

Effect of Slag-based Gypsum on Availability of Secondary and Cationic Micronutrients in Relation to Growth and Yield of *Kharif* Onion in Lateritic Soil

Sujit Kumar Bhunia*, Prasanta Kumar Patra and Rohit Kumar Das

Dept. of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: bhuniakumarsujit@gmail.com

Abstract

Slag-based gypsum (SBG), a steel industry by-product, contains Calcium Sulphate as the major component and some detectable amount of iron oxide. A field experiment was conducted in a lateritic soil at Chhatna, Bankura, West Bengal, India during *Kharif* season 2021 to study the effect of 10 doses of SBG, *viz*., 0 (control), 100, 200, 300, 400, 500, 600, 700, 800 and 900 kg ha^{-1} along with 10 t ha^{-1} FYM and the recommended doses of chemical fertilizer, laid out in RCBD, on the availability of secondary and some cationic micronutrients in relation to growth and yield of *Kharif* onion (cv. *Agrifound dark red*). Soil and plant samples were collected after harvest of the crop and analysed for different soil parameters *viz*., pH, organic carbon, available Calcium, Magnesium and Sulphur; DTPA extractable Iron, Manganese, Zinc and Copper contents and nutrient contents of onion. With respect to the control treatment, application of SBG at 900 kg ha^{-1} effectuated the highest to the tune of about 27.83%, 1.90%, 114.90%, 138.77%, 33.49%, 189.48% and 149.09% increase in available Ca, Mg, S, Fe, Mn, Zn and Cu content of soil. The highest level of these nutrients in onion bulb and onion bulb yield is also observed in application of SBG at 900 kg ha^{-1}. The results of this experiment pointed out that SBG can be safely used as a source of S and supplementary source of some cationic micronutrients in agricultural production without any deleterious effect and be an example of utilization of hitherto considered waste material into a wealth.

Keywords: Cationic micronutrients, *Kharif*, Lateritic soil, Onion, Slag-based gypsum

Evaluation and Identification of Suitable Sweet Corn Cultivars in North Eastern Plain Zone of India

Srabani Debnath, Afridi Mondal*, Sonali Biswas and Anirban Maji

All India Co-ordinated Research Project on Maize, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: afridimondal1112@gmail.com

Abstract

Maize is a unique crop in nature having highest yield potential, wider adaptability and diversified uses. India ranks 4th in area and 7th in production in world. Maize is mainly grown as grain corn, fodder and specialty corn throughout the world. Among specialty corns sweet corn is very much important and this is consumed in soft dough stage which is sweet in taste. Identification of promising lines is one of the important breeding goals for North Eastern Plain Zone (NEPZ) of West Bengal. Under this purview, 12 hybrids of sweet corn were evaluated under AICRP on Maize at District Seed Farm, Kalyani, BCKV including two checks in the *Rabi* 2021 and 2022. The experiment was laid out in Randomized Block Design (RBD) with three replications. The results revealed that two lines CPSC-301 and MSCH-2101 showed significant higher yield 11,025.69 kg ha^{-1} and 8,534.03 kg ha^{-1} with TSS 13.3 and 14.8, respectively in the year 2021. Similar results were recorded in the year 2022 also. Moreover, two hybrids showed significant percentage of heterosis over best checks in two consecutive years. Therefore, these two hybrids can be identified as promising sweet corn lines of NEPZ particularly in West Bengal.

Keywords: Heterosis, Maize, Sweet corn, TSS, Yield

Spatio-Temporal Dynamics of Land Use Land Cover: Comparative Perspective at Different Land Administration Levels

Snehalata Chaware[1*], Nitin Patil[2] and Gajanan Satpute[1]

[1]Dept. of Soil and Water Conservation Engineering, Dr. PDKV, Akola, Maharashtra (444 104), India
[2]National Bureau of Soil Survey and Land Use Planning, Amravati Road, Nagpur, Maharashtra (440 033), India

E-mail: snehal22chaware@gmail.com

Abstract

Change in Land use and land cover (LULC) is a topic of wide interest to academicians, policy makers, administrators and land users alike. Most reported investigations are conducted for a singular land unit of interest. This study reports different analytical perspective of LULC by comparing changes at three different land revenue administration levels-subnational (Maharashtra), regional (Amravati district), subregional (Bhatkuli block) and one hydrological level (Nagjhari watershed) over a decade (2007-2017). It was observed that across all the levels, there is an increase in land use class 'habitation' (increasing order from 12.3 to 37.1%) and 'water body' (increasing from 8 to 57.1%) while area under 'wasteland' (1.2 to 25.5%) decreased. However, the magnitude of change varied and drivers causing these changes exhibited varied interplay at different levels. At subregional level, a significant decline in 'forest' was noted (28.4%). Change in 'water body' was sharply evident when analyzed at watershed level than land administration levels. It also indicated success of major public investment in watershed development since 2014. Saline-sodic soils at watershed level underscored importance of local factors. In general, it emerged that increasing population is bringing more 'cultivated area' under 'habitation', concurrently increasing cultivation of 'wastelands'. Thus, fertile lands are being lost to habitation, while relatively poor soils are increasingly cultivated; foremost cause of concern in monsoon dependent agriculture especially when the state is facing serious agrarian distress. The study provided glimpses of emerging LULC trends and issues driven by identified institutional, economical, natural, technological and environmental factors operating at different levels of land management units.

Keywords: Drivers of change, Geographic Information System Geospatial techniques, Land management unit, Land use land cover, Remote sensing

Response of Seaweed Liquid Spray on Maize Varieties under Prayagraj Condition of UP

M.R. Meshram[1*], L.K. Sanodiya[1], Shivani Kumari[1] and Joy Dawson[2]

[1]Dept. of Agronomy, NAI, SHUATS, Prayagraj, Uttar Pradesh (211 007), India
[2]Dept. of Agronomy, Nagaland University, Meriema, Nagaland (797 004), India

E-mail: mayurcicr@gmail.com

Abstract

A field experiment was undertaken at the agricultural research farm of the Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj during zaid 2020 and 2021 to find out the effective seaweed spray dose for getting higher yield of maize cultivar for that area. Maize is a heavy feeder of nutrients, there is a significant demand for fertilizer in maize-growing areas. The lack of crop nutrients in adequate levels and forms is one of the key crop productivity restrictions in the developing countries. In this case, seaweed sap were good choice with inorganic fertilizer, chemical fertilizer which degrades soil health and the ecosystem the use of organic and natural fertilizers that are readily available help to maintain soil fertility in the intensive cropping systems. Results revealed that the productivity of maize was influenced by cultivars and seaweed sap foliar concentration. On pooled analysis of both the year experiment, it was clearly evaluated that among cultivars VLMH-57 produced higher plant height (180.79 cm), stem girth (4.93 cm), dry matter (178.55 g plant^{-1}), cob length (19.53 cm), cob girth (15.25 cm), grains row^{-1} (26.98), number of grains row cob^{-1} (16.64), grains cob^{-1} (448.49), cob weight (151.44 g), seed index (29.84 g), which resulting in higher grain (5.87 t ha^{-1}) and straw yield (9.91 t ha^{-1}), than all other cultivars. Further in case of seaweed sap, foliar application of S-Seaweed Sap 10% (S_7) produced higher plant height (176.47 cm), stem girth (4.91 cm), dry matter (185.6 g plant^{-1}), cob length (19.65 cm), cob girth (15.57 cm), grains row^{-1} (26.74), number of grains row cob^{-1} (15.75), grains cob^{-1} (423.64), cob weight (151.50 g), seed index (29.72 g), which resulting in significantly higher grain (5.43 t ha^{-1}) and straw yield (9.42 t ha^{-1}), than all other foliar application of seaweed sap concentration except foliar application K-Seaweed Sap 10% (S_4) was followed similar trend and found to be at par to foliar application of S-Seaweed Sap 10% (S_7). Therefore, the cultivar VLMH-57 with foliar application of S-Seaweed sap 10% may be adopted by corn growers to harness the maize production and profitability under the ecological parameters of Uttar Pradesh.

Keywords: Liquid spray, Maize production, Seaweed, Varieties

Nutritional Evaluation of Tree Leaves from North-Eastern Himalayas Forest for Domestic Animal's Feed

Tadung Taku

Faculty of Agricultural Sciences, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh (791 112), India

E-mail: tadungtaku87@gmail.com

Abstract

Five Himalayan forest tree leaves, *viz*., Domkar (*Symplocus racemosa*), Karsing (*Acer hookeri*), Kaew (*Costus speciosus*), Maarma (*Spiraea canescens*) and Barhar (*Artocarpus lakoocha*) were evaluated for nutritional value as tree fodder for domestic animal using *in vitro* gas production test. The tested tree leaves had an average content of Organic Matter (OM), Crude Protein (CP), Ether Extract (EE), Total Carbohydrate (T-CHO), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), cellulose and lignin of 92.4, 12.3, 3.4, 76.8, 44.5, 32.6, 19.5 and 12.9% on a dry matter basis respectively. For 96 hours, *in vitro* gas production investigation was carried out to determine the quantity of gases produce by different leaves. Over the course of 96 hours of incubation period, time-dependent rises in production of gases were seen in all tree leaves. The maximum *in vitro* total dry matter digestibility (IVTDMD %) was found in the leaves of Domkar and Kaew trees at the end of the incubation period. The microbial biomass productions (MBP) per unit digested dry matter were highest for Maarma and Kaew leaves. Thus, from the current study it can be concluded that these tree leaves can be utilized as a novel feed source for the local domestic animals.

Keywords: Domestic animals, Fodder, Himalayan forest, *in vitro* gas production, Microbial biomass

Strategies for Improvement of Quality in Rice

Sreelakshmi, Ch.*, Paramasiva, I., Sameera, S.K., Vineetha, U. and Madhusudhan, P.

Agricultural Research Station, Nellore, ANGRAU, Andhra Pradesh (524 003), India

E-mail: sreelakshmi.angrau@gmail.com

Abstract

The main aim of quality improvement in rice is to increase the returns to the farmers along with getting good yields. Grain quality plays a major role in adaptation of newly developed high yielding variety with pests and disease resistance. Quality aspects includes appearance, milling, cooking, sensory, nutritional aspects which are polygenic in nature and having low heritability. Physical traits include grain size, shape, absence of chalkiness, appearance of endosperm, aroma and texture of the cooked rice which may depend on the geographical, social and economic conditions of the farmers. Milling quality refers to head rice recovery, an important aspect for getting profit to the millers which will be preferably more than 60%. It again depends on the crop growing season, machinery used for milling, moisture content of the grain, method of drying, *etc*. The parboiling process strengthens the starch grain molecules in endosperm and increase the head rice recovery even upto 58%. Among cooking quality traits, amylose has direct relationship with the water uptake of rice kernel during cooking and positive association with volume expansion ratio of cooked rice. In addition to this, nutritional quality includes presence of iron, zinc and protein in sufficient quantities in grain. Habitual features of people prevent the nutritional value of rice from being utilized, *e.g.*, the inverse relationship between rice amylose content and Glycemic index. The cost of brown rice is substantially increased by the need of stabilize lipids and removed as bran while milling. However, there is a negative relationship between the grain yield and nutrient content in rice grain. Agronomic aspects like, application of nutrient in the form of sprays, usage of genetic engineering approaches along with breeding methodologies proposed to increase the nutrient content in rice grain. Another side, the presence of toxic heavy metals in rice grain is due to wetland rice cultivation. It is essential to develop ambitious rice development strategies aiming to improve the value of rice by increasing grain quality and there by getting high price to the farmers.

Keywords: Grain, Quality improvement, Rice, Strategies, Yield

Productivity and Profitability of Transplanted Rice under Different Fertility Levels and Weed Management Practices in East and South Eastern Coastal Plain Zone of Odisha

S. Samantaray[1*] and S. S. Nanda[2]

[1]Dept. of Agronomy, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal (731 236), India
[2]Dept. of Agronomy, Faculty of Agricultural Sciences, Siksha 'O' Anusandhan Deemed to be University, Bhubaneswar, Odisha (751 029), India

E-mail: subhashree.samantaray43@gmail.com

Abstract

A field experiment was conducted at the Agricultural research station of the Faculty of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar to assess the influence of varying weed management practices across different fertility levels, on weed population dynamics, plant growth characteristics, yield attributes and crop yield of rice. The experiment was laid out in a factorial RBD design which consisted of twelve treatments combinations including three levels of fertility *viz*., 100% recommended dose of fertilizer (RDF), 75% RDF, 50% RDF and four levels of weed management practices *viz*., Fenoxaprop-P-ethyl @ 60 g ha^{-1}, 2,4-D ethyl ester @750 ml ha^{-1}, hand weeding at 20 & 40 DAT and weedy check. The weed population exhibited a significant increase at higher levels of fertility with the 100% RDF, recording higher weed population m^{-2} (*i.e.*, 3.88, 4.14, 3.80, and 3.62 at 30, 50, 70 DAT and harvest, respectively). Post-emergence application of Fenoxaprop-P-ethyl @ 60 g ha^{-1} which was found to be most effective in controlling the weed population as compared to 2,4-D ethyl ester, hand weeding twice at 20 and 40 DAT and weedy check. The experimental results unveiled that growth attributes, such as the leaf area index (LAI), demonstrated a consistent increase with post-emergence application of fenoxaprop-P-ethyl, significantly surpassing 2,4-D ethyl ester, hand weeding twice at 20 & 40 DAT, and the unweeded control treatment. This is due to effective control of weeds in critical periods that accelerated photosynthetic activity ultimately leading to higher LAI. The application of 100% RDF along with post-emergence application of Fenoxaprop-P-ethyl @ 60 g ha^{-1}, was found to be most beneficial for achieving a higher grain yield (3.63 t ha^{-1}) and straw yield (4.42 t ha^{-1}), which was at par with 75% RDF coupled with post-emergence application of 2,4-D ethyl ester @ 750 ml ha^{-1}.

Keywords: Fertility levels, Hand weeding, Productivity, Profitability, Transplanted rice, Weed management

Development of Transitional Synthetic Amphidiploids in Brassica: An Approach for the Trait(s) Transfer from Wild to Cultivated Species in Rapeseed Mustard

Shiv Shankar Sharma[1,2*], Pooja Garg[1], Anamika Kashyap[1], Ranjeet Kushwaha[1], Ashish Kumar[1], N.C. Gupta[1], Rashmi Yadav[3], Jai Chand Rana[4], Ramcharan Bhattacharya[1] and Mahesh Rao[1]

[1]ICAR-National Institute for Plant Biotechnology, Pusa Campus, New Delhi (110 012), India
[2]Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India
[3]ICAR-National Bureau of Plant Genetic Resources, New Delhi (110 012), India
[4]Bioversity International, India Office, New Delhi (110 012), India

E-mail: shankar97688@gmail.com

Abstract

Globally and in India, Brassica species play a crucial role in serving as oilseed and vegetable crops. Among the Brassica species, *Brassica juncea*, a significant amphidiploid-cultivated species, holds a second position in oilseed production. Cultivated amphidiploid species exhibit a limited genetic diversity, which lacks economically valuable traits in their primary gene pool. However, its diploid species and crop wild relatives (CWRs) represent a valuable resource for accessing diverse economic traits. The close relationships and abundance between the species and wild relatives, reservoirs of genetic diversity, are the primary importance of using a wide hybridization method to transfer desirable traits from wild species into Brassica U-triangle species and for improvement.

At ICAR-NIPB in Delhi, we maintain a collection of numerous wild relatives of Brassica, which are currently being evaluated for various abiotic stresses such as heat, drought, tolerance to herbicide and heavy metals. Also, we are assessing their responses to biotic stresses for Alternaria blight, white rust, powdery mildew and stem rot. We have encountered challenges while working on transferring specific traits from wild species through wide hybridization due to linkage drag, which tremendously declined the success rate of obtaining seeds in these cross combinations. Interestingly, to overcome the challenges associated with low seed sets in crosses involving wild and amphidiploid-cultivated species, we adopted an alternative approach that involves using *B. rapa*, a diploid species, as a bridge species. Using this strategy, we developed first amphihaploids and then amphidiploids after the application of colchicine. These synthetic amphidiploids serve as a transitional stage and can be crossed and backcrossed with amphidiploid *B. juncea*, leading to the development of introgression lines (ILs). Synthetic amphidiploids have been successfully created throughout the extensive wide hybridization program conducted at ICAR-NIPB in Delhi over the years. These synthetic amphidiploids resulted from the hybridization of *B. rapa* with various wild species (*viz*., *Enarthrocarpus lyratus*, *Diplotaxis erucoides*, *B. oxyrrhina*, *Erucastrum canariense*, *Erucastrum gallicum*, *Moricandia arvensis* and *B. fruticulosa*). These hybrids are currently in different generations and are undergoing comprehensive analysis for morphological and cytological characterization. This research represents a novel dimension in pre-breeding studies, aiming to transfer valuable traits from wild species to cultivated ones in crop plants.

Keywords: Brassica, Mustard, Rapeseed, Synthetic amphidiploids, Traits, Wild species

Calibration and Validation of DSSAT Crop Model for Rice-Rice Sequence under Long Term Fertility Experiment

B. Mohanty[1*], M. Shahid[2] and B.K. Saren[1]

[1]Dept. of Agronomy, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, Birbhum, West Bengal (731 236), India
[2]Dept. of Soil Science, Crop Production Division, ICAR-National Rice Research Institute, Bidyadharpur, Cuttack, Odisha (753 006), India

E-mail: banabasinimohanty@gmail.com

Abstract

Rice (*Oryza sativa* L.) is the most important staple food crop in India and rice-based production systems provide livelihood for more than 50 million households. These cropping systems are being noticeably affected by long term changes in management practices and will have serious implications on productivity and sustainability of various rice-based cropping systems. Amongst various sequential cropping, rice-rice sequence holds the leading position and acts as the backbone of Indian food security. Crop models potentially offer a means to readily explore and decide over long term management options to optimise yield as well as to determine trade-off between different environmental inputs and economic outcomes. In this regard a field experiment was conducted at agronomy farm of ICAR-National Rice Research Institute, Cuttack to evaluate the credibility and efficiency of DSSAT crop model. The experiment comprised of two rice sequences, *i.e.*, rabi (2021) – kharif (2022) and rabi (2022) – kharif (2023) by taking Lalat and Gayatri variety during rabi and kharif respectively. During kharif treatments were T_1: No fertilizer, T_2: 60-40-40 N-P_2O_5-K_2O kg ha^{-1}, T_3: FYM @ 5 t ha^{-1} and T_4-T_2+T_3; whereas during rabi T_1: No fertilizer, T_2: 80-40-40 N-P_2O_5-K_2O kg ha^{-1}, T_3: residual FYM and T_4-T_2+T_3 treatments were taken and the experiment was laid in Randomised Block Design. Decision Support System for Agro-technology Transfer (DSSAT) is a collection of independent programs that operate together to simulate crop growth, development, yield and in this study DSSAT-Crop Environment Resource Synthesis (CERES)-Rice model was applied. Sequence analysis of this crop model was used under the above mentioned long term fertility experiment including organic matter incorporation along with traditional major nutrients. CERES-Rice of DSSAT4.7 was calibrated and validated using experimental data of two subsequent years respectively. Model accuracy was basically assessed by Root Mean Square Error (RMSE). The study showed a strong agreement between the observed and the simulated yield values. The sequence analysis of DSSAT could satisfactorily simulate the yields of rabi rice - kharif rice under long term incorporation of farm yard manure (FYM) and NPK supplements. It is also necessary to evaluate the economic outcomes of this cropping sequence under modified weather parameters to deal with upcoming climatic adversities and to maintain the sustainable production.

Keywords: DSSAT crop model, Kharif, Long term fertility, Rabi, Rice-Rice sequence

Effect of Nano Zinc Oxide-Biofortification and Drip Irrigation on Summer Maize

S.N. Aktar* and K. Pramanik

Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal (731 236), India

E-mail: sknaim10096@gmail.com

Abstract

One of the most significant cereal crops in the world is maize. Accurate irrigation water application is crucial to achieving maximum output in the summer maize. The issue of zinc deficiency in food and soil is widely recognized now-a-days. Zinc biofortification using nanoscale fertilizer particles may provide an advance method for enhancing current crop management practices in order to solve these issues. In this regard a field trial was conducted as a second year experiment at Agricultural Farm, Visva-Bharati, West Bengal in the year 2023 to understand the effect of micro irrigation and comparative influences of zinc oxide nanoparticles on summer maize. Four irrigation regimes, *viz*., DI_1: Once in 2 days, DI_2: Once in 3 days, DI_3: Once in 4 days, DI_4: Farmer Practice, as main plot treatment and five levels of Zn application, *viz*., Zn_0: Control, Zn_1: Soil application of $ZnSO_4$ at 20 kg ha^{-1}, Zn_2: Foliar application of ZnO NP at 40 ppm, Zn_3: Seed priming of ZnO NP at 40 ppm, Zn_4: Seed coating of ZnO NP at 40 ppm as sub-plot treatments were used following the split plot design with three replications. Drip irrigated maize crop, once in 3 days had higher values of plant height, LAI, and dry matter accumulation at 30 DAS followed by once in 2 days, once in 4 days and farmer practice but at 60 DAS, 90 DAS and harvest once in 2 days had higher values of plant height and LAI, which is at par with once in 3 days. Lowest values of plant height and LAI recorded once in 4 days and farmer practice. Among the Zn application levels Zn_4: Seed coating of ZnO NP at 40 ppm showed the highest plant height, LAI and dry matter accumulation which is in same pipeline with Zn_3: Seed priming of ZnO NP at 40 ppm. Maximum yield was recorded under drip irrigation regimes of once in 2 days followed by once in 3 days, once in 4 days and farmer practice. Zn_4: Seed coating of ZnO NP at 40 ppm showed the optimum yield followed by Zn_3: Seed priming of ZnO NP at 40 ppm and Zn_0: Control treatment showed the lowest yield among the Zn application treatments. Considering the water difficulties of present day and cost of zinc oxide nano particles, drip irrigation at once in 2 days and seed primining with zinc oxide nano particles (ZnONP) could be an alternative option to realize a reasonably good yield of summer maize in future.

Keywords: Drip irrigation, Nano zinc oxide, Summer maize, Yield

Makhana Farming and Processing for Maximizing Farm Income: Success Stories from Darbhanga, Bihar

Manoj Kumar

ICAR-National Research Centre for Makhana, Darbhanga, Bihar (846 005), India

E-mail: mkumar_iari@yahoo.co.in

Abstract

Remuneration from farming sector is not enough to sustain the interest of farming community in agriculture as a profession. Average monthly income of a farmer's household in Bihar is least among all the states in India. It is therefore important to improve remuneration from agriculture in order to attract the younger generation to farming. Makhana (*Euryale ferox* Salisb.) could be a saviour for farmers of north Bihar, with huge abundance of low land areas and relatively higher rainfall during *Kharif* season. The crop, also known as Gorgon nut and Fox nut, can be grown in fields, ponds and low land areas with water depth ranging from 30 cm to more than 300 cm. Net profit from this crop has been reported to be much higher than the traditionally cultivated rice and many other competing crops. Fascinated by economic prospect of makhana farming, a young PhD scholar (Dhirendra Kumar) opted for makhana cultivation in his three hectares of lowland area located in Belwara village of Kamtaul, Darbhanga. Trained at National Research Centre for Makhana, Darbhanga, the student-turned farmer earned an income three to four folds higher than what his family used to earn from the same piece of land. Another farmer, Mahendra Sahni also earned more than Rs. 1.2 lakh $hectare^{-1}$ from Makhana farming. Mahesh Mukhiya, a farmer from Bahadurpur block of Darbhanga earned an income as high as Rs. 3.5 lakh $hectare^{-1}$ when he adopted processing along with Makhana cultivation. On the whole, these famers proved the economic potential of Makhana cultivation and processing, setting an example for the rural youth who can adopt Makhana farming and processing as a lucrative source of income and livelihood in Mithilanchal region of north Bihar and beyond.

Keywords: Darbhanga, Farm income, Makhana farming, Processing, Success story

Dhaincha Brown Manuring and Mulching Effect on Relative Greenness of Leaves of Dry Direct Seeded Rice (DSR) as Reflected by Leaf Colour Chart (LCC) Value

Sagun Hembram* **and S.K. Maity**

Dept. of Agronomy, Palli Siksha Bhavana (Institute of Agriculture) Visva-Bharati, Sriniketan, Birbhum, West Bengal (731 236), India

E-mail: sagunsb30@gmail.com

Abstract

Relative greenness of leaves is a good indicator of plant's health particularly with respect to nitrogen nutrition. To monitor the rate of greenness of leaf, an easy-to-use and inexpensive diagnostic tool i.e. leaf colour chart (LCC) is used generally for rice and wheat. The optimum LCC value for high yielding variety of rice generally ranges between 3 to 3.5. In a field experiment, dry direct seeded rice (DSR) was grown in kharif season of 2022-23 and 2023-24 with different sowing methods and dhaincha brown manuring (DBM) with 25% less recommended dose of fertilizer (RDF) at Agricultural Farm, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal. The effect of simultaneous and staggered sowing of DBM and dhaincha mulching on LCC value of dry DSR was significantly increased or at par in case of both simultaneous and staggered sowing of DBM with 75% RDF as compared to the 100% RDF and without DBM at different growth stages in both the seasons. During first season the result of LCC at 60 and 90 DAS showed that the value of LCC was significantly higher in simultaneous sown DBM and DSR with 75% RDF in comparison to broadcast, line sowing and pellet sowing with 100% RDF and without DBM. But in case of second seasons rice pellet sowing with simultaneous sowing of DBM resulted higher LCC at 60 and 90 DAS and in broadcast and line sowing LCC value was at par. For staggered DBM with line sowing of rice showed significant higher value than line sowing of rice without DBM and in pellet sowing with 75% RDF was at par with the pellet sowing without DBM. When dhaincha green biomass was applied as mulch over broadcast sown rice, it was also found to record at par LCC reading while saving 25% RDF. The observation on LCC reading for two growing seasons confirmed that dhaincha brown manuring/ mulching could maintain rice plant health in terms of nitrogen nutrition even with 25% less RDF.

Keywords: Dhaincha bown manuring, Direct seeded rice, LCC, Mulching, Plant's health

Effect of Organic Manures and Bio-Stimulant on Plant Growth and Rhizome Production of Black Turmeric (*Curcuma caesia* Roxb.)

Prithwish Mandal and Babli Dutta*

Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal (736 165), India

E-mail: babli.here@gmail.com

Abstract

The experiment was focused to study on the effect of organic nutrition and planting material on growth, yield and quality of black turmeric (*Curcuma caesia* Roxb.). The present study was carried out in two factor randomized block design with 10 treatments and 3 replications with the following treatments: Factor I: P_1 = Mother Rhizome , P_2 = Primary Rhizome, Factor II: T_1 = Farm Yard Manure @ 15 t ha^{-1}, T_2 = Vermicompost @ 5 t ha^{-1}, T_3 = Farm Yard Manure @ 15 t ha^{-1} + Humic Acid (0.2%) , T_4 = Vermicompost @ 5 t ha^{-1} + Humic Acid (0.2%), T_5 = Farm Yard Manure @ 15 t ha^{-1} + Vermicompost @ 5 t ha^{-1} + Humic Acid (0.2%). Morphological parameters like plant height (cm), collar girth (mm), leaf length (cm), leaf breadth (cm), number of leaves $plant^{-1}$, number of tillers $plant^{-1}$ and yield parameters like fresh weight of rhizome $clump^{-1}$ (g), $plot^{-1}$ (kg), projected rhizome yield (ha^{-1}), length of rhizome (cm), dry recovery (%) and bio-chemicals observations like essential oil (%) and total phenolic (GAE per 100 g) was found highest in T_5 (Farm Yard Manure @ 15 t ha^{1} + Vermicompost @ 5 t ha^{-1} and Humic Acid @ 0.2%). The treatment was mostly followed by T_3 (Farm Yard Manure @ 15 t ha^{-1} + Humic Acid @ 0.2%). In all the parameters in respect of growth and yield of black turmeric, mother rhizome proved superior as compared to primary rhizome. Hence, it may be concluded that the mother rhizome treated with organic manures like Farm Yard Manure @ 15 t $ha^{-1}$and vermicompost @ 5 t ha^{-1} when applied with foliar spray of Humic acid @ 0.2%, had a positive impact on black turmeric under the *Terai* zone of West Bengal.

Keywords: Bio-stimulant, Black turmeric, *Curcuma caesia* Roxb., Organic manures, Plant growth, Rhizome production

Performance of Different Varieties of Rapeseed-Mustard (*Brassica* spp.) in Agro-Climatic Condition of Tripura

Triparna Das Chaudhuri*, Utpal Giri, Anandika Kar, N. Paul, N. Majumder, B.C. Thangjam, T. Bhattacharjee and T.K. Maity

College of Agriculture Tripura, Lembucherra, West Tripura, Tripura (799 210), India

E-mail: triparnadc@gmail.com

Abstract

Rapeseed-Mustard (*Brassica* spp.) group of crops are among the oldest cultivated plants in human civilization. It is third important oilseed crop in the world after Soybean and Palm Oil. Rapeseed-Mustard crop are occupying the second position in production in Indian economy next to Groundnut. It is worthy to mention that 90% of the total oil requirement in Tripura is met through imported oil from outside the state. In Tripura production of oilseeds, particularly mustard, has increased too, but at a much slower pace. Like other states, in Tripura also Mustard is being cultivated in Rabi season under rice fallow to utilize the residual moisture & residual nutrients. The productivity of Mustard-Rapeseed in Tripura is comparatively lower (840 kg ha^{-1}) than the national average (1161 kg ha^{-1}). The problem of low productivity of mustard under Tripura condition may be attributed to cultivation of low yielding varieties, late sowing, line sowing, thinning, non-application of fertilizer, non-adoption of good agronomic practices, *etc*. Keeping in view of the above facts one field experiment is held to evaluate Rapeseed-Mustard varieties and lines for yield related traits in Tripura upland areas at the Experimental farm of College of Agriculture, Lembucherra, Tripura Agartala, Tripura (W) during 2022-23. The 12 varieties (Anushka, Binoy, Sanchita, Sarma, Sita, Pusa Mustard 25, Pusa Mustard 26, Pusa Mustard 27, Pusa Mustard 28, Pusa Mustard 30, Pusa Mustard 31 and Pusa Vijay) are tested in a RBD (Randomised Block Design) design and replicated thrice. The result revealed that among the three short duration varieties (less than 90 days), 'Anushka' performed better. But irrespective of duration of the varieties and lines, 'Pusa Mustard 26' variety recorded higher growth attributes; yield attributes and yield as compare to other varieties. It may contribute significantly towards sustainable agriculture in Tripura upland condition.

Keywords: Rapeseed-Mustard, Treatment, Variety, Yield

Prioritizing Sustainable Biofortification for Zinc and Iron in Rice

Sk. Sameera*, Ch. Sreelakshmi, I. Paramasiva, P. Madhusudhan and U. Vineetha

Agricultural Research Station, Nellore, Acharya NG Ranga Agricultural University, Lam, Guntur, Andhra Pradesh (524 003), India

E-mail: s.sameera@angrau.ac.in

Abstract

Biofortification, the process of increasing the nutrient content of crops through breeding or agronomic practices in rice is gaining prominence as a sustainable approach to address global malnutrition and dietary deficiencies. It is a major staple crop in more than 40 countries and supplies at least 20% of the daily caloric intake of more than Zinc-Biofortified Rice. Asia, with 60% of the global population, consumes more than 90% of the total rice produced annually. However, milled rice is less nutritious; thus, most of the poor people who largely depend on rice without access to a mineral-rich diverse diet suffer from hidden hunger, including Zn deficiency. The urgent need to address micronutrient malnutrition has been widely recognized globally; hence, decreasing childhood mortality and maternal death by eradicating malnutrition is an important Sustainable Development Goal. The emphasis should be given more in pre-breeding for an increase of Zn and Fe contents in the polished rice, as the % loss during polishing depends on the degree and duration of polishing as well as location and variety. The duplicate epistatic interactions that control the expression of grain Fe and Zn contents can be exploited through recombination and heterosis breeding coupled with selection in later generations, which could be an effective approach for increasing both grain Fe and Zn contents in rice. Previous research studies show that single-plant selection is the best method for improving grain Zn content, as the heritability of the seed genetic effect and high levels of narrow-sense heritability are influencing factors. By prioritizing pre-breeding efforts and leveraging genetic interactions through recombination and heterosis breeding, there is a promising avenue for effectively increasing both zinc and iron contents in rice, offering a sustainable solution to hidden hunger and nutritional deficiencies.

Keywords: Biofortification, Iron, Rice, Sustainable, Zinc

Varietal Evaluation and Nutrient Management in Dry Direct Seeded Rice

U. Vineetha[1*], Ch. Sreelakshmi[2], I. Paramasiva[3] and P. Madusudan[4]

[1]Dept. of Agronomy, [2]Dept. of Plant Breeding, [3]Dept. of Entomology, [4]Dept. of Plant Pathology, Agricultural Research Station, Nellore, Acharya N.G. Ranga Agricultural University, Andhra Pradesh (524 003), India

E-mail: u.vineetha@angrau.ac.in

Abstract

Rice is being cultivated in Andhra Pradesh in an area of 22 lakh hectares with a production of around 137 lakh tonnes. Most of the rice area under cultivation is only under puddled transplanted conditions. In recent times due to shortage of labour, increased labour wages, corona pandemic, farmers are interested to grow dry direct sown rice to cut short the labour wages. Major rice area converted to dry direct sown rice. Hence trial has been taken up to evaluate rice varieties suitable for southern zone and nutrient management for dry direct seeded rice with seed drill. The trial has been taken up at Agricultural research station, Nellore during Early *kharif* 2022, in factorial RBD, replicated thrice with three varieties as first factor namely, V_1: NLR 3354, V_2: NLR 34449 and V_3: NLR 40024 and four fertilizer doses, *viz*., F_1: 75% RDF, F_2: 100% RDF, F_3: 125% RDF and 150% RDF (RDF: 120:60:40 $N:P_2O_5:K_2O$ kg ha^{-1}). The results indicated that, under dry direct sown rice with seed drill, the highest grain yield (4472 kg ha^{-1}) was recorded with NLR 40024 followed by NLR 34449 (3859 kg ha^{-1}) and NLR 3354 (3692 kg ha^{-1}) which were in turn on par with each other. Among the fertilizer doses, Highest grain yield was recorded with 150% RDF (4681 kg ha^{-1}) followed by 125% RDF (4291 kg ha^{-1}), 100% RDF (3862 kg ha^{-1}) and the lowest grain yield (3209 kg ha^{-1}) was recorded with 75% RDF.

Keywords: Direct seeded rice, Grain yield, Nutrient management, Varietal evaluation

Impact of Irrigation and Weed Regimes on Yield of Sesame (*Sesamum indicum* L.) in Lateritic Soil of West Bengal

Divya Jaiswal*, B.K. Saren, B. Duary and K. Pramanik

Dept. of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal (731236), India

E-mail: divyajaiswal1195@gmail.com

Abstract

An experiment was conducted to study the performance of sesame (*Sesamum indicum* L.) as influenced by irrigation and weed regimes. Two irrigation regimes [three irrigation (I_1) at branching + flowering + capsule development and four irrigation (I_2) at branching + flowering + capsule development + seed development] in main plot and eight weed regimes [W_1: crop only (weed free); W_2: crop + grasses; W_3: crop + broad leaved weeds (BLW); W_4: crop + sedges; W_5: crop + grasses + BLW; W_6:crop + grasses + sedges; W_7: crop + BLW + sedges and W_8: crop + weeds of all categories] were imposed in sub-plots. *Digitaria sanguinalis* (L.) Scop., *Echinochloa colona* (L.), Link, *Echinochloa glabrescens* Munro ex Hook. f., *Panicum repens* (L.), *Paspalum distichum* L. and *Eleusine indica* (L.) Gaertn., among grasses; *Cyperus iria* (L.) and *Fimbristylis miliacea* (L.) among sedges and *Heliotropium indicum (*L.), *Croton bonplandianus* Baill., *Eclipta alba* (L.), *Spilanthes calva* DC, *Ludwigia perennis* L., *Alternanthera philoxeroides* (Mart.) Griseb., *Alternanthera sessilis*(L.) R. Br. ex DC and *Malvastrum coromandelianum* (L.) Garcke among broad leaved were major weeds in the experimental field. The seed yield of sesame did not vary significantly among irrigation regimes (I_1 and I_2). However, among weed regimes, the highest seed yield of sesame was found under weed free as compared to other weed regimes. The crop + weeds of all categories reduced the crop yield to the tune of 78%. The plots with grassy weed only had greater yield loss (74-76%) compared to crop + sedges only (20%), crop + BLW (40%) only and crop + BLW + sedges (51%).

Keywords: Broad leaved, Grass, Sedges, Sesame, Weed regimes, Yield loss

Study of Icthyofaunal Diversity of Maralur Pond of Tumakuru, Karnataka, India

Parimala B.

Dept. of Zoology, University College of Science, Tumkur University, Tumkur, Karnataka (572 103), India

E-mail: parimala.nccbdp@gmail.com

Abstract

Fish diversity indicates a balanced ecology and is a useful measure of the health of the aquatic ecosystem. The present study was conducted in Maralur pond which is located in the North-east of Tumakuru district, at a distance of 04 km from Tumakuru city of Karnataka. It lies at 13°30'72" N latitude and 77°09'17" E longitude. It receives water mainly from rainfall an average of 620 mm. This underutilized fishery resources after immense scope and potential for generating additional national income by adopting appropriate management measures and fishery regulation principles. In recent years due to varied climatic conditions and disturbed rainfall, the impacts of human activity have increased variations in the ecosystem. At present fish productivity is considerably low. No much reports are available on Maralur Pond. Keeping all these views, we have selected Maralur Pond for study on fish diversity. A total of 08 species of fishes belonging to 07 genera and 02 orders were identified from the lake. The order Cypriniformes was found to be dominant among fishes. Hence the protection of this lake is mandatory for sustainable fishery.

Keywords: Cypriniformes, Diversity, Ichthyofauna, Maralur pond, Tumkur

Factor Influencing Black Rice Growers Marketing Channel Choice in Manipur with Multinomial Logit Model

Lh. C. Catherine* and Deepak Bhagat

Dept. of Management, NEHU, Tura Campus, Meghalaya (794 002), India

E-mail: catherineanal123@gmail.com

Abstract

Black rice has long history of cultivation and recently recognized for its medicinal values due to contained of high anthocyanin. Therefore, smallholder growers of black rice in Manipur have different characteristics of choosing marketing channel to obtain more profit. To the factor that influences the market channel selected by black rice growers in Manipur, we classify four types of channels - Channel I, Channel II, Channel III & Channel IV. 12 variables were inspected based on survey data of 400 households from four provinces. Multinomial logit model was employed for four valley districts, *viz*., Imphal West, Imphal East, Bishnupur and undivided Thoubal of Manipur to study how the factors influence the smallholders' farmer choice of marketing channel. We find that compared to Channel II, the Channel I is mainly affected by the land holding, membership in farmer organization & total production in Imphal East & West districts, education and access to FPO in Bishnupur district, household size & access to market in Imphal West, distance to market in Thoubal district; Channel III is influence by land holding in four districts, total production in Bishnupur, Imphal West & East districts, education in Bishnupur district, membership in farmer organization in Bisnupur and Imphal East districts, group participation in Imphal West & East districts, access to FPO and access to market in Imphal West district; Channel IV is influence by age in Thoubal district, distance to market in Imphal East district and land holding in Imphal West & Thoubal district. In conclusion, the logistics factor has a significant positive & negative effect on each channel choice by the growers. The negative significant shows that black rice growers in Manipur are likely to choose other marketing channel compared to the existing marketing channel followed.

Keywords: Black rice, Choice, Manipur, Market participation, Marketing channel

Effect of Foliar Application of Different Organic Inputs on Growth and Yield of Green Gram

Aditi Saha Roy* **and Mahadev Pramanick**

Dept. of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (741 252), India

E-mail: aditisaharoy16@gmail.com

Abstract

Greengram is a protein-rich, staple pulse in Indian diet with several nutritional values. However, the productivity of this crop is very low, with the aim of incorporating a short duration pulse crop during summer, a field experiment was undertaken to study the effect of different organic inputs on growth and yield of green gram (var. Virat) during *pre-kharif* season of 2023. The experiment was conducted at C-Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia under New Alluvial Zone of West Bengal with 9 different treatments, T_1: Control with residual (R) effect of BD compost (BDC), T_2: (BDC + BD 500) (R) + Moringa leaf extract, T_3: (BDC + BD 501) (R) + Humic acid, T_4: (BDC + BD 500 + BD 501) (R) + Cow urine spray, T_5: BDC (R) + Panchagavya, T_6: BDC (R) + Vermiwash, T_7: BDC (R) + Sea weed extract, T_8: BDC (R) + Jeevamrut, T_9: Control with residual chemical fertilizer. The results revealed that treatment T_4, *i.e.*, application of cow urine (20%) produced highest plant height, total dry matter accumulation and gave highest grain yield (948.44 kg ha^{-1}) with harvest index of 26.58%, although no significant difference in yield was observed between treatments T_3, T_4 and T_5. The residual effect of BD compost + BD 500 + BD 501 along with the application of cow urine at 20, 30 and 40 DAS has enhanced the productivity of green gram.

Keywords: Cow urine, Grain yield, Green gram, Organic inputs

Constraints and Prospects of Seed Cocoon Generation in Annamayya, Chittoor and Anantapur Districts and Its Impact on Silkworm Seed Production - A Study in Andhra Pradesh

P. Deepa[1*], V. Harlapur[2] and S. Manthiramurthy[2]

[1]Silkworm Seed Production Centre, Central Silk Board, Nakkaldinne, Madanapalle, Andhra Pradesh (517 325), India
[2]National Silkworm Seed Organization, Central Silk Board, Madiwala, Bangalore, Karnataka (560 068), India

E-mail: dr.dipaiyer@gmail.com

Abstract

Availability of quality seed cocoons is a detrimental factor for the production of Disease Free Layings (DFLs) and stringent selection criteria is followed as per the norms for the purchase of seed cocoons from the Adopted Seed Rearers (ASRs). Superior quality mulberry leaves, proper knowledge in rearing and disease management are quintessential for the success of a P1 crop. Around 20 adopted seed rearers are producing bivoltine seed cocoons in Annamayya, Chittoor and Anantapur districts to sustain the seasonal demands of Double Hybrid Bivoltine Dfls production of Silkworm Seed Production Centre, Madanapalle. The main seed crop growers are located in Punganur, Madanapalle, Tanakallu and Rayachoty in Annamayya district; Palamaner and Gangavaram in Chittoor district, and Agali and Enumuladoddi in Anantapur district. Awareness programmes were regularly organized for Seed farmers and Lead farmers under Capacity Building and Training programs and explained regarding the improvement of package and practice of mulberry cultivation, manipulation of micro-climatic condition in rearing house by adoption of season specific rearing packages and improved technologies for qualitative and quantitative improvement of seed cocoon production as well as economic upliftment of stake holders. In spite of all the efforts made by CSB and DOS, it is observed that Seed cocoon generation has come down from 41.02 lakhs in 2020-21 to 11.60 lakhs in 2021-22 and 6.82 lakhs in 2022-23. Average yield was 56.760 kg in 2020-21, 56.230 kg in 2021-22 and 58.660 kg in 2022-23. Pupation percentage has come down from 93.20% in 2020-21 to 92.00% in 2021-22 and 86.54% in 2022-23. Seed production has come down from 13,47,800 in 2020-21 to 9,21,501 in 2021-22 and 7,03,446 in 2022-23. Egg recovery was 57.40 g in 2020-21 to 68.19 g in 2021-22 and 59.82 g in 2022-23. Based on the above study, improvement of seed cocoon production has to be taken up as a priority in collaboration with DoS for sustainable development of Bivoltine seed cocoons generation.

Keywords: Adopted seed rearer, Implementation, Seed cocoon generation, Silkworm seed production, Sustainable development

Navigating Credit Challenges: An In-depth Analysis of Challenges Faced by Bank Officials in Agricultural Credit Disbursement in Tripura

Poulami Ray

Division of Dairy Economics, Statistics & Management, ICAR-National Dairy Research Institute, Karnal, Haryana (132 001), India

E-mail: poulamiray.econ@gmail.com

Abstract

Several challenges are faced by bank officials during credit disbursement in India. Some common problems include complexity during documentation process, errors in risk assessment and collateral valuation, increasing fraud prevention and communication barriers. The current research aimed at finding the problems faced by bank professionals while disbursing agricultural credit from the banks. The research methodology involved a comprehensive survey in the West Tripura district, utilizing multistage random sampling. Findings highlight issues such as insufficient collateral, financial illiteracy, misappropriation of funds, processing costs, subsidy dependence, agricultural risks, limited market access and prolonged approval processes. The study provides valuable insights into the challenges of farmer finance, offering a foundation for strategic improvements in credit disbursement processes.

Keywords: Collateral valuation, Credit disbursement, Credit worthiness, Financial literacy

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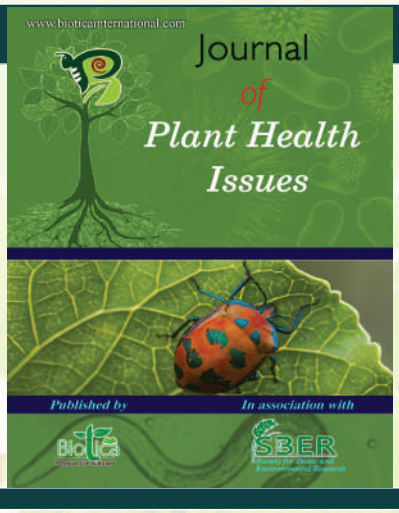

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