ICAR-NATIONAL INSTITUTE OF BIOTIC STRESS MANAGEMENT
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NEWS LETTER
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From The Director's Desk

Early Warning System (EWS) for Plant Biosecurity

Plant biosecurity is a strategic and integrated approach encompasses the policy and regulatory framework to analyse and manage risks in the sectors of plant life and health, and related environmental concerns. It covers the protection of a country from transboundary pests, emerging indigenous pests/diseases, as well as from the use of pests/diseases/GMOs in biological warfare.

A plant biosecurity system requires early detection, accurate diagnosis and a rapid response to prevent the establishment and dispersal of pests, thus minimizing the subsequent impact. There is an urgent need to work on exotic and emerging pests and diseases with a focus on developing early warning systems (EWS) and risk analysis models.

An early warning system is an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events. Important activities of EWS include: i) New technologies for data mining and fusion 2) Tools for characterizing diseases new to science, or variants of existing diseases 3) Portable devices for on-the-spot identification of known diseases, and 4) Methods for high-throughput screening for disease in areas of concentration, such as ports.

The current concept of efficient or people-centred EWS is based on four elements including i) Disaster risk knowledge based on the systematic collection of data and disaster risk assessments, ii) Detection, monitoring, analysis and forecasting of the hazards and possible consequences, iii) Dissemination and communication, by an official source, of authoritative, timely, accurate and actionable warnings and associated information on likelihood and impact, and iv) Preparedness at all levels to respond to the warnings received.

Globally few early warning systems are functioning including i) PestLens, ii) European and Mediterranean Plant Protection Organization (EPPO), iii) North American Plant Protection Organization Phytosanitary Alert System (NAPPO), iv) ProMED, iv) International Plant Protection Convention (IPPC), and v) International Plant Sentinel Network (IPSN) which are dissemination the current information on emerging plant pests, invasive pests *etc.* in the form of advisories, publications, websites, e mail *etc.*, to the member countries on request and/or subscription.

In India, the Plant Quarantine Organization, Ministry of Agriculture and Farmer Welfare, Government of India is the apex body for implementation of plant quarantine regulations and provides plant protection advisories concerning the country through obtaining information from EWSs. The Department of Plant Protection, Quarantine and Storage (DPPQS), India has a national network of 29 plant quarantine stations at different sites which include airports (10), seaports (10) and land frontiers (9). In all, two categories of materials are being imported under the PQ Order, 2003: (a) bulk consignments for consumption and sowing/ planting, and (b) samples of germplasm in small quantities for research purposes. The Plant Quarantine Stations under the DPPQS undertake quarantine processing and clearance of consignments of the first category.

The National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi undertakes the quarantine processing of all plant germplasm and transgenic planting material under exchange for which it has well-equipped laboratories and green house complexes and recently, a containment facility has also been established for processing transgenics. The NBPGR also has a well-equipped quarantine station at Hyderabad, which mainly deals with export samples of the International Crops Research Institute for The Semi-arid Tropics (ICRISAT), Telangana.

In order to develop policies towards the monitoring and mitigation of emerging pests and invasive alien species in India, the ICAR-National Institute of Biotic Stress Management, Raipur, Chhattisgarh has initiated a long-term flagship programme on 'National Strategic Crop Health Monitoring Network' (NSCHMN) in co-ordination with institutes/ organizations like, National Institute of Plant Health Management, Telangana, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, ICAR-National Bureau of Plant Genetic Resources, New Delhi, ICAR-National Centre for Integrated Pest Management, New Delhi, ICAR-National Bureau of Agriculturally Important Microorganisms, Mau, Directorate of Plant Protection, Quarantine and Storage (GOI) *etc.*

P. K. Ghosh
Founder Director and Vice-Chancellor

Research Achievements

Biotechnology

A novel method of agroinoculation for enhancing the efficiency of Mungbean yellow mosaic India virus infection

(P. N. Sivalingam, Vinay Kumar, J. Sridhar, Lalit L. Kharbikar)

Agroinoculation is the most preferred way to test the function of genomic components of *MYMIV*. Tandem dimeric infectious agro-constructs of DNA A and DNA B of *MYMIV* was inoculated by different methods to assess the efficiency of infection in *mungbean*. Among several methods evaluated, incubation of pin-pricked epicotyl region after removing one cotyledon of mungbean sprouted seeds in 1.0 OD of agroculture containing dimeric construct of *MYMIV* for 2-4 hrs without acetosyringone, followed by sowing in soil induced absolute infection (100%) of *MYMIV* within 10-12 days on first trifoliate leaf (Fig. 1a,b). This agroinoculation method has potential to screen the germplasm lines, and will be useful in *mungbean* biological/ virological studies and resistance breeding programmes in *mungbean* against *MYMIV*.

(a) (b)

Fig 1. Symptoms of agroinoculated *MYMIV* on the epicotyl region method. (a) Agroinoculated without *MYMIV* (b) agroinoculated with *MYMIV* dimeric construct

Role of isoflavones in differential reaction to soybean yellow mosaic virus

(Ashish Marathe, P. N. Sivalingam, Lalit L. Kharbikar)

On the basis of field screening during *kharif* 2020, the resistance and susceptible lines were identified based on AICRP MuLLaRP protocol. These were further subjected to artificial inoculation using viruliferous whitefly under controlled condition . The soybean mini-core lines such as CAT-1809, CAT-1921A, CAT-411B, UPSM-57, CAT-313A have shown susceptible reaction while CAT-1318, CAT-156, CAT-1808, CAT-411B, EC-456647 were resistant to *Mungbean yellow mosaic India virus*

Biological control

Bacterial endophyte-induced tolerance in chickpea against Sclerotium rot and moisture stress

(Vinay Kumar, Lata Jain, S.K. Jain)

Bacterial endophytes having antagonistic activities against soil borne fungal pathogens namely *Sclerotium, Fusarium* and *Rhizoctonia* and plant growth promoting attributes (moisture stress) were selected. Among the bacterial endophytes, 53P was showed promising against *Sclerotium rolfsii* and moisture stress on chickpea plants grown in pots. Further this isolate was tested in micoplots for individual and combined (*Sclerotium rolfsii* and moisture stress) stress tolerance. The result suggests that the endophyte 53P found to provide dual protection in chickpea against *Sclerotium rolfsii* and moisture stress. The 53P endophyte wil be utilized for developing endophytes meditated multi stress tolerance in crop plants.

Bacteriophage for rice BLB management

(Lata Jain, Vinay Kumar, S.K. Jain)

A total of 19 bacteriophages were studied for their morphological diversity (shape and size of head and tail) through TEM. The bacteriophages identified through TEM imageries belonged to the order Caudovirales and the families, Myoviridae (4), Siphoviridae (12), Podoviridae (2) and unclassified (1). Among them, members of Siphoviridae are widespread bacteriophges in Chhattisgarh state. The length of head and tail varied from 36 to 120 nm and 12 to 210 nm, respectively (Fig. 2). The diversity and distribution of these phages in Chhattisgarh and adjoining states have been located (Fig. 3).

Viral nucleic acid extraction procedure was standardized to get maximum viral nucleic acid. Further molecular characterization of phages on basis of whole genome sequencing is under progress (Fig. 4).

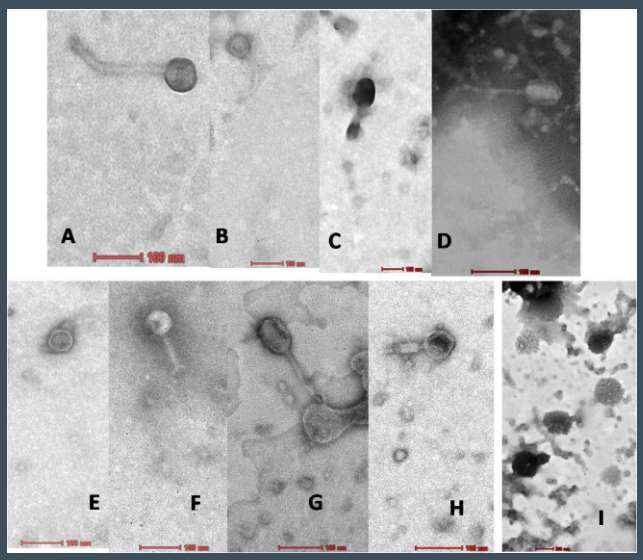

Fig 2. Transmission electron micrograph of bacteriophages: Siphoviridae (A, B, C, D, G); Podoviridae (E); Myoviridae (F, H); unclassified (I)

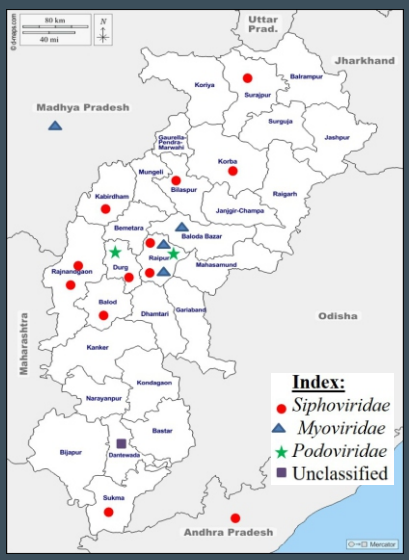

Fig 3. Distribution of bacteriophages in Chhattisgarh and adjoining states

Fig 4.Agarose gel electrophoresis of nucleic acid of bacteriophage M : ladder lambda HindIII + EcoRI; 1-10: phage samples

Kairomone-augmented biocontrol of rice yellow stem borer

(R. K. Murali Baskaran, K. C. Sharma, J. Sridhar, L. Jain)

A field trial was conducted in Baronda farm during Summer 2021 in low land rice (cv. MTU 1010) with four treatments including i) Split release of *Trichogramma japonicum*, ii) Octadecane + split release of wasps, iii) Inundative release of wasps, and iv) Control to evaluate the efficacy of kairomone in enhancing the biocontrol potential of wasps against yellow stem borer (Fig. 5). Application of octadecane 500 ppm, 24 hr after each release of *T. japonicum* reduced the symptoms of dead heart and white ear caused by yellow stem borer over control by 38.1% and 34.1%, respectively while they were 31.16% and 25.60% in wasp alone released plots (Fig. 6). It is evident that the application of kairomone can enhance the biocontrol potential of *T. japonicum* against rice yellow stem borer.

Fig 5. Field view on evaluation of kairomone gel on biocontrol potential of *T. japonicum*

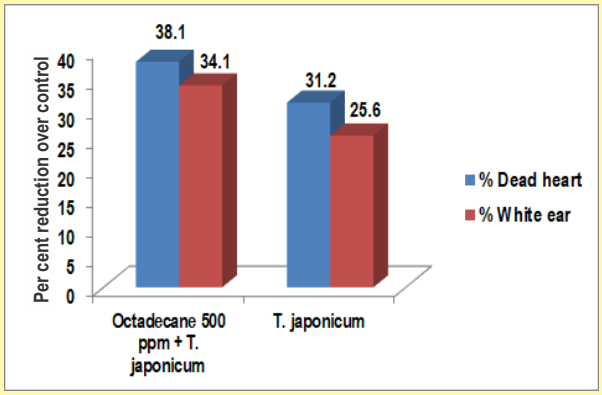

Fig 6. Per cent reduction of damage symptoms caused by rice yellow stem borer

In planta evaluation of efficacy of native Bacillus thurigiensis

(R. K. Murali Baskaran, K. C. Sharma, J. Sridhar, L. Jain)

The efficacy of three selected native *Bacillus thuringiensis* was evaluated in the cowpea plants grown pots, against 3rd instar of *Spodoptera litura* in comparison with Almora *Bt* (VL*Bt*) and control plants. The mean leaf damage was the lowest (26.96%) in N*Bt* 18 treated plants which was on a par with VL*Bt*, followed by N*Bt* 27 (31.69% leaf damage) and N*Bt* 31 (30.77% leaf damage) as compared to negative control plants (42.60% leaf damage) (Fig. 7). Three native *Bt* are found to provide good efficacy in causing mortality on *S. litura* both under lab and *in planta* conditions.

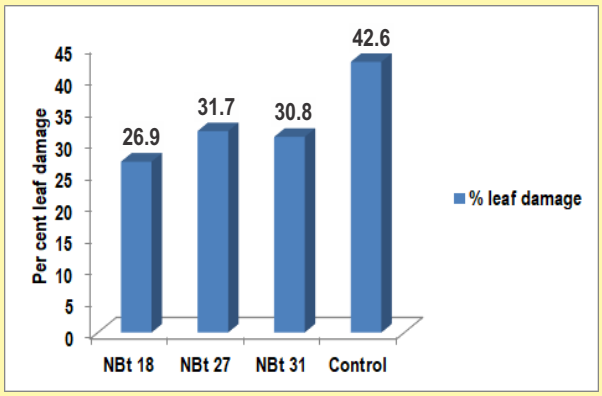

Fig 7. Per cent leaf damage caused by *S. litura*, as influenced by native *Bt*

Large scale demonstration of Silicon technology for wheat pink stem borer management

(K. C. Sharma, Mallikarjuna, J.)

Based on our previous results in the experiment, large scale demonstration of the silicon (150 kg per ha) technology for managing pink stem borer in wheat was taken up during *rabi* 2020-21 at experimental farm of NIBSM. There were two treatments *viz*., T_1: Si (150 kg per ha); T_2: No Si application (control). The demonstration was laid down in RCB design with individual plot size of 286 sq. m. with seven replications. Wheat variety, HI 1544 was selected for this demonstration. The T_1: Si (150 kg per ha) was imposed as soil application at the time of sowing. All recommended package of practices were followed except for plant protection measures. The observations were recorded on percent white ear damage and yield. The per cent white ear damage in Si-treatment was significantly low (8.54%) in comparison to control (15.24%). Similarly, yield was significantly higher in Si-treatment (2.9 t/ha) in comparison to control (2.03 t/ha).

Antimicrobial Cyclic Lipopeptides (AMLs) for antagonistic activity

(S. K. Sharma, Lata Jain)

A total of 19 soil samples from rhizosphere of chickpea cultivated in Bemetra and Kawardha districts of Chhattisgarh were collected to isolate *Bacillus* spp., having antagonistic effect on soil borne diseases of chickpea. Out of 80 putative *Bacillus* isolated, 24 were antagonistic to *Fusarium oxysporum* f. sp. *ciceris* while 30 were antagonistic to *Sclerotium rolfsii* (Fig. 8a,b) in the dual plate assay method.

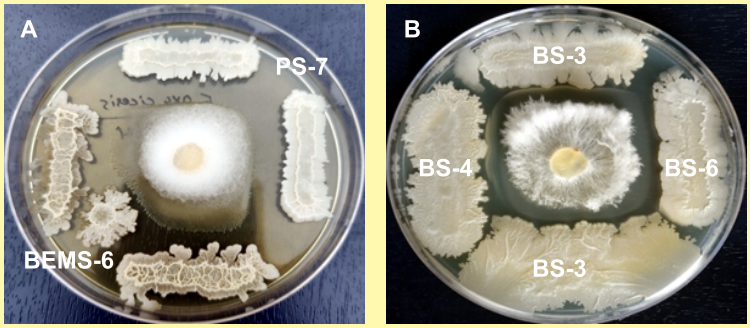

Fig 8a. Antagonism against *Fusarium oxysporum* f.sp. *ciceris*; 8b. *Sclerotium rolfsii* (B) by putative *Bacillus* isolates

Farmer FIRST Programme (FFP)

(P. Mooventhan, Anil Dixit, G. L. Sharma, L. Verma, M. A. Khan, P. K. Verma)

In crop-based module, *rabi* crops including improved varieties of *Lathyrus* (Prateek and Mahateoda), chickpea (Vaibhav and JG11,12), mustard (CG Sarson), linseed (RLC-133) and lentil (IPL-316) were cultivated in 28 ha of rice fallow land. *Utera* cropping (1.2 ha) and improved varieties of rice *viz*., Chandrahasini, IGKV R-1, IGKV R-2, Indira Aerobic, Swarna, HMT, Mahamaya and Indira Barani were introduced. The improved vegetable cultivation technologies were demonstrated in 8.4 ha, besides introducing recent varieties of radish, fenugreek, brinjal, chilli, palak, cauliflower, tomato, coriander *etc.*, in home nutritional garden in horticulture-based module. A total of 78 farmers benefited due to the demonstrations on kadaknath farming including hatchery unit maintenance and vaccination of kadaknath, goat farming *etc.*, in livestock-based module. The production technologies of various kinds of mushroom and processing of rice, turmeric, dhal, mustard, linseed *etc.* in agro-processing centre were demonstrated to tribal farmers and farm women. Establishment of six low-cost Azolla production units, composting of agricultural wastes and mulching with paddy straw in vegetable were few interventions in NRM based module. A total of 37 capacity building programme were organized for the benefit of 445 farmers. Totally three Farmer Producer Groups (FPGs) formed on Kadaknath production and Vegetable production. Five Self Help Groups (SHGs) formed under Livestock and Enterprise module.






DBT Biotech KISAN project

(P. Mooventhan, S. K. Upadhyay, B. S. Rajput, S. K. Verma)

Zinco MS bio-fortified rice with all POPs was demonstrated in 150 ac areas. Thirty capacity building programme including demonstration, farmers training, Goshthi *etc.*, were conducted in 15 villages in which 1443 farmers benefited. Protected cultivation of coloured capsicum and tomato were demonstrated in low-cost poly house with drip irrigation facility. Totally three Farmer Producer Groups (FPGs) were formed on bio-fortified rice production at three aspirational districts.



Management of yellow stem borer (YSB) in Zinco MS rice with and without biocontrol agent

(R. K. Murali-Baskaran, P. Mooventhan)

During summer 2021, the extent of control of rice yellow stem borer in Zinco MS rice with and without biocontrol agents was evaluated in one acre area of low land at Baronda farm, Raipur. Four treatments evaluated include i) Zinco MS rice + YSB pheromone trap @ 5/ac + split release of *Trichogramma japonicum*, ii) MTU 1010 + YSB pheromone trap @ 5/ac + split release of *T. japonicum*, iii) Zinco MS alone and, iv) MTU 1010 alone. The reduction of dead heart and white ear symptoms, caused by YSB over control was computed based on the incidence of YSB in Zinco MS and MTU 1010 (Fig. 9). The Zinco MS rice along with YSB pheromone trap and split release of wasps recorded 19.1 per cent reduction in dead heart symptom over control as against Zinco MS rice alone. The reduction in dead heart and white ear symptoms over control were 26.9% and 19.2%, respectively in MTU 1010 rice treated with YSB pheromone trap and split release of wasps.

Fig 9. Field view on evaluation of kairomone gel on biocontrol potential of *T. japonicum*

Establishment of biocontrol lab at main hub, NIBSM, Raipur

(R. K. Murali-Baskaran, P. Mooventhan)

Trichogramma spp. have been reported to attack eggs of insects belonging to 11 orders with special preference on Lepidoptera pests. Two species of promising native egg parasitoid, *viz*., *Trichogramma japonicum* (Fig. 10) and *T. chilonis* were recovered from crop ecosystems of Chhattisgarh during 2018-20. To create awareness among farmers on field utilization of egg parasitoid in pest management

under DBT Biotech KISAN project, a mass production unit was established at main hub, ICAR-NIBSM, Raipur in which production of both species of *Trichogramma* has been initiated. The scaling-up of production is in progress with the production capacity of 30 cc/week and 136 cc/month.

Fig 10. Native *T. japonicum*

In-situ diagnosis of plant pathogenic fungi through Foldscope microscopy

(P. Mooventhan, H. K. Singh)

Sixteen fungal diseases and their organisms were diagnosed from samples collected from farmers' fields of Chhattisgarh region and Agricultural institutes, using foldscope which included *Penicillium digitatum* (Green mould disease of citrus), *Botrytis* spp. (Botrytis blight of brinjal), *Erysiphe polygoni* (Powdery mildew disease of *mungbean*), *Oidium erysiphoides* (Powdery mildew disease of ber), *Albugobliti* (White rust disease of Amranthus), *Fusarium* spp. (Damping off disease of tomato), *Puccinia recondita* (Brown rust disease of wheat), *Rhizopus* spp. (Seedling blight disease of tomato), *Ustilago tritici* (Loose smut of wheat), *Alternaria lini* (Leaf blight disease of linseed), *Erysiphe cichoracearum* (Powdery mildew disease of muskmelon), *Golovinomyces cichoracearum* (Powdery mildew disease of sunflower), *Erysiphe* spp. (Powdery mildew disease of coriander), *Erysiphe polygoni* (Powdery mildew of blackgram), *Leveillula taurica* (Powdery mildew disease of fenugreek) and *Alternaria carthemi (*Leaf blight of safflower).

Leveillula taurica (Powdery mildew disease of fenugreek) observed under Foldscope

The socio-economic status, knowledge level of farmers on plant pathogens, disease diagnosis and farmer's attitude/perception on Foldscope microscopy were studied. Four hands on training on diagnosis of plant pathogenic fungal diseases with foldscope were imparted in which 102 including rural farmers, women and youth benefitted.

Institute Activities

One-day Awareness Workshop on intellectual property rights (March 20, 2021)

One-day Awareness Workshop on Intellectual Property Rights in Agricultural Research was organized on March 20, 2021 under the National Agriculture Innovation Fund scheme. Dr. K.S. Kardam (Former Senior Joint Controller of Patents & Designs, Ex-Head of Office, Patent Office Delhi) presented an overview on IPR including Patents, Industrial Designs, Trademarks and Geographical Indications. Dr. S. K. Soam (Joint Director, ICAR-NAARM, Hyderabad) delivered a talk on copyrights and Geographical indications as IP. Dr. Kanika Malik (Principal Scientist, CSIR-NISCAIR, New Delhi) gave a detailed presentation on Drafting of Patents. More than 50 participants from different ICAR Institutes and Amity University Chhattisgarh, Raipur participated.

Seed distribution under Scheduled Caste Sub Plan (June 23-24, 2021)

ICAR-NIBSM organized two days paddy seed distribution programme on June 23-24, 2021 under the SCSP scheme for the year 2021-22. The programme was organized in collaboration with National Rural Livelihood Mission (NRLM), Raipur. During the seed distribution programme, farmers of different villages were highlighted the significance of this scheme sponsored by GoI for the benefits of farmers of SC community. A total of 120 quintals of certified seeds of paddy/rice variety, Swarna to cover 300 acres were distributed to the farmers belonging to Raipur and Balodabazar districts in which 160 farm families benefited. The entire programme was organized by following COVID-19 pandemic protocol.

TSP activities

During 2021-2022, the scheme TSP has been implemented with the collaboration of KVK, Mahasamund for livelihood by employing various

agriculture and livestock based modules like floriculture, apiculture, poultry/quail rearing, fishery cum duckery, goatery and rabbit rearing. Apart from general distribution, three progressive farmers were selected for development of integrated farming system (IFS) using three different modules for comparative analysis in doubling farmer's income. Training programmes were conducted on Quail rearing and Apiculture for developing scientific skills in the respective field. A total of 101 farmers were provided with bee colonies along with accessories subsequent to the skill development training.

Training on Japanese Quail rearing


Training on Apiculture


Distribution of Bee colonies to beneficiary farmers

Monthly seminar

S. No.	Topic of seminar	Date	Delivered by institute scientist/international scientist
1.	Epigenetic Control of Seed Development	27.01.2021	Dr. Marry Gehring, Associate Professor of Biology, Whitehead Institute for Biomedical Research, Cambridge, MA 02142, USA.
2.	IPR in Agriculture-An Overview	30.01.2021	Dr. P. Mooventhan, Scientist, NIBSM, Raipur
3.	Biotic and abiotic stress tolerance: A roadmap for sustainable agriculture.	10.02.2021	Dr. Kiran Mysore, Professor, Noble Research Institute, 2510, Sam Noble Parkway, Ardmore, Oklahoma, USA.
4.	Novel components of the Polycomb Group pathway and their roles in plant development	10.03.2021	Dr. Sara Farrona, The Ryan Institute Aras de Brun, ADB-2008, National University of Ireland, Galway.
5.	Harnessing plant microbiome to manage biotic and abiotic stresses in agriculture	19.04.2021	Dr. Brajesh Singh, Professor, Western Sydney University, Locked Bag 1797, Penrith NSW, Australia
6.	Adaptive trait diversity, molecular mechanisms, herbicide resistance evolution, response to climate change and management of Italian ryegrass	24.05.2021	Dr. Aniruddha Maity, Texas A&M University, USA
7.	Plasma technology in plant disease management	29.05.2021	Dr. Sanjay K. Jain, PS, NIBSM, Raipur
8.	A genomics perspective for managing biotic stress management	15.06.2021	Dr. Rajeev Varshney, ICRISAT, Pattanchru, India
9.	Harnessing Plant-Microbiome Interactions for Disease Management	19.06.2021	Dr. Pankaj Trivedi Colorado State University, Fort Collins, CO 80523, USA
10.	Silicon mediated resistance against herbivores	26.06.2021	Dr. Mallikarjuna, J., Scientist, NIBSM, Raipur

Lectures

S. No.	Topic of seminar	Date	Organised by	Delivered by
1.	World Water Day	22.03.2021	ICAR-IIPR, Kanpur; ICAR-CIAE, Bhopal	Dr. S. K. Ambast, JD (Edn.) i/c
2.	Value of Water for Agriculture	22.03.2021	ICAR-NIBSM, Raipur	

Workshops/Symposium/Seminar/Conference/training/other fora organized/attended

Workshops/Symposium/Seminar/Conference/training/other fora organized

S. No.	Symposia/seminar/training	Period	Venue/organised by	Name of scientist (Dr.)
1.	Two days Training programme on "Designs of experiments and Next Generation Sequencing Data Analysis" was organized by the ICAR-IASRI, New Delhi and ICAR-NIBSM, Raipur for the Scientists of NIBSM on in Virtual mode	March 16-17, 2021	NIBSM, Raipur	S. K. Jain, Ashish Marathe

Workshops/Symposium/Seminar/Conference/training/other fora attended

S. No.	Symposia/seminar/training attended	Period	Venue/organised by	Name of scientist (Dr.)
1.	Alternative Therapies to Mitigate Microbial Resistance	3-5.2.2021	ICAR-Indian Veterinary Research Institute, Izatnagar	Lata Jain
2.	Designs of experiments and Next Generation Sequencing Data Analysis	16-17.3.2021	ICAR-IASRI, New Delhi	Lata Jain, Vinay Kumar
3.	Intellectual Property Rights in Agriculture	20.3.2021	National Agriculture Science Fund, New Delhi	All Scientists of NIBSM, Raipur
4.	FADC virtual meeting	23.3.2021	Bureau of Indian Standards	S. K. Ambast, JD (Education) i/c
5.	International Conference on Agricultural Extension and Advisory Services: Innovations to Impact	25-27.2.2021	MANAGE, Telangana	P. Mooventhan
6.	Blockchain-Disrupting the Agriculture Sector	6.3.2021	National Institute of Agricultural Extension Management - Centre for Innovation and Agripreneurship, Telangana	
7.	4th meeting of Reconstituted Programme Steering and Monitoring Committee (PSMC) under Biotech-Krishi Innovation Science Application Network (Biotech-KISAN)	20.3.2021	DST, New Delhi	
8.	Centre for Innovation and Agripreneurship: Offerings and Opportunities for Agri-Startups	3.4.2021	National Institute of Agricultural Extension Management - Centre for Innovation and Agripreneurship, Telangana	
9.	International Workshop on Policy Initiatives for Attracting Youth and Preventing Attrition in Agriculture	6-8.4.2021	Asian Productivity Organization (APO), Japan at Indonesia	

Publication

Research/Review papers

Dey, A., P. R. Shashank, N. M. Meshram, S. Subramanian, M. Jeer, C. M. Kalleshwaraswamy, S. M. Chavan, J. Jindal and S. B. Suby. 2021. Molecular diversity of *Sesamia inferens* (Walker, 1856) (Lepidoptera: Noctuidae) from India. 3 Biotech 11: 134.

Kumar, J., R. K. Murali-Baskaran, S. K. Jain, P. N. Sivalingam, A. Dixit, J. Mallikarjuna and P. K. Ghosh. 2021. Biotic stresses of agricultural crops in India: re-visiting national status and mitigation strategies. Current Science 120: 264-265.

Murali-Baskaran, R. K., J. Sridhar, K. C. Sharma and L. Jain. 2021. Kairomone gel formulations enhance biocontrol efficacy of *Trichogramma japonicum* Ashmead on rice yellow stem borer, *Scirpophaga incertulas* Walker. Crop Protection 146: 105655.

Sahu, B., D. Dokka, M. M. Mahajan, K. C. Sharma, H. K. Singh, A. Marathe, B. P. Dewangan, P. Mooventhan, Y. Yele, J. Sridhar, V. Kumar, P. N. Sivalingam, J. Kumar, P. Kaushal and P. K. Ghosh. 2021. Begomoviruses affecting pulse and vegetable crops are unevenly distributed in distinct agroecological zones of the eastern India. Journal of Phytopathology 169: 209-228.

Book chapters

Ghosh, P. K., P. N. Sivalingam, P. Kumar, D. Chakraborty and D. Mandal. 2021. Governance and Policy Reforms, 749-762. In: (P. K. Ghosh, P. Kumar, D. Chakraborty, D. Mandal, P. N. Sivalingam eds.), Innovations in Agriculture for self-reliant India, New India Publishing Agency, New Delhi, 810p. (ISBN: 978-98-90591-53-4)

Ghosh, P. K., P. N. Sivalingam, P. Kumar, D. Chakraborty and D. Mandal. 2021. Indian Agriculture: Issues, Challenges and Priorities, 1-14. In: (P. K. Ghosh, P. Kumar, D. Chakraborty, D. Mandal, P. N. Sivalingam eds.), Innovations in Agriculture for self-reliant India, New India Publishing Agency, New Delhi, 810p. (ISBN: 978-98-90591-53-4)

Jeer, M., M. P. Sahu, and V. K. Choudhary. 2021. Novel Approaches for Biotic Stress Management in the Emerging Production System,

305-330. In: (P. K. Ghosh, P. Kumar, D. Chakraborty, D. Mandal, P. N. Sivalingam eds.), Innovations in Agriculture for self-reliant India, New India Publishing Agency, New Delhi, 810p. (ISBN: 978-98-90591-53-4)

Kiran Kumar, J. Sridhar, V. K. Choudhary, H. K. Singh, B. Parameshwari, K.M. Senthil Kumar, Bhimeshwari Sahu, Narasimham Dokka and P. N. Sivalingam. 2021. New Innovations and Approaches for Biotic Stress Management of Crops, 265-292. In: (P. K. Ghosh, P. Kumar, D. Chakraborty, D. Mandal, P. N. Sivalingam eds.), Innovations in Agriculture for self-reliant India, New India Publishing Agency, New Delhi, 810p. (ISBN: 978-98-90591-53-4)

Kumar, J., P. N. Sivalingam, Mallikarjuna, J., S. K. Jain, Sridhar, J., K. Kiran Kumar, Sujay Anand and P. K. Ghosh. 2021. Innovations in Agriculture: An Overview, 15-32. In: (P. K. Ghosh, P. Kumar, D. Chakraborty, D. Mandal, P. N. Sivalingam eds.), Innovations in Agriculture for self-reliant India, New India Publishing Agency, New Delhi, 810p. (ISBN: 978-98-90591-53-4)

Mooventhan, P., R. R. Burman and S. Ghosh. 2021. Innovations on Extension Models for Self-Reliant India, 705-720. In: (P. K. Ghosh, P. Kumar, D. Chakraborty, D. Mandal, P. N. Sivalingam eds.), Innovations in Agriculture for self-reliant India, New India Publishing Agency, New Delhi, 810p. (ISBN: 978-98-90591-53-4)

Abstracts

Jain, L., V. Kumar and S. K. Jain. 2021. Isolation and characterization of bacteriophages against *Xanthomonas oryzae* pv. *oryzae* as a potent bio-control for bacterial leaf blight of rice. In: Annual International e-Conference on Microbial world: recent Development in Health, Agriculture and Environmental Sciences, organized by Association of Microbiologist of India (AMI) in collaboration with INSCR, TERI, DU, IARI and INSA, held during February 3-5, 2021.

Popular articles

Mooventhan, P., Singh, S. R. K., Venkatesan, P. and Singh. U. 2021. Waste Decomposer to improve soil and plant health: A success story from the tribal belt of Chhattisgarh under the Farmer FIRST Initiative. Harit Dhara 4(1): 7-9.

Extension folders

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10. केंचुआ खाद उत्पादन तकनीक

Mallikarjuna, J. 2021.

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2. Integrated management of Root-knot nematode (*Meloidogyne graminicola*) in Rice
3. Nematode pests of pulse crops and their management
4. Management of nematode pests in protected/polyhouse cultivation
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