

# INDIAN PHYTOPATHOLOGICAL SOCIETY



## Platinum Jubilee Conference

## Plant and Soil Health Management: Issues and Innovations



February 2-4, 2023

### Venue:

Vijnana Bhavan  
University of Mysore, Manasagangotri  
Mysuru, Karnataka, India

# SOUVENIR & ABSTRACTS

### Organizers



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Platinum Jubilee Conference  
**Plant and Soil Health Management:  
Issues and Innovations**

February 2-4, 2023

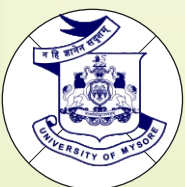
University of Mysore  
Mysuru, Karnataka, India

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&  
ABSTRACTS**

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सत्यमेव जयते

डॉ. एस. चंद्रशेखर  
Dr. S. Chandrasekhar



सचिव  
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विज्ञान एवं प्रौद्योगिकी मंत्रालय  
विज्ञान एवं प्रौद्योगिकी विभाग  
**Secretary**  
**Government Of India**  
Ministry of Science and Technology  
**Department of Science and Technology**



27<sup>th</sup> January, 2023

### MESSAGE

It gives me immense pleasure to note that the University of Mysore, the Karnataka State Open University and the Indian Phytopathological Society (IPS) are jointly organizing the IPS Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations" from February 2-4, 2023 at the University of Mysore, Mysuru, Karnataka.

All life on Earth is dependent on healthy plants for ecological support, food security, and nutrition. The development of agriculture in a sustainable manner is necessary to feed the world's expanding population.

I convey my heartfelt appreciation for the prompt planning of this crucial conference, which focusses on the significance of soil and plant health, new challenges in managing plant diseases and providing potential solutions through pertinent application-based research. The conference will provide an excellent platform to facilitate exchange of most recent technical information and new developments in the field of plant pathology, thus providing directions towards working for a better tomorrow.

I extend my best wishes to the organizing team including the esteemed faculty, research scholars, students and the renowned speakers who are taking part in this conference. I am confident that this conference will provide effective solutions to the global challenges in this area of utmost significance.

I wish the conference a grand success.

(S. Chandrasekhar)



सत्यमेव जयते

**डॉ. हिमांशु पाठक**

सचिव (डेयर) एवं महानिदेशक (भाकूअनुप)

**Dr HIMANSHU PATHAK**

SECRETARY (DARE) & DIRECTOR GENERAL (ICAR)



भारत सरकार  
कृषि अनुसंधान और शिक्षा विभाग एवं  
भारतीय कृषि अनुसंधान परिषद  
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001  
GOVERNMENT OF INDIA  
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION (DARE)  
AND  
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)  
MINISTRY OF AGRICULTURE AND FARMERS WELFARE  
KRISHI BHAVAN, NEW DELHI 110 001  
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## MESSAGE

I am happy to learn that University of Mysore (UOM) and Karnataka State Open University, is organizing Platinum Jubilee Conference on 'Plant and Soil Health Management: Issues and Innovations' at University of Mysore, Mysuru, Karnataka, India, during February 2-4, 2023.

Healthy crops result from a healthy soil, the basis for our plant, animal and aquatic food systems. The food security and nutrition are inextricably linked to soil health. The biological, physical, and chemical features of soil influence the growth and nutrition of plants and ultimately its productivity. A healthy soil leads to higher yields of food and fodder crops which enables the resilient agri-food systems for all dietary requirements. Over the years, the intensive cropping with imbalanced use of chemical fertilizers and less application of organic manures have affected the soil health and productivity. The intensive systems, transboundary diseases & pests and climate change, have resulted into increased occurrence of new and re-emerging pests and threaten the plant health. Combating multiple and highly dynamic biotic stresses necessitates the development of an array of technologies for the prevention, monitoring, control, and management of pests and diseases. The future food security shall depend on our capacity to raise yields and food quality as well as maintaining the health of the soils available for agricultural production.

I hope that the conference will serve as an attractive platform for researchers and all other stakeholders to communicate and imbibe novel ideas and information pertaining to the trending issues related to crop diseases and their management. I believe the recommendations of the conference will help preparing a roadmap to enhance soil health and crop yields and minimize crop loss caused by insect-pests and plant diseases.

I wish the conference a grand success.

(Himanshu Pathak)

**27<sup>th</sup> January, 2023**  
**New Delhi**

भारतीय कृषि अनुसंधान परिषद  
कृषि एवं किसान कल्याण मंत्रालय  
भारत सरकार, कृषि भवन  
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Indian Council of Agricultural Research  
Ministry of Agriculture and Farmers Welfare  
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डॉ. तिलक राज शर्मा  
उप महानिदेशक (फसल विज्ञान)

Dr. T. R. Sharma, Ph.D  
FNA, FNAAS, FNASc, JC Bose National Fellow  
Deputy Director General (Crop Science)




## MESSAGE

It is estimated that up to 40 percent of food crops are lost to plant pests and diseases annually. Plant health is increasingly under threat. Climate change and human activities have altered ecosystems, reducing biodiversity and creating new niches where pests can thrive. Plant pathogens are the biggest threat to food security. The diseases caused by fungal, bacterial, viral and phytoplasmal pathogens are great concern in today's agriculture. Food and nutritional security of a nation can be achieved through production of healthy crops. Healthy food is the most important prerequisite to ensure food and nutritional security and to boost immunity. Though the tools in plant protection arsenal are diverse and developing, crop losses still occur before and after the harvest. To address such issues, meeting and brainstorming involving researchers, academia, entrepreneurs, farmers and policy makers are organized.

I am pleased to know that Indian Phytopathological Society (IPS), New Delhi, the third largest society in the field of plant pathology with active members from fifty plus countries is organizing Platinum Jubilee Conference on '**Plant and Soil Health Management: Issues and Innovations**' at University of Mysore, Mysuru, Karnataka, India, during February 2-4, 2023 to mark 75 years of service to the science at national and international level. I believe that the conference will attempt to cover all important aspects of plant health through its well-designed seven thematic sessions over three days discussion. The galaxy of learned delegates will deliberate on the challenges and opportunities in plant health and suggest way forward for future course of action. The outcomes of the event will provide a useful document to the stakeholders for future initiatives in protecting plant health.

I wish the conference a grand success.

  
(T.R. Sharma)

Dated the 30<sup>th</sup> January' 2023  
Place: New Delhi



**भारतीय कृषि अनुसंधान परिषद**  
**Indian Council of Agricultural Research**  
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**डॉ. सुनील चन्द्र दुबे**  
**Dr. S.C. Dubey**  
Assistant Director General  
(Plant Protection and Biosafety)

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### Message

I am pleased to know that the Indian Phytopathological Society, New Delhi is organizing Platinum Jubilee Conference on 'Plant and Soil Health Management: Issues and Innovations' at University of Mysore, Mysuru, Karnataka, India, during February 2-4, 2023 to mark 75 years of service to the science and Society in India and also at International level.

The present conference is focused on various themes related to health management of plant as well as soil which are playing an important role in agriculture production and also provide shelter for several plant pathogens. The conference is going to address major National issues in the area of plant pathology including diagnostics, host-pathogen interactions, phytobiome and microbiome, disease forecasting under changing climatic conditions and eco-friendly plant and soil health management for sustainable food production. I am glad to know that the conference is also addressing various issues and challenges related to academia, farmers and industries through interactive session of their representatives.

I hope delegates in the conference will deliberate upon the important issues related to plant and soil health prevalent in the country and will come out with suitable recommendations.

I congratulate and wish all success to the organizers and participants of the conference.

Date: January 27, 2023

(S.C. Dubey)



UNIVERSITY



OF MYSORE

**Prof. H. RAJASHEKAR**

M.Com., Ph.D.,

Vice Chancellor (I/C)

*Crawford Hall, Mysuru - 570 005, INDIA*

25.01.2023

## MESSAGE

I would like to send my warmest greetings to all of the attendees of the IPS Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations" on behalf of the University of Mysore. I am confident that this conference, like those the Indian Phytopathological Society (IPS) has held in the past, will play a significant role in promoting activities in research and development of plant and soil health management in India. It will also provide a fantastic opportunity to establish partnerships between research institutions both domestically and with foreign partners.

This event's broad focus, which covers the significant field of agriculture, offers a singular forum for researchers from across the entire range of our study. I'm hoping that some fruitful partnerships can be forged during the conference's three days. I also hope that the emphasis on plant and soil health this year will spur the growth of research and applications in this field to meet the different demands of global development.

I want to sincerely thank the eminent speakers for being here and for what they brought to the conference. Finally, I truly hope that the technical information presented at this conference will be useful to all of the attendees.

I also wish you a successful conference and a wonderful stay in Mysuru.



Vice Chancellor

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Email : [vc@uni-mysore.ac.in](mailto:vc@uni-mysore.ac.in), [rajashekarh1@yahoo.co.in](mailto:rajashekarh1@yahoo.co.in), Website : [www.uni-mysore.ac.in](http://www.uni-mysore.ac.in)



# KARNATAKA STATE OPEN UNIVERSITY

Mukthagangothri, Mysuru - 570 006

**Prof. Sharanappa V. Halse**

M.Sc., M.Phil., Ph.D., E.D.P. & C.M.

**Vice-Chancellor**

Off. : +91-0821-2515149

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## MESSAGE

I am happy to learn that Karnataka State Open University, University of Mysore, and Indian Phytopathological Society, and, are jointly organizing the IPS Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations" at University of Mysore, Mysuru. I want to start by congratulating the organizers for holding this significant conference at the appropriate time. The need to combine knowledge of plant and soil health for crop improvement and agricultural disease control makes the theme of this year's conference particularly pertinent and significant. The time has come to combine various approaches for comprehending the crucial importance of soil and its health, which has a direct impact on plant and its health, which in turn has bearing on food quality and productivity, given the rapid advances being made in genomics, transcriptomics, proteomics, and metabolomics.

I want to express my gratitude to the conference organizers and their staff for their careful planning and execution of the event. The conference's chosen themes are crucial for supporting and advancing technology development for preserving soil and plant health.

Let me conclude by saying that this conference offers a special chance for researchers and students to explore how to improve agricultural output and nutritional quality by guaranteeing soil and plant health. I have no doubt that the esteemed delegates present will discuss a range of topics and formulate suggestions for new directions in research aimed at tackling crop productivity enhancement challenges as they arise.

I wish all of you pleasant stay and great success for the conference.

  
Prof. Sharanappa V. Halse  
Vice-Chancellor

**Dr. K. M. INDIRESH**  
Vice-Chancellor,  
University of Horticultural Sciences,  
Bagalkot, Karnataka  
Ph. (O) 08354-230351,  
Email : vc@uhsbagalkot.edu.in  
Website: www.uhsbagalkot.edu.in



## **MESSAGE**


It gives me immense pleasure to know that Indian Phytopathological Society, University of Mysore, and the Karnataka State Open University, are jointly organizing the IPS Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations" from February 2-4, 2023 at University of Mysore, Mysuru.

The extensive scope of this event, which includes the significant topic of agriculture, provides a singular venue for researchers from throughout the entirety of our field of study. During the course of the three days of the conference, I'm really hopeful that some good partnerships will be formed. I also have high hopes that this year's focus on the health of plants and soil will encourage a rise in the amount of research and applications being conducted in this area so that it may better satisfy the many requirements of global development.

I am sure that the deliberations amongst renowned and eminent scientists of this field will be highly productive and fruitful to generate awareness in this domain.

On behalf of University of Horticultural Sciences, Bagalkote, I congratulate the organizers of this event and wishes for the success of the conference.

Date: 25-01-2023  
Place: Bagalkote

  
(K. M. Indires)  
Vice-Chancellor  
UHS, Bagalkot

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9449411434



ಕೆಲದಿ ಶಿವಪ್ಪ ನಾಯಕ ಕೃಷಿ ಮತ್ತು ತೋಟಗಾರಿಕೆ ವಿಜ್ಞಾನಗಳ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಶಿವಮೊಗ್ಗ

**KELADI SHIVAPPA NAYAKA UNIVERSITY OF AGRICULTURAL AND  
HORTICULTURAL SCIENCES, SHIVAMOGGA**

**Dr. R.C. Jagadeesha**

Vice-Chancellor

M.Sc.(Agri.), Ph.D.,

Iruvakkki - 577 412, Sagara Taluk  
Shivamogga District, Karnataka, India

## *MESSAGE*

*I am glad to know that the IPS Platinum Jubilee Conference will be held during 2-4 February, 2023 at University of Mysore. The Conference theme "Plant and Soil Health Management: Issues and Innovations", is appropriate in that it calls for broad discussion among all of the stakeholders. It is true that plant health, which in turn affects human health, depends on the health of the soil.*

*I am glad to see that this Conference, which aims to raise awareness about the importance of soil and plant health for enhancing food productivity worldwide, is being attended by notables from all across the nation and from overseas. I have no doubt that the large gathering of knowledgeable experts will encourage the exchange of research knowledge and concepts. It is commendable that the Indian Phytopathological Society, University of Mysore, and Karnataka State Open University worked together to put this Conference together. It will undoubtedly be a step in the right direction for advancing knowledge and research in this crucial field of agriculture.*

*I express my solidarity and support and wish the Conference a grand success.*

Shivamogga, 27<sup>th</sup> Jan. 2023

  
(R.C. JAGADEESHA)





**MESSAGE**

The fact that the Indian Phytopathological Society, University of Mysore, and Karnataka State Open University will collaborate to host the IPS Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations" from February 2-4, 2023 at University of Mysore, Mysuru, makes me happy.

The importance of soil and plant health and its management is the key to this India's agricultural development story. By focusing on soil and plant health in the next centuries, India has the potential to become a science and technology giant in the field of agriculture. One strategy to achieve this good environmental and human health is to raise knowledge of the value of healthy soil for the growth of healthy crops. It is pointless to try to enhance food production without putting an emphasis on healthy crops. The conference's theme is highly pertinent and significant in this setting. Given the current situation, this conference is being arranged at the best time.

At this conference, I hope eminent academics and researchers will join together to discuss all the numerous facets of this intriguing topic and produce useful recommendations. I'd also like to take this opportunity to thank the organizers for pulling off such an important gathering.

I thank all participants for their dedication and active engagement and send my best wishes for further success.

**Prof. K.S. Rangappa**  
Former Vice-Chancellor  
University of Mysore

Sir Asutosh Mookerjee Fellow, (Indian Science Congress Association, Kolkata)

Chief Scientific Advisor, Sinotar Pharmaceutical (Schenzen) Co., Ltd., China.,

Former Vice-Chancellor, University of Mysore and Karnataka State Open University, Mysuru

Former General President, Indian Science Congress Association, Kolkata; UGC-BSR Faculty Fellow (2017-2020)

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## Indian Phytopathological Society

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**RAKESH PANDEY, Ph.D., DAAD Fellow, FNAAS**  
**Professor AcSIR & CSIR Emeritus Scientist**  
**CSIR-Central Institute of Medicinal and Aromatic Plants,**  
**P.O. CIMAP, Lucknow-226015, India**  
**President-Indian Phytopathological Society**



### MESSAGE

It is a great pleasure for us to organize IPS Platinum Jubilee Conference on “**Plant and Soil Health Management: Issues and Innovations**” at University of Mysore, Mysuru, Karnataka, India during 2-4<sup>th</sup> February 2023.

The present symposium would serve to address major important issues like plant disease diagnostic, phytobiome and microbiome, soil and plant health management, climate resilience agriculture, omics etc. to achieve sustainable agriculture and food security in India.

I am happy that University of Mysore, Mysuru, Karnataka is, one of the premier and finest university of the country that had led several advancements in the fields of agriculture and biotechnology, has taken up the task of shouldering the responsibility to organize this IPS Platinum Jubilee Conference. The symposium will provide a great platform for the researchers in plant pathology from both academia and industry to come together, discuss, deliberate and to devise strategies to combat the threats posed by various plant pathogens and to ensure food and nutraceutical security.

I convey my best wishes to all the participants hoping for the event to be a grand success.

**Rakesh Pandey**

**Lucknow**  
**January 27, 2023**



**Prof. Robin Gogoi**  
*Secretary*  
*Indian Phytopathological Society*  
*Head (Acting) and Professor*  
*Division of Plant Pathology, ICAR-IARI*  
*New Delhi 110 012*

## Message

Globally plant pathogens have adverse on the crops and it impacts on the security of food and nutrition, fibre and biofuel crops, and on the economy of each country. To lessen this sharp impact, plant pathologists across the globe have been working persistently, and to mitigate the problems caused by the biotic agents like fungi, bacteria, virus and phytoplasmas. Further, the prevailing changing climatic conditions not only influence the phenology of insect-pests and diseases but also their time of appearance/emergence consequently favoring their increased spread and damage potential of the crops.

So far, the Indian Phytopathological Society (IPS) has productively crossed 75 years after its establishment in 1947 laid by the visionary personnel B. B. Mundkur, J.F. Dastur, S.R. Bose, B.N. Uppal, A. Sattar and R.S. Vasudeva. Since then our crop protection workers are committed to extend truthful services to the Indian Agriculture and to support the farmers' livelihood. Tuning this motto, the Society is going to further celebrate its **Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations"** during 2-4 February, 2023 at University of Mysore, Mysuru, Karnataka.

A large number of plant pathologists and crop protection scientists from India and abroad, research scholars and post graduate students will be joining the conference. The conference has been articulated with seven technical sessions covering Diagnostics, Phytobiome and microbiome, Eco-friendly plant and soil health, Multidisciplinary interventions for PDM, Climate resilient agriculture, Omics in crop protection and Industry, academia and farmers' interface. It is undoubtedly an outstanding platform for the researchers and different stakeholders to communicate, exchange and imbibe novel ideas and information pertaining to the trending issues related to crop diseases and their management.

I am extremely delighted to welcome you all to the Platinum Jubilee Conference of the IPS convening in the beautiful campus of University of

Mysore, Mysuru. The Society is highly obliged to the Vice Chancellor of the University for hosting the grand programme of the plant pathologists. I offer my best and hearty congratulation to the organizers and their team members for coming forward to organize the conference. I extend my warm greetings and felicitations to all the participants as well. I further hope all the participants will fully enjoy Mysuru, the City of Palaces and one of the Cleanest of India.

In advance, I wish the National Conference to be a grand success.



**(Robin Gogoi)**

Dated: 23<sup>rd</sup> January, 2023  
New Delhi





**University of Mysore**  
**Manasagangotri**  
**Mysuru-570006**



**Karnataka State Open University**  
**Mukthagangotri**  
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### **MESSAGE**

We are excited to inform you that the University of Mysore, the Karnataka State Open University, and the Indian Phytopathological Society are collaborating to host the IPS Platinum Jubilee Conference on "Plant and Soil Health Management: Issues and Innovations" from February 2-4, 2023 at University of Mysore, Mysuru. In the twenty-first century, food security and declining environmental health are the two major problems that people must contend with. In addition to producing food, plants are a vital component of a healthy environment. The relevance of soil and plant health in battling plant diseases, as well as the most recent advancements made in this field, will be the main topics of discussion at this platinum jubilee conference. The meeting will provide a unique forum for discussing recent research, technological improvements, and significant difficulties in managing plant diseases. We hope that this conference will push the boundaries of strategy creation, research advancement, and innovation in all facets of managing plant and soil health. It is the perfect setting for idea exchange because this platform brings together the best minds from throughout the nation and beyond.

We are incredibly grateful for every notable international and national speaker, faculty member, research scholar, and student who is participating in this conference. We have no doubt that each of you will remember this experience vividly and add significantly to our collective knowledge.

We also want to express our gratitude to the individuals who worked with the organizing committee for their assistance in planning and overseeing this event.

We wish all the best for the conference.

**Dr. Chandra Nayaka S.**  
Organizing Secretary

**Dr. Niranjana Raj S**  
Organizing Secretary

**IPS Platinum Jubilee Conference**  
**Plant and Soil Health Management: Issues and Innovations**  
February 2-4, 2023; University of Mysore, Mysuru, Karnataka, India

## **INDIAN PHYTOPATHOLOGICAL SOCIETY**

Platinum Jubilee Conference  
**Plant and Soil Health Management: Issues and Innovations**  
**February 2<sup>nd</sup> - 4<sup>th</sup>, 2023**  
**Venue: Vijnana Bhavana, Manasagangotri, University of Mysore, Mysuru**

### **INAGURATION PROGRAMME SCHEDULE**

Time		Sequence of events
9:30–9:35	Invocation	<b>Fine Arts College Students</b>
9:35–9:45	Naada Geethe / State Anthem	<b>Fine Arts College Students</b>
9:45–9:55	Welcome Address	<b>Dr. Robin Gogoi</b> , Secretary, Indian Phytopathology Society, New Delhi.
9:55–10:05	About the Conference	<b>Dr. S. Chandra Nayak</b> Organizing Secretary, Indian Phytopathology Society, University of Mysore. Mysuru.
10:10 – 10:20	Lighting the lamp	All the Dignitaries
11:20 – 11:30	About the Society	<b>Dr. Rakesh Pandey</b> President, Indian Phytopathology Society, New Delhi.
10:30 – 10:40	Address by the Guest of Honor	<b>Dr. Sharanappa V. Halse</b> Hon'ble Vice-Chancellor, Karnataka State Open University, Mysuru.
10:40 – 10:50	Address by the Guest of Honor	<b>Dr. K. M. Indiresh</b> Hon'ble Vice-Chancellor University of Horticultural Sciences, Bagalkote.
10:50 – 11:00	Address by the Guest of Honor	<b>Dr. K. S. Rangappa</b> Former Vice Chancellor & Distinguished Professor University of Mysore, Mysuru.
11:00 – 11:10	Address of Chief Guest	<b>Dr. S. Chandrashekar</b> Secretary, Department of Science & Technology, New Delhi
11:20 – 11:40	<b>Felicitation of Awardees</b>	
	<b>A.P. Mishra Lifetime Achievement Award</b>	<b>Dr. S. S. Chahal</b> , former VC (MPUAT) & Honorary Emeritus Professor, Punjab University, Chandigarh, Punjab

**IPS Platinum Jubilee Conference**  
**Plant and Soil Health Management: Issues and Innovations**  
February 2-4, 2023; University of Mysore, Mysuru, Karnataka, India

	<b>IPS Recognition Award</b>	<p><b>Dr. N. Iboton Singh</b>, Former Dean, Department of Life Sciences, Manipur University, Canchipur, Imphal, Manipur</p> <p><b>Prof. B. N. Chakraborty</b>, Department of Biological Sciences, Aliah University, New Town, Kolkata, west Bengal</p> <p><b>Dr. R. Dridhar</b>, Former Principal Scientist (Central Rice Research Institute, Cuttack, Odisha), Chennai, Tamil Nadu</p> <p><b>Dr, A. P. Suryawanshi</b>, Former Professor (Plant Pathology) and Associate Dean and Principal, College of Agriculture, Latur VNMKV, Parbhani, Maharashtra.</p>
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	<p><b>Release of IPS Publications</b></p> <ol style="list-style-type: none"> <li>1. Compendium of Maize Diseases, edited by <b>Dr. Robin Gogoi et. al.</b></li> <li>2. Compendium of Medicinal and Aromatic Plants Diseases, edited by <b>Dr. Rakesh Pandey et. al.</b></li> <li>3. Diseases of Oilseed Crops in India: Diagnosis and management, edited by <b>Dr. Pankaj Sharma et. al.</b></li> <li>4. Spices Disease Compendium edited by <b>Dr. C. N. Biju et.al.</b></li> <li>5. Sugarcane Disease Compendium authored by <b>Dr. R. Viswanathan et.al.</b></li> <li>6. <i>Hindi Book: Sabjiyon mein samanvit padap rog niyantran</i> authored by <b>Dr. Pramod K. Gupta et al.</b></li> <li>7. BACTERIAL DISEASES OF PLANTS AND THEIR MANAGEMENT — A Textbook - <b>Shamarao Jahagirdar et al.,</b></li> <li>8. Abstract and Souvenir of IPS Conference</li> </ol>	
11:40-11:50	President	<b>Prof. H Rajashekar</b> Hon'ble Vice-Chancellor, University of Mysore, Mysuru.
11:50-12:00	Vote of Thanks	<b>Dr. Niranjan Raj S,</b> Organizing Secretary, Indian Phytopathology Society, Karnataka State Open University, Mysuru.
11:50–12:15	<b>High Tea</b>	

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**TECHNICAL PROGRAMME**

Day 01 (Thursday, February 02, 2023)		
09.00-10.00	<b>Registration</b>	<b>Hall 1</b>
10.00-11.45	<b>Inauguration and Felicitation</b>	
11.45-12.15	<b>Tea Break</b>	
12.15-13.15	<p><b>Presidential Lecture:</b> Green strategies and innovations for plant and soil health management  <b>Dr. Rakesh Pandey</b>, <i>President (IPS) &amp; CSIR-CIMAP, Lucknow, Uttar Pradesh, India</i></p> <p><b>Plenary Lecture:</b> Comparative Genomics Resolves Historic Puzzles in Plant Pathology  <b>Dr. Krishna V. Subbarao</b>, <i>University of California, Davis, CA, USA</i></p> <p><b>Chair:</b> Prof. Appa Rao Podile, <i>University of Hyderabad, Hyderabad, Telangana, India</i>  <b>Co-Chair:</b> Prof. K.R. Sridhar, <i>Mangalore University, Mangalore, Karnataka</i>  <b>Rapporteurs:</b> Dr. Harleen Kaur, <i>PAU, Ludhiana Punjab, India</i>  Dr. D. Pramesh, <i>AICRIP-Rice, Gangavathi, Karnataka, India</i></p>	
13.15-14.15	<b>Lunch Break</b>	
14.20-17.00	<p><b>Technical Session 1A:</b> Diagnostics: Issues and innovations  <b>Chair:</b> Dr. R. Viswanathan, <i>ICAR-IISR, Lucknow, Uttar Pradesh, India</i>  <b>Co-Chair:</b> Dr. M. Krishna Reddy, <i>ICAR-IIHR, Bengaluru, Karnataka, India</i>  <b>Rapporteurs:</b> Dr. Prakash, T.L., <i>ICAR-IARI, RS, Indore, Madhya Pradesh, India</i>  Dr. Amrita Das, <i>Division of Plant Path., ICAR-IARI, New Delhi</i></p>	<b>Hall 1</b>
	<b>KEYNOTE LECTURE</b>	
<b>KN 01(S1A)</b>	<p><b>Chitosans - role in plant disease, immunity and symbiosis</b>  <b>Dr. Appa Rao Podile</b>, <i>University of Hyderabad, Hyderabad, Telangana, India</i></p>	
<b>KN 02(S1A)</b>	<p><b>Strategies for Integrated management of virus diseases in vegetable crops</b>  <b>Dr. Krishna Reddy M.</b>, <i>ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, India</i></p>	
<b>KN 03(S1A)</b>	<p><b>Application of omic tools to study dynamics and varying pathogenicity of sugarcane red rot pathogen <i>Colletotrichum falcatum</i></b>  <b>Dr. Viswanathan R.</b>, <i>ICAR-Indian Institute of Sugarcane Research, Lucknow, Uttar Pradesh, India</i></p>	
<b>IL 01(S1A)</b>	<p><b>Draft genome of <i>Wilsonomyces carpophilus</i> causing shot hole disease of stone fruits using Illumina HiSeq and PacBio NGS platforms</b>  <b>Dr. Mehraj UI Din Shah</b>, <i>Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India</i></p>	
<b>IL 02(S1A)</b>	<p><b>Managing recent outbreaks of foliar fungal diseases in arecanut and coconut: Challenges and Strategies</b>  <b>Dr. Vinayaka Hegde</b>, <i>ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala, India</i></p>	
<b>IL 03(S1A)</b>	<p><b>Robust diagnostics for major virus and virus-like pathogens infecting horticultural crops in north east India</b>  <b>Dr. Susheel Sharma</b>, <i>ICAR-Indian Agricultural Research Institute, New Delhi, India</i></p>	

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	<b>ORAL PRESENTATIONS</b>	
OP 01(S1A)	Investigation on progressive systemic localization, seed borne nature and symptoms-based advancement of <i>Fusarium oxysporum</i> f. sp. <i>ciceri</i> inoculum incited wilt in chickpea Dr. Rakesh Kumar Singh, RVSKVV, College of Agriculture, Indore, Madhya Pradesh, India	
OP 02(S1A)	Host range, aggressiveness and fungicide sensitivity of <i>Alternaria brassicicola</i> affecting broccoli in Georgia, USA Dr. Aparna Petkar, 11 Juniper Creek Tifton 31793 GA, United States	
OP 03(S1A)	Induced resistance to mitigate phomopsis blight of brinjal using inorganic chemicals Dr. Adesh Kumar, Lovely Professional University, Phagwara, Punjab, India	
OP 04(S1A)	Real time detection and transmission of viruses (ApMV and ApNMV) associated with mosaic disease of apple ( <i>Malus domestica</i> ) Dr. Sajad Un Nabi, ICAR-Central Institute of Temperate Horticulture, Srinagar, Jammu and Kashmir, India	
OP 05(S1A)	New report of a bacterial wilt disease in bush cowpea ( <i>Vigna unguiculata</i> ) caused by <i>Klebsiella pneumoniae</i> Dr. Sajeena Abdul Majeed, Integrated Farming System Research Station (IFSR), Thiruvananthapuram, Kerala, India	
OP 06(S1A)	Molecular characterization of fungal species found on major crops in Mauritius Dr. Vijayantimala Ranghoo-Sanmukhiya, The University of Mauritius Reduit Portlouis, Mauritius	
OP 07(S1A)	Diagnosis of emerging fungal pathogen on robusta coffee Dr. Sudha M., Central Coffee Research Institute, Coffee Research Station, Chikkamagaluru, Karnataka, India	
14.20-17.00	<b>Technical Session 2:</b> Phytobiome and microbiome: Challenges and advances Chair: Dr. R. Selvarajan, ICAR-NRC for Banana, Tiruchirapalli, Tamil Nadu, India Co-Chair: Dr A.P. Suryawanshi, College of Agriculture, Latur, MS, India Dr. Iboton Singh, College of Agriculture, CAU, Imphal, Manipur, Rapporteurs: Dr. Ram Prasanna Meena, ICAR-DMAPR, Anand, Gujarat, India Dr. Girish, H.V., University of Mysore, Mysuru, Karnataka	<b>Hall 2</b>
	<b>KEYNOTE LECTURE</b>	
KN 01(S2)	Tailoring plant microbiome for disease management in fruit crops Dr. Ashok Bhattacharyya, Assam Agricultural University, Jorhat, Assam, India	
	<b>INVITED LECTURES</b>	
IL 01(S2)	On the macrofungal resources of southwest India Prof. Kandikere R. Sridhar, Mangalore University, Mangalore, Karnataka	
IL 02(S2)	Effect of inoculation method on endophytic colonization of cashew seedlings with the entomopathogenic fungus <i>Beauveria bassiana</i> (Balsamo) Vuillemin (Ascomycota: Hypocreales) Dr. Ambethgar Vellaisamy, Tamil Nadu Agricultural University, ADAC & RI, Tiruchirappalli, Tamil Nadu, India	
	<b>ORAL PRESENTATIONS</b>	
OP 01(S2)	Exploring potential of Endophytic Biodiversity from North Western Himalayas for new pharmacophores Dr. Brajeshwar Singh, S.K. University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India	

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	<b>Rapporteurs:</b> Dr. Ajithkumar, K. UAS, Raichur, Karnataka, India Dr. Thava Prakasa Pandian R., ICAR-CPCRI, RS, Vittal, Karnataka, India	
	<b>KEYNOTE LECTURES</b>	
KN 01(S4)	<b>Biopesticides: registration process, challenges and future prospects in India</b> Dr. S.C. Dubey, Indian Council of Agricultural Research, New Delhi, India	
KN 02(S4)	<b>Pomegranate diseases challenges and management through multidisciplinary intervention</b> Dr. Jyotsana Sharma, ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra, India	
	<b>INVITED LECTURES</b>	
IL 01(S4)	<b>Harnessing the potential of microbial metabolites for the management of sheath blight disease of rice caused by <i>Rhizoctonia solani</i> Kühn</b> Dr. N. Mathivanan, University of Madras, Chennai, Tamil Nadu, India	
IL 02(S4)	<b>Black scurf of potato in Jammu and its management</b> Dr. Sachin Gupta, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Jammu, Jammu & Kashmir, India	
IL 03(S4)	<b>Biogenic Nanoparticles elicit cellular, biochemical, and transcriptomic defense mechanisms against late blight of tomato</b> Dr. Sudisha J., Central University of Kerala, Kasaragod, Kerala, India	
IL 04(S4)	<b>Recent trends in the diagnosis of plant diseases in plantation crops</b> Dr. Thava Prakasa Pandian R., ICAR-CPCRI, Regional Station, Vittal, Karnataka, India	
IL 05(S4)	<b>Emerging and reemerging rice pathogens: swotting through morpho-molecular characterization, virulence profiling, diagnostics, and pathogenomics</b> Dr. Pramesh Devanna, AICRIP-Rice, ARS Campus Gangavathi, University of Agricultural Sciences, Gangavathi, Karnataka, India	
IL06 (S4)	<b>Current scenario of sugarcane diseases and their management in North West Zone of India</b> Dr. Rakesh Mehra, CCS HAU, Regional Research Station, Karnal, Haryana, India	
IL 07(S4)	<b>Biology and characterization of an emerging false smut pathogen <i>Ustilaginoidea virens</i> of rice (<i>Oryza sativa</i> L)</b> Dr. Bishnu Maya Bashyal, ICAR-Indian Agricultural Research Institute, New Delhi, India	
	<b>ORAL PRESENTATIONS</b>	
OP 01(S4)	<b>Integrated disease management on dry root rot safflower</b> Dr. Vikram M. Gholve, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India	
OP 02(S4)	<b>The key to India's food security lies with crop protection</b> Dr. Sanjeev Kumar, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh, India	
OP 03(S4)	<b>An overview of basic and applied research on diverse bacterial diseases on onion</b> Dr. Bhabesh Dutta, University of Georgia, United States	
OP 04(S4)	<b>Studies on Rhizome rot of Turmeric caused by <i>Pythium aphanidermatum</i> (Edson) Fitzp. in Central India</b> Dr. Pramod Kumar Gupta, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India	

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OP 05(S4)	Exploring stem and leaf rust resistance in large wheat germplasm lines and landraces Dr. Prakasha T.L., ICAR-Indian Agricultural Research Institute, Regional Station, Indore, Madhya Pradesh, India	
OP 06(S4)	Exploring genetic resources to develop banded leaf and sheath blight resistant hybrids in maize Dr. Surinder Sandhu, Punjab Agricultural University, Ludhiana, Punjab, India	
OP 07(S4)	Prevalence of blue mould rot of Indian gooseberry ( <i>Emblica officinalis</i> Goertn.) caused by <i>Penicillium islandicum</i> (Sopp.) and its management Dr. Anil Kumar, CCS Haryana Agricultural University, Hisar, Haryana, India	
OP 08(S4)	Mangrove and <i>Ampelomyces quisqualis</i> on the management of black gram powdery mildew Dr. Vengadeshkumar L., Annamalai University, Chidambaram, Tamil Nadu, India	
OP 09(S4)	Influence of carbon and nitrogen sources on the growth of <i>Ustiloginoidea virescens</i> , incitant of false smut of rice ( <i>Oryza sativa</i> ) Dr. A.S. Savitha, University of Agricultural Sciences, Raichur, Karnataka, India	
OP 10(S4)	Management of <i>Phytophthora</i> diseases in capsicum by employing combi-fungicides Dr. K. Ajithkumar, AICRP on Linseed, University of Agricultural Sciences, Raichur, Karnataka, India	
OP 11(S4)	Exogenous delivery of dsRNAs derived from the two genes of S RNA of groundnut bud necrosis virus combating the virus accumulation and symptom expression in host plants Mr. Suryakant Manik, ICAR-Indian Agricultural Research Institute, New Delhi, India	
15.30-15.45	<b>Tea Break and</b>	
15.45-17.00	<b>Poster Presentation Session (Session 4, 5, 6, 7)</b>	
15.45-17.00	<b>Technical Session 6:</b> Omics in crop protection  Chair: Dr. Gururaj Sunkad, UAS, Raichur, Karnataka, India Co-Chair: Dr. Dinesh Singh, ICAR-IARI, New Delhi, India Rapporteurs: Dr. Vanita Salunkhe, ICAR-NIASM, Pune, Maharashtra, India Dr. Susheel K. Sharma, ICAR-IARI, New Delhi, India	<b>Hall 2</b>
	<b>KEYNOTE LECTURES</b>	
KN 01(S6)	Citrus tristeza virus, a sleeping giant, responsible for mandarin ( <i>C. reticulata</i> ) decline in NE India: a challenge to combat through biotechnology-cross protection-based management system Dr. Kajal Kumar Biswas, ICAR-Indian Agricultural Research Institute, New Delhi, India	
KN 02(S6)	T3SS-effector of <i>Xanthomonas oryzae</i> pv. <i>oryzae</i> subverts rice immune system through interacting rice key proteins during bacterial blight development Dr. Kalyan K. Mondal, ICAR-Indian Agricultural Research Institute, New Delhi, India	

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	<b>INVITED LECTURES</b>	
IL 01(S6)	<b>Three decades of Phaseolus vulgaris – Colletotrichum lindemuthianum interface in India: The road behind and the road ahead</b> <b>Dr. Bilal A. Padder, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu and Kashmir, India</b>	
IL 02(S6)	<b>Studies on economically important diseases of horticultural crops</b> <b>Dr. Sessa Kiran Kollipara, Horticultural Research Station, Madanapalli, Annamayya (Dt) Dr.Y.S.R. Horticultural University, Andhra Pradesh, India</b>	
IL 03(S6)	<b>Transcriptome analysis of wheat–Tilletia indica interaction provides defense related genes</b> <b>Dr. Malkhan Singh Gurjar, ICAR-Indian Agricultural Research Institute, New Delhi, India</b>	
	<b>ORAL PRESENTATIONS</b>	
OP 01(S6)	<b>Genetic diversity analysis of stem rust (Puccinia graminis f.sp. tritici, Pgt) of wheat prevailing at Southern Hill Zone of India</b> <b>Dr. Uma Maheswari C., ICAR-Indian Agricultural Research Institute, Regional Station Wellington (The Nilgiris), Tamil Nadu, India</b>	
OP 02(S6)	<b>Allelic test and molecular characterization in white rust resistant Indian mustard [Brassica juncea (L.) Czern &amp; Coss] germplasm to identify new donors</b> <b>Dr. J. Nanjundan, ICAR-Indian Agricultural Research Institute, Regional Station Wellington (The Nilgiris), Tamil Nadu, India</b>	
OP 03(S6)	<b>Comparative proteomic analysis in Ascochyta blight resistant and susceptible chickpea</b> <b>Dr. Manjunatha Lakshmaiah, ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, India</b>	
OP 04(S6)	<b>Identification of novel QTLs/genomic regions associated with seedling and adult plant stage stem rust resistance in bread wheat (Triticum aestivum L.) through genome-wide association studies (GWAS) and their validation through KASP marker assays</b> <b>Dr. Vikas V.K., ICAR-Indian Agricultural Research Institute, Regional Station Wellington (The Nilgiris), Tamil Nadu, India</b>	
OP 05(S6)	<b>Assessment of genetic diversity of virulence genes in the Magnaporthe population infecting millets in India</b> <b>Dr. Palanna K.B., ICAR-AICRP on Small millets, PC Unit, UAS, GKVK, Bangalore, Karnataka, India</b>	
18.00-20.00	<b>Cultural Programme</b>	<b>Hall 1</b>
20.00-21.00	<b>Dinner</b>	



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<b>Day 03 (Saturday, February 04, 2023)</b>		
09.30-09.50	<p><b>S.P. Raychaudhuri Memorial Award Lecture</b>  <b>Dr. U.S. Singh</b>, <i>International Rice Research Institute, New Delhi, India</i>  <b>Title:</b> Direct seeded rice - impact on rice diseases and their management</p>	<b>Hall 1</b>
09.50-10.10	<p><b>J.F. Dastur Memorial Award Lecture</b>  <b>Dr. P.D. Meena</b>, <i>ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan, India</i>  <b>Title:</b> Topographical dispersal of rapeseed-mustard diseases under changing climate in India</p>	
10.10-10.30	<p><b>S. Sinha Memorial Award Lecture</b>  <b>Dr. B. Parameswari</b>, <i>ICAR-NBPGR, Regional Station, Hyderabad, Telangana, India</i>  <b>Title:</b> A whole genome based reduced representation approach for identification of resistance against Sugarcane yellow leaf virus in Indian sugarcane</p>	
10.30-10.45	<p><b>M.K. Patel Memorial Young Scientist Award Lecture</b>  <b>Dr. Amalendu Ghosh</b>, <i>ICAR-Indian Agricultural Research Institute, New Delhi, India</i>  <b>Title:</b> New insights into the transmission biology of plant viruses by thrips and whitefly and their management</p> <p><b>Chair:</b> Dr. Pratibha Sharma, <i>SKNAU, Jaipur-Jobner, Rajasthan, India</i>  <b>Co-Chair:</b> Dr. V. Devappa, <i>College of Horticulture, Bengaluru, Karnataka, India</i>  Dr. Kajal Kumar Biswas, <i>ICAR-IARI, New Delhi, India</i>  <b>Rapporteurs:</b> Dr. Malkhan Singh Gurjar, <i>ICAR-IARI, New Delhi, India</i>  Dr. Manjunath L., <i>ICAR-IIHR, Bengaluru, Karnataka, India</i></p>	
<b>10.45-11.00</b>	<b>Tea Break</b>	
11.00-13.00	<p><b>Technical Session 5:</b> Climate resilient agriculture and disease forecasting</p> <p><b>Chair:</b> Dr. Sharanappa Harlapur, <i>UAS, Dharwad, Karnataka, India</i>  <b>Co-Chair:</b> Dr. Bikas Mandal, <i>ICAR-IARI, New Delhi, India</i>  <b>Rapporteurs:</b> Dr. Dinesh Rai, <i>Dr. RPCAU, Pusa, Samastipur, Bihar, India</i>  Dr. Santosh Watpade, <i>ICAR-IARI, RS, Shimla, Himachal Pradesh, India</i></p>	<b>Hall 1</b>
	<b>KEYNOTE LECTURES</b>	
KN 01(S5)	<p><b>Significance of plant growth promoting microorganisms for plant and soil health under changing climatic scenario</b>  <b>Dr. Gururaj Sunkad</b>, <i>University of Agricultural Sciences, Raichur, Karnataka, India</i></p>	
KN 02(S5)	<p><b>Decision making tools for integrated disease management</b>  <b>Prof. K.P. Singh</b>, <i>G.B. Pant University of Agriculture &amp; Technology, Pantnagar, Uttarakhand, India</i></p>	
KN 03(S5)	<p><b>Disease dynamics and soil health under conservation agriculture: challenges, experience and future strategy</b>  <b>Prof. Apurba Kumar Chowdhury</b>, <i>Uttar Banga Krishi Viswavidyalaya, Coochbehar, West Bengal, India</i></p>	
	<b>INVITED LECTURES</b>	
IL 01(S5)	<p><b>Molecular epidemiology of viral disease complex of <i>Capsicum chinense</i> Jacq. in North Eastern Region of India</b>  <b>Dr. Palash Deb Nath</b>, <i>Assam Agricultural University, Jorhat, Assam, India</i></p>	
IL 02(S5)	<p><b>Mango diseases: Influence of climate change and integrated management</b>  <b>Dr. Arvind Saxena</b>, <i>ICAR-Indian Institute of Horticultural, Bengaluru, Karnataka, India</i></p>	
	<b>ORAL PRESENTATIONS</b>	

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OP 01(S5)	<b>Management of stem rot of groundnut through biocontrol agents and chemical fungicides</b> Dr. Deepa Khulbe, <i>Regional Research and Technology Transfer Station (Coastal Zone), Odisha University of Agriculture and Technology, Bhubaneswar, Odisha, India</i>	
OP 02(S5)	<b>Evaluation of fungitoxicants against powdery mildew of ber</b> Dr. Amaresh Y.S., <i>University of Agricultural Sciences, Raichur, Karnataka, India</i>	
OP 03(S5)	<b>Global warming vis-a-vis biotic and abiotic stresses in cotton crop in Indian Punjab</b> Dr. Rupesh Kumar Arora, <i>Regional Research Station (PAU, Ludhiana), Bathinda, Punjab, India</i>	
OP 04(S5)	<b>Integrated management of root-rot (<i>Fusarium solani</i>) and root borer (<i>Emmalocera Depressella</i>) in bael (<i>Aegle marmelos</i> L.)</b> Dr. Manoj Kumar Buswal, <i>CCSHAU, Regional Research Station, Bawal, Rewari, Haryana, India</i>	
OP 05(S5)	<b>Bell pepper disease segmentation using Deep Convolutional Neural Network (DCNN)</b> Dr. Thenmozhi M., <i>SRM Institute of Science &amp; Technology, Chennai, Tamil Nadu, India</i>	
OP 06(S5)	<b>Effect of soybean yellow mottle mosaic virus on yield and seed quality parameters of soybean</b> Dr. Nagamani Sandra, <i>ICAR-Indian Agricultural Research Institute, New Delhi, India</i>	
OP 07(S5)	<b>Diversity and phylogeography of fungal pathogens associated Avocado in South India</b> Dr. Venkataravanappa V., <i>ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, India</i>	
OP 08(S5)	<b>Epidemiology of bacterial blight of cluster bean caused by <i>Xanthomonas axonopodis</i> during kharif 2021</b> Dr. Manjeet Singh, <i>CCS Haryana Agricultural University, Hisar, Haryana, India</i>	
OP 09(S5)	<b>Screening of matromorphic progenies and their parental lines for powdery mildew and rust in Garden Pea (<i>Pisum sativum</i> L.)</b> Dr. Anil Bhushan, <i>Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu, Jammu and Kashmir, India</i>	
11.00-13.00	<b>Technical Session 7: Industry, academia and farmers' interface</b>  Chair: Dr. D.J. Bagyaraj, <i>CNBRCD, Bengaluru, Karnataka, India</i> Co-Chair: Dr. Krishna Kant Mishra, <i>ICAR-VPKAS, Almora, Uttarakhand, India</i> Rapporteurs: Dr. Rajashekara H., <i>DCR on Cashew, Puttur, Karnataka, India</i> Dr. Mahadevakumar S., <i>BSI, Port Blair, South Andaman, India</i>	<b>Hall 2</b>
	<b>KEYNOTE LECTURE</b>	
KN 01(S7)	<b>Edible Mushroom: Key to Nutritional food for Human health care and Entrepreneurship development</b> Prof. B.N. Chakraborty, <i>Aliah University, Kolkata, West Bengal, India</i>	
	<b>INVITED LECTURES</b>	
IL 01(S7)	<b>Beauvericin, a magical secondary metabolite from <i>Fusarium</i> and its applications</b> Dr. Sanjay K. Singh, <i>Agharkar Research Institute, Pune, Maharashtra, India</i>	
IL 02(S7)	<b>Guggal gummosis: Red alert for the survival of guggal plant</b> Dr. Kalubhai Rakholiya, <i>N.M. College of Agriculture, Navsari Agricultural University Navsari, Gujarat, India</i>	
IL 03(S7)	<b>Medicinal mushrooms: A potential source of nutraceuticals</b> Dr. Krishna Kant Mishra, <i>ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, Uttarakhand, India</i>	
IL 04(S7)	<b>Prospects of entomopathogenic nematodes in India and their application in raising the socioeconomic status of marginal farmers</b> Dr. A.K. Chaubey, <i>Chaudhary Charan Singh University, Meerut, Uttar Pradesh, India</i>	

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	<b>ORAL PRESENTATIONS</b>	
OP 01(S7)	<b>Multifaceted and dual-edged native <i>Trichoderma</i> for the management of <i>Fusarium</i> wilt disease in Subabul - a sustainable approach</b> Dr. Balanagouda Patil, <i>ITC - Life Sciences and Technology Centre, Peenya, Bengaluru, Karnataka, India</i>	
OP 02(S7)	<b>Potential of local <i>Trichoderma asperellum</i> in minimizing the corynespora leaf spot disease and enhancing the biomass of Kalmegh (<i>Andrographis paniculata</i> Nees.)</b> Dr. Dinesh Rai, <i>Dr. Rajendra Prasad Central Agricultural University, Samastipur, Bihar, India</i>	
9.30-13.00	<b>M.J. Narasimhan Award Contest</b>  <b>Chair:</b> Dr. K.B. Rakholiya, <i>Navsari Agricultural University, Navsari, Gujarat, India</i> <b>Co-Chair:</b> Prof. Satish S., <i>University of Mysore, Mysuru, Karnataka, India</i> Dr. Sessa Kiran Kollipara, <i>Dr.Y.S.R. Horticultural University, Andhra Pradesh, India</i> <b>Rapporteurs:</b> Dr. Sanjeev Kumar, <i>JNKVV, Jabalpur, Madhya Pradesh, India</i> Dr. Vikram M. Gholve, <i>VNMKV, Parbhani, Maharashtra, India</i>	<b>Hall 3</b>
	<b>APS-IPS Travel Grant Contest</b>  <b>Chair:</b> Dr. Sanjay K. Singh, <i>Agharkar Research Institute, Pune, Maharashtra, India</i> <b>Co-Chair:</b> Dr. Mehraj UI Din Shah, <i>SKUAST-K, Srinagar, Jammu &amp; Kashmir, India</i> Dr. Madhusudan K N , <i>CSRTI, Mysuru, Karnataka, India</i> <b>Rapporteurs:</b> Dr. Vikas V.K., <i>ICAR-IARI, RS, Wellington, Tamil Nadu, India</i> Dr. Deepa James, <i>Krishi Vigyan Kendra, Thrissur, Kerala, India</i>	
<b>13.00-14.00</b>	<b>Lunch</b>	
14.00-15.30	<b>Annual General Body Meeting of the Society</b>	<b>Hall 1</b>
15.30-17.00	<b>Valedictory Session</b>	
<b>20.00-21.00</b>	<b>Dinner</b>	

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OP 02(S2)	<b>Management of dry root rot (<i>Rhizoctonia bataticola</i> (taub). Butler) of chickpea using endophytes</b> Dr. Venkatesh Kulkarni, <i>University of Agricultural Sciences, Dharwad, Karnataka, India</i>	
OP 03(S2)	<b>Bioactivity of fungal endophytes and their secondary metabolites against pathogens causing anthracnose and bacterial leaf spot diseases in grapes</b> Dr. Somnath Holkar, <i>ICAR-National Research Centre for Grapes, Pune, Maharashtra, India</i>	
OP 04(S2)	<b>Antifungal activity of potential epiphytic yeasts against banana anthracnose caused by <i>Colletotrichum musae</i></b> Dr. Amrita Das, <i>ICAR-Indian Agricultural Research Institute, New Delhi, India</i>	
OP 05(S2)	<b>Interplay of biotic and abiotic factors shaping pigeonpea root microbiome</b> Ms. Danteswari Chalasani, <i>University of Hyderabad, Hyderabad, Telangana, India</i>	
OP 06(S2)	<b>Plant growth promoting attributes of endophytic bacterial strains inhabiting Eggplant (<i>Solanum melongena</i> L.) and their antagonistic potential against important soil borne plant pathogenic fungi</b> Mr. Santhosh C.R., <i>University of Mysore, Mysore, Karnataka, India</i>	
15.30-15.45	<b>Tea Break</b>	
15.30-17.00	<b>Poster Presentation Session (Session 1, 2, 3)</b>	
17.00-18.00	<b>Panel Discussion Session:</b> GM Crops, Food Security and Plant Pathology <b>Chair:</b> Prof. S.S. Chahal, <i>Punjab University, Chandigarh, Punjab, India</i> <b>Co-Chair:</b> Dr. R.M. Gade, <i>Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, MS, India</i>  <b>Panellists:</b> Dr. M. Krishna Reddy, <i>ICAR-IIHR, Bengaluru, Karnataka</i> Dr. Surinder Sandhu, <i>Punjab Agricultural University, Ludhiana, Punjab</i> Dr. Pankaj Sharma, <i>ICAR- Directorate of Rapeseed-Mustard Research Bharatpur, Rajasthan</i> Dr. Kalyan K. Mondal, <i>ICAR-IARI, New Delhi</i>  <b>Rapporteurs:</b> Dr. Dharmendra Kumar, <i>BUAT, Banda, Uttar Pradesh, India</i> Dr. Bishnu Maya Bashyal, <i>ICAR-IARI, New Delhi, India</i>	<b>Hall 2</b>
	<b>KEYNOTE LECTURE</b>	
KN 01	<b>At crossroad of introducing GM crops for food security and pest management in agriculture</b> Prof. S.S. Chahal, <i>Former Vice Chancellor, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India</i>	
20.00-21.00	<b>Dinner</b>	

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<b>Day 02 (Friday, February 03, 2023)</b>		
09.30-09.50	<p><b>S.N. Dasgupta Memorial Award Lecture</b>  <b>Dr. T. Makesh Kumar</b>, ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala, India  <b>Title:</b> Strategies to maintain the health of tropical tuber crops against viral diseases</p>	<b>Hall 1</b>
09.50-10.10	<p><b>Sharda Lele Memorial Award Lecture</b>  <b>Dr. R.M. Gade</b>, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, MS, India  <b>Title:</b> Phytophthora diseases: A major threat to citrus industry</p>	
10.10-10.30	<p><b>J.P. Verma Memorial Award Lecture</b>  <b>Dr. T.S.S.K. Patro</b>, Acharya N.G. Ranga Agricultural University, Agricultural Research Station Vizianagaram, Andhra Pradesh, India  <b>Title:</b> Exploiting the potential of Miracle grains on eve of international year of Millets by ecofriendly management of banded leaf and sheath blight</p> <p><b>Chair:</b> Dr. Ashok Bhattacharyya, Assam Agricultural University, Jorhat, Assam, India  <b>Co-Chair:</b> Prof. Shamarao Jahagirdar, UAS, Dharwad, Karnataka, India  Dr. Palash Deb Nath, Assam Agric.University, Jorhat, Assam, India  <b>Rapporteurs:</b> Dr. Jitender Singh, CCS University, Meerut, Uttar Pradesh  Dr. Sajad Un Nabi, ICAR-CITH, Srinagar, Jammu and Kashmir</p>	
<b>10.30-11.00</b>	<b>Tea Break</b>	
11.00-13.00	<p><b>Technical Session 1B:</b> Diagnostics: Issues and innovations</p> <p><b>Chair:</b> Dr. S.C. Dubey, Indian Council of Agricultural Research, New Delhi  <b>Co-Chair:</b> Dr. V. Celia Chalam, ICAR-NBPGR, New Delhi, India  Dr. Udayashankar, A.C., University of Mysore, Mysuru, Karnataka, India</p> <p><b>Rapporteurs:</b> Dr. Balanagouda Patil, ITC-Life Sciences &amp; Tech. Centre, Bengaluru, Karnataka, India  Dr. Somnath S. Pokhare, ICAR-NRC on Pomegranate, Solapur, MS, India</p>	<b>Hall 1</b>
	<b>KEYNOTE LECTURES</b>	
<b>KN 01(S1B)</b>	<p><b>Plant virus detection, innovations, and issues</b>  <b>Dr. Selvarajan R.</b>, ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu, India</p>	
<b>KN 02(S1B)</b>	<p><b>Concern of aflatoxin in food grain contamination and identification of resistance sources for aflatoxigenic (AFB1) <i>Aspergillus flavus</i> in Indian maize inbred lines</b>  <b>Dr. Robin Gogoi</b>, ICAR-Indian Agricultural Research Institute, New Delhi</p>	
<b>KN 03(S1B)</b>	<p><b>Transboundary movement of plant pathogens: A global crop biosecurity threat</b>  <b>Dr. V. Celia Chalam</b>, ICAR-National Bureau of Plant Genetic Resources, New Delhi, India</p>	
	<b>INVITED LECTURES</b>	
<b>IL 01(S1B)</b>	<p><b><i>Ceratocystis fimbriata</i> in pomegranate can be manageable? Present status and future prospective</b>  <b>Prof. Devappa Venkatappa</b>, College of Horticulture, Bengaluru, Karnataka, India</p>	

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IL 02(S1B)	<b>Epidemiology and molecular characterization of yellow vein mosaic disease of Pumpkin</b> Dr. Anjaneya Reddy B., <i>Regional Horticultural Research and Extension Centre, Bengaluru, Karnataka, India</i>	
IL 03(S1B)	<b>Pathological investigation and morpho-molecular characterization of <i>Lasiodiplodia theobromae</i> associated with leaf spot and blight disease of <i>Coscinium fenestratum</i> (Gaertn.) Colebr. – First global record from India</b> Dr. Shambhu Kumar, <i>KSCSTE–Kerala Forest Research Institute, Peechi, Thrissur, Kerala, India</i>	
	<b>ORAL PRESENTATIONS</b>	
OP 01(S1B)	<b>Diversity, phylogeny and current diagnostics of invasive and emerging Phytophthora species in fruit crops with special reference to citrus</b> Dr. A.K. Das, <i>ICAR-Central Citrus Research Institute, Nagpur, Maharashtra,</i>	
OP 02(S1B)	<b>Identification, Pathogenicity and phylogeny of new reports of fungal pathogens associated with foliar and soil-borne diseases of mulberry (<i>Morus</i> spp.) in India</b> Dr. Arunakumar G.S., <i>Central Sericultural Research and Training Institute, Mysuru, Karnataka, India</i>	
OP 03(S1B)	<b>Multigene Phylogenetics and Morphology Reveal <i>Neoscytalidium dimidiatum</i> association with Stem canker of Dragon fruit (<i>Hylocereus</i> spp) in India</b> Dr. Vanita Salunkhe, <i>ICAR-National Institute of Abiotic Stress Management, Pune, Maharashtra, India</i>	
OP 04(S1B)	<b>Report of Cashew leaf blight disease (CLB) caused by <i>Neopestalotiopsis clavispora</i> from India</b> Dr. Rajashekara H., <i>ICAR-Directorate of Cashew Research, Puttur, Karnataka, India</i>	
OP 05(S1B)	<b>Diagnosis of emerging new fungal pathogens in important flower crops through multi locus molecular phylogeny</b> Dr. Mahadevakumar S., <i>Botanical Survey of India, Andaman and Nicobar Regional Centre, Haddo, Port Blair, South Andaman, ANI</i>	
OP 06(S1B)	<b>First report of <i>Colletotrichum kahawae</i> subsp. <i>ciggaro</i> causing leaf spot disease on arecanut, <i>Areca catechu</i> L. in India</b> Dr. Thava Prakasa Pandian R., <i>ICAR-CPCRI, Regional Station, Vittal, Karnataka, India</i>	
OP 07(S1B)	<b>New convenient disease rating scale for the resistant screening against Begomoviruses causing yellow mosaic disease in different crops</b> Mr. Harshalkumar Patel, <i>Navsari Agricultural University, Navsari, Gujarat, India</i>	
11.00-15.30	<b>Technical Session 3: Eco-friendly plant and soil health management towards natural farming</b>  <b>Chair:</b> Prof. B.N. Chakraborty, <i>Aliah University, Kolkata, West Bengal, India</i> <b>Co-Chair:</b> Dr. P. Nallathambi, <i>ICAR-IARI, RS, Wellington, Tamil Nadu, India</i> Dr. Sudisha Jogaiah, <i>Central University of Kerala, Kasaragod, Kerala, India</i> <b>Rapporteurs:</b> Dr. Pramod Kumar Gupta, <i>JNKVV, Jabalpur, Maharashtra,</i> Dr. Somnath Holkar, <i>ICAR-NRC for Grapes, Pune, MS, India</i>	<b>Hall 2</b>
	<b>KEYNOTE LECTURES</b>	
KN 01(S3)	<b>Arbuscular mycorrhizal fungi for biocontrol of soil-borne plant pathogens</b> Prof. D.J. Bagyaraj, <i>Center for Natural Biological Resources and Community Development, Bangalore, Karnataka, India</i>	

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KN 02(S3)	<b>Manipulation of soil microbiome for the soil borne disease management in natural farming</b> Prof. Pratibha Sharma, <i>SKN Agriculture University, Jobner, Jaipur, Rajasthan</i>	
KN 03(S3)	<b>Ecofriendly management of bacterial wilt of solanaceous crops</b> Dr. Dinesh Singh, <i>ICAR-Indian Agricultural Research Institute, New Delhi</i>	
	<b>INVITED LECTURES</b>	
IL 01(S3)	<b>Endophytes and green nanoparticles in management of soybean diseases and their productivity enhancement in India</b> Prof. Jahagirdar Shamarao, <i>University of Agricultural Sciences, Dharwad Karnataka, India</i>	
IL 02(S3)	<b>Integrated plant and soil health management strategies against maize diseases</b> Dr. Sharanappa Harlapur, <i>ICAR-AICRP on Maize, University of Agricultural Sciences, Dharwad, Karnataka, India</i>	
IL 03(S3)	<b>Current status on wheat diseases and role of hot spot location (Wellington) in sustainable management through host resistance</b> Dr. Nallathambi P., <i>ICAR-Indian Agricultural Research Institute, Regional Station, Wellington (The Nilgiris), Tamil Nadu, India</i>	
IL 04(S3)	<b>Endophytic bacteria: biocontrol agents for plant pathogens</b> Dr. Kushal Raj, <i>CCS Haryana Agricultural University, Hisar, Haryana, India</i>	
IL 05(S3)	<b>Nematode-trapping fungi: Genomics, soil adoptability and their nematophagous and mycoparasitic biocontrol potential against plant pathogens</b> Dr. Dharmendra Kumar, <i>Banda University of Agriculture and Technology, Banda, Uttar Pradesh, India</i>	
IL 06(S3)	<b>Harnessing beneficial bioinoculants for building sustainable soil and plant health natural farming</b> Dr. V.R. Prabavathy, <i>M.S. Swaminathan Research Foundation, Chennai, Tamil Nadu, India</i>	
IL 07(S3)	<b>Harnessing on farm waste in managing soil borne plant pathogens in hot arid region</b> Dr. Ritu Mawar, <i>ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan, India</i>	
	<b>ORAL PRESENTATIONS</b>	
OP 01(S3)	<b>Management of Sclerotinia stem rot in Oilseed Brassica: Progress and future prospects</b> Dr. Pankaj Sharma, <i>ICAR-Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan, India</i>	
OP 02(S3)	<b>Virulence analysis of <i>Blumeria graminis</i> causing powdery mildew of oats in Himachal Pradesh and identification of resistance</b> Dr. Devinder Banyal, <i>CSK Himachal Pradesh Agriculture University, Palampur, Himachal Pradesh, India</i>	
OP 03(S3)	<b>Selection of potential entomopathogenic fungal strains to control <i>Bemisia tabaci</i> in upland cotton</b> Dr. Satish Kumar Sain, <i>ICAR-Central Institute for Cotton Research, Regional Station, Sirsa, Haryana, India</i>	
OP 04(S3)	<b>Development of talc based formulation of DALHANDERMA (IIPRTh-31) and DALHANDERMA-1 (IIPRTh-33) and their Multi-location evaluation for wilt disease management and plant growth promotion ability in major pulse crops</b> Dr. Raj Mishra, <i>ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh, India</i>	

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OP 05(S3)	<b>Resistance in maize to foliar blights - Present status and prospects in Punjab state</b> Dr. Harleen Kaur, <i>Punjab Agricultural University, Ludhiana, Punjab, India</i>	
OP 06(S3)	<b>Investigations on the potential of plant beneficial rhizobacteria for soil P solubilization and enhanced yield and quality in turmeric (<i>Curcuma longa</i> L.)</b> Dr. Praveena Ravindran, <i>ICAR-Indian Institute of Spices Research, Kozhikode, Kerala, India</i>	
OP 07(S3)	<b>Diversity of Target leaf spot disease incited by <i>Corynespora cassiicola</i>, an emerging threat to Cotton production in India</b> Dr. Shailesh Gawande, <i>ICAR-Central Institute for Cotton Research, Nagpur, Maharashtra, India</i>	
OP 08(S3)	<b>Studies on wheat powdery mildew (<i>Blumeria graminis</i> f. sp. <i>tritici</i>) in the North-Western Himalayan region of India</b> Dr. Santosh Watpade, <i>ICAR-Indian Agricultural Research Institute, Regional Station, Shimla, Himachal Pradesh, India</i>	
OP 09(S3)	<b>Molecular aspects of pathogens associated with major diseases on Aloe vera and management strategies</b> Dr. Ram Prasanna Meena, <i>ICAR- Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat, India</i>	
OP 10(S3)	<b>Microbial surfactants for plant disease management</b> Dr. Hameeda Bee, <i>University College of Science, Osmania University, Hyderabad, Telangana, India</i>	
OP 11(S3)	<b>Integrated disease management of important diseases of soybean crop and their impact on yield attributes under field condition</b> Dr. Deepak Singh, <i>Krishi Vigyan Kendra, Bhopal Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh, India</i>	
OP 12(S3)	<b>Microbe mediated regenerative farming to insure plant and soil health and nutrient dense food production</b> Dr. Harsh Vardhan Singh, <i>ICAR-National Bureau of Agriculturally Important Microorganisms Mau, Uttar Pradesh, India</i>	
OP 13(S3)	<b>Managing bacterial blight of pomegranate - the natural way</b> Dr. Somnath Suresh Pokhare, <i>ICAR-National Research Centre on Pomegranate, Solapur, Maharashtra, India</i>	
OP 14(S3)	<b>Biofumigation: a biorational technique to manage soil-borne plant pathogen <i>Sclerotium rolfsii</i> Sacc.</b> Dr. Bholanath Mondal, <i>Palli-Siksha Bhavana (Institute of Agriculture), Sriniketan, West Bengal, India</i>	
OP 15(S3)	<b>Trichoderma sp.: As a wonder bio-pesticide</b> Dr. Shaily Javeria, <i>ICAR-Indian Agricultural Research Institute, New Delhi, India</i>	
OP 16(S3)	<b>Elicitation of defense response by transglycosylated chitooligosaccharides in rice seedlings</b> Mr. Sarma P.V.S.R.N., <i>University of Hyderabad, Hyderabad, Telangana, India</i>	
<b>13.00-14.00</b>	<b>Lunch</b>	
14.00-17.00	<b>Technical Session 4:</b> Multidisciplinary interventions for plant disease management  <b>Chair:</b> Dr. Jyotsana Sharma, <i>ICAR-NRC on Pomegranate, Solapur, MS, India</i> <b>Co-Chair:</b> Dr. Raghavendra M.P., <i>Govt. Maharani's Science College for Womens, Karnataka, India</i>	<b>Hall 1</b>



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## Presidential Lecture

### Green Strategies and Innovations for Plant and Soil Health Management

**Rakesh Pandey**

*Crop Protection and Production Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow - 226015, Uttar Pradesh, India*

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Indian agriculture is facing and will continue to face massive challenges towards improving food and nutraceutical security due to human population explosion, massive urbanization, shrinking agriculture land, soil degradation, loss of soil fertility and depletion of water resources. During this era of global warming, huge crop losses caused by variety of plant pest and pathogens, plant pathology as a science has more than ever challenges to develop green strategies to improve soil and plant health. Expanding and improving plant pathological research in India is critical to address the issue of food and nutrition security. Nowadays Indian farmers are more inclined to cultivate a variety of agricultural crops including medicinal and aromatic crops for the generation of income and to develop agri based entrepreneurship. Development of healthier and disease-free plants and planting materials becomes a major challenge for plant pathology researchers and in this utmost need of the hour plant pathology researchers are engaged in developing new green technologies and disease resistant plant varieties for sustainable agriculture. The major biomass of soil is composed of various microorganisms and it is estimated that 50 million bacterial cells are present in a gram of soil and are considered as the building blocks of the soil ecosystem. During experimentation, it has been observed that agriculture is always benefitted from the synergistic soil microbial wealth and for sustainable agriculture, microbial consortia play a potential role. Apparently, the beneficial impact of soil microbial wealth (SMW) on soil and plant health offers an opportunity to improve the sustainable approach to protect the plant and their useful products. Exploiting the combination of synergistic microbial wealth in the form of consortia possesses intensive cross talk with the plant in different ways like induction of plant resistance, enhanced production of secondary metabolites, better supply of and access to the micro and macro nutrients through degradation of numerous organic wastes, increased plant biodiversity and alternation of plant hormones and metabolism. Plant–microbe interactions are the major driving force which regulate and maintain fertility of the soil by various mechanisms like solubilization of phosphate and zinc, production of antibiotics, anti-biofilm, quorum sensing etc. In this context, soil microbial wealth has been widely exploited in maintaining the plant health and their active secondary metabolites, used in the agricultural crops as a potential replacement for toxic chemical fertilizers and pesticides. Also, the focus is currently shifting due to the recognition that a significant number of phototherapeutic compounds are actually produced during interaction between microbes and plants. Assuredly the introduction of soil microbial wealth in rhizosphere by creating “tiny revolutionizers” can be an excellent promoter for improving soil and plant health in natural conditions as well as sustainable agriculture. Such important questions require an in-depth answer, which I have tried to summarize through this lecture.

## Plenary Lecture

### Comparative genomics resolves historic puzzles in plant pathology

Krishna V. Subbarao

Distinguished Professor, Department of Plant Pathology, University of California, Davis, CA, USA

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Unprecedented advances in high throughput sequencing and computational tools have made it possible to sequence and analyze whole genomes of a plethora of organisms including plant pathogens. The dawn of this genomics era has enabled the examination of genome structure and organization at a detail unconceivable even a decade ago. *Verticillium dahliae* is a broad host-range pathogen that causes vascular wilts in over 200 plant species. Specific *V. dahliae* strains in addition to causing wilt, also cause defoliation on three hosts, and these strains have been classified as defoliating (D) and others as nondefoliating (ND). The underlying mechanisms of defoliation have remained unresolved ever since the phenomenon was discovered nearly 70 years ago. Comparisons of the genomes of D and ND strains revealed the presence of a D-specific genomic region (G-LSR2). Population genomics revealed that G-LSR2 was acquired from *Fusarium oxysporum* f. sp. *vasinfectum* through horizontal gene transfer. Deletion of seven genes within G-LSR2, designated as VdDfs, and virulence assays, produced the nondefoliation phenotype on cotton, olive, and okra with only two genes within G-LSR2, and complementation of these two genes restored the defoliation phenotype. These two genes, VdDf5 and VdDf6, shared homology with polyketide synthases involved in the biosynthesis of N-acylethanolamine (NAE) 12:0, whereas VdDf7 shared homology with an enzyme that synthesizes even more NAE 12:0. NAE 12:0 induces the overexpression of fatty acid amide hydrolase in cotton that causes defoliation either by altering abscisic acid sensitivity, hormone disruption, or sensitivity to the pathogen. The phenomenon that had challenged generations of *Verticillium* researchers for nearly 70 years was resolved by comparative genomics.

## Award Lectures

### **S.N. Dasgupta Memorial Award**

#### **AL 01: Strategies to maintain the health of tropical tuber crops against viral diseases**

**T. Makesh Kumar\***

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Tropical tuber crops are the most useful food crops after cereals, provide food to over 500 million people living in rural tropics and subtropics. They include cassava, sweet potato, yams, edible aroids etc. The storage root provide more dietary energy per hectare and less working hours than any other staple crops, making it the mainstay of small holders in tropics with limited access to agricultural inputs. These crops are widely grown in several states of India. Distribution of these crops varies among the states and they were grown for food, feed and industrial use. These crops are able to produce acceptable yields even on very marginal soils and in drought conditions, but susceptible to a number of pathogens which results in high yield loss. Among them the diseases caused by viruses are most important, as they are carried through infected planting material (setts / tubers) from one season to next season leading to substantial loss in yield and quality. They belong to different virus groups viz., *Potyvirus*, *Begomovirus*, *Carlavirus*, *Badnavirus* etc. Primary spread of these causal agents is through infected propagating material and secondary spread through vectors like whitefly, aphids. In cassava, so far twenty nine different viruses have been reported around the world; however, in India only two viruses viz., *Indian cassava mosaic begomovirus* (ICMV), *SriLankan cassava mosaic begomovirus* (SLCMV) are prevalent. About 20 different viruses are known to infect sweet potato world over, however only sweet potato feathery mottle caused by *Sweet potato feathery mottle virus* (SPFMV) and leaf curl disease caused by *Sweet potato leaf curl virus* (SPLCV) are prevalent in India at present. The yam mosaic is also commonly present in many of the yam growing areas and occurrence of *Yam mosaic virus* (YMV), *Yam mild mosaic virus* (YMMV), *yam chlorotic necrosis virus* (YCNV), *Cucumber mosaic virus* (CMV) and *Dioscorea alata bacilliform virus* (DaBV) were confirmed in India. The virus infecting elephant foot yam and taro has been identified as *Dasheen mosaic virus* (DsMV) based on next generation sequencing. Different diagnostic techniques like ELISA, DIBA, PCR / RT-PCR, qPCR, LAMP were standardized for detection of ICMV / SLCMV from cassava plants. Polyclonal antiserum against SLCMV, SPFMV and DsMV has been produced by expressing the coat protein gene of the virus in bacterial expression vector and validated. Lateral flow device for detecting DsMV in elephant foot yam also succeeded. The continuous research efforts at ICAR-CTCRI depicted the diversity of virus in tropical tuber crops at genomic level and variation in symptom expression. In order to mitigate these virus disease problems, several strategies were developed which include, development of resistant varieties, *in vitro* tissue culture techniques (meristem/shoot tip/nodal culture combined with thermo or chemotherapy) for virus elimination and transgenic approach.

## Sharda Lele Memorial Award

### AL 02: Phytophthora diseases: A major threat to citrus industry

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Citrus occupies an important place in the horticultural wealth and economy of India as the third largest fruit industry after mango and banana. Amongst all fungal diseases of citrus, *Phytophthora* spp. are the causal agents of several serious diseases of citrus in India. Foot rot, root rot, Collar rot, crown rot, gummosis, die back caused by *Phytophthora* spp. in citrus from nursery stage to matured orchards in India. Citrus face short life span and low productivity because of these three species of *Phytophthora* viz. *P. parasitica*, *P. citrophthora* and *P. palmivora*. In central India the major cause of citrus decline is supposed to be because of *Phytophthora* causing diseases in citrus. The pathogen attack citrus plants right from nursery causing damping off of seedlings, decay of fibrous roots, crown rot, collar rot, foot rot and gummosis in mature orchards. An intensive rapid roving survey of selected mandarin orchards was conducted during the year 2016 and 2017 to access incidence and intensity of *Phytophthora* diseases (root rot and gummosis). According to rapid roving survey of root rot in selected orchards, pooled data indicate similar disease progress with root rot incidence in the range of 10.42 to 62.50% and intensity from 1.62 up to 23.48%. In case of gummosis pooled data indicate similar trend of disease development with gummosis incidence in the range of 14.58 to 64.58% and intensity in between 2.08 to 19.91%. The several effective chemical management practices are available for management of these epidemic diseases but in view of organic farming and sustainable agriculture several potential bio-agents and botanicals have been investigated for management of *Phytophthora* diseases. Soil solarization of nursery beds was found very beneficial to avoid nursery stage losses and further spread of pathogen. The bio-agents like *Trichoderma* spp., *Pseudomonas fluorescens* and *Bacillus subtilis* were investigated and found effective for management of pathogen under field condition. Integrated disease management modules for long term strategy need to be adopted. The epidemiological studies of *Phytophthora* diseases in citrus field are beneficial to view dispersal pattern of *Phytophthora* spp. from disease foci and importance of inoculum sources. This may be the first attempt to correlate environmental parameters and soil ecology impacting disease situation in Nagpur mandarin due to *Phytophthora*. Fixed plot survey was undertaken at fortnightly intervals at six locations to analyze correlation between environmental factors and soil moisture with propagule density of *Phytophthora* as well as disease severity by using linear correlation. Rainfall, relative humidity and air temperature probes typically consist of three separate sensors packaged in a single instrument called as 'SENSTUBE' and that instrument was used for recording the data in field. Root rot in Nagpur mandarin gradually increased after heavy rainfall and progressed with faster rate when soil moisture with high humidity and low temperature and vice versa. *Phytophthora* population and disease progression was directly proportional to environmental and soil parameters like rainfall, relative humidity, soil moisture, but inversely proportional to air temperature. This study will be helpful to the citrus growers to predict the timing of disease severity to take appropriate management practices in time. To reduce the use of chemicals at certain level a compatibility study of fungicides commonly use for management of the disease with fungal and bacterial biocontrol agents were studied and recorded excellent results. Macroscopic modeling approaches based on the solution of the Richards equation with root water uptake (RWU) as a sink term can help in understanding soil-water-plant interactions within the rhizosphere. Results indicate that calibration targets to validate uptake reduction functions should be chosen cautiously based on the dominant stress experienced by the plant root system. Considering various plant, soil and environmental factors, the Citrus Gummosis prediction model has been developed with the multi-source data sets from June 2014 to November 2016 using Support vector regression (SVR) and multilinear regression (MLR). The research is carried out for healthy (5–10 Yrs. and 11–15 Yrs.) and unhealthy (5–10 Yrs. and 11–15Yrs.) age group of

plants. Both the weather and soils based disease prediction models has been developed and validated with MLR and SVR. Further, the influence of Gummosis disease on plant parameters was also studies with the new contribution of Biophysical variables (LAI and Cab) based statistical prediction model. The SVR model gave fairly good performance as compared to MLR. In addition to these parate models a the combined scenario approach (Integrated Gummosis Disease Forecast Model: IGDFM) is designed to understand the interconnectivity of the parametric conditions (weather-soil- plant parameters) with disease physiology with respect to different age group of the plants. The RMSE of proposed approach for higher age group plants (i.e. 11–15 years) in the combined scenario was 0.9061 and 0.8518 for SVR and MLR methods, respectively. It is envisaged that this study could enable farmers to recognize and predict the timing and severity of the Gummosis disease in Citrus and thereby achieve yield improvement.

### **J.P. Verma Memorial Award**

#### **AL 03: Exploiting the potential of Miracle grains on eve of international year of Millets by ecofriendly management of banded leaf and sheath blight**

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Most of millet crops are native of India and are popularly known as Nutri-cereals as they provide most of the nutrients required for normal functioning of human body. They are the oldest food crops known to humans and possibly the first cereal grains to be used for domestic purpose. Millets are termed as “yesterday’s coarse grains and today’s nutri-cereals.” Millets are considered to be “future crops” as they are resistant to most of the pests and diseases and adapt well to the harsh environment of the arid and semi-arid regions of Asia and Africa. It is adapted to wide range of temperatures, moisture-regimes and input conditions supplying food and feed to millions of dry land farmers. Millets have nutraceutical properties in the form of antioxidants which prevent deterioration of human health such as lowering blood pressure, protects from diabetes, improves digestive system, lowers the risk of cancer, detoxifies the body, increases immunity in respiratory health, increases energy levels and improves muscular and neural systems and are protective against several degenerative diseases such as metabolic syndrome and Parkinson’s disease. Millets production was mostly hampered by both biotic and abiotic factors. Banded leaf and sheath blight incited by *Rhizoctonia solani* (Kuhn.) is one of the emerging malady in successful cultivation of millets. The pathogen has wide host range, most wide spread, destructive and versatile found in most parts of the world and infecting host plants. The disease is characterized by oval to irregular light gray to dark brown lesions on the lower leaf and leaf sheath enlarge rapidly and coalesce to cover large portions of the sheath and leaf lamina. Later a series of copper or brown color bands across the leaves giving a very characteristic banded appearance. Field experiments during *kharif*, 2021-2022 revealed that The disease severity and yield parameters (grain yield and straw yield) were evaluated against banded blight using potential biocontrol agents *viz.*, *Trichoderma asperellum* *Bacillus subtilis*, *Pseudomonas fluorescens*, an organic amendment (Neem cake), natural polymer Chitosan and fungicides Trifloxystrobin + Tebuconazole (0.05%) were tested. Among all the treatments, foliar spray of Trifloxystrobin + Tebuconazole (0.05%) showed maximum reduction in disease intensity (19.33%) with higher grain and fodder yield over control.

### **S.P. Raychaudhuri Memorial Award**

#### **AL 04: Direct seeded rice - impact on rice diseases and their management**

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## J.F. Dastur Memorial Award

### AL 05: Topographical dispersal of rapeseed-mustard diseases under changing climate in India

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In the galaxy of plant biodiversity at a global level, rapeseed-mustard share a significant role as edible oil crop of rich nutrients source. In India, about 80% of total rapeseed-mustard cultivation is under *B. juncea* mainly in Rajasthan, MP, Gujarat, UP, Haryana, and West Bengal states of the country. Among other *Brassica* species, *B. rapa* ssp. Brown Sarson is grown under upper Himalayan temperate regions in Srinagar while, *B. napus* is under cultivation in Jammu, Himachal Pradesh, and Punjab states. Although, *B. rapa* ssp. Toria is mainly grown in foothills regions of Himalayas particularly in Uttarakhand, Eastern Uttar Pradesh, Bihar, Eastern parts of the country and Odisha. Other species including *B. rapa* ssp. Yellow Sarson is widely cultivated in West Bengal and Taramira (*Eruca sativa*) is grown in some pockets of Rajasthan and Haryana states. Farmers of rapeseed-mustard are now cultivating the mustard varieties that can be harvested within 120 days, as opposed to the traditional 150 days. Two decades of data analysis has shown that crops are being affected with diverse nature pathogens due to change in the weather conditions and pattern. Among 44 pathogens known to infect crucifers, 16 pathogens causing crucifers diseases are considered as of major consequences based on their geographical distribution, host range, losses caused, and resources spend to manage them. Among biotic stresses, some important diseases cause damage to crop at different stages of plant growth starting from seedling stage (Downy mildew and white rust), leaf development stage (white rust), stem elongation (Alternaria blight), flowering stage (Sclerotinia rot), silique development, and ripening stage (powdery mildew) and others are minor, which occasionally causes considerable damage to the crop. Among minor diseases, stem blight disease caused by *Nigrospora oryzae* (Berk. & Broome) Petch, and wilt disease caused by *Fusarium equiseti* (Corda) Sacc., have been reported for the first time from rapeseed-mustard growing regions of India. While, root rot caused by *Erwinia carotovora* pv. *carotovora*, and *Sclerotium rolfsii* are the emerging threats for rapeseed-mustard production system, recently reported from the farmers' field in some pockets of the country. Among four major diseases, Alternaria blight covered 32% share with average 26.6% disease severity on different *Brassica* species over the period mainly in humid areas where rapeseed-mustard is under cultivation. While, powdery mildew holds 30% share among diseases with 25.1% mean severity particularly in Gujarat, Maharashtra, Rajasthan, Haryana, Chhattisgarh states of the country. Whereas, 17.3% white rust mean disease severity occurred with a 21% share on *B. napus* and *B. carinata* crops which are considered as resistant to the disease. Sclerotinia rot disease incidence appeared upto 14.2% and contributed 17% share of all the diseases on oilseed Brassica. Trends of disease occurrence revealed that the highest WR severity (22.1 %) has been observed during 2019-2020 followed by 17.6 % during 2004-2005 crop season which was prevalent on different *Brassica* species in 17 states of the country. Sclerotinia rot has been considered as most damaging disease for rapeseed-mustard crop in India since 1999 which was at peak during 2012, 2013, and 2014, afterward, the disease significantly decreased may be due to climatic effects and technological advances for its management. Though, the disease was considered as major problem since 1999 for rapeseed-mustard crops particularly in Rajasthan, Haryana, Madhya Pradesh, Uttar Pradesh, Bihar and Punjab states of the country. Similar trends were also observed for powdery mildew disease in different parts of the country. Alternaria blight was considered number one threat for the crop earlier but now the data revealed decreasing trend of this disease particularly in Rajasthan, Haryana, Madhya Pradesh states of the country. Alternaria blight disease is not a problem on rapeseed-mustard crop cultivation in western Rajasthan and Gujarat states. Although, AB is a severe problem in Uttarakhand, HP, Bihar, UP, Assam and West Bengal states of the country. Initiation of different diseases varied from locations, and prevalence of



favourable weather conditions. Downy mildew disease appeared at Pantnagar during 20-October to 26 November depending upon favourable weather conditions. Alternaria blight frequently appeared between 15 November to 6 January at Pantnagar, 15 Nov to 21 January at Morena and 15 Nov to 17 Feb at Shillongani, although AB appeared late during second week of January at Kangra and mid-February at Jagdalpur as per availability of suitable environmental conditions. White rust disease appearance has been observed between 15 November to 21 January depending upon the availability of favourable weather conditions suitable for the pathogen development. WR severely occurred at Panatnagr, Morena, and Kangra. Powdery mildew disease appeared early in the first week of January at SK Nagar while late in the third week of January at Pantnagar, Jagdalpur and Morena sometimes upto third week of February favoured by high humidity with higher temperature. Frequent surveillance of crop is needed to observe the initiation of any disease on rapeseed-mustard crop to implement appropriate management strategies timely to avoid heavy economic losses. Amongst the four diseases, maximum white rust severity was observed on *B. juncea* (27.1%) whereas *B. carinata*, *B. napus* and *B. rapa* ssp. Yellow Sarson showed resistance against *Albugo candida*. Different *Brassica* species showed variations in Alternaria blight severity with highest 38.9 per cent on *Eruca sativa* followed by *B. rapa* ssp. Toria (37.3%), *B. rapa* ssp. Yellow Sarson (34.9%), and *B. juncea* (31.1%). Although, lowest AB severity was on *B. carinata* (22.1%) and *B. napus* (26.0%). Powdery mildew is emerging severely on *B. juncea* (43.2%) followed by *B. rapa* ssp. Toria (28.6%). Whereas, Sclerotinia rot was recorded maximum on *B. rapa* ssp. Yellow Sarson (51.2%), *B. rapa* ssp. Toria (50.2%), *Eruca sativa* (49%), *B. napus* (38.5%) and *B. carinata* (33.4%). In India, *Brassica carinata* and *B. napus* crops showed lower attack of pathogens followed by *Eruca sativa*, and *B. rapa* ssp. Toria. *B. juncea* comparatively suffered more with the attack of different pathogens. Maximum SR disease incidence has been observed on *B. rapa* ssp. Yellow Sarson, *B. rapa* ssp. Toria and *Eruca sativa*.

## S. Sinha Memorial Award

### AL 06: A whole genome based reduced representation approach for identification of resistance against *Sugarcane yellow leaf virus* in Indian sugarcane

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Yellow leaf disease (YLD) of sugarcane caused by *Sugarcane yellow leaf virus* (SCYLV) is an important viral disease affecting Indian sugarcane cultivars and causes 38.9 to 42.9 % reductions in cane growth and 30.26 to 34.15% losses in juice yield in susceptible cultivars. Identification of varietal resistance is the most efficient strategy to manage the disease. ICAR-SBI, Coimbatore plays a predominant role in breeding of sugarcane varieties in India through National Hybridization Garden (NHG), where ~ 600 parental clones are being maintained every year for sugarcane breeding. To study the YLD resistance based on GWAS, parental clones were screened during 2018-2020 using 0-5 YLD rating scale and categorized as R (0.0-1), MR (1.1-2), MS (2.1-3), S (3.1-4) and HS (4.1-5). Totally, 200 YLD free samples in R category and 143 samples under the MS, S and HS category were collected. Total RNA was extracted from the collected leaf samples using TRI Reagent (Sigma, USA) by following the manufacturer's protocol and cDNA was synthesized. In the RT-PCR diagnosis, all the susceptible samples had shown intense amplification of the expected length of 615 bp. SCYLV titer in all the three categories of symptomatic susceptible samples (MS, S, HS) and asymptomatic samples were assessed by absolute RT-qPCR which were standardized using the coat protein specific primers with the amplicon sizes of 181bp. In RT-qPCR assay, standard curves were obtained using the Ct values for known titre of diluted plasmids. In RT-qPCR assay, standard curves were obtained using the Ct values for known titre of diluted plasmids. In susceptible samples, the viral copy ranged from  $4.40 \times 10^2$  to  $6.761 \times 10^6$  and in YLD free asymptomatic samples the viral copy ranged from  $44.97 \pm 13.25$  to  $3.29 \times 10^2$ . Further to understand the genetic

basis of YLD resistance, DNA was isolated from panel of 343 sugarcane clones and genotyped using an Affymetrix® Axiom® array (SNP chip). Five independent markers were significantly detected in association with SCYLV resistance phenotype. Among them, two markers were detected repeatedly across the GWAS exercises based on the different disease resistance parameters. This result illustrates the potential of GWAS approaches to prospect among sugarcane germplasm for accessions likely bearing resistance alleles of significant effect useful in breeding programs.

### ***M.K. Patel Memorial Young Scientist Award***

#### **AL 07: New insights into the transmission biology of plant viruses by thrips and whitefly and their management**

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Thrips and whitefly are principal pests in pulses, oilseeds, vegetables, fiber, and ornamental crops. They also transmit several plant viruses. Less is known about the relationships of thrips and whitefly with plant viruses in the Indian context. Tospoviruses propagate within the thrips body; thus, thrips serve as alternate hosts. Tospoviruses (GBNV, WBNV) induce harmful effects such as delayed larval molting, reduced adult longevity, and survivability of *Thrips palmi*. *T. palmi* can only acquire the tospoviruses at the early larval instar and transmit the virus during the adult stage. The inability of the adult stage to transmit the virus was described earlier due to the breakage of the connection between primary salivary glands and the anterior midgut. We have shown for the first time that the connections remain intact throughout the adult stage. It is the susceptibility of the midgut epithelial cells that determines the stage-specific virus infection in thrips. We also demonstrated the stage-specific progress of the tospovirus infection in *T. palmi* that helps better understand the disease epidemiology. Primary cell culture of *T. palmi* has been developed that is immensely useful to tospovirus workers worldwide to study the virus-vector interaction *in vitro*. Tospovirus-nucleoprotein (GBNV-N) localizes in the nucleus of *T. palmi* cells in primary cell culture. The virus particles probably enter vector cells by clathrin-mediated endocytosis. In response, genes associated with innate immunity, endocytosis, and cuticle development are differentially expressed in viruliferous *T. palmi*. UHRF1-binding protein 1-like (UHRF1BP1L) is recruited in the early endosomes during viral endocytosis. Silencing *T. palmi* UHRF1BP1L using chemically modified antisense oligos reduces the virus titer in *T. palmi*. Silencing innate immune-associated gene like phosphoribosylformylglycinamide synthase (PFAS) induces morpho-deformities and knockdown in *T. palmi*. These could be novel targets for genetic management of thrips. Besides, we have developed rapid field-based diagnostics of major thrips vectors based on recombinase polymerase amplification and polymerase spiral reaction. These assays do not require sophisticated laboratory equipment and are useful for non-expert personnel in quarantine. In whitefly-begomovirus relationships, the transovarial transmission of a bipartite begomovirus (DoYMV) by whitefly (*Bemisia tabaci* Asia II 1) was demonstrated for the first time that is an exception to the classical concept of the whitefly-begomovirus relationship. The findings have great epidemiological relevance as the virus can survive in the insect vector in absence of host plants and bridge the gap between cropping seasons. Further, the dynamics of a monopartite and a bipartite begomovirus during acquisition and inoculation by whitefly have been reported. The putative genes of whitefly associated with begomovirus (ChLCV) transmission have been identified and their functional role has been validated by RNAi. In the management of insect vectors, a novel method by spray-on application of dsRNA targeting key genes of insect vector has been demonstrated to induce mortality and inhibit virus transmission under semi-field conditions. This would be a potential eco-friendly alternative to hazardous pesticides and can reduce pesticide use.

## MJ Narasimhan Academic Merit Award Contest

### MJN 01(NZ): Elucidating genetic variability and detection of shot hole disease infecting different stone fruits using SSR markers

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The conidial ascomycota fungi *Wilsonomyces carpophilus* causing shot hole of stone fruits is a major constrain in the production of stone fruits worldwide. The current investigation was carried out to ascertain the variability in *W. carpophilus* using microsatellite markers. *W. carpophilus* isolates were collected from different stone fruits viz., peach, plum, apricot, cherry and almond grown in different areas of Srinagar and Ganderbal during the year 2020-2021 (20 isolates). The pathogen isolates of the year 2018 (20) and 2012 (17) were already available in laboratory. AMOVA analysis showed a high level of variation within the populations compared to among the populations in different geographical, temporal and host-species. Pairwise differentiation ( $F_{st}$ ) revealed a significant differentiation in the populations based on temporal and host species. The highest genetic distance (0.061) was observed between populations of 2012 and 2020 in year-wise populations which indicates that the pathogen is evolving and adapting with time. In host-crop populations, almond and cherry isolates have shown the highest genetic distance (0.31), whereas, the geographical population results were non-significant may be due to less geographical distance between the two districts and continuous exchange of planting material between the districts. Structure analysis resulted in clustering of 57 *W. carpophilus* isolates into four clusters indicating a high level of genetic variation with little similarities between the clusters depicted from admixture. Overall genetic diversity revealed that 57 isolates of the pathogen were divided into two major clusters at 5 percent similarity coefficient with further sub-clustering within the clusters. These results revealed a high level of diversity in *W. carpophilus* isolates infecting various stone fruits collected from different locations at different time intervals. A successful detection protocol directly from infected and healthy portions of the leaves of stone fruits viz., peach, plum, apricot, cherry and almond was developed using PCR based SSR markers that were designed from genome of *Wilsonomyces carpophilus* using GMATA software to detect the pathogen at early stages.

### MJN 02(NZ): Mapping of novel anthracnose resistance gene on Pv10 in common bean cv. KRC-5 by BSA-Seq

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Landrace of common bean, KRC-5 is known to possess resistance to many races of anthracnose pathogen. In this study, efforts have been made to use BSA-seq to plot the resistance gene in KRC-5. The competence of resistance gene was tested against 2 dreadful races such as Race 3 and Race 211 on 119 RILs (Recombinant Inbred Line). We obtained 3:1 and 1:1 segregation ratios at  $F_2$  and  $F_{2:8}$  respectively specifying that one major gene was accountable for resistance. This laid the groundwork for NextGen Sequencing using the Illumina Hiseq platform. DNA of parents such as Jawala, KRC-5; 17 resistant lines and 17 susceptible lines were chosen for sequencing. Subsequent to BSA-Seq we found a novel region in KRC5 conferring resistance to two races by utilizing SNPs (Single Nucleotide

Polymorphisms) markers. This is the pioneering work as the novel anthracnose resistance gene is being reported on Pv10 at a physical position of 4.0-4.1 Mb. After that, InDel (Insertion Deletions) and SSR (Simple Sequence Repeats) markers were designed to authenticate the results. These markers were screened and we found 5 polymorphic InDels and 6 polymorphic SSR markers in total. Then these markers were run on 6 % Polyacrylamide Gel Electrophoresis (PAGE) on the whole RIL population. The linkage map was constructed for "Co-Ind" on Pv10.

### **MJN 03(WZ): Isolation, identification and morphological characterization of native *Chaetomium* spp. of south Gujarat region**

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As a potential antagonist of various plant pathogens, The present investigation on studies on biocontrol potential of *Chaetomium* sp. was carried out at the Department of Plant Pathology, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during the year 2018 to 2019. Fifty soil samples were collected from the rhizosphere of castor, sugarcane, cucumber, pigeon pea, brinjal and tomato. Seeds of brinjal, tomato, greengram and chilli were also used for isolation of *Chaetomium* sp. From the above samples ten isolates of *Chaetomium* viz., *C. brasiliense* isolates (C1: rhizosphere of castor), (C2: rhizosphere of sugarcane), (C3: rhizosphere of tomato), (C4: rhizosphere of cucumber), (C7: seeds of brinjal), (C8: seeds of tomato) and (C10: seeds of chilli), *C. globosum* isolate (C5: rhizosphere of pigeon pea) and (C6: rhizosphere of brinjal), *C. fuscum* isolate (C9: seeds of greengram) were isolated and identified morphologically based on ascomata, ascomatal hairs, colony colour and size and shape of ascospores. Colonies grew and developed their typical brown to black colour and the ascomata were olivaceous to brown in colour. Ascomatal hairs were spirally coiled or arcuate, circinate in most of the isolates. Asci were clavate in shape with eight ascospores per ascus.

### **MJN 04(NEZ): Leaf assisted biosynthesis of silver-silica nanocomposite for management of sheath blight disease of rice**

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Sheath blight of rice, is one of the most ruinous diseases, especially in intensive rice cropping systems and no rice cultivar has been found to be completely resistant to this disease. In current scenario of conventional farming methods new technologies are essential and the application of nanotechnology, especially green technology offers considerable promise in answering these problems. In this study, *Litsea salicifolia* mediated silver (Ag) and silica (SiO<sub>2</sub>) nanocomposite (NC) was synthesized. In efficacy test Ag nanoparticles (NP) alone was found to have antimicrobial property and SiO<sub>2</sub> nanogel (NG) as a good enhancer of plant defense mechanism. Combining both the nanoparticles, the NC was formed and found to be a potent drug for management of *R. solani*. Characterization of Ag-NP and SiO<sub>2</sub>-NG was done using UV-vis spectroscopy, dynamic light scattering, zeta potential, SEM, TEM, SAED, EDX and NTA. NC at seven doses when tested for efficacy against the mycelia and sclerotia of *R. solani*, the effect was found as dose dependant. The highest inhibition against both sclerotia and mycelia was recorded at a concentration of 200 ppm with inhibition of 85.66% and 73.55% respectively. An encapsulated (EN) product of Ag-SiO<sub>2</sub> was developed and when tested for its efficacy and compared with the Ag-SiO<sub>2</sub> NC and a chemical, 100% mycelial growth inhibition of *R. solani* at 200 ppm of encapsulated product was recorded. Further analysis of the

NC on rice plants with challenged inoculation of *R. solani* showed a reduction of per cent disease incidence up to 20% from 80% incidence in untreated control and also enhanced effect of plant growth parameters and biochemical defences in rice.

### **MJN 05(NEZ): Molecular epidemiology and pathological characterization of *Citrus tristeza virus* in Assam lemon (*Citrus limon* Burm.) using serological and molecular approaches**

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Assam lemon (*Citrus limon* Burm.), a widely grown and economically important fruit crop locally known as Kaji Nemu belongs to the Rutaceae family. Well known for its distinct aroma, flavour, and seedless character, Assam lemon earned GI tag recognition. *Citrus tristeza virus*, the deadly pathogen, causes global yield loss in citriculture. Vein clearing, midrib yellowing, chlorosis, twig dieback, leaf shedding, and rapid decline are common symptoms. In the current investigation, leaf samples were obtained from Assam lemon plants aged 3, 5, 10, 15, 20, and 25 years for CTV detection using both serological and molecular methods. The DAS-ELISA and RT-PCR results confirmed that all samples tested positive for CTV, independent of symptoms. qPCR analysis revealed that virus titer grew from 3 to 15 year old plants, then steadily declined in the latter age groups. Yield of Assam lemon declined from 15 year old age group, indicating the possible role of high CTV titer in decreasing the output. Phylogenetic analysis showed that CTV isolates were closely related to isolates from Northeast India and other neighbouring areas. Plants with mild strain did not exhibit severe disease symptoms, implying that the mild strain may play a role in the natural cross protection of the crop. The current study's findings underlined the necessity of producing high-quality planting material from CTV-indexed foundation blocks and using it to build new orchards, as well as growers' adoption of vector management programmes in the field.

### **MJN 06(DZ): Induction of virus resistance in chilli through direct application of chitosan nanoparticle conjugated dsRNA**

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Chilli leaf curl virus is one of the most important constraints in the production of chilli in India that causes significant disease outbreaks and yield losses. The lack of resistant cultivars makes it extremely difficult to effectively manage the disease. An alternative novel approach was attempted in this study to prevent the virus by inducing RNA interference in the host plant. Four different dsRNAs (dsC2, dsC4, dsV2, and ds $\beta$ C1) were prepared from suppressors genes of ChiLCV DNA-A and the associated betasatellite by using the vector, L4440 and the bacterial strain, HT115 (DE3). All four dsRNAs were mixed in equimolar concentrations and the cocktail dsRNA (dsCK) was conjugated with chitosan nanoparticles through heating and rapid vortex. The dsCK and the chitosan nanoparticle conjugated dsCK (dsCK-CTNP) was applied by rubbing in six weeks old chilli leaves followed by the virus inoculation through whitefly one day after the dsRNA treatment. PCR was performed at 15 dpi to detect the presence of the virus in the individual plants using ChiLCV-CP specific primer. A disease incidence of 100% was observed in the positive control, while only 25% disease incidence was observed in dsCK treated plants and no virus (0%) was detected in any of the individual plants in the dsCK-CTNP treated plants. Further, the level of virus protection was estimated through absolute quantification of the pool DNA samples and compared between the treatments and

the control plants. At 15 dpi, the virus copy number in the positive control was  $1.61 \times 10^6 \pm 2.45 \times 10^5$  per 100 ng of plant DNA, while it was only  $1.35 \times 10^5 \pm 2.42 \times 10^4$  and  $1.62 \times 10^4 \pm 6.65 \times 10^2$  in dsCK and dsCK-CTNP treated plants respectively. By 48 dpi, the virus copy number in the positive control reached a maximum of  $2.4 \times 10^8 \pm 1.66 \times 10^7$ , while it remained at a low copy number of  $8.05 \times 10^7 \pm 2.91 \times 10^6$  in dsCK-CTNP treatment which was significantly lowered than the virus copy number of  $1.27 \times 10^8 \pm 1.68 \times 10^7$  exhibited in plants treated with dsCK. Also, the average plant heights in dsCK-CTNP treated plants ( $30.31 \pm 0.45$  cm) were found to be significantly higher than the plants treated only with the dsCK ( $28.06 \pm 0.49$  cm), and the positive control ( $24.69 \pm 0.73$  cm) at 40 dpi. This study for the first time showed that the conjugation of dsRNA with chitosan nanoparticles is effective in reducing the disease incidence and increasing the effective period of virus protection as compared with the direct application of naked dsRNA.

### MJN 07(DZ): Molecular characterization and development of high throughput field-based diagnostics for *Fusarium fujikuroi* causing bakanae of rice

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Bakanae disease or foolish seedling disease of rice caused by *Fusarium fujikuroi* is one of the emerging diseases of rice in India. The disease mainly affects basmati varieties of rice and more prevalent in Haryana, Punjab, Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. *Fusarium fujikuroi* isolates collected from different rice growing states of India such as Punjab, Haryana, Uttar Pradesh, Uttarakhand, Rajasthan and Delhi were characterized using rice genotypes differing for their resistance. In preliminary screening, twelve promising rice genotypes, which were identified in screening large pool of germplasm/genotypes (around 1000 genotypes) were included and evaluated with 20 randomly selected *Fusarium fujikuroi* isolates. Further, five rice genotypes differing in their resistance were selected based on preliminary screening for virulence and molecular characterization. The isolates were grouped into pathotypes based on disease response in five rice genotypes. The isolates were mainly grouped into 15 pathotypes. Pathotype 1 was found to be more prevalent and pathotype 8 was identified as highly virulent. When we compared the pathotype distribution in different states, pathotypes 11 and 15 were found to be originated from the state of Punjab. Further the isolates representing different pathotypes were selected for gene expression and multilocus sequence analysis (MLSA). A positive correlation could be established between six pathotype groups and the expression profile of virulence-related genes such as acetylxylin (*FFAC*), exopolygalacturanase (*FFEX*), and pisatin demethylase (*FFPD*). Total six genes (*Tef1 $\alpha$* , *RPB2*, Histone H<sub>3</sub>,  $\beta$ -tubulin, IGS rDNA and Calmodulin) were selected for multilocus sequence analysis (MLSA). Housekeeping genes such as *Tef1 $\alpha$* , *CL*, *HIS3* shown 3 SNPs, *TUB2*, *28S-18S rRNA IGS* have 2 SNPs and *RPB2* shown 1 SNP. Total 14 SNPs were identified across six housekeeping genes in *Fusarium fujikuroi* isolates. The unique secondary metabolite gene cluster present in *Fusarium fujikuroi* has been utilized to amplify and develop the specific point of care diagnostic protocol for bakanae disease through recombinase polymerase amplification (RPA). The target gene was amplified only in *Fusarium fujikuroi* and did not amplify in other spp. of *Fusarium*. The study culminated in development of a novel technique rapid nucleic acid isolation followed by amplification of *Fusarium fujikuroi*, applicable for fungal pathogens and lateral flow detection for *Fusarium fujikuroi*. Further purified antibody against target peptide of *Fusarium fujikuroi* shown positive interaction with peptide, pathogen, rice seedlings and seed samples. The study characterized pathotypes in *Fusarium fujikuroi* and identified SNPs in housekeeping genes, which need further validation. The Lateral flow-RPA (LF-RPA) has been successfully developed for *Fusarium fujikuroi*, detected the samples in less than 30 minutes.

## MJN 08(MEZ): Demarcation of brown rot (*R. solanacearum*)-free area of potato in western Uttar Pradesh for international export

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Production of healthy potatoes is a key factor in maximizing the yield and export of table potatoes for consumption or processing. Potato contribution in agricultural GDP per unit area of cultivable land is about 4 times higher than rice and 4.5 times higher than wheat. Although India shares approximately 7.5 percent of the world's total potato production which is 388.20 million tonnes. But the export of freshly produced potato from India is negligible due to quarantine and pesticides issues as various pest and disease problems occurs in cultivated area. Brown rot or bacterial wilt caused by *Ralstonia solanacearum* is considered as the most important bacterial disease of potato in the tropics. Whereas common scab of potato is one of the most quality degrading diseases in potato. By keeping this in view and being India is a member country of International Plant Protection Convention (IPPC), study was conducted to detect *R. solanacearum* in Daurala block of Meerut district (western Uttar Pradesh) for declaration of Disease-Free Areas (DFA). Total 283 samples were collected from different farmers field and cold storage for occurrence of *R. solanacearum*. We have characterized the isolates based on cultural, morphological, and biochemical method and all presumptive isolates were subjected to PCR-based amplification also with specific primers to obtain a unique band of 280 bp DNA fragment with a positive control of *R. solanacearum* (DNA samples was provided by CPRI, Shimla, on a complimentary basis). In the result, none of the presumptive isolates from the sample were amplified which indicated the absence of *R. solanacearum* in all samples against the positive control. Apart of this, 5 quality degrading bacteria were also isolated and confirmed as *S. scabiei* based on pathogenicity and molecular characterization of the 16S rDNA sequence during the post survey and common scab disease was more prevalent in some villages of the Daurala block. The cultural characteristics of the identified *Streptomyces scabiei* isolates were studied on different media. A creamy white to white brown colony colour was observed on SCA and yeast extract–malt extract agar. Further the pathogenicity-related *txtA* and *nec1* genes were also studied for their presence in the isolated *S. scabiei* isolates. The *txtA* gene is responsible for the synthesis of the thaxtominaA toxin, and the *nec1* gene is responsible for the production of necrosis factor 1, which is an important virulence factor of pathogenic *Streptomyces* spp. It was found that all the 5 pathogenic isolates have *txtA* and *nec1* genes. Different drugs were also tested against all five isolate and Gentamicin, Amicacin, Tobramycin were found most effective against *S. scabiei*. Hence, the above finding indicated that the Meerut region is free from infection by brown rot disease. Therefore, potatoes from these areas can be recommended for export to the international market and boost up the farmers economic condition through involvement in export of potato from India.

## MJN 09(EZ): Exploring ring spot associated complexities and their robust diagnosis in papaya and cucurbits

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Papaya plantation is severely affected by different viruses causing considerable yield loss. Severe insect-vectors infestation and uncertain weather promoting viral epidemics in papaya growing areas. Among viruses, *Papaya ringspot virus* (PRSV) is one of the emerging threat in papaya and cucurbits globally. In a field based survey of Southern Bihar,

papaya plants were found showing diverse symptom like prominent ring spot, leaf deformation, curling, puckering and stunted growth. Therefore, due to symptomatic diversity, comprehensive molecular detection programme was initiated. PRSV, leaf curl associated viruses, Phytoplasma were diagnosed in suspected plant samples using PCR and RT-PCR. In one step RT-PCR Potyvirus were commonly detected in leaves samples of both hosts suspected to PRSV. CP gene of PRSV was successfully amplified resulting 850 bp band in papaya samples collected from different surveyed locations. However, a limited cucurbit plants also indicated presence of PRSV. Papaya and cucurbit plants also showed curly elongated leaves in which *Tomato leaf curl New Delhi virus* was diagnosed. Apart from tested viruses, Phytoplasma indication was observed in plants showed curly top symptom. Based on nucleotide sequence of 16S RNA revealed its presence in papaya plants. However, in cucurbit plants no such evidence was noticed. Present study explored various causal agent linked to specific disease symptom. It seems continuous growing of diverse crops, uncertain weather and severe infestation of sucking insect pest might play a vital role for disease development. Therefore, a study must be initiated to understand the disease development factors to execute a sustainable disease management programme.

### **MJN 10(CZ): Biotic stress tolerance and field evaluation against maydis leaf blight of maize caused by *Bipolaris maydis* [(Nisikado and Miyake) Shoemaker]**

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Maydis leaf blight of maize is one of the devastating foliar diseases of maize with historical importance. The biotic stress tolerance can be reduced by different ways. Among which seed biopriming is the one which synthesizes in antioxidant enzyme production and activates the salicylic acid metabolic pathways etc. Seed biopriming on susceptible maize cv. CM-202 with different biocontrol agents, maydis leaf blight pathogen and control exhibited that maximum vigour index was found in *Pseudomonas fluorescens* + *Bacillus subtilis* (3644.04) followed by *Pseudomonas fluorescens* (3401.96) and the minimum vigour index was observed in *Bipolaris maydis* (2768.23) bio primed seeds. Biochemical studies revealed that peroxidase and phenylalanine ammonia lyase increased after pathogen inoculation and reached highest level on fifth day in most of the treatments whereas total phenols and polyphenol oxidase reached highest level on third day and superoxide dismutase was recorded in transient manner after that gradually decreased. Among the biocontrol agents, *P. fluorescens* + *B. subtilis* showed maximum production of various antioxidant enzymes followed by *T. harzianum* and minimum activity was found in *B. maydis* pathogen treated seeds and control. The field efficacy of twelve treatments was studied for the management of maydis leaf blight of maize during rabi 2020-21 and 2021-22. Among the treatments two sprays, one at 40 days after sowing (DAS) and second at 25 days after the first spray with tebuconazole (50%) + trifloxystrobin (25%) at 0.1 per cent recorded significantly lowest disease intensity (28.66 %) with the highest grain yield (56.00 q/ha) and was found to be the most effective for the management of maydis leaf blight disease and increasing grain yield over control.



## APS-IPS Travel Sponsorship Award Contest

### APS 01(NZ): Exploring the endophytic microbiota as potential bioagents for management major fungal diseases of rice (*Oryza sativa* L.)

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Rice (*Oryza sativa* L.) is the world's most widely consumed cereal crop, and 50 per cent of the world's population uses it as a staple food. It is affected by many diseases. The aim of the study was to identify the most potent endophytes which not only prevents the rice plants from three major fungal diseases namely blast, brown spot, and sheath blight but also increases its production. Altogether one hundred twenty-five (125) endophytic microorganisms were isolated from roots, stem and leaves of four major cultivars of rice viz., C1039, SR3, SR4 and SR5. Among the isolated endophytes, total 18 (five fungal and thirteen bacterial) were found best performing for inhibition of growth of all the tested pathogens under *in vitro* conditions. All the eighteen endophytes were characterized by cultural, morphological and molecular means. The highest growth inhibition among fungal isolates was shown by *Trichoderma harzianum* (91%) followed by *Aspergillus flavus* (90%). Similarly, among the bacterial isolates, highest growth inhibition was shown by *Ureibacillus massiliensis* (75.47%) followed by *Ochrabactrum rhizosphaerae* (75.25%). The characterized endophytes were also tested for growth promotion attributes and it was found that all the five fungal and ten bacterial endophytes [A2] were able to solubilize phosphorous. All the endophytes (5 fungal and 13 bacterial) were able to produce IAA and gibberellic acid. Eleven endophytes showed chitinase activity with highest chitinase activity by *Bacillus licheniformis*. Thirteen isolates were able to produce ammonia, fourteen isolates showed siderophore production with highest siderophore production of 57 percent by *Aspergillus flavus*. Only three bacterial isolates were found positive for HCN production with highest HCN production of 54µgml<sup>-1</sup> by *Bacillus flexus*. [A3] Under greenhouse conditions, the highest disease control was shown by *Aspergillus flavus* and *Bacillus licheniformis*, while as highest growth promotion was shown by *Enterobacter cloacae* and *Aspergillus flavus*. Formulation of *Trichoderma harzianum*, *Aspergillus flavus*, *Bacillus licheniformis* and *Enterobacter cloacae* can be made and used for biocontrol and growth promotion.

### APS 02(NEZ): Distribution, molecular diagnostics and host diversity of phytoplasma associated with brinjal little leaf disease in Assam

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Brinjal, (*Solanum melongena* L.), also called as eggplant belongs to the family Solanaceae, is one of the important vegetable crops grown throughout the year in all parts of India except in higher altitudes. Brinjal is affected by several diseases among which brinjal little leaf (BLL) disease caused by BLL phytoplasma is one the major constraints in its production and productivity. To determine the prevalence of the disease, a roving survey was conducted in seven major brinjal-growing districts in Assam. The disease incidence was observed in all the surveyed locations and ranged from 3.62 to 23.63 per cent. All the symptomatic brinjal samples collected from seven districts of Assam yielded the expected amplicon size from PCR. Further analysis of the 16S rRNA gene based on phylogenetic tree

and the iPhyClassifier-based virtual RFLP analysis of the 16S rRNA gene sequences revealed that the phytoplasma-associated with little leaf of brinjal belongs to the 16SrVI-D subgroup. The BLL disease was successfully transmitted by the leafhopper *Hishimonus phycitis* (Dist.) and dodder with transmission efficiency of 80.00 and 60.00 per cent, respectively. Also, we detected several new phytoplasma hosts in Assam, including Indian nightshade, king chilli, jasmine, spine guard, and ridge guard etc, which have not been reported elsewhere in the world, indicating these hosts as potential reservoirs of BLL phytoplasma. The disease management relies strongly on a fast and accurate identification of the causal agent. In this study we developed a novel method to isolate total nucleic acid using GES buffer which reduced the detection time to only 2 to 3 hours depending upon the primers used. Further, a new nested real-time PCR assay developed in this study proved valuable for the rapid screening of phytoplasma in many plant samples to detect phytoplasmas.

Keywords: Brinjal, 16SrVI-D, phytoplasma

### APS 03(NEZ): Encapsulation of microbial bioagents for development of bioinoculant kit for sustainable disease management

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An attempt has been made to develop encapsulated of the biocontrol agents with biodegradable biopolymers as a long-term viability option as well as efficient microbial delivery mechanism and subsequent biopolymer coated antagonistic *Bacillus* sp. and *Trichoderma* sp. against bacterial leaf blight of rice (*Xoo*). Screening of different biopolymers viz., sodium alginate, sodium CMC, xanthan gum established sodium alginate as the most efficient polymer for encapsulation of the antagonistic microbes. *In vitro* antagonistic assay of different *Bacillus* spp. (viz. *B. subtilis*, *B. velezensis* and *B. amyloliquefaciens*) and *Trichoderma* spp. (viz. *T. harzianum*, *T. viride* and *T. asperellum*) have been conducted against the bacterial leaf blight pathogen, *Xanthomonas oryzae* pv. *oryzae* which revealed that *Bacillus velezensis* and *Trichoderma viride* could inhibit the pathogen effectively, confirmed by Scanning Electron Microscopy (SEM). *B. velezensis* was also found to degrade organophosphate and neonicotinoid pesticides up to 500 ppm while *T. viride* was found to degrade neonicotinoid and organophosphate pesticides up to 300 ppm effectively. Both the antagonists are compatible with the fungicides Propiconazole and Carbendazim. The microcapsules containing antagonistic *B. velezensis* and *T. viride* along with the control beads were prepared and the properties have been studied culturally followed by SEM, DSC and FTIR study. The beads were found photo-stable and viable upto eight months after preparation. Microbial encapsulation would be a novel approach for smart and efficient microbial delivery into the crop ecosystem which is an alternative to bulky bioinput and can have significant effects on increasing both the quality and quantity of agricultural produce.

### APS 04(DZ): Genomics led population diversity studies of leaf blight complex pathogens of wheat

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Wheat, consumed as a staple food by 35% of the world's population, is globally threatened by the Helminthosporium leaf blight (HLB) complex, which can be devastating with upto 100% severity under favourable climatic conditions, resulting in more than 30% yield loss in susceptible wheat cultivars. Earlier studies have demonstrated that foliar blight complex is a combination of the diseases tan spot (*Pyrenophora tritici repentis*) and

spot blotch (*Bipolaris sorokiniana*), although *B. sorokiniana* continues to be the dominating one in causing losses. We intend to explore the pathogenic flora associated with foliar blight complex, their interactions and the impact of soil-borne inoculum. The results revealed the association of *Bipolaris spicifera*, *Exserohilum rostratum* and *Bipolaris oryzae* along with *Bipolaris sorokiniana* with the spot blotch disease complex in wheat across Indian Wheat growing zones. Through this study, we have established by morpho, molecular and pathological approaches that these pathogens employed in the study contribute significantly to the disease complex. Also, population dynamics studies using q-PCR revealed that the soil inoculum keeps multiplying for two months and then shows a sharp decline. Based on these observations, 8 diverse isolates from these pathogenic classes were selected for whole genome illumina sequencing. The data received was analysed and compared for pathogenic variability in the form of SSRs and SNPs. Also, the loci involving biosynthetic gene clusters (BGCs), CAZymes, secretome, pathogenicity and toxin production genes were identified, compared and correlated with their virulence data. Our study emphasized on relooking into the pathogenic flora associated with wheat foliar blight complex and further genomics studies will provide newer insights to their pathogenic nature.

### APS 05(DZ): Prediction of leaf curl disease risk in chili for management decision

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Chili leaf curl virus (ChiLCV), one of the most important begomovirus, has emerged as a serious constraint to chilli production in India. Leaf curl epidemic is complicated by coincidence of whiteflies, thrips and mites infestation along with viruses. It is necessary to develop an efficient system for specific detection of ChiLCV to characterize epidemic pattern for management decision. A recombinase polymerase amplification (RPA) and CRISPR-Cas12a based DETECTR system for specific detection of ChiLCV has been developed to detect the virus 3 fg specifically ChiLCV but not tomato leaf curl New Delhi virus and other five begomoviruses, infecting chilli, indicating the specificity of the system. The assay protocol can serve as an effective platform for detection of other begomoviruses for epidemiological studies. Leaf curl epidemic is characterized by contact rate dynamics between host and migrant whitefly population which is influenced by succulence level of the plant. Based on temperature influence on whitefly abundance and virus transmission efficiency southern region has been predicted to be leaf curl epidemic prone throughout the year. Major chilli areas estimated by crop spectral indices superimposed crop succulence stage and whitefly abundance is likely to predict accurate areas of leaf curl incidence where management advisory could be provided. The field detection assay, geographical distribution of leaf curl disease and accurate prediction of infection time could be useful for development of management strategy.



# Technical Sessions

(Keynote/ Invited/ Oral Presentations)



## Session 1A. Diagnostics: Issues and Innovations

### KEYNOTE LECTURES

#### KN 01(S1A): Chitosans - role in plant disease, immunity and symbiosis

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Chitin is a polysaccharide made up of repeated units of N-acetyl glucosamine (A) and the presence of decetylated residues (D) in the chitin, converts it to different chitosans. Chitooligosaccharides (COS) are the oligosaccharides derived from chitin/chitosan. Chitin, chitosans and COS are necessarily defined in terms of the degree of polymerization (DP-number of monomeric residues) and degree of acetylation (DA/FA – number/proportion of 'A' and 'D' residues), the pattern of acetylation (PA – the arrangement of 'A' and 'D' residues in the polymer/oligomer). While the crustaceans are rich renewable natural source of chitin, the fungal cell walls are also mostly made up of chitin. Research progress in the past two decades allowed us to understand a part of the complexity of how this chitin/chitosans/COS are sensed by the plant, with different outcomes including immunity, disease and symbiosis. How the plants respond to these molecules and the potential use of these molecules for the benefit of plants will be discussed in the lecture.

#### KN 02(S1A): Strategies for Integrated management of virus diseases in vegetable crops

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Plant virus diseases are emerging as a serious constraint and a limiting factor for vegetable crop production systems in India. Plant viruses are a significant threat to global food security, and the majority of viruses that infect plants are naturally spread through three main transmission pathways: pollen, seed, and vector. Disease management is an important factor in meeting the growing demand for food quality and quantity. Given the diversity of agrosystems, the range viruses of crop health problems, and the massive changes in vegetable cultivation due to climate change, globalization, and technology shifts, having a clear understanding of the required metric for the impact of plant diseases is more essential than ever. The main strategy to limit the incidence of virus-infected plants has been the application of insecticides to reduce vector populations aided to some extent by the use of selected cultural practices. However, due to concerns about the effect of insecticides on pollinators, consumer demand for reduced pesticide use, and the ability of the vectors to develop insecticide-resistance, there is a growing need to develop and deploy strategies that do not rely on insecticides. Management of viral diseases requires an integration of several methods aimed at preventing or delaying infection of vegetable crops. Resistance combined with selected IPM strategies could become a viable means to increase yields in crops produced in open fields despite the presence of vector-transmitted viruses. Harnessing new technologies and knowledge to create more durable resistant crops and sustainable virus disease management will be discussed. The integration of technologies at the national and global scale - are necessary to mitigate future plant disease outbreaks and protect the national food supply.

## INVITED LECTURES

### IL 01(S1A): Draft genome of *Wilsonomyces carpophilus* causing shot hole disease of stone fruits using Illumina HiSeq and PacBio NGS platforms

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Anecrotrophic plant pathogenic fungus *Wilsonomyces carpophilus* causing shot hole disease in stone fruits such as peach, plum, apricot and cherry, and almonds among the nut crops is one of the most devastating plant pathogens. The disease management failures using fungicides has been reported many time and no information on the host-pathogen interaction is available. Therefore, we examined the pathogen morphology, pathology, and genomics. The pathogen isolates collected from five different hosts showed difference in their morphology, however, the probability value ( $p=0.29$ ) suggests insignificant difference in pathogenicity with respective to different hosts. Here, we reported the draft genome of *W. carpophilus* for the first time based on hybrid assembly of Illumina HiSeq and PacBio NGS platforms and found genome size of 29.9 megabase submitted to GenBank, NCBI (Accession number: PRJNA791904). A total of 10,901 protein-coding genes have been predicted, including heterokaryon incompatibility genes, cytochrome-p450 genes, kinases, sugar transporters etc. In the genome assembly, we found 2851 simple sequence repeats (SSRs). The most prominent proteins showing the necrotrophic lifestyle of the *W. carpophilus* pathogen were hydrolases, polysaccharide-degrading enzymes, esterolytic, lipolytic, and proteolytic enzymes, which accounted for 225 released proteins. We also discovered tRNAs, rRNAs, and pseudogenes in the pathogen genome.

### IL 02(S1A): Managing recent outbreaks of foliar fungal diseases in arecanut and coconut: Challenges and Strategies

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India is one of the largest producers of arecanut and coconuts and accounted for about 31.45% and 50.37 % of the world's coconut and arecanut production respectively. Pest and diseases are one of the major production constraints causing an average 15 to 20 per cent annual loss. Leaf spot and blight diseases caused by *Colletotrichum* and *Lasiodiplodia* have emerged as serious maladies in recent years causing huge losses. The arecanut leaf spot disease caused by *Colletotrichum gloeosporioides* species complex (Cgsc) has emerged as a major problem and severe infection on leaves and nuts is becoming a serious concern among the arecanut growers. More than 42,000 hectares of arecanut plantations in seven major areca-growing districts of Karnataka are affected leading to 20 to 80 per cent yield loss. The severe incidence of the disease is also noticed in the arecanut growing areas of Kerala and the Jampui hills area of Tripura. The disease symptom appears as small, irregular, brown to dark brown specks with a yellow halo on the leaf lamina. These spots later coalesce to form bigger lesions and turn into blight. The severe infection leads to the withering of leaflets and the drying and drooping of leaves. Symptoms are also recorded on nuts and leaf sheath as irregularly shaped dark brown to black coloured sunken spots with a yellow halo. The disease-affected nut and leaf samples were collected from affected areas and the fungus *Colletotrichum kahawae* sub sp *ciggaro*, a member of the Cgsc was established as the causal agent of the recently emerged leaf spot disease in Karnataka. In the case of coconut, the leaf blight caused by the fungus *Lasiodiplodia* species has emerged as a major concern and spreading to various coconut growing areas. The leaves in the outer whorl of the coconut palms are affected severely. The affected leaflets start drying from the tip downwards and exhibit a charred



or burnt appearance. The affected nuts were desiccated, shrunken, deformed and dropped prematurely and resulting in nut yield loss of up to 10 to 25%. The incidence was noticed throughout the year and the maximum incidence was observed during the summer months. Recently, the same fungus was also found to cause spindle rot in below four-year-old coconut seedlings, basal rot of fronds in adult palms and more severe rotting and the toppling of coconut crowns in certain coconut growing regions. Thirty-two *Lasiodiplodia* isolates from coconut were purified from infected samples and out of 20 isolates from coconut leaf blight, 18 were identified as *Lasiodiplodia theobromae* and one each as *L. parva* and *L. psuedotheobromae*. Among the eight spindle rot samples, seven comprised *L. theobromae* and one as *L. iranensis*. Recently from the samples collected from diseased coconut leaves, fronds, spindle and nuts in the Kasaragod district of Kerala, it was observed that *Lasiodiplodia theobromae* infection from leaves spread to the petioles and from the petioles, the infection spread to stalk portions of the spathe and the inflorescence leading to rotting of those regions. In advanced stages, the infection reaches up to the inner whorls of leaves around the cabbage portion resulting in severe rotting of internal tissues of the bud. As a result, the last whorl of leaves along with the bud portion topples down and the palms die. There is an urgent need to develop more effective management strategies based on the understanding of pathogen diversity and predisposing factors.

### IL 03(S1A): Robust Diagnostics for Major Virus and Virus-like Pathogens Infecting Horticultural Crops in North East India

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Virus and virus-like pathogens have emerged as the major constraint in production and productivity of horticultural crops in North East (NE) region of India. Present study focused on development and validation of simplified and robust detection assays for major virus and virus-like pathogens infecting different horticultural crops in the region. A simplified and robust multiplex PCR (mPCR) assay for the simultaneous detection of five RNA viruses, capsicum chlorosis orthotospovirus (CaCV), chilli veinal mottle virus (ChiVMV), large cardamom chirke virus (LCCV), cucumber mosaic virus (CMV), and pepper mild mottle virus (PMMoV), and a DNA virus, chilli leaf curl virus (ChiLCV) infecting chilli was developed. A simplified template preparation using crude sap extract of plants in isothermal recombinase polymerase amplification (RPA) was developed for the detection of potyviruses infecting passion fruit and chilli. Simple template-based RPA assay for detection of *Candidatus Liberibacter asiaticus*-associated with huanglongbing and citrus tristeza virus were developed using crude plant extract of infected citrus plant as template. Crude plant extract from infected plant tissues extracted in simple buffers was best suited for the simplified detection of these virus and virus-like pathogens. Developed RPA assay could detect the target pathogens up to 10<sup>-7</sup> to 10<sup>-10</sup> dilution of crude plant extract and was as sensitive as bench mark PCR. The developed assays were validated using large number of field samples and found robust.

## ORAL PRESENTATIONS

### OP 01(S1A): Investigation on progressive systemic localization, seed borne nature and symptoms-based advancement of *Fusarium oxysporum* f.sp. *ciceri* inoculum incited wilt in chickpea

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Wilting (*Fusarium oxysporum* f.sp. *ciceri*) in chickpea is caused by the combination of pathogen activities such as toxin production, accumulation of fungal mycelium in the xylem vessels, production of gums, gells and tyloses and vessel crushing by proliferating adjacent parenchymatous cells. Wilting can be observed in susceptible genotypes within 25 days after sowing in the field (early wilting) (Diaz *et al.*, 2015). However, symptoms are usually more visible in the early stages of flowering i.e., 6 to 8 weeks after sowing and can also appear at podding stage (late wilting). Late wilted plants show drooping of the rachis, leaflets and petioles, necrosis of foliage and yellowing. Systemic progression of pathogen in different genotypes was evaluated based on the occurrence of infection at 5 different stages of pod formation such as infection at <10% pod formation stage; infection at 25% pod formation; infection at 50% pod formation; infection at 75% pod formation; infection at 100% pod formation. Systemic infection or progression of pathogen to different parts of plants was highest in plants showing chlorosis symptoms when compared to plants showing drooping symptoms. Higher infection was found in the seeds of chlorosis plants (32.5%) compared to drooping plants (7.5%). Different late wilting lines were collected for studies of progressive systemic infection in parts like root, stem, stalk and seed. Mean systemic infection in the root (93.5), stem (74), stalk (44) and seeds (32.5) of plant showing chlorosis symptoms was highest as compared to the root (91.5), stem (69), stalk (26.5) and seeds (7.5) of plants showing drooping symptoms. Infection in the roots is more than 90% irrespective of infection at any stage of pod formation. Infection in the stem was highest when the plants were infected at <10% pod formation (73.75) and was lowest when the plants were infected at 100% pod formation (66.25). Infection in the stalk was highest when the plants were infected at <10% pod formation (56.25) and was lowest when the plants were infected at 100% pod formation (12.5). Infection in the seed was highest when the plants were infected at <10% pod formation (36.25) and was lowest when the plants were infected at 100% pod formation (2.5).

### OP 02(S1A): Host range, aggressiveness and fungicide sensitivity of *Alternaria brassicicola* affecting broccoli in Georgia, USA

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*Alternaria* leaf blight and head blight (ABHR) caused by *Alternaria* species complex is an emerging threat to brassica crops in the eastern United States. Effective ABHR management practices include cultural (use of certified seeds, long rotation, weed control and drip irrigation) and chemical controls (use of fungicides). Quinone outside inhibitors (QoI) are widely utilized fungicide class for ABHR management. However, little is known about the fungicide sensitivity status of ABHR against QoIs. A total of 163 isolates were collected from ten commercial broccoli fields in Georgia in two years from three predominant broccoli growing counties (Colquitt, Grady, and Tift Counties). One hundred percent of the isolates were identified as *A. brassicicola* based on a species-specific PCR assay. Further host-range assay indicated that majority of the isolates were highly aggressive on broccoli (65%), cabbage (46%) and collard (44%) than on kale (8%). Conidial germination assay for a sub-set of isolates on azoxystrobin-amended agar medium indicated 100% of the isolates ( $n=102$ ) to be sensitive at both concentrations (10 and 100  $\mu\text{g/ml}$ ).

Together, this study indicates that *A. brassicicola* is the major contributor of ABHR in Georgia, and that the pathogen is highly aggressive on broccoli but sensitive to azoxystrobin.

### OP 03(S1A): Induced resistance to mitigate phomopsis blight of brinjal using inorganic chemicals

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One of the most destructive diseases of brinjal is phomopsis blight (*Phomopsis vexans*), which is managed with resistant cultivars, chemicals, and cultural practices. However, each of these methods has drawbacks, including pathogenic pesticide resistance and fungicidal toxicity to plants, produce, and products. Various resistance-inducing chemicals, such as potassium phosphate, sodium phosphate, sodium chloride, silicon dioxide (each @25mM, 50mM), and ferric chloride (@5mM, 10mM), were evaluated for their effects on induced resistance during the investigation. Physical and biological analyses of brinjal were performed. With these, the disease can be controlled and its severity decreased from 59.20% (Silicon dioxide@50mM) to 19.09% (Ferric chloride@5mM) in control. The plants were given inducers before the infection challenge to increase their sensitivity and levels of soluble proteins and phenolic chemicals. The content of soluble proteins was 45.93 mg/g of leaf after 72 hours of treatment with ferric chloride@5mM. Phenol, a marker for the first stage of the defense mechanism, was discovered in ferric chloride@5mM at a concentration of 4.98 mg/g along with protein. Total phenol content and soluble protein content both had an indirect correlation with the disease severity ( $r = -0.71135$  to  $-0.75186$  and  $-0.67646$  to  $-0.89193$ , respectively).

### OP 04(S1A): Real time detection and transmission of viruses (ApMV and ApNMV) associated with mosaic disease of apple (*Malus domestica*)

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Among viral diseases apple mosaic disease (AMD) is economically most important viral disease associated with apple cultivation, having widespread distribution and a major threat to apple industry throughout the world (Li et al.2002 and Nabi et al. 2022). The mosaic symptoms pattern on the leaves has a direct bearing on the photosynthetic ability of the plant reducing it upto 46% and thereby reducing the fruit yield by 20-30%. Earlier only apple mosaic virus (ApMV) was found to be associated with AMD, however, several other viruses, viz., apple necrotic mosaic virus (ApNMV), prunus necrotic ring spot virus (PNRSV), cucumber mosaic virus (CMV) During present study we have applied high throughput sequencing of mosaic infected apple cultivars and the the results confirmed the association of new virus ApNMV individually or in association with ApMV. To confirm further the presence of ApMV and ApNMV, various commercially grown cultivars showing mosaic symptoms were tested for presence of both the viruses. The results showed that the association of ApNMV with mosaic disease was more common than ApMV. However, given the strong correlation between the ApNMV distributions among various cultivars, it is likely that ApNMV is a major cause of the mosaic symptoms in Indian apple cultivars. Both the viruses belong to Illarivirus and being labile in nature, their titer varies negatively with high temperatures, which needs proper tissue as well as time for real time detection within the plants. To understand the distribution and titre of ApMV and ApNMV in apple trees from different plant parts (spatial) during different seasons (temporal) for

optimization of tissue and time for their timely detection. The Reverse Transcription-Polymerase Chain Reaction (RT-PCR) and Reverse Transcription-Quantitative Polymerase Chain Reaction (RT-qPCR) was carried out to detect and quantify both the viruses in various plant parts of apple trees during different seasons. Depending upon the availability of tissue, both ApMV and ApNMV were detected in all the plant parts during spring season using RT-PCR. During summer both the viruses were detected only in seeds and fruits, whereas in leaves and pedicel during autumn season. The RT-qPCR results showed that during spring the ApMV and ApNMV expression was higher in leaves, whereas in summer and autumn the titre was detected highest in seeds and leaves respectively. The leaves during spring and autumn, whereas seeds during summer season can be used as detection material via RT-PCR for early and rapid detection of ApMV and ApNMV. Transmission was undertaken for ApNMV in mixed infection with ApMV, through grafting and budding as both viruses are difficult to transmit via mechanical inoculation in apple. Eight and three rootstocks were used for grafting and budding respectively with scion wood from ApMV and ApNMV infected apple cultivar Golden Delicious. Development of mosaic symptoms was scored over time and symptoms were first seen on two rootstocks MM106 and MM111 after 60 and 280 days after grafting and budding respectively. The number of days after which symptoms were developed on each rootstock ranged from 60 to 80 days in grafting, whereas it was observed as 280 days in budding. The comparative transmission efficiency of mosaic associated viruses was found more in grafted plants (61.5%) than budded plants (25%) on three rootstocks studied in both approaches. Both the viruses were confirmed from grafted/budded plants through conventional RT-PCR using ApMV and ApNMV specific primers. Our results demonstrated that grafting/budding inoculation methods are efficient for transmission of both the viruses (ApMV and ApNMV) and the established protocol will help in maintaining the virus isolates for long term as well as help in screening the germplasm for resistance. The future of the disease includes the development of point of care detection along with host pathogen interaction for better management of the disease.

### OP 05(S1A): New report of a bacterial wilt disease in bush cowpea (*Vigna unguiculata*) caused by *Klebsiella pneumoniae*

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Typical wilt symptoms were observed in bush cowpea (*Vigna unguiculata* subsp. *unguiculata* (L.) Verdcourt) at IFSRS, Karamana, Trivandrum, Kerala with wilting and drying of green leaves, collapse of stem and eventual death of plants. Ooze test confirmed the presence of bacteria. Bacterial colonies were off white, fluidy, circular, mucoid and convex with pink colouration at centre on Triphenyl tetrazolium chloride (TZC) medium. The isolate was gram negative, rod shaped, facultatively anaerobic, negative for Kovac's oxidase test and positive for esculin hydrolysis, glucose fermentation, arabinose and urease tests which were consistent with *Klebsiella pneumoniae*. BLASTn analysis of 16S rRNA and rpoB loci amplified sequences revealed 100 per cent identity with *Klebsiella pneumoniae*. The sequence was deposited in NCBI database (Acc. no. OP554812). Phylogenetic analysis using maximum likelihood analysis of rpoB sequences confirmed the bacteria as *K. pneumoniae*. Thus, BLASTn, phylogeny and multiple sequence alignment results confirmed the identity as *K. pneumoniae*. Stem of two-week-old twenty plants were injected with 2 ml of bacterial suspension ( $10^7$ cfu/ml). The inoculated plants exhibited symptoms at 15 days after inoculation and *K. pneumoniae* was re-isolated and confirmed by morphology, biochemical studies and BLASTn analysis proving Koch's postulates. No disease symptoms were observed and no bacteria could be isolated from

non-inoculated negative control plants. This is the first report of bacterial wilt caused by *Klebsiella pneumoniae* in bush cowpea in India and world. The disease results in 100 per cent plant mortality thereby, demanding urgent attention towards its management and further studies.

### OP 06(S1A): Molecular characterization of fungal species found on major crops in Mauritius

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The aim of this study was to investigate the occurrence and distribution of the major diseases of the major crops in Mauritius and carry out in depth studies on the causal fungal pathogen and their diversity. The major crops studied included potato, tomato, onion and chillies. Potato late blight (PLB) was by far the most important potato disease in Mauritius. The main fungal disease affecting tomato was early blight, caused by *Alternaria solani*. Stemphylium Leaf Blight (SLB) disease was one of the most serious and destructive disease of onions and the major limiting factor in its production. Anthracnose, caused by *Colletotrichum* species is recognized as a devastating fungal disease and as the main hurdle in chilli production, resulting in high yield losses reaching 80% under high disease severity condition. The current study aimed to characterize the fungal species in Mauritius based on morphological and cultural attributes as well as at the molecular level using ITS gene and multi-locus phylogenetic analyses. Proper and precise identification of fungal species in these major crops will result in more efficient disease control and management.

### OP 07(S1A): Diagnosis of emerging fungal pathogen on robusta coffee

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Coffee is one of the leading commodities in the international trade and comes next to the petroleum products in terms of volume and foreign exchange. Coffee cultivation in India is unique as it is grown under multi-tier shade in simulated micro-climate. Disease management in coffee plantations plays an important role. Both arabica and robusta are susceptible to fungal diseases. Important coffee diseases seen in field are leaf rust, black rot, stalk rot, stem canker and root diseases but in recent years because change in climate some of the new diseases are emerging and minor diseases are becoming major. Random visits to coffee plantations in Chikkamagaluru districts consequent to the report of heavy berry drop and blackening of berries in robusta coffee plantations were undertaken as per the request of planters. Interestingly, we could observe a characteristic symptom of black rotten berries with prominent white thread like structures of mycelia and minute brown color sclerotial bodies on the infected berries all along the twigs which were different from that of generally noticeable diseases like black rot or stalk rot disease symptoms. These samples were collected and subjected for isolation of the fungus on potato dextrose agar medium. After isolation and purification of the fungus, sub-cultured and morphological characters were recorded, white colour, fluffy and fibrous mycelial growth was observed five days after inoculation and light to dark brown colour small round to large irregular shaped sclerotial bodies were noticed on culture plates twenty days after inoculation. By these observations it is confirmed the infection of fungus *Sclerotium rolfsii*. Due to erratic rains with heavy downpour continuously without any dry spell and water stagnation in coffee plantations predisposes the infection of *Sclerotium* in robusta coffee. This type of infection by *Sclerotium rolfsii* is first report on the robusta coffee in India. Further, systematic studies for management are in progress.

## Session 1B. Diagnostics: Issues and Innovations

### KEYNOTE LECTURES

#### KN 01(S1B): Plant virus detection, innovations, and issues

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Globally Plant viruses cause serious diseases that lead to significant losses in agriculture and horticulture, costing several billion dollars each year. It has been reported that many pathogens infect several crops; however, new infectious viruses emerge frequently through outbreaks. An effective virus management strategy requires an accurate, rapid, sensitive, and cheap diagnosis of viral diseases. With the advancements in biochemical and molecular biology techniques, several diagnostic methods with improved sensitivity and specificity for the detection of prevalent and/or unknown plant pathogens are being continuously developed. Enzyme-linked immunosorbent assay (ELISA) or polymerase chain reaction (PCR) has been widely used for the detection of plant viruses. These methods are time-consuming and laborious and require special skills such as prior information on taxonomy to detect the pathogen responsible for the disease. For several plant viruses, new novel detection methods are being developed, including on-site or point-of-care Lateral flow devices (LFDs), loop-mediated isothermal amplification (LAMP), and recombinase polymerase amplification (RPA). Next-generation sequencing (NGS)-based innovative methods like nanopore based detection have shown great potential to detect multiple viruses simultaneously. New on-site portable devices and technologies that could provide real-time analyses in a relatively short period of time are prime important for in-field diagnostics. In this presentation, special emphasis is given to the detection of pathogens in banana. Herein we emphasize the development and application of diagnostic methods has accelerated in recent decades and the adoption of new methods by plant diagnostic lab along with their potential limitations to detect plant viruses are discussed in detail.

#### KN 02(S1B): Concern of aflatoxin in food grain contamination and identification of resistance sources for aflatoxigenic (AFB1) *Aspergillus flavus* in Indian maize inbred lines

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Safety of food and feed, and also the agricultural economy are influenced by exposure of mycotoxins. After a successful crop culture, grains may be contaminated during the process of harvesting, storing, and transportation by a group of mycotoxin producing fungi. Maize grains are prone to infection of the moulds like *Aspergillus* and *Penicillium*. Presence of potentially dangerous aflatoxin B1 (AFB1), the secondary metabolites, in food and feed is detrimental to both humans, poultry and livestock. Aflatoxin B1 (AFB1) is widely studied mycotoxin due to its highly toxic and hepatocarcinogenic nature. We dealt one highly aflatoxigenic *Aspergillus flavus* isolate viz., AF-3 isolated from maize grains. Existence of aflatoxin B1 in maize kernels was verified by indirect competitive ELISA test using aflatoxigenic isolates. In kernel screening assays, kernels of thirty maize inbred lines were tested for fungal (*A. flavus*) colonization. Of these, eight maize lines (M2, M4, M5, M6, M7, M9, M17 and M22) exhibited lower fungal colonization and poor aflatoxin B1 level than other tested lines. Further, amplification of *Trypsin inhibitor (TI)* gene was found in eight maize inbred lines whereas it was not visualized in the remaining inbred lines. In western blotting

test, same eight lines revealed positive result in TI enzyme assay and presence of 14 KDa TI proteins which governs resistance to *A. flavus* colonization in maize kernel. Interestingly it was inversely related to aflatoxin B1 build up. As per the reports, TI proteins contribute host resistance in maize against AFB1 that build up by aflatoxigenic *A. flavus*. Consequence of existence of AFB1 leads to significant health danger and hence its management remains always the chief concern. Among the numerous management resources available, use of inherent resistant host plant lines is a crucial, long-term eco-friendly strategy. Here we report few most promising inbred lines of maize viz., M2, M4, M5, M6, M7, M9, M17 and M22 which could be utilized in developing *A. flavus* hybrid maize resistant to aflatoxin contamination.

### **KN 03(S1B): Transboundary movement of plant pathogens: A global crop biosecurity threat**

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Emerging, re-emerging and endemic diseases continue to challenge our ability to safeguard plant health. The rush to global market systems that connect countries with well-developed plant biosecurity infrastructure to countries with poorly developed and ineffective plant biosecurity infrastructure will continue to have consequences of spread of pests. National Plant Protection Organizations have the responsibility to protect their crops from transboundary pests including pathogens. The combination of regulatory and technical approaches would ensure biosecurity of crops against pathogens for a country/region. In India, the Directorate of Plant Protection, Quarantine and Storage under the Ministry of Agriculture and Farmers' Welfare is responsible for enforcing quarantine regulations and for quarantine inspection and disinfestation of commodities meant for commercial purpose. The imported germplasm material including transgenics are subjected to quarantine processing at the ICAR-National Bureau of Plant Genetic Resources, New Delhi. The Plant Quarantine (Regulation of Import into India) Order, 2003 requires *Additional Declarations* to be included in Phytosanitary Certificate for seeds and other planting material as free from pests. As per the PQ Order, 1261 pests are regulated pests which are of quarantine significance for India. Also, the PQ Order stipulates post-entry quarantine growing of plant propagative materials of specific commodities for specific period in a confined area to prevent spread of exotic/ economically important pests, especially plant pathogens that are associated with import. The role of diagnostics for detection of pathogens which threaten biosecurity is well established. Also, Early, sensitive and accurate diagnosis is necessary for detection of pathogens in quarantine. The technique should be reliable for quarantine requirements, reproducible within statistical limits, economical and should be rapid. The challenges in pathogens detection include availability of reference material, antisera, pathogens genome sequences in GenBank, detecting an unknown pathogen etc. Attention is now given to user-friendly lateral flow strips, database on sequences of pathogen-specific primers, Multiplex PCR, Real-time PCR, LAMP, HAD, RPA, high throughput sequencing etc. Adopting a strategy of post-entry quarantine growing/inspection followed by use of combination of conventional, serological and molecular detection techniques several pathogens of great economic and quarantine importance were intercepted in imported germplasm including transgenics in the last two decades. The interceptions include several pathogens not yet reported from India and not known to occur on particular host(s) in India. India need to establish a National Plant Pests Diagnostic Network of interconnected diagnostic laboratories and strong surveillance programme to identify new pathogens. By closely monitoring which pathogens are most frequently reported from which countries, and what commodities tend to be infected, it may be possible to predict high-risk pathogens and commodities. Adopting the reliable diagnostics and following quarantine regulations strictly would go a long way in ensuring crop biosecurity against transboundary pathogens through quarantine, pest-free trade and exchange of germplasm.

## INVITED LECTURES

### IL 01(S1B): *Ceratocystis fimbriata* in pomegranate can be manageable? Present status and future prospective

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Pomegranate (*Punica granatum* L.) is one of the important fruit crop and the world surface dedicated to the cultivation of pomegranate is more than 300,000 ha. The leading producers globally are India and China followed by Iran, Turkey, Afghanistan, the US, Iraq, Pakistan, Syria and Spain (UNECE Report, 2022). In India area (000 ha) and production (000 MT) was 288 and 3271, 278 and 3188 during year 2020-21 and 2021-22 respectively. However, the estimated global cultivated area under pomegranate is around 3 lakh ha and production of 3.0 million tones. It has nutritional and therapeutic values because of presence of several bioactive phytochemicals like sterols, terpenoids, organic acids, flavonoids, catechin, procyanidin, anthocyanidins. Its juice is popular for culinary purpose, also used in jelly and wine preparation. Maharashtra contributes more than 75% of the total area alone followed by Karnataka and Andhra Pradesh. In arid and semi-arid regions of Karnataka, the area under pomegranate is fast dwindling due to onslaught by a number of diseases. Among the diseases, pomegranate wilt is the most important disease and which produces symptoms *viz.*, yellowing of the leaves, epinasty, wilting and complete drying. Wilting of pomegranate is purely due to infection by *Ceratocystis fimbriata* and it was first reported by Somasekhara, 1997 in Karnataka. The wilt is disease is also more prevalent in Maharashtra, Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu states (Jadhav and Sharma, 2009). If roots of partially wilted plant are observed near soil surface by splitting them, black brown streak are observed. There are many views regarding the cause of disease, such some insect like pinhole boring the trunk near roots and on main roots, nematode infestation on root, unfavourable soil condition, improper irrigation and less spacing between the plants. Finally the severity of wilt is caused by *Ceratocystis fimbriata* is confirmed, wilt is considered to be one of the destructive disease and causes losses about 5 to 13.2 per cent (Navyashree *et al.*, 2022). The pathogen spreads through infected seedlings, sanitation measures such as removal and destruction of affected trees, soil sterilization can check the disease. The disease with the objectives *viz.*, isolation of causal organism, it's identification, pathogenicity, and symptomatology of disease, cultural characteristics, molecular characterization and *in-vitro* efficacy of fungicide against *C. fimbriata* has been studied by Navyashree *et al.*, 2022. Under field conditions, indicated that, twice drenching with propiconazole (0.1%) at 30 days interval recorded significantly lowest disease incidence of 46.30 per cent followed by propiconazole 13.9 % + difenoconazole 13.9 % EC at 0.1 per cent and mancozeb at 0.2 per cent with disease incidence of 50.23 and 51.15 per cent respectively when compared to control (100%). Pomegranate wilt can be managed by using integrated methods of soil, water and plant health management practices.



## IL 02(S1B): Epidemiology and molecular characterization of yellow vein mosaic disease of Pumpkin

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Pumpkin yellow vein mosaic virus (PYVMD) is one of the important viral diseases, which decrease the yield significantly in pumpkin and the virus is readily transmitted by whitefly, *Bemisia tabaci*. The per cent incidence of mosaic disease based on symptoms in the field was noticed highest in Kolar district (22.30 %) and the least incidence of mosaic disease was observed in Chikkaballapura (19.20%). Highest per cent disease incidence and whitefly population was found during *summer* season followed by *kharif* and *rabi* season. Host range studies revealed that among the different plants studied, 3 plant species such as ridge gourd, squash and bottle gourd were infected with the PYVMD under artificial conditions. Comparison of the nucleotide sequence of pumpkin infecting SLCCNV isolates under study with selected begomoviruses using SDT showed that three SLCCNV isolates (SLCCNV-TMK, SLCCNV-DBPSLCCNV-BLR) shared nucleotide identity of 93% to 97.70% nucleotide identity with SLCCNV (EU573715). Further RDP analysis of DNA-A and DNA-B components of three SLCCNV isolates (SLCCNV-TMK, SLCCNV-DBPSLCCNV-BLR) revealed that in most parts its genomes is derived from previously identified begomo viruses (SLCCNV and TOLCNDV) already prevailing in India.

## IL 03(S1B): Pathological investigation and morpho-molecular characterization of *Lasiodiplodia theobromae* associated with leaf spot and blight disease of *Coscinium fenestratum* (Gaertn.) Colebr. – First global record from India

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The present study investigates a new leaf spot and blight disease of *Coscinium fenestratum*, a high demanding critically endangered medicinal plant found in Western Ghats of India. The leaf spot and blight was observed in Kerala during 2021 with disease incidence of 40% in twenty assessed plants. The associated fungus was isolated on PDA medium. A total of six isolates were identified morphologically. Based on morpho-cultural features, the fungus was identified as *Lasiodiplodia* sp. which was further confirmed by molecular identification using a representative isolate (KFRIMCC 089). For molecular characterization, the internal transcribed spacer (ITS), large subunit rRNA (LSU), small subunit rRNA (SSU), beta tubulin (TUB2) and translation elongation factor-1 alpha (TEF1- $\alpha$ ) genes were amplified and sequenced using ITS1/ITS4, LROR/LR7, NS1/NS4, Bt2a/Bt2b and EF1-688F/EF1-1251R primer pairs respectively. The NCBI-nBLAST search and concatenated (ITS-TEF1- $\alpha$ -TUB2 loci) phylogenetic analysis confirmed the pathogen identity as *Lasiodiplodia theobromae*. Pathogenicity tests were assessed *in vitro* and *in vivo* using mycelial disc and spore suspension of *L. theobromae* and the pathogen's behaviour was confirmed after re-isolation and morpho-cultural features. Literature survey reveals that there are no reports of *L. theobromae* on *C. fenestratum* from all over the world. Hence, this is the first global report of *L. theobromae* associated with leaf spot and blight of *C. fenestratum* from India. Since, the plant is highly valued medicinally and used widely in preparation of many

Ayurvedic medicine formulations. Hence, proper management strategies for managing this leaf spot and blight disease need to be developed to reduce losses.

### OP 01(S1B): Diversity, phylogeny and current diagnostics of invasive and emerging *Phytophthora* species in fruit crops with special reference to citrus

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*Phytophthora* species are notorious plant pathogens which cause a variety of devastating crop diseases. More than 60% of all root diseases and more than 80% stem rot diseases on all horticultural plants are caused by *Phytophthora* spp. *Phytophthora* is a genus on the move. Approximately 200 species have been described so far, although 100-500 undiscovered *Phytophthora* species are estimated to exist. With the advent of DNA sequencing, the taxonomic concept for the genus has evolved from morphology to molecular phylogeny-based. *Phytophthora* spp. induce an array of diseases viz. root rot, crown rot, foot rot, gummosis and brown rot of fruits in citrus causing severe decline and yield losses in India. During last decade, over 300 citrus orchards in fifteen citrus growing states were surveyed for the occurrence of *Phytophthora*. A total of 257 isolates belonging to 11 different *Phytophthora* species (180 isolates of *P. nicotianae*, 47 isolates of *P. palmivora*, 7 isolates *P. citrophthora*, 9 isolates of *P. insolita*, 4 isolates of *P. boehmeriae*, 3 isolates of *P. heveae*, 2 isolates of *P. tropicalis*, 2 isolates of *P. macrochlamydospora*, 1 isolate of *P. inundata* 1 isolate of *P. virginiana*-like and 1 isolate of *P. lacustris*) were recovered from rhizosphere soil and water, root, leaf, bark and fruit samples. Isolates were identified to the species level through morphological traits, PCR-RFLP analyses of the internal transcribed spacer (ITS) region and sequence analyses of the ITS region,  $\beta$  tubulin gene, translation elongation factor 1 $\alpha$  and cox 1 and 2 gene fragments. Detection of new spp. adds to the biodiversity of *Phytophthora* in India.

### OP 02(S1B): Identification, Pathogenicity and phylogeny of new reports of fungal pathogens associated with foliar and soil-borne diseases of mulberry (*Morus* spp.) in India

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The mulberry diseases were broadly categorized as foliar and soil-borne diseases. Out of various foliar pathogens, the fungal pathogens are more serious and prevalent. Leaf spot is one of the major foliar diseases in mulberry which affects the nutritive value of leaves and makes unsuitable for feeding to silkworm larvae. Similarly, root rot is become major epidemic soil-borne disease in mulberry limiting its production. In the present study, leaf spot and root rot samples from various farmers' field and panel of diverse germplasm were collected and isolated the associated fungal pathogens. Morpho-cultural and molecular characterization was carried out for identification. The several fungal pathogens which were previously reported on mulberry were isolated and identified. Whereas, few isolates identified as *Geotrichum candidum*, *Bipolaris sorokiniana*, *Curvularia lunata*, *C. sphaerospermum*, *C. tenuissimum* and *Epicoccum sorghinum* which new reports from the present study in India from mulberry. Hence, detailed study was conducted to prove the pathogenicity of these new pathogens on popular mulberry cultivars (G4 and V1). It was proved that all the new isolates were found to be pathogenic on mulberry. Phylogenetic analysis

using internal transcribed spacer (ITS) was carried out to identify the pathogens. It was found that ten fungal pathogens were identified to be associated with leaf spot of mulberry as causal agent. Among them five pathogens *Bipolaris sorokiniana*, *Curvularia lunata*, *C. sphaerospermum* and *C. tenuissimum* and *E. sorghinum* were reported first time in India. Similarly, four root rot causing pathogens were identified, in which *Geotrichum candidum* was first report in India. Further, fungicides were screened for the management of these pathogens and found 100 per cent inhibition of mycelial growth over control *in vitro* by six fungicides. Future studies should be undertaken on field efficacy of these fungicides and extent of crop loss by these newly identified pathogens in mulberry.

### OP 03(S1B): Multigene Phylogenetics and Morphology Reveal *Neoscytalidium dimidiatum* Association with Stem canker of Dragon fruit (*Hylocereus spp*) in India

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Presently, dragon fruit (*Hylocereus spp*), an exotic fruit crop became very popular among Indian growers and consumers. Inherent health benefits and endurance under adverse climate increased its world acceptance. *Hylocereus polyrhizus* and *H. undatus* are predominant dragon fruit species grown throughout the India. However, its marked profitability has been hampered due to certain biotic and abiotic constraints. Emerging diseases are frequently faced biotic constraint in case of new introductions and prevalence of dragon fruit stem canker can be considered as one of them. Stem canker symptoms start with small, circular, sunken, chlorotic to orange brown spots which turn to canker lesions with black erumpent pycnidia followed by subsequent yellowing and stem rotting in affected plant parts. During, 2021 and 2022 dragon fruit plantations from 10 districts of Maharashtra were surveyed, showed the symptoms of stem canker disease. Disease symptoms were recorded on all three types viz., *H. undatus*, *H. polyrhizus* and *H. megalanthus*. Unmanaged orchards showed >50% disease severity. In the present study, total 25 isolates from different districts of Maharashtra were collected and based on morphological, phylogenetic analyses of internal transcribed spacer (ITS),  $\beta$ -tubulin (*tub2*) and translation elongation factor 1- $\alpha$  (*Tef-1 $\alpha$* ) gene sequences, the pathogen was identified as *Neoscytalidium dimidiatum*. Pathogenicity were tested by detached stem assay and confirmed the association of *N. dimidiatum* with stem canker disease. This is the first record of *N. dimidiatum* causing dragon fruit stem canker in India. This study provided the scientific basis for development of appropriate management strategies.

### OP 04(S1B): Report of Cashew leaf blight disease (CLB) caused by *Neopestalotiopsis clavispora* from India

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Cashew (*Anacardium occidentale*) is an important commercial crop and is highly prone to many biotic and abiotic stress. During March 2021, severe leaf blight symptoms were observed with 25-30% incidence in the nursery at Indian Council of Agricultural Research-Directorate of Cashew Research, Puttur (12°740892' N and 75°229722' E with 97 m above MSL), Karnataka. The typical symptoms were characterized as minute to irregular necrotic spots at the margins of leaf, leaf midrib and leaf petiole. These spots enlarged, turn grey-silvery in colour by covering the

major portion of the leaf lamina. Severely affected leaves showed blight appearance and premature defoliation. The mycelial growth on potato dextrose agar media appeared whitish in colour. The growth pattern also had crenate margins and smooth margins, while others had smooth margins. Topography of the colonies was predominantly raised and fluffy, and zonations were also observed. The conidia were fusiform, five-celled, versicoloured with three olivaceous brown median cells, two apical and basal hyaline cells. The apical cells had two to three flexuous, unbranched appendages, and basal appendage was solitary, tubular and unbranched. Morphological and cultural characteristics confirmed the pathogen as *Neopestalotiopsis* sp. Further, molecular characterization of multi genes viz., internal transcribed spacer (ITS), translation elongation factor (TEF),  $\beta$  tubulin and large subunit (LSU) was done to confirm the species identity. The multi gene sequences were analyzed using nucleotide BLAST in NCBI database and confirmed the species as *Neopestalotiopsis clavispora*. ITS gene sequence was submitted to NCBI with the GenBank accession No. OM679447. A phylogenetic tree was generated using multigene sequences obtained from NCBI database. Based on the cultural, microscopic and molecular characterization the pathogen was confirmed as *Neopestalotiopsis clavispora*. This is first confirmed report of cashew leaf blight disease (CLB) caused by *Neopestalotiopsis clavispora* from India.

### OP 05(S1B): Diagnosis of emerging new fungal pathogens in important flower crops through multi locus molecular phylogeny

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Fungal pathogens are becoming severe constraints in agriculture systems. There are known fungal diseases causing severe damage to the agriculture production and scientists are working tirelessly and managing crop diseases. Diagnosis and identification of pathogens to the respective species is becoming more complicated due to cryptic nature and utilization of molecular tools is inevitable to aid the identification process. Further, there are new and emerging diseases (new species, new variants, subspecies) which creating severe problems and for many of these, we don't have suitable management strategies. Proper diagnosis will help proper designing of the management strategies and for that increased exploration using advanced molecular techniques is a must. In the present investigation, we recorded several new and emerging fungal diseases associated with flower crops cultivated in Karnataka. These include *Crossandra infundibuliformis*, *Callistephus chinensis*, *Jasminum multiflorum*, *Tagetes erectus*, *Gomphrena globosa*, *Jasminum sambac*, *Polianthes tuberosa*, and other commercially valued important plants. Conventional phytopathological process and principles followed to establish the cultures and micro-morphological studies were carried out. After, establishing pure cultures, identity was also established through molecular sequence data and comparative phylogeny. The study revealed the occurrence of new host records (*Diaporthe*, *Pestalotiopsis*, *Colletotrichum*, *Fusarium*), new geographical records (*Neopestalotiopsis* sp., *Melanospora* sp., *Chaetomium* sp.) and along with new species (*Neopestalotiopsis* sp., *Didymella* sp., *Xylaria* sp., *Puccinia* sp. etc.) lineages were observed after concatenated phylogenetic analysis. The study determined that it is very much vital to re-look on the plant diseases and exploring their diversity using advanced molecular tools, to better maneuver management tactics for effective management.

### OP 06(S1B): First report of *Colletotrichum kahawae* subsp. *ciggaro* causing leaf spot disease on arecanut, *Areca catechu* L. in India

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During 2018 post-monsoon season (October-November), severe outbreak of leaf spot disease was reported from the farmer's gardens located in Kalasa hobli, Chikkamangaluru, Karnataka, India where arecanut is cultivated along with coffee plantation. Leaf spot symptoms started as small, irregular, light to dark brown spots with yellow halo which gradually extended to form irregular lesions, and finally, become necrotic with grey center and brown margin with typical yellow halo. Spots on leaves coalesce to form blight appearance. Cultural, microscopic, molecular characterization using multi-gene phylogeny [Calmodulin, Glutamine synthetase, glyceraldehyde-3-phosphate dehydrogenase,  $\beta$ -Tubulin, and Apn2-Mat1-2 intergenic spacer and partial mating type gene (Ap-Mat)] and pathogenicity assays with Koch's postulates established the association of *Colletotrichum kahawae* subsp. *ciggaro* as the causal agent of arecanut leaf spot disease. To the best of our knowledge, the current investigation confirms the first report of leaf spot disease caused by *C. kahawae* subsp. *ciggaro* in arecanut from India.

### OP 07(S1B): New convenient disease rating scale for the resistant screening against Begomoviruses causing yellow mosaic disease in different crops

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The utmost care is required for the measurement of disease in resistance screening as a minor error may lead to the inappropriate selection and collapse of the entire breeding program. Resistance screening aims to select the highly resistant or resistant germplasm. For this, we should pay more attention to the germplasm showing no disease symptoms or very mild symptoms. Severely symptomatic plants efficiently represent crop loss; therefore, they cannot be ignored in the disease appraisal. However, it does not have any significance in the resistance screening. Accordingly, modifying a disease rating scale by focusing more on plants with mild symptoms can enhance precision. The proposed disease rating scale has been prepared on this principle. Proposed rating scale, a score of 0 indicates no visible symptoms, 1 indicates small yellow specks covering 0.1 to 5%, 2 indicates the yellow mottling of leaves covering 6 to 10%, 3 indicates yellow mottling of leaves covering 11 to 30%, and 4 indicates yellow mottling and discoloration of 31 to 100% leaf area of the plant. The scale uses absolute values as it is estimated by the observer based on visual observation. However, the categorization of the disease reaction of various genotypes is based on PDix which is a calculated value; it has been represented as more than an absolute value. The line having a disease rating of 0 is considered disease free, >0 to <13 is highly resistant, >13 to <26 is resistant, >26 to <50 is susceptible, and >50 to 100 is highly susceptible.

## Session 2. Phytobiome and Microbiome: Challenges and Advances

### KEYNOTE LECTURE

#### KN 01(S2): Tailoring plant microbiome for disease management in fruit crops

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Plant health management through disease redressal is one of the priority research agenda in horticultural crops including fruits for production sustainability as well as to sustain human health. Plants and the microbes have co-evolved, and during the process the healthy plants have harbored taxonomically structured diverse microbial communities known as phyto microbiome that confer multifaceted advantages to the plant viz., growth promotion, disease suppression etc. These plant beneficial microbes, have now become new normal in plant health care programme including disease management programmes in fruit crops. The successful management of crown gall pathogen *A. tumifaciens* by using *Agrobacterium radiobacter* K 84, have paved the way of microbial technologies in disease management under organic and integrated production system. Microbial antagonists have been successfully used to control of soil borne pathogenic genera represented by Pythium, Phytophthora, Rhizoctonia, Fusarium and Sclerotium, in a wide range of crops like banana, citrus, papaya, strawberry etc. where microbial antagonists such as *Trichoderma* spp., *Bacillus subtilis*, *Gliocladium* spp, *Pseudomonas* spp, *Agrobacterium radiobacter* proved their worth beyond any doubt. Fusarium wilt of banana caused by *Fusarium oxysporum* fsp *cubense* Tropical race-4 is an example of successful disease management through microbial antagonists under field conditions with *T. reesei*. Fungal antagonists, such as *Chaetomium* sp, *Aureobasidium* sp and *Phoma* spp. were also reported to inhibit the growth of apple scab fungus, while other antagonists such as *B. subtilis* and *T. koningii* have been effective in controlling apple canker. However, technologies need large scale field validation. Onus has now been given to non chemical management of post harvest diseases considering the harmful residual toxicity of fungicides as well as keeping in mind the consumer demand for residue free fruits/vegetables. Such research is still in its infancy, and hence microbe based bioformulation designed against post harvest diseases, standardization of application methods are considered a research priority. Moreover, development of cell free bioactive compound based products may also present another frontier in both field and post harvest disease management in fruit crops.

### INVITED LECTURES

#### IL 01(S2): On the macrofungal resources of southwest India

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Macrofungi (mushrooms) are versatile non-conventional sources of a human diet consisting of amino acids, vitamins, minerals, bioactive compounds and therapeutics. The geographic locations of southwest India encompass a variety of ecosystems in the Western Ghats, foothills, coastal plains and maritime regions. The wide climatic conditions as well as the type of ecosystems in southwest India influence the diversity, distribution and dissemination of macrofungi. The species and sporocarp richness were higher in the Western Ghats forests than in other coastal ecosystems. The core-group fungi recorded so far are unique to the southwest Indian ecosystems

without much overlapping. Although soil, leaf litter and woody litter have been mainly studied in southwest India, other substrates are less studied (e.g. animals, animal excrements and termite mounds). Macrofungal mutualistic association in southwest India needs special attention (e.g. ectomycorrhizae, bipartite association and tripartite association). Traditional knowledge of tribals on macrofungal identification (edible, medicinal and poisonous) needs more emphasis. Special attention needs to be implemented in southwest India (in forests, agroforests, plantations, sacred groves and agricultural lands) for sustainable growth, harvest, utilization and domestication of wild macrofungi. The present talk emphasizes the diversity, distribution and ecological studies on macrofungi of southwest India along with their significance in soil ecosystems.

### **IL 02(S2): Effect of inoculation method on endophytic colonization of cashew seedlings with the entomopathogenic fungus *Beauveria bassiana* (Balsamo) Vuillemin (Ascomycota: Hypocreales)**

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Cashew (*Anacardium occidentale* L.) is one of the important commercial plantation crops in India. Damage inflicted by pests and diseases is a major production constraint in cashew cultivation. Pest management of cashew has been achieved with application of chemicals, but pesticides often have limited effectiveness due to the cryptic nature of pests and diseases inhabiting cashew. Fungal endophytes are well known to contribute plant fitness benefits, enabling adaptation of the plant host to biotic and abiotic stresses. It is well recognized that the entomopathogenic *Beauveria bassiana* (Balsamo) Vuillemin has ability to endophytically colonize different plants. The aim of this research was to establish *B. bassiana* in cashew plants. A study was conducted to determine the effect of different inoculation method on colonization of cashew seedlings with *B. bassiana* applied as foliar sprays, stem injections, and soil drenching. The colonization by *B. bassiana* was assessed 40-days after application of the fungus with varying extent of establishment. Foliar inoculation of seedlings with fungal conidia resulted in substantial endophytic colonization in leaves or stem, but caused no root colonization. Inoculation by direct stem injection of *B. bassiana* poorly colonized the cashew seedlings. Soil drenching resulted in better root colonization but caused poor stem or no leaf colonization. The higher intensity of endophytic colonization occurred in leaves, roots and stems in the order mentioned. Endophytic colonization by *B. bassiana* had no adverse effects on the growth of cashew plants. Further research should focus on the virulence of endophytic *B. bassiana* against major pests and diseases infesting cashew plants.

## **ORAL PRESENTATIONS**

### **OP 01(S2): Exploring potential of Endophytic Biodiversity from North Western Himalayas for new pharmacophores**

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The Himalayan region with its wide range of altitudes, topography, and climatic conditions, is rich in medicinal wealth repositories. More than 800 valuable medicinal plants are reported from this part of India. These have been

used by the locals since time immemorial for curing various ailments. The medicinal plant sector possesses great potential to uplift the economy of India, however, various developmental and anthropogenic pressures on the forests and unscrupulous/unscientific exploitation of medicinal plants in the wake of their increasing national and global trade demand have caused severe depletion of the medicinal plant's resource base thereby affecting the health and livelihood options of the people. Medicinal plants are gaining global attention owing to the fact that herbal drugs are cost-effective, easily available, and with negligible side effects. Bioactive natural products of medicinal plants have long been and will continue to be an important source of medicinal raw materials. The natural habitats for wild medicinal plants are being threatened by over-use and environmental and geopolitical instabilities. Various traditionally used medicinal plants for their ability to host endophytic fungi having antimicrobial potential have been undertaken worldwide. Microorganisms that grow intra-and/or intercellular in the tissues of higher plants without causing over symptoms on the plants in which they live are known as endophytes. They are a potential source of novel natural products for medicinal, agricultural, and industrial uses, such as antibiotics, anticancer agents, biological control agents, and other bioactive compounds. Endophytic fungi are considered an outstanding source of bioactive natural products because there are so many of them occupying millions of unique biological niches growing in different types of environments. The search for new and effective antimicrobial agents has become a necessity due to the rise in the number of super-resistant strains and the failure of currently used antibiotics against them leading to increased global health concerns.

### OP 02(S2): Management of dry root rot (*Rhizoctonia bataticola* (Taub.) Butler) of chickpea using endophytes

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Chickpea (*Cicer arietinum* L.) is the world's most important pulse crop. More than 50 diseases have so far been reported in chickpea. Dry root rot caused by *Rhizoctonia bataticola* is causing severe damage in many chickpea growing regions. In last decades endophytes attracted more and it is a novel resource in biological control of plant diseases. In the present scenario biological control of dry root rot of chickpea offered a great promise over chemical control. A total 40 endophytes (22 bacteria and 18 fungi) were isolated from stem and roots of healthy chickpea plant. Among the endophytes, 19 were isolated from stem and 21 were from root part. The maximum number of endophytes were isolated from DRR tolerant variety ICC-14395 and from susceptible variety Pusa-212, minimum number of endophytes were obtained. In the dual culture technique, all the isolates showed significant inhibition of pathogen. Among the fungal endophytes, IFRE 2 (*Trichoderma yunnanense*) shown the maximum mycelial inhibition followed byBFRE 3 (*Trichoderma simmonsii*) and among bacterial endophytes, IBSE 1 (*Bacillus cereus*) has shown the maximum inhibition of pathogen. In compatibility test, carbendazim and captan were compatible with all the three effective endophytes. Chemicals, thiophanate methyl 45% + pyraclostrobin 5% was incompatible with *T.yunnanense* and *T. simmonsii* and carboxin 37.5% + thiram 37.5% was incompatible with all the endophytes tested. They also found compatible with *Rhizobium* and *Trichoderma harzianum* (IOF, Dharwad). Glass house evaluation results revealed that, combined seed treatment of *T. yunnanense*, *T. simmonsii* and *B. cereus* was effective in controlling the disease, per cent germination and seedling vigour index and T<sub>9</sub>-*Trichoderma harzianum* was superior in plant growth parameters recorded like plant height and fresh weight.



### OP 03(S2): Bioactivity of fungal endophytes and their secondary metabolites against pathogens causing anthracnose and bacterial leaf spot diseases in grapes

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Anthracnose is one of the major diseases of grapes in India caused mainly by *Colletotrichum gloeosporioides*. Bacterial leaf spot is an important disease of grapevine caused by the *Xanthomonas campestris* pv. *viticola* in Maharashtra (Kamble et al., 2019). Management of both the diseases have become important to reduce the crop losses. Therefore, identification of novel fungal endophytes and their metabolites have played a major role in management of these diseases in grapevine. In the present study, a total of 21 fungal endophytes were isolated from the roots (grapevine cv. Manik Chaman) and berries (grapevine cv. Cabernet Sauvignon) on PDA medium. Eleven fungal endophytes were identified based on ITS sequence information as *Trichoderma asperellum* (CSBY1, CSBY2, CSBY3, CSBY4, CSBY5, CSBY6, CSBY7, CSBY8, MCB1, MCB2, and DGRS) whereas, remaining ten endophytes were identified as *Lasiodiplodia theobromae* (MCR1, MCR6, MCR7, MCR8, MCR9), *Pseudofusicoccum adansoniae* (MCR4, MCBK1), *Lasiodiplodia pseudotheobromae* (MCR5), *Lasiodiplodia brasiliensis* (MCR2) and *Alternaria alternata* (MCR3). Indirect confrontation assay revealed that 46.52 to 73.95% mycelial growth inhibition of *C. gloeosporioides* by *T. asperellum* isolates. Root isolates viz., *P. adansoniae* (MCR4: 100%), *L. theobromae* (MCR1 and MCR9: 71.76%) showed growth inhibition of *C. gloeosporioides* *in vitro*. Rest of the root endophytes showed 50.58% to 65.88% growth inhibition of the test pathogen. Besides, MCR4, MCBK1, MCR1 isolates showed 98.77%, 97.50% and 96.60% growth inhibition of *C. gloeosporioides* in dual culture plate assay. Secondary metabolites extracted from most of the isolates significantly reduced the growth of *C. gloeosporioides* and *X. campestris* pv. *viticola* pathogens *in vitro* conditions.

### OP 04(S2): Antifungal activity of potential epiphytic yeasts against banana anthracnose caused by *Colletotrichum musae*

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Postharvest fungal pathogens are considered the main cause of losses of fresh fruits and vegetables at the postharvest, distribution, and consumption levels. The post-harvest issue with ripe bananas is a major issue in bananas, particularly during transportation and storage. The biological management of postharvest diseases with antagonistic yeasts are attracting research focus, due to their wide antimicrobial spectrum, good antagonistic effects, genetic stability, low nutrition requirements, and high security. In this present study, sixty-eight (68) epiphytic yeast isolates from diverse host plants were primarily screened for antagonistic activity against the banana postharvest anthracnose pathogen *Colletotrichum musae*. Among them, only 3 isolates (KG-1, PO-2, LE-1) showed more than 50 per cent radial growth inhibition in *C. musae* and further evaluated under both *in vitro* and *in vivo* conditions for the biocontrol efficacy. The selected yeast isolates KG-1, Po-2, and LE-1 were identified as *Aureobasidium pullans*, *Trichosporon asahii*, and *Hanseniaspora uvarum* respectively based on morphology and molecular study. The *in vitro* antagonistic activity of non-volatile and volatile metabolites from three yeast isolates were also evaluated and *H. uvarum* (LE-1) significantly reduced the growth of aerial mycelium of *C. musae* up to 22.12% and 65%, respectively. Under *in-vivo* assay, all the three isolates showed reduction in disease over control whereas the *H. uvarum* (LE-1) showed maximum disease reduction up to 68.39%. With these possible findings of this study will provide the basis for developing an effective and novel biofungicide to control banana anthracnose disease.

### OP 05(S2): Interplay of biotic and abiotic factors shaping pigeonpea root microbiome

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Pigeon pea (*Cajanus cajan* L. Millsp.) ranks amongst the world's most important legumes and is the main protein source for more than one billion people, with India accounting for about 80% of global production. Poor nodulation and less yield major problems associated with pigeon pea growing soils. Multiple varieties of pigeonpea grown in different regions and very few studies available on host specificity in nodulation and nitrogen fixation. Soil samples has been collected during various stages of plant growth from various fractions of root zones for isolating nodule formers belongs to Rhizobiales members majorly in our studies currently. What factors control the microbiome associating with pigeon pea: genotype, vegetative state or soil type is unknown. The diversity among different fractions of root microbiome i.e. Bulk soil, Rhizosphere, Rhizoplane and Endosphere is limited in leguminous plants and how it changes in pigeon pea is unknown. To address these questions an experiment has been setup with three genotypes and three soil types and various root samples has been isolated during different plant states including vegetative and flowering state respectively. It's first kind of study from pigeon pea to identify important factors playing key role in root microbiome are plant state nested with soil type. None of the Rhizobiales members observed to be biological indicators being classical example of legume-nodule symbiosis.

### OP 06(S2): Plant growth promoting attributes of endophytic bacterial strains inhabiting Eggplant (*Solanum melongena* L.) and their antagonistic potential against important soil borne plant pathogenic fungi

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The study was aimed to isolate, identify and evaluate the potential of endophytic bacterial strains inhabiting *Solanum melongena* L. for plant growth promotion (PGP) and biocontrol against some of the common fungal phytopathogens. A total of 36 endophytic bacteria isolated from *Solanum melongena* L. (Eggplant) were characterized for qualitative PGP traits such as phosphate solubilization, indole-3-acetic acid (IAA), siderophore, ammonia and extracellular hydrolytic enzymes (cellulase, protease, amylase) production, Hydrogen cyanide (HCN) production, 1-aminocyclopropane-1-carboxylate (ACC) deaminase production. Most promising strains SS\_BS01, SS\_BL08, SS\_BL12 were identified using 16S rDNA sequencing as *Serratia marcescens*, *Bacillus amyloliquefaciens* and *Pseudomonas taiwanensis* respectively. In addition, quantitative assays and antagonistic activities proved *Bacillus amyloliquefaciens* strain SS\_BL08 efficient at all respects with maximum  $145.8 \pm 4.5 \mu\text{g mL}^{-1}$  (after 192 hours) phosphate solubilization,  $25.0 \pm 1.6 \mu\text{g}$  ( $5 \text{mg mL}^{-1}$  L-tryptophan) IAA production and 74 %, 90%, 60 % inhibition against selected phytopathogens (*Fusarium verticillioides*, *Sclerotium rolfsii*, *Rhizoctonia solani*, respectively) Furthermore, germination percentage, vigour index and seedling growth (root and shoot length) were also significantly increased by the bacterial inoculations. *Bacillus amyloliquefaciens* strain SS\_BL08, efficient both in terms of plant growth promotion and biocontrol could be used as biofertilizer and biocontrol agents for solanaceous crops in organic agricultural practice. This study greatly promotes the integrated management of nutrients and pests by sustainable crop production utilizing the PGP endophytic bacteria. Their utilization could decrease the use of chemical fertilizers and pesticides.

## Session 3. Eco-friendly Plant and Soil Health Management towards Natural Farming

### KEYNOTE LECTURES

#### KN 01(S3): Arbuscular mycorrhizal fungi for biocontrol of soil-borne plant pathogens

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The common mycorrhizal association in most of the agriculturally important plants is the arbuscular type. The arbuscular mycorrhizal (AM) fungi belong to the phylum Glomeromycota. These fungi are obligate symbionts and have not been cultured on nutrient media. These endophytes though are not host specific exhibit host preference thereby we can select an efficient fungus for inoculating a particular host. The role of AM fungi in improving plant growth is now well documented. The mechanism of improved plant growth caused by mycorrhizal association is because of greater soil exploration for nutrients, especially diffusion-limited nutrients like P, Zn, Cu, etc. The other beneficial effects are their role in biological control of root pathogens, synergistic interaction with PGPR, hormone production, greater ability to withstand biotic and abiotic stresses, etc. Most of the studies on AMF soil-borne pathogens suggest that AMF decreased or mitigated the disease severity. Consistent reduction of disease symptoms has been described for fungal, bacterial and nematode pathogens. Studies conducted so far suggest that the mechanisms of suppression may be due to morphological, physiological and biological alterations in the host. Thickening of the cell walls through lignification and production of other polysaccharides in mycorrhizal plants preventing penetration and growth of pathogens like *Fusarium oxysporum* and *Pyrenochaeta terrestris* (*Phoma terrestris*) have been demonstrated. Higher concentration of orthodihydroxy phenols present in mycorrhizal plants compared to non-mycorrhizal plants was found to be inhibitory to the root rot pathogen *Athelia rolfsii* (*Sclerotium rolfsii*). The activation of specific plant defense mechanisms as a response of AMF colonization is an obvious basis for the protective capacity of AMF. Among the compounds involved in plant defense studied in relationship to AMF formation are phytoalexins, enzymes of the phenylpropanoid pathway, chitinases, peroxidases, pathogenesis related (PR) proteins etc. Mycorrhizal plants harbour higher population of microorganisms in the rhizosphere thus making it difficult for the pathogen to compete and gain access to the root. Further mycorrhizosphere supports higher population of antagonists and siderophore producers. Thus the possibility of biologically controlling the soil-borne pathogens with AMF looks promising.

#### KN 02(S3): Manipulation of soil microbiome for the soil borne disease management in natural farming

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Components in sustainable agriculture are an important topic due to its impact on soil and human health and became debatable among the farmers, scientists, biologists, conservationists, ecologists and policy makers. Natural farming is a chemical free traditional agroecology based farming which integrate the crops, trees and livestock with functional biodiversity. In natural farming practices, indigenous microorganisms (IMOs), a consortium of native beneficial microbes playing vital role in improving the soil fertility, utilization of macro and micronutrients from ecosystem, bioremediation, biocomposting, maintain soil flora and soil fauna, improving plant growth and pest

management. These microbes are mainly associated with rhizospheric region in soil including fungi, bacteria and archaea. The soil microbiome consists of IMO's which contribute to nutrient recycling, protecting soil structure, and pathogen suppression. There are several beneficial microbes present in the soil microbiome which includes *Trichoderma*, arbuscular mycorrhizal fungi, Actinobacteria, *Pseudomonas* and *Bacillus*. These species are identified as a dominant microbial community from soil which inhibit the growth of soil borne pathogens and induce resistance in host against pests. Manipulation of soil microbiome will be useful in the integration of microbial community and plant-microbe-nutrient relationships, disease suppression in soil, and also improve the soil ecosystem. Understanding of soil and root microbiome community dynamics and communication has the potential for efficient exploitation of largely untapped resources. The key challenge in future work can be protection and conservation of biodiversity in rhizosphere soil. The application of microbial inoculants has improved the soil ecosystem which are helpful in plant growth and pest management. Due to inconsistent efficacy in different agroclimatic conditions, there is an urge to explore and adopt large scale of microbial inoculants in natural farming practices.

### KN 03(S3): Ecofriendly management of bacterial wilt of solanaceous crops

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Bacterial wilt disease of solanaceous crops (tomato, chilli, capsicum, brinjal and potato) caused by *Ralstonia pseudosolanacearum* is a major devastating soil borne disease in India, limiting the production of these vegetable crops. The bacterial wilt pathogen infects more than 450 plant species under 54 botanical families. The loss due to this disease is very high, ranging from 2 to 100% depending on environmental conditions, aggressiveness of the pathogen and crops. The affected plants show a typical wilt symptoms and browning of vascular tissue in roots, stems and tubers. The pathogen is a gram -ve, rod shaped, frequently occurs in pairs, motile with 1 to 4 polar flagella, aerobic, non-fluorescent, positive in catalase and oxidase tests, forms nitrites from nitrates and negative in levan production as well as starch hydrolysis. Virulent isolates on 2,3,5- Triphenyl Tetrazolium Chloride (TTC) medium develop fluidal, irregular colonies having peripheral white and pinkish in centre. The optimum growth of the bacterium on artificial medium occurs at 28 to 32°C. In India, race 1 and bvs 3 and 4 are prevalent in tomato chilli capsicum and brinjal. However, race 1 and 3 infect the potato plant. Bacterial wilt disease in solanaceous crops is very difficult to control due to its soil borne nature. Although, some other methods like pesticides application are available to control the plant diseases, but they may have other problems such as residues, hazardous to health and frequent development of pesticide resistant mutants. Ecofriendly management strategies are applied to control and suppress the disease including, cultural practices, host-plant resistance and biological control and integrated disease management. Change in planting dates is generally designed only to avoid either period of high temperature or heavy rainfall or both. Crop rotations solanaceous crops with maize or ragi crops are found effective to control the disease because of these crops reduce the population of *R. solanacearum* in the soil significantly. Application of resistance cultivar of solanaceous crops is the best strategy to control bacterial wilt disease. Multiplication of *R. solanacearum* in stems of resistant cv. Hawaii 7996 of tomato was suppressed and restricts the movement of bacterial pathogen from the protoxylem or the primary xylem to other xylem tissues. Grafting is another technique in which susceptible cultivar of tomato grafted on resistant rootstocks of eggplant Pusa Purple Cluster and found effective to manage the wilt disease. Among all reported bacteria from plant system, species of *Bacillus*, *Burkholderia*, *Pantoea*, *Pseudomonas* and *Serratia* etc. have potential to use as bioagents to control bacterial wilt disease of solanaceous crops. Various species of bacteria either may inhabit the rhizosphere, rhizoplane, phyllosphere and phyloplane with different mode of action or different group of bacteria with same mode of action. It depends on environmental factors, plants and nature of bacteria. These bacteria suppress the

growth of wilt pathogens by different mode of action such as induction of systemic resistance, niche exclusion and competition for nutrients, parasitism and predation and production of antimicrobial metabolites. Antibiotic produced by some strains of fluorescent pseudomonads are phenazines, pyoluteorin, tropolone, pyocyanin, 2, 4-diacetyl phloroglucinol and pyrrolnitrin. *Bacillus* spp. produces surfactin and iturin A antibiotics which suppress the diseases. Bacteriocins are antibiotic-like compounds with bactericidal specificity, which restrict bacterial strains closely related to the bacteriocin producer. This inhibits the growth of bacterial pathogen and eventually led to the suppression of the disease. Wilt incidence was not observed when bacterized (*P. fluorescens* and *B. cereus*) tomato seedlings of moderately resistant line EC 191536 were planted in 10 weeks solarized soil. Achieving consistent performance in the field where there is heterogeneity of abiotic and biotic factors and competition with indigenous organisms is more difficult. Development of better formulations to ensure survival and activity in the field and compatibility with chemical and biological seed treatments is another area of focus. Another approach which includes optimization of growth conditions prior to formulation and development of improved carriers and application technology are area of concern. Formulation development must consider factors such as shelf life, compatibility with current application practices, cost, and ease of application.

## INVITED LECTURES

### IL 01(S3): Endophytes and green nanoparticles in management of soybean diseases and their productivity enhancement in India

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Endophytes and green nano particles have emerged as a new innovative and sustainable approach to manage the diseases, abiotic stresses and to promote plant growth. Thirty fungal endophytes were isolated from major soybean growing areas of northern Karnataka and Maharashtra. Out of which, eight effective fungal endophytes were obtained by *in vitro* screening against major soil-borne pathogens such as *Sclerotium rolfsii*, *Rhizoctonia bataticola* and *Fusarium oxysporum*. The fungal endophytes RF-BV-3 (46.46%), SF-DM-8 (49.15%) were effective against *S. rolfsii*, and the isolate SF-DM-8 (49.32%) was effective against *R. bataticola*. The effective bacterial endophytes against *F. oxysporum* were RB-HS-1 (41.99%), SB-Bij-9 (40.07%), LB-BU-1 (54.20%) and LB-BV-2 (51.64%). Based on molecular characterization, the effective bacterial endophytes were identified as *Acinetobacter* Sp. (RB-HS-1), *Alcaligenes faecalis* (RB-KK-6), *Stenotrophomonas* Sp. (SB-Bij-9), *Bacillus pumilus* (SB- DG-11 and LB-BiN-8), *Paenacaligenes* Sp. (LB-BU-1), *B. cereus* (SB-BS-6) and *Brevibacillus* Sp. (LB-BV-2). *Neofusicoccum parvum* and *Daldinia eschscholzii* showed positive results for siderophore production and zinc solubilisation. *N. parvum*, *D. eschscholzii* and *Colletotrichum aenigma* showed positive results for HCN production. For chitinase production, only *N. parvum* was found to be positive. Green synthesized PAAgNF could be explored as a novel technology in managing *C. truncatum*. Characterization through PSA and SEM showed the range of particle size as 9.9 to 83.5 nm and shape as circular to irregular. Elemental confirmation was also performed by EDS. Among tested nano-formulations, PAAgNF was found effective in suppressing *C. truncatum* mycelium up to 82.75 percent under laboratory conditions. PAAgNF was also found best in managing anthracnose disease at 500 ppm as it could reduce disease up to 100 and 96.97 percent in JS 335 and DSb 21 variety which was on par with recommended fungicide. LC-MS analysis of PAAgNF showed major role of phenolic acids (hydroxy benzoic, protocatechuic, gallic, caffeic and ferulic) and flavonoids (naringenin and epicatechin) in antimicrobial activity. Endophytes and green synthesized PAAgNF could be explored as a novel technology in managing soybean diseases and productivity enhancement of soybean in India.

## IL 02(S3): Integrated plant and soil health management strategies against maize diseases

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Maize diseases incited by various fungi causing turicum leaf blight, curvularia leaf spot, common rust and post flowering stalk rot diseases are important in tropical and subtropical maize production regions. Holistic disease management strategies through multidisciplinary interventions are effective components of integrated disease management, which could be used in combination with varietal resistance and fungicides to obtain reasonable management and to combat quantitative and qualitative losses. Ecological intensification comprised of innovative agronomic interventions resulted in lowering foliar diseases pressure and further limited the post flowering stalk rot disease incidence. Deep summer plowing followed by green manuring and destruction of residues is an effective strategy to minimize primary inoculum. The highest yield reduction happens at flowering stage by airborne pathogens infection. Seed treatment with bio fertilizers, bio fungicides and fungicides are recommended to limit the initial infection and inoculum buildup in the field, thereby being beneficial to control airborne, seed borne and soil borne diseases. Crop rotation with non-host crops such as pulses and oilseeds helps in minimizing inoculum density and reduces disease pressure. The optimum seed rate of 25 kg<sup>-ha</sup> with plant geometry of 60 cm in between row and 20 cm between plants, having a total plant population of 83,300 per hectare resulted lower disease pressure. Sowing is recommended in June and November, which will reduce the amount of field inoculum. Physiological parameters like higher chlorophyll content, higher specific leaf weight, lesser stomata frequency, smaller sized stomata and phenolic content play an important role in inducing resistance against further invasion of the pathogen as they are toxic to the pathogens. Higher concentration of protein and higher expression of peroxidase and polyphenol oxidase enzymes played important role in governing resistance against turicum leaf blight disease. Salicylic acid @ 200 ppm as foliar spray found to suppress the severity of foliar diseases to the extent of 26.80 per cent and resulted in 7.51 per cent yield increase over untreated check. Salicylic acid limited foliar diseases infection on foliage and suggests the induced resistance. Seed treatment with *Pseudomonas fluorescens* @ 10g/kg seed, *Trichoderma harzanium* @ 10g/kg seed and Carboxin 37.5% + Thiram 37.5% WP @ 2 g/kg seeds showed maximum reduction in seed infection which also enabled increase in seedling vigour, seed germination and suppressed soil borne diseases. Seed treatment with *Azospirillum* strain ACD-15 @ 25 g/kg seed and *Trichoderma harzianum* @ 10 g/kg seed followed by foliar spray with Azoxystrobin 18.2 % + Difenoconazole 11.4% SC @ 1.0 ml/L of water at 35 and 50 days after sowing effective against foliar diseases of maize. Seed treatment with PSB (*Pseudomonas striata* strain H-21) @ 25 g/kg seed and *Trichoderma harzianum* @ 10 g/kg seed bio-agent fortified FYM (1:50) furrow placement and spray @ 0.5% and soil application of Murate of potash @ 80 kg /ha additional dose at 45 days after sowing recommended for effective management strategy against post flowering stalk rot of maize. Combination or mixture of compatible organisms would be an added advantages over single species application. These apart from their action against pathogens, are also good growth promoters as indicated by high seedling vigour index which is an added advantages for sustainable agriculture. Hybrids namely, AH-8127, AH-8178, AH-8323, H-553 and HT-5109 registered combined resistance to foliar and stalk rot diseases which may be deployed and integrated with bio agents and fungicides.

### IL 03(S3): Current Status on Wheat Diseases and Role of Hot Spot Location (Wellington) in Sustainable Management through Host Resistance

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The biotrophic fungal pathogens adversely affect yield and quality of wheat grains. All three rust pathogens (*Puccinia graminis tritici*, *P. triticina* and *P. striiformis*) were studied in details. Since the inception of our hot spot location (Wellington), few more deleterious fungal pathogens viz., *Fusarium graminearum* *Blumeria graminis* f.sp. *tritici* and *Bipolaris sorokiniana* are now surpassing the infectivity of *Puccinia* spp in recent days in our hot spot location and it play vital roles in identification of multiple diseases resistant wheat genotypes. Our systematic screening methods predict the resistant categories from genetic stocks represented from different agro-climatic zones. Few predominant races ie., 40-A, 77-5 and 77-9 and group of *Bgt* isolates are used to identify the resistant genotypes but the strength of resistance is frequently challenged by changing scenario on weather conditions in this location. Out of large number of 'R' genes catalogued from *Triticum* species, very few genes (*Sr24 Sr36*, and *Sr31* for SR; *Lr24*, *Lr26*, and *Lr34* for LR and *Pm6* and *Pm8* for PM) confer resistance to rusts are used in breeding programme. Although, the genetic diversity and few effector genes have been identified in *Bgt*\_Wtn1 of PM, other major aspects on the biology and genetics of rest of the pathogens are unattended so far. In addition to routine works in national off-season nurseries, selected basic research are underway. Considering advantages on epiphytotic conditions, currently we explore the biomolecules from higher fungi for their management.

### IL 04(S3): Endophytic Bacteria: Biocontrol agents for Plant Pathogens

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Plant pathogens as increasing worldwide can form a stumbling block on the economic and life stability due to causation of various diseases in leaf, stem, root, vascular system and fruit. The use of non-chemical sources in the form of plant growth-promoting agents, as well as biotic / abiotic stress-alleviating factors, is the requirement of current era. Plant communities are considered a complex form of ecosystems where many microorganisms inhabit different niches. Plant microbiota is the result of attraction between plants / plant parts and huge microbial hubs. The association between plants and prevailing microbiota gives rise to a combined genome, as the "plant microbiome". Endophytes are such group of microbes that colonize the plant's internal tissues (either in an obligate or facultative manner) without causing any symptomatic / visible infection of a particular disease and develop a mutualistic association with concerned plants at least for a part of plants' life cycle. Endophytes are a wealthy source of various secondary metabolites possessing bioactive properties. Endophytes are also able to enhance the growth of plants by using diverse modes as well as inducing the plants' resistance against environmental extremes. The most prominent role of endophytes is being visualized in the agriculture sector owing to their growth-promoting and survival-mobilizing characteristics on plants under extreme growth conditions. During the last few decades, these plant-associated microorganisms (or endophytes) have been explored extensively owing to their potential benefits in agricultural sectors. Besides that, a more comprehensive exploration of beneficial properties of endophytes worldwide, summarizing documentation is still lacking. There is still need to fulfil the gap between

research performed in the past and work still needs to be carried out before commercial application, and at the same time, carrying the ambition of exploring the diverse applications of endophytes. Plants are shielded from infections by endophytes. They significantly stimulate host development, facilitate nutrient uptake, improve tolerance to abiotic stressors, and enhance resistance. They have the potential to reduce the assault from pathogens. Exploiting endophyte-plant interactions can improve plant health and become crucial in applications for low-input sustainable agriculture. Concerning the plant system, endophytes improve the physiology, fitness, and metabolite profile of the plants through the production of phytohormones, secondary metabolites, antibiotics, siderophores as well as act as biofertilizers. The amount of pesticides used in agriculture can be reduced using these microorganisms. For future medication development, the endophyte-based nanoparticles have demonstrated promising outcomes. Similar to this, crop types that colonize the endophytes can also be created with induced resistance against phytopathogens in the near future. Owing their beneficial properties on plant and soil systems without harming the ecosystem, they are attracting the widespread interest of the agricultural industry and academia.

### **IL 05(S3): Nematode-trapping fungi: Genomics, soil adoptability and their nematophagous and mycoparasitic biocontrol potential against plant pathogens**

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Nematode-trapping fungi are remarkable soil living microbes that develops adhesive or non-adhesive traps to capture and kill nematodes. Some species of these fungi parasitize the hyphae of fungal pathogen *Rhizoctonia solani*. We used the comparative genomics and transcriptomics to gain insights into the adaptation to parasitism in nematode-trapping fungi. We found that gene duplications leading to formation of novel genes and expansion of gene families resulting in a large number of species – specific genes. The differential gene expression of orthologs between the two fungi during infection, suggest that the differential gene expression has been important machismos for evolution of parasitism in nematode-trapping fungi. We also studied the genes expression in some nematode-trapping fungi during infection of *Meloidogyne hapla* and *Heterodera schachtii*. Divergence in gene expression pattern associated with fungal species was found significantly larger than that related to the host nematode species. Adoptability of nematode trapping fungi in fungisatatic soil and their biocontrol potential against root knot nematodes of tomato and rice was also found satisfactory. These fungi were also found to grow well in various agricultural soils by forming germ tube and forming conidial traps. Nematophagous and mycoparasitic ability of different species of nematode-trapping fungi were studied against important plant parasitic nematodes and against *Rhizotonia solani*. Application of nematode-trapping fungi in root-knot nematode infected soil caused a significant reduction in root knot disease of tomato and rice in pot conditions. *Arthobotrys conoides*, *A. eudermata* and *Dactylellina gephyropaga* were observed to form hypha coils around hyphae of *Rhizoctonia solani* within 24 hours of hyphal interface. *A. eudermata* was found most virulent against *R. solani* followed by *A. conoides* and *Dactylellina gephyropaga*. *Dactylellina phymatopaga* was failed to parasitize any isolate of *R. solani*. Treatment of *R. solani* infested soils with colony forming units of *A. eudermata*, *A. conoides* and *D. gephyropaga* decreased sheath blight infection in rice tillers by 43.39-50.74% as compared to non-treated but *R. solani* inoculated plants. Results indicate that nematode-trapping fungi could be used as component of integrated disease management programme for bio-management of plant parasitic nematodes and *Rhizoctonia solani*.



## IL 06(S3): Harnessing beneficial bioinoculants for building sustainable soil and plant health natural farming

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The soil biological function is vital for soil health management to sustain plant, animal and human health. The current cultivation practices of continuous cropping and unbalanced inputs had led to reduced biological functions, soil nutrient reserves depletion, resulting in soil degradation. In addition, use of chemical pesticides has resulted in pest and disease outbreak and also toxicological effects. The population growth in India projected to reach ~ 1.7 billion by 2050, demands to feed the growing population. Hence, it is imperative to adopt climate smart sustainable farming practices that not only increases productivity, but also conserves natural resources and protects agricultural ecosystems. Building sustainable soil health and restoring degraded soils by adopting practices based on ecological principles is essential as the natural farming rely on microbes for provision of nutrients, decomposition of organic materials and biocontrol. Plant growth promoting microbes influence multiple plant growth and development factors and protect against harmful microbes. The use of beneficial Plant Growth Promoting Rhizobacteria (PGPR) bacteria and Arbuscular Mycorrhizal Fungi (AMF) increased millet grain yields by 30%, and reduced chemical inputs by >50% without yield compromise as indicated by empirical data obtained from multilocation trials conducted for 5 years. Micronutrient -Fe and Zn mobilising bacteria significantly increased grain micronutrient content in rice. Individual and consortia application reduced incidence of *Magnaporthe grisea*-blast disease in millets, and *Fusarium oxysporum* -wilt in tomato cultivated under organic conditions by 50%. However, improved assessment of soil health indicators is necessary to understand the dynamics of the soil-rhizosphere microbes- plant interactions in natural farming systems.

## IL 07(S3): Harnessing on farm waste in managing soil borne plant pathogens in hot arid region

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In the arid zone of India pearl millet, and legumes are the major crops grown under rain fed conditions while wheat, cumin, mustard and Isabgol are the principal crops grown in winter season with assured irrigation. In this region, diseases caused by certain soil-borne pathogens are responsible for low productivity of crops Losses due to wilt in cumin alone may reach 40%. Frequently growers are left with no alternative except to abandon cumin cultivation after a few successive years of cropping. In recent years, the arid region witnessed large scale mortality due to attack of *Ganoderma* in the Indian mesquite (*Prosopis cineraria* (L.) Druce), locally known as *Khejri*. This tree is the most important component of the agro forestry systems prevalent in the region. Use of organic amendments as crop residues has found to be of wider acceptance and practical relevance. Organic amendments are traditionally used to improve soil structure and plant nutrition but their addition can also lead to control of pathogen. These amendments can take the form of crop residues, farmyard manure, mulches, composts and specially grown cover cops, often legumes, which are ploughed in as green manure and helps in maintaining the tilth, fertility and productivity of agricultural soils; protecting them from wind and water erosion; and preventing nutrient losses through runoff and leaching. These amendments commonly result in a highly metabolically active microbiota, which can be antagonistic towards many pathogen There exists ample scope of using organic wastes in suppression of soil borne plant pathogens. Utilization of on-farm wastes in rain fed and irrigated farming for cultivation of cumin, in

winter season and clusterbean and other legumes in rainy season may increase seed yield by 10-15%. Simultaneously in rain fed agriculture, composts prepared from on-farm wastes can be used for managing soil-borne pathogens besides improving soil-fertility and moisture holding capacity of sandy soils. Enhancement in the population of antagonists is additional advantage for inducing suppressiveness in otherwise conducive soils.

## ORAL PRESENTATIONS

### OP 01(S3): Management of Sclerotinia stem rot in Oilseed Brassica: Progress and future prospects

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India cultivates nine annual oilseed crops and their contribution to the national agricultural economy is next only to the cereals. The share of rapeseed-mustard is about 25% of total area and 30% of total production. Among different biotic stresses, *Sclerotinia sclerotiorum* (Lib.) de Bary, the causal organism of Sclerotinia stem rot (SR) of *Brassica* is menace to cultivation of oilseed *Brassica* crops in the world. Significant increase in the sclerotial population in the soil due to monocropping and cultivation of rapeseed-mustard, has made SR very serious disease in rapeseed-mustard growing states. Management of *S. sclerotiorum* is difficult, inconsistent and uneconomical due to the presence of wide host range and long-term survival of the resting sclerotia. Since no single method can effectively control *S. sclerotiorum*, the best approach to control the pathogen is by the integration of various eco-friendly measures. Cultural practices including wider row and plant spacing along with no irrigation during 25 December to 15 January reduce the microclimate favorable for carpogenic infection. Soil application of bio-agents to different host crops reduced carpogenic germination and viability of sclerotia under wide range of temperature, relative humidity and soil moisture. *T. harzianum* was most effective in reducing the lesion length and disease intensity. Fungicides have been extensively used for the control of SR, seed treatment with carbendazim and foliar spray of carbendazim or propiconazole at full bloom stage provided significant disease reduction and highest seed yield of Indian mustard. Breeding for resistance against *S. sclerotiorum* is very challenging. Partial resistance has also been identified in some *B. napus* and, to a lesser extent, in *B. juncea* genotypes from China. During two consecutive cropping seasons at ICAR-Directorate of Rapeseed-Mustard Research, >5000 *Brassica* germplasm were field-screened under Sclerotinia sick plot to determine their relative levels of resistance to SR. In contrast, the nine *B. juncea* lines did not develop lesions, two of these lines were crossed with high yielding *B. juncea* varieties. We are in the process of mapping quantitative trait loci (QTL) conferring resistance to Sclerotinia using populations of recombinant inbred lines (RIL) derived from the two crosses. Molecular markers around the QTLs will facilitate development of Sclerotinia resistant *B. juncea* varieties.

### OP 02(S3): Virulence analysis of *Blumeria graminis* causing powdery mildew of oats in Himachal Pradesh and identification of resistance

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Oat (*Avena sativa*) is one of the major *rabi* fodder crops in the north-western Himalaya. Powdery mildew of oats caused by *Blumeria graminis* f. sp. *avenae* has emerged as one of the most destructive foliar disease of cultivated oats, particularly in the cooler regions resulting in severe losses of green fodder and grain yield. Breeding cultivars

with powdery mildew resistance for these areas is one of the most suitable approach for management of oat powdery mildew. Characterization of the pathogenic variability in *B. graminis* f. sp. *avenae* is imperative pre requisite and constitutes the elementary framework for breeding resistant varieties and their deployment. Differential set of 11 lines viz., ADG-96, HFO-102, IG-03-213, JPO-40, OL-1847, OG-77, PLP-1, JO-11, OL-1867, UPO-212 and susceptible check HJ-8 was developed and used to analyzed variability in 24 isolates, which resulted into 14 pathotypes (OMP-1 to OMP-14). The OMP-2, OMP-7 and OMP-13 were found to be the most virulent, which gave susceptible reaction on 9 out of 11 differential lines. Analysis of genetic diversity of 22 isolates of *B. graminis* f. sp. *avenae* using 4 polymorphic ISSR markers formed 12 groups at 98 per cent similarity coefficient indicating high genetic diversity among isolates. To identify the resistant sources, 303 oat germplasm lines were evaluated under field conditions for 3 years and 11 lines were found resistant. Nineteen accessions belonging to 12 species of *Avena* also evaluated under field conditions and none of the accessions of any species was found highly resistant, however, OG-77 (*A. sativa*) and HFO-864-16 (*A. byzantina*) were found resistant against powdery mildew pathogen. Among these, 142 lines were also evaluated *in vitro* against five different isolates of the pathogen. Host pathogen tests with different isolates revealed varied level of disease reaction with these isolates, indicating variation in virulence behaviour of the pathogen. The cultivars IG-03-203, JPO-20 and KRR-AK-06 were identified as slow mildewers on the basis of low values of AUDPC, high incubation and latent period, smaller size of colonies, less sporulation as represented by number of 'conidiophores bearing conidia' per colony as compared to highly susceptible check HJ-8.

### OP 03(S3): Selection of potential entomopathogenic fungal strains to control *Bemisia tabaci* in upland cotton

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Whitefly, *Bemisia tabaci* (Genn.) is the most devastating and widespread insect pest of cotton. It is a serious threat to crop production due to the direct damage and transmission of cotton leaf curl virus disease. Among several bioagents, entomopathogenic fungi (EPFs) are important bioinsecticides causing the natural mortality of whitefly nymphs and adults without deleterious effects on the environment and ecosystem. We evaluated 373 EPFs to find out the most virulent EPF to utilize them as an alternative approach to chemical control. Based on the bioefficacy index (mycelial growth, conidia production, nymphal mortality), 17 chemical insecticides & botanicals compatibility and two-year field trials, *Cordyceps javanica* (Cj)-102, *Beauveria bassiana* (Bb)-4511 and *Metarhizium anisopliae* (Ma)-1299 were selected for field evaluation. The highest pooled nymphal mortality (2017 & 2018) at 7 days-after sprays was recorded with Bb-4511 (86.3%), Cj -0102 (84.7%) and Ma-1299 (79.4%). The pooled data of 2018-19 and 2019-20 revealed that the biomodule-1 (neem, Cj -0102), existing IPM module (neem, flonicamid, spiromesifen), IPM module-3 (neem, flonicamid, Ma -1299) and biomodule-2 (neem, Bb-4511) showed higher nymphal mortality than the control. The lowest CLCuD PDI was recorded in the new IMP module-3, -1, and biomodule-3. The population of natural enemies in biomodules and new IPM modules comparatively varied and was higher in biomodules. EPFs alone may not always provide enough insect pest control, but combining the most virulent EPFs in conjunction/pairing with the compatible insecticides, and botanicals in an IPM module or Biomodule can make an integrated pest management program considerably more effective.

### OP 04(S3): Development of talc based formulation of DALHANDERMA (IIPRTh-31) and DALHANDERMA-1 (IIPRTh-33) and their Multi-location evaluation for wilt disease management and plant growth promotion ability in major pulse crops

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A three year field experiment was conducted at Research Farm of ICAR-IIPR, Kanpur and Farmers field of Jalaun, Hamirpur, Fatehpur & Banda districts during 2019-20, 2020-21 & 2021-22, to evaluate the efficacy of developed *Trichoderma* formulations i.e. DALHANDERMA (*T. asprellum*, IIPRTH-31) and DALHANDERMA-1 (*T. afroharzianum*, IIPRTh-33) for the management of wilt disease of major pulse crops (Pigeonpea, Lentil & Chickpea). The experiment was laid out in the Randomized Block Design with three replications. The treatment consisted of susceptible varieties of pigeonpea (Bahar), Chickpea (JG-62) and Lentil (L9-12) with seed treatment of DALHANDERMA and DALHANDERMA-1 @10g/kg of seed. Percent germination (%), disease incidence (%), shoots length (cm), root length (cm) and plant height (cm) were recorded after 60 and 75 days after sowing (DAS). The results revealed that in experimental field, significant increase in germination (0.87% to 18.90%), Shoot length (2.51% to 38.54%), root length (5.64% to 83.76%) and plant height (5.66 to 46.49%) was observed in treated seeds over check. DALHANDERMA formulation treatment recorded maximum grain yield in Pigeonpea (21.6, 20.4, 21.1 q/ha), Chickpea (7.57, 8.44, 7.57 q/ha) and Lentil (10.8, 11.2, 10.7q/ha). Similarly, disease incidence reduction (5.66 To 46.49%) was observed after application of DALHANDERMA and DALHANDERMA-1 formulation for continuous three years. It is concluded that the developed *Trichoderma* based formulation had significant role in reducing the disease incidence and enhancing the plant growth in pulse crops.

### OP 05(S3): Resistance in maize to foliar blights - Present status and prospects in Punjab state

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Genetic resistance to foliar blights in maize used by breeders is mainly quantitative. Among foliar blights, southern leaf blight (SLB) and banded leaf and sheath blight (BLSB) cause great losses during *Kharif* season in Punjab state. Southern leaf blight (SLB), caused by *Drechslera maydis*, is a disease that significantly affects maize productivity and also deteriorates the value and quality of the grains across the globe. This disease has strong influence on early hybrids, speciality corn (sweet corn, baby corn, pop corn and QPM) and the losses vary with the genotype and environment conditions. Warm and wet temperate and tropical areas are more conducive for this disease. It may cause up to 40 percent grain yield loss under favourable conditions. Symptoms and severity of SLB depends on the pathogen race and host germplasm. Genetic resistance to SLB is quantitative, and the gene action is primarily additive or partially dominant or epistatic. Several resistant sources - JCY<sub>2</sub>-7-1, LM 19, LM 23, CM 143, LM 16, LM-5, CM 139, JCY 3-7, LM 13, LM 14, LET DR-49 and LMDR 2 have been identified and are being used for developing potential maize hybrids. Recently, study conducted at PAU revealed that four major QTL from the resistant parent LM5 found on chromosomes 3, 8 and 9 were associated with large and consistent effects on SLB reactions and accounted for most of the genetic variation seen among the RILs. Banded leaf and sheath blight has emerged as a major threat, especially where rice-maize rotation is followed, with no good sources of resistance against this

disease. BLSB caused by *Rhizoctonia solani* is favoured by warm-humid weather at vegetative stage of the crop. Its pathogen being soil borne, survives in the form of mycelium or sclerotia in soil and on infected crop debris. An optimum temperature  $28\pm 2^{\circ}\text{C}$  coupled with more than 88 per cent relative humidity favours rapid disease development. Identifying genotypes with genetic resistance to BLSB is quite difficult among maize germplasm as experienced in rice against the same fungus. However, national programmes in India are making efforts towards screening for BLSB resistance. Inheritance studies have indicated digenic and oligogenic nature of disease resistance. Recently, we studied the virulence of 44 isolates of *R. solani* on four hybrids and seven inbred maize lines and revealed that maize hybrid JH3459 and inbred LMDR-2 were less susceptible to Punjab population of *Rhizoctonia* species. Our major focus lies on identifying the resistant germplasm and its utilisation in the breeding programme. However, outbreak of new diseases and evolution of more virulent strains pose a major challenge to the available host-plant resistance.

### OP 06(S3): Investigations on the potential of plant beneficial rhizobacteria for soil P solubilization and enhanced yield and quality in turmeric (*Curcuma longa* L.)

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Turmeric is grown in a wide range of soils and requires ample supply of organic manures and nutrients for profitable yield. Among the three major nutrients (N, P & K), P is a major component in key metabolic pathways like nutrient uptake, biological oxidation, and energy metabolism and severely limits turmeric growth and yield in deficient soils. This study focused on isolation and characterization of an array of rhizobacteria with multi beneficial traits including soil P solubilization, biocontrol and growth promotion. For this, several bacterial strains isolated from the rhizosphere of turmeric grown across India were assessed for their capacity to solubilize tri-calcium phosphate and di-calcium phosphate under *in vitro* condition and in liquid medium. The soluble P turnover by the promising PSB was then investigated in soil *per se* and their effects were further validated in turmeric under both green house and field conditions for two successive years. The results revealed that *Bacillus safensis*, *B. marisflavi*, *B. cereus* and *Pseudomonas aeruginosa* solubilized significantly greater levels of labile P in the liquid medium due to their capacity to produce significant amounts of organic acids (gluconic,  $\alpha$  ketogluconic, succinic, oxalic and tartaric). Green house studies indicated that soil available P was significantly higher in the treatments involving PSB suggesting enhanced P solubilization. The positive effects of PSB were also reflected in field experiments, wherein the treatments with combined application of *B. safensis* with 50% or 75% or 100% P significantly increased soil available P by 143.0 – 246.0%, rhizome yield by 29.0 – 120.0%, P uptake by 51.0 – 223.0% and curcumin content by 30.0 – 32.5% compared to control (100% P alone). The *B. safensis* strain (NAIMCC-SB-0055) had all the trappings of a promising PSB due to higher solubilization efficiency and positive impacts on turmeric yield and quality making it a promising candidate for integration into nutrient management schedules.

### OP 07(S3): Diversity of Target leaf spot disease incited by *Corynespora cassiicola*, an emerging threat to Cotton production in India

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During recent past various new emerging diseases in cotton have been reported in major cotton growing zones of India causing economic losses. An emerging challenge for growers is target spot disease caused by the fungal pathogen *Corynespora cassiicola* is on the increasing trend in cotton and has become an important disease in the major cotton growing States of Central, North and South Zones of India. There have been widespread reports of target leaf spot (TLS) on cotton across multiple cotton cultivars along the cotton growing regions of India since last five years (2017-2022). Survey has been conducted to collect the infected leaf samples from different geographic locations of India. In this study we have investigated the diversity pattern of *C. cassiicola* isolates from symptomatic leaves of cotton by studying the morphology, pathogenicity, and molecular phylogeny. The leaf samples were subjected to the isolation of causal pathogen followed by morphological and molecular characterization by ITS-Sequencing and also confirmed by housekeeping gene primers. Based on genetic characterization the isolates had little diversity at the genome level. The radial phylogenetic analysis showed that the published isolates and isolates collected from across India are closely associated which shows the least genomic changes amongst the organism over the years. The similarity of significant number of base-pairs of the collected *Corynespora cassiicola* study isolates and the *C. cassiicola* infecting different hosts indicate the presence of genetic similarity of the organism present throughout the country.

### OP 08(S3): Studies on wheat powdery mildew (*Blumeria graminis f. sp. tritici*) in the North-Western Himalayan region of India

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Powdery mildew (PM) caused by *Blumeria graminis* (DC.) E.O. Speer f. sp. *Tritici* (Bgt) Em. Marchal (syn. *Erysiphe graminis* f. sp. *tritici*) is one of the major diseases of wheat across the globe. This disease is favoured by modest temperature, reduced light, humidity and succulent plant growth. The weather conditions in the North-Western Himalayan region of India are favourable for the development of this disease where it has now acquired a serious proportions among other important diseases of wheat. In order to ascertain the severity, recurrent surveys were undertaken and the distribution of powdery mildew was assessed in the wheat-growing fields in the different districts of Himachal Pradesh. A total of 75 wheat fields located in 10 districts (Shimla, Kinnaur, Lahaul-Spiti, Sirmour, Mandi, Bilaspur, Chamba, Kangra, Kullu and Solan) were surveyed for occurrence of PM. On the basis of comprehensive data, the maximum PM severity was recorded from Dalang Maidan (Lahaul-Spiti), Tutikandi, Dhanda in Shimla, Kala Amb (Sirmour) and Dhaula Kuan (Sirmour). Also, locations such as Dalang Maidan (ICAR-IIWBR RS, Lahaul-Spiti), Tutikandi (ICAR-IARI RS Shimla) and Dhaula Kuan (HAREC, Sirmour) are research stations. Keeping in view on the severity of powdery mildew, these could be ideal locations for screening wheat germplasm

at field conditions. In another experiment, a set of 510 Indian bread wheat, durum, dicoccum and triticale germplasm were evaluated for two consecutive seasons under field conditions at ICAR- IARI Regional Station, Shimla, considered as hotspot location for PM. Same set of wheat germplasm were subjected for SRT (Seedling Resistance Test) using Shimla isolate of *Bgt*. Based on field evaluation only 3% of the germplasm was immune, 8% was resistant and 24% was moderately resistant. A total of 49% of germplasm was moderately susceptible and 16% was susceptible. Based on SRT, only 3% germplasm was resistant, 25% was intermediate and as many as 73% were susceptible to the Shimla isolate. The resistant germplasm identified in our study has the practical utility in breeding programs for the development of durable PM resistant varieties.

### OP 09(S3): Molecular aspects of pathogens associated with major diseases on Aloe vera and management strategies

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Aloe vera (*Aloe barbadensis miller*) is perennial succulent plant and successfully grown in wide range of ecology. Soft rot and leaf spot are the devastating diseases of aloe. Soft rot infected plants developed rotting of tissues from collar upwards but they possessed normal root systems. Whereas, in leaf spot symptoms were initiated with circular shaped water-soaked lesions on adaxial surfaces of leaves and in later stage transformed into depressed dark brown to black spots. The associated pathogens of soft rot were isolated, three partial genes of bacteria (*dnaX*, *icdA* and *mdh*) and fungi (*ITS*, *TEF-1 $\alpha$*  and *RPB-2*) were amplified and based on sequences and phylogenetic analyses identified as *Dickeya zae* and *Fusarium falciforme*, respectively. Similarly, the leaf spot pathogen was also isolated and based on the morphology and *ITS* region sequence it was confirmed as *Alternaria alternata*. For exploring the resistance sources of aloe for soft rot disease, an artificial inoculation technique was developed for quick screening of the aloe germplasm. Temperature played a crucial role and predisposing factor in soft rot symptoms development. At 35°C rapid rotting was observed whereas no rotting at 15°C, on the detached leaf under control condition. *In planta* bacterium concentration increased gradually with the rise of incubation temperature between 15 and 35°C. Based on the observations in this study, the possible management of the problem through (i) exploiting host resistance and (ii) escaping post-harvest decay by storing and transporting aloe leaves at temperatures  $\leq 15^\circ\text{C}$  (iii) avoidance of water stagnation in field. In case of the leaf spot disease management strategy included the use of disease free planting material, pre-emptive spray of NSKE @ 2% or mancozeb @ 0.2% solution.

### OP 10(S3): Microbial surfactants for plant disease management

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Microbial surfactants, produced by bacteria, yeast, fungi are the surface active agents used in agriculture, cosmetics, food, environment and health. They are classified as glycolipids, lipopeptides, lipoproteins, polymeric surfactants. They owe their interest over the synthetic counterparts due to their biodegradable, low toxic nature and stability features. In addition, they can be produced from renewable sources with aspect of sustainable economics and can be the focus to meet the sustainable development goals. Biosurfactants emerged as most eco-compatible molecules of 21<sup>st</sup> century, and there is increase in demand with CAGR of 4.3% from 2014 to 2020. The revenue generated from the biosurfactant market is US\$ 1.8 billion, which is anticipated to increase to US\$ 2.6 billion by 2023, a gain of more than 8%, resulting 540 kilo tons of biosurfactant by 2024. We at the Plant Probiotic and Biosurfactant Lab (P2BL) work are working on production of microbial surfactants from *Pseudomonas*, *Bacillus*, *Streptomyces*, *Rhizobium*, *Stenotrophomonas*, *Serratia*. Our research is focused on valorization of low cost

substrates such as seeds of mango kernel, sal, sunflower oil cake, spent mushroom waste for production of biosurfactants. *P. aeruginosa* DR1 produced rhamnolipid which has potential application as biocontrol agent. *Bacillus mojavensis* showed fengycin and surfactin production and was used to control charcoal rot disease of sorghum and bio fortification of iron. *Bacillus velezensis* MS 20 showed surfactin production with ISR in maize plants. Results of different biosurfactants we worked at P2BL and their role in biological control will be presented.

### OP 11(S3): Integrated Disease Management of Important Diseases of Soybean Crop and their Impact on Yield Attributes under field condition

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The soybean (*Glycine max* (L.) Merrill.) is very important crop for Madhya Pradesh. Its grown by the farmers in all the district of Madhya Pradesh . Changing climatic scenario and intensive cultivation practices, its led to outbreak of various diseases in soybean like Rhizoctina Aerial Leaf Blight (RALB), Phytophthora Root and Stem Rot (PRSR), Cercospora Leaf Blight (CLB), Anthracnose Stem Blight (ASB ) and Frogeye Leaf Spot (FELS) and its causes huge losses up to 40- 54% since last two years in Bhopal district of Madhya Pradesh. ICAR-CIAE KVK Bhopal conducted on farm testing trails on the farmers field during 2021 and 2022 in kharif to find out the effect of different management practices against the important diseases of soybean. During the trail the observations were taken on percent diseases severity, no of pod/plant, maturity in the day and yield (q/ha).The pooled of two years its showed that among the tested technological, T2-Soybean Variety - JS-2034 treated with *Trichoderma* spp@10gm/kg seed + two foliar application of Hexaconazole 75% wg @2ml/5lit after 30<sup>th</sup> and 45<sup>th</sup> days of sowing was found very effective to control the diseases. Under field condition T2 maximum reduced the diseases severity against RALB ( 73.31 % ) , PRSR (49.08%), CLB ( 53.98%) and FELS (59.86%) than farmers practices .However the treatment T1- Soybean Variety - JS-2034 treated with carbendazim @ 2gm/kg seed+ two foliar application of Propiconazole @2ml/5lit after 30<sup>th</sup> and 45<sup>th</sup> days of sowing was very effective to control the ASB. Its reduced ASB disease upto 56.7% than farmers practices. The Maximum no of pods/plant, Maturity in days and yield (q/ha) were recorded in T2 followed by T1.

### OP 10(S3): Microbe mediated regenerative farming to insure plant and soil health and nutrient dense food production

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Modern agricultural practices include high yielding varieties coupled with agrochemical-based farm management and mechanisation enhanced per unit productivity to make this country food scarcity to food surplus. However, in result of some faulty agriculture practices drastically destroy our natural resources significantly. It has been realized that if we continue with the similar kind of agricultural operations the soil and plant will not be able to produce quality and healthy food and our planet become unsuitable for life. Several reports suggested that application of inorganic synthetic fertilizers pose several threats to plant and environment which ultimately affect the human and animal health. To address these problems an alternative mean of farming that is called as regenerative farming in which recycling of farm produce with help of soil microbes is used with limited or no cultural operations and inorganic inputs. The quality of food in term of its components like vitamins minerals and phytochemicals quantity has increased in many folds. Plant grown under regenerative farming are healthy, soil microbial population doubled in compression of modern farming based on agrochemicals and soil organic matter also increased. The experiment



conducted on crop like tomato, maize, wheat, rice and grapes at ICAR NBAIM at its own experimental farm or farm of other ICAR institute in collaboration, result clearly indicates that microbe mediated farming has less biotic and abiotic stress and able to produce nutrient dense produce. Keeping quality of vegetable and fruit was also enhanced.

### OP 13(S3): Managing bacterial blight of pomegranate - the natural way

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India is a global leader in pomegranate with maximum area (2.88 lakh ha) and production (32.71 lakh MT). This ancient crop is facing multitude of biotic stresses which hamper both production and productivity of this commercial fruit crop in India. Among the various biotic stresses, bacterial blight disease (BBD) caused by a bacterium *Xanthomonas axonopodis* pv. *punicae* is most threatening. BBD is most severe during rainy season and can cause yield losses to the extent of 60-80%. Orchards with bacterial blight face huge losses if timely sprays are not taken. Nevertheless, with slight negligence farmer can face 80-90 % losses. Hence, ICAR-NRCP, Solapur has developed an eco-friendly, economical and effective blight management strategy for the off-season after harvest. The promising technique developed, demonstrated and widely accepted by farmers facing blight is known as 'Stem Solarization'. The exposure of the naked stems (for minimum 20 days) after natural defoliation during summer months before rains when day temperatures is more than 35° C kills inoculum present in the infected plant stems, that otherwise serves as source of inoculum for next season crop. Demonstration of this technology in farmers field during 2018 to 2021 had greater impact in BBD reduction (88 – 97 %) over control with significant increase (132 - 445%) in quality yield with reduced cost of cultivation. The benefit: cost ratio in three farmers' demo-orchards ranged from 3.03:1 to 3.57:1. This technology helps to farmers from arid and semi-arid regions facing losses due to bacterial blight disease can take 'Mrig bahar' (rainy season) successfully and antibiotics will not be required, and this technology can be useful for organic pomegranate production.

### OP 14(S3): Biofumigation: a biorational technique to manage soil-borne plant pathogen *Sclerotium rolfsii* Sacc.

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Biofumigation is an environment friendly technique for managing soil borne pathogens by using volatile biocidal compounds that are released in soil when certain glucosinolate containing plants are incorporated to soil for decomposition. A study was conducted to find out the biofumigation efficacy of Indian mustard (*Brassica juncea* L.) against *Sclerotium rolfsii* Sacc., causing collar rot disease in betelvine (*Piper betle* L.). Freshly macerated mustard leaves collected at various crop growth stages (seedling, pre-flowering, 50% flowering and seed formation stage) were used at various concentrations (0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5 and 6.0 g). The mycelial culture and sclerotia of *S. rolfsii* were exposed to different doses of macerated fresh mustard leaf (MFML) inside a closed chamber, without any contact. The mustard leaves showed best biofumigation activity at 50% flowering stage, with 99% inhibition of mycelial growth and sclerotial germination at a dose of 2.49g and 3.86g of MFML per 127 ml air space, respectively. In soil system, the saprophytic colonization ability of the pathogen was also studied under different doses of biofumigation. A significant ( $p < 0.001$ ) inhibition in saprophytic colonization ability of *S. rolfsii* in

soil was observed at a dose of 1.5 kg MFML m<sup>-3</sup> soil volume. The results opened up a new strategy to reduce sole reliance on synthetic pesticides and minimize unintended impacts on the environment.

### OP 15(S3): *Trichoderma* sp.: As a wonder bio-pesticide

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Rhizosphere is the niche of many micro-organisms which leads to their interaction as the exudate secreted from plant roots is the nutritional source for microbes to accelerate their growth and population density. Many soil-borne pathogens and beneficial micro-organisms survive in the plant's rhizosphere. Beneficial microbes provide plant roots a shield from pathogen attack. Soil-borne pathogens attack the rhizosphere that effects adversely on the growth promotion of crops. Fusarium wilt is caused by *Fusarium oxysporum*, Sclerotinia rot is caused by *Sclerotinia sclerotiorum*, Aphanomyces root rot is caused by *Aphanomyces euteiches*, and root rot is caused by complex of fungi like *Pythium* spp., *Fusarium* spp., *Sclerotium rolfsii*, and *Rhizoctonia solani* are the prominent soil-borne diseases of economically important crops in India. For the eco-friendly management of important soil-borne pathogens, *Trichoderma* species are majorly used and studied fungal biocontrol agents. It not only parasitizes plant pathogens, but it also promotes improve growth and maintains or improves the quality of soil by bioremediation. This review focuses on *Trichoderma* sp. as a bio-pesticide that indulges in a beneficiary effect on the crops against plant diseases.

### OP 16(S3): Elicitation of defense response by transglycosylated chitooligosaccharides in rice seedlings

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Plants are able to sense evolutionarily conserved general elicitors of pathogens called pathogen-associated molecular patterns (PAMPs), and activate immune responses, a process that known as pathogen-triggered immunity. Chitooligosaccharides (COS), released during plant fungal interaction, and elicit plant defense upon recognition. COS is of interest to the food, agriculture, and medicine-related biotechnology industries in light of the diverse applications for these molecules. Production of higher chain length COS is a daunting task, as the available methods including chemical hydrolysis, direct synthesis, and enzyme-catalyzed processes result in COS with low degree of polymerization (DP), while most biological activities require COS (DP $\geq$ 4). In the present study to produce longer chain length COS we followed enzymatic means using Transglycosylation (TG) enzyme (*SpChiDY28A*). Optimizations were carried out and bulk reactions were set up using DP5 substrate followed by purification of higher chain length COS using semi-prep HPLC. Further we tested for elicitor response of purified DP5, DP6 and DP7 on rice seedlings. Among the COS used, DP7 strongly induced oxidative burst response as well as peroxidase, and phenylalanine ammonia lyase activities. A few selected marker genes in salicylic acid (SA)- and jasmonic acid-dependent pathways were evaluated by real-time PCR. The expression levels of pathogenesis-related (PR) genes *PR1a* and *PR10* and defense response genes (chitinase1, peroxidase and  $\beta$ -1,3-glucanase) were up regulated upon COS treatment in rice seedlings. The DP7 induced *Phenylalanine ammonia lyase* and *Isochorismate synthase 1* genes, with concomitant increase of *Mitogen-activated protein kinase 6* and *WRKY45* transcription factor genes indicated the possible role of phosphorylation in the transmission of a signal to induce SA-mediated defense response in rice.

## Session 4. Multidisciplinary Interventions for Plant Disease Management

### KEYNOTE LECTURES

#### KN 01(S4): Biopesticides: registration process, challenges and future prospects in India

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In India, biopesticides are regulated through Insecticide Act (IA), 1968 and Insecticide Rules, 1971. Under the overall ambit of the IA, 1968 the Registration Committee (RC) a statutory body constituted under section 5 of the IA, 1968, scrutinize the formulae of pesticides, verify claims regarding efficacy and safety to human beings and animals, specify the dosage, manner of use, application technique, precautions against poisoning etc. to be printed on labels and leaflets and register pesticides including biopesticides. The Government of India under its strengthening and modernization of pest management approach (SMPMA) scheme strives for the promotion of integrated pest management (IPM) with a major objective to encouraging farmers to use various ecologically sustainable pest management approaches rather than relying only on chemical pesticides and promote the use of biopesticides and biocontrol agents. Biopesticides being environment friendly have high specificity and selectivity to target pests and safety to non-target and beneficial organisms. Biopesticides have an immense role in intensification of sustainable agriculture using green and nature friendly technologies. The thrust of the regulatory authorities is to promote and facilitate the registration of biopesticides without compromising the quality, safety and efficacy aspects. It is apparently visible from the number of the biopesticides registered in India. More than 70 different strains belonging to more than 8 different genera of entomopathogenic/ entomototoxic bacteria, antagonistic bacteria, entomopathogenic fungi, antagonistic fungi, nuclear polyhedrosis virus (NPV) and granulosis virus (GV) have been registered. The number of registrants of biopesticides have also reached to 970 in 2021-2022. The consumption of biopesticides increased from 7174.43 MT in 2017-2018 to 8898.92 MT in 2021-2022. Different guidelines are available for registration of biopesticides (botanicals and biocontrol agents) or microbial pest control agents (MPCA) in India. The major data requirements are legal, scientific data on chemistry, bioefficacy, safety, packaging and labelling. Based on data submitted, registration is granted as provisional under 9(3B) for any new strain and regular or original as 9(3). The guidelines for registration of biopesticides along with consortium of biopesticides have been revised to facilitate registration process. Nevertheless, the biopesticides testing infrastructure also require upgradation. The challenges which need to be addressed are manufacturing and sale of quality biopesticides, less facilities and heavy costs involve in toxicological studies for testing and promotion and popularization of already existing biopesticides among farmers. The companies engaged in chemical pesticide production should also encouraged for biopesticides production. Monitoring at national level for quality production and other related aspects to popularize biopesticides technology is required. The thrust is required towards the development of Indian standards for the uniformity in quality testing parameters to enhance the confidence for use and availability of quality biopesticides to Indian farmers. Linkages with National and International organizations are also required for imparting trainings to the farmers, stakeholders and scientists.

## KN 02(S4): Pomegranate diseases challenges and management through multidisciplinary intervention

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Increasing global food demand of rising population, climatic changes and environmental challenges have resulted in yield losses in several commercial crops and emergence of new pathogens and pests. Plant disease management today require multidisciplinary interventions for meeting global challenges. I am briefing here some multidisciplinary interventions with respect to pomegranate (*Punica granatum* L) cultivation in India. India is the global leader in pomegranate cultivation. Due to Rapid increase in pomegranate area with monoculture of cv. 'Bhagawa' the pomegranate crop faced hurdles due to diseases and insect pests. The major diseases and pests that affect fruit yield and quality are bacterial blight, fungal wilt (*Ceratocystis* major pathogen), root knot nematode (*Meloidogyne*. spp.), fungal fruit spots and rots caused by different pathogens, abiotic stresses and sap sucking and borer insect pests. Among the major biotic stresses, bacterial blight (BB) caused by *Xanthomonas axonopodis* pv. *punicae* (Xap) (Syn *Xanthomonas citri* pv. *punicae*) gained significance due to its destructive nature leading to failure of crop and huge economic losses to the farmers in India. ICAR- National Research Centre on Pomegranate (NRCP) today has given technology for effective management during crop season using Integrated Disease, Insect-Pest and Nutrient Management (IDIPNM) schedules, constantly modified with research and new agrochemicals, promising bioagents (*Penicillium pinophilum*), micronutrients and salicylic acid with widespread demonstrations in 3 states. Average blight reduction was up to 86.04 %, marketable yield increased 25-79.5% and average benefit: cost: 4.19. The schedule also takes care of major diseases like *Sphaceloma* scab, *Cercospora* spots, *Colletotrichum* rots and losses due to insect pests like sucking pests, fruit and stem borer etc. with export quality production. Later the Centre developed 'Stem Solarization' an ecofriendly, economical, effective technology for bacterial blight management without use of bactericides. This is done during rest period after harvest in hot dry period. The technology in farmers field had significant impact in BB reduction (88 - 100%) over control with significant increase (132 - 486%) in quality yield and the benefit: cost ratio in ranged from 3.03:1 to 3.57:1 and 20:1 in one orchard. Native endophytes (*Bacillus*, *Burkholderia*, and *Lysinibacillus*) have been identified as potential biocontrol agents for BB of pomegranate with blight incidence of 11.6% compared to control with 77.33%. These isolates were also effective against other fungal pathogens of pomegranate viz. species of *Ceratocystis*, *Cercospora*, *Colletotrichum*, *Sphaceloma*, *Lasiodiplodia* and *Calonectria*. A promising bioproduct is expected after multilocation field trials. Recently lytic bacteriophages isolated from phytoplasm and soil of pomegranate orchards were also identified as promising biological control agents against bacterial blight of pomegranate. Planting material being primary source of BBD spread, technology for bio-hardened tissue culture plants was developed and commercialized by this Centre. Work on developing resistant cultivars is in progress, around 310 germplasm (Indigenous and Exotic) and seedling population of several accessions screened vigorously. Two seedling accessions IC-318766, IC 318776 identified for further studies. Pomegranate wilt complex caused by *Ceratocystis fimbriata*, and root knot nematode is the most devastating health issue. Soil Solarization before planting a new orchard is most effective with multiple benefits. Use of biocontrol agents like *Aspergillus niger* AN 27 along VAM fungi, *Paecilomyces* sp. and *Trichoderma* spp. from the planting was the best remedy for both wilt and root knot nematode. Green manuring, inter cropping marigold, use of nematicides once a year during rest period helps to keep nematode infestation under check. Abiotic problems –fruit cracking, aril blackening and sunburn major issues in summer season crop are best reduced with proper training and pruning, bagging with white polypropylene bags or crop covers. This also takes care of hailstorms and fruit sucking moths. The Centre has also initiated work on identifying potential pesticide degrading micro-flora for pesticide degradation in pomegranate and preparation of commercial bio-formulation for pesticide residue free

production. Multidisciplinary approach is therefore important to meet the present and future challenges in agriculture in different crops.

## INVITED LECTURES

### IL 01(S4): Harnessing the potential of microbial metabolites for the management of sheath blight disease of rice caused by *Rhizoctonia solani* Kühn

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Rice is the most popular staple food being consumed by more than half of the world population and hence it is always in the lime light in research and development. Various biotic and abiotic stresses are affecting the successful cultivation of rice all over the world. Among the various diseases, the sheath blight (ShB) disease caused by *Rhizoctonia solani* Kühn [Teleomorph: *Thanetophorus cucumeris* (Frank) Donk] is one of the limiting factors seriously infecting rice cultivation globally and responsible for up to 69% yield loss. Therefore, research focus towards management of ShB disease is gaining attention among rice pathologists. Although, several ShB disease management strategies were developed and are being recommended, farmers are mostly following chemical control for ShB disease control. But, continuous and indiscriminate applications of agrochemicals have led to environment pollution, resistance to fungicides in pathogens and also cause harmful effects in animals and human. Hence, development of alternate disease control strategies is gaining momentum. With this background, research has been carried out to harness the potential of microbial metabolites against ShB disease of rice. In the past two decades, bacterial, actinobacterial and fungal isolates have been isolated in large numbers from various soil and sediment samples collected from terrestrial and marine environments. Most of the pure cultures were screened against the ShB pathogen, *R. solani*, the promising isolates were selected and investigated for their mechanisms of biocontrol activity. As antibiosis is one of the important mechanisms of biological control, in which, the biocontrol agents are able to produce antimicrobial substances during their interactions with pathogens. Therefore, production of secondary metabolites by the most promising bacterial, actinobacterial and fungal strains was determined and tested against *R. solani*. Notably, two *Streptomyces* spp., *Pseudomonas aeruginosa* and *Trichothecium roseum* exhibited significant antifungal activity against *R. solani* under *in vitro* condition. The above organisms were cultured separately in the standardized secondary metabolites production media and seven different antifungal compounds were isolated from the above mentioned microorganisms, purified by column chromatography technique and characterized by various spectral analyses. The antifungal activity of the purified compounds against *R. solani* was determined under *in vitro* experiments. Importantly, application of the purified compounds significantly decreased ShB disease in greenhouse experiments with commensurate increase in grain yield. The outcomes of the research have clearly revealed that antifungal metabolites produced by bacterial, actinobacterial and fungal biocontrol agents are highly promising for the management of ShB of rice.

## IL 02(S4): Black scurf of potato in Jammu and its management

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Fungicides, bio-control agents and organic amendments that showed promising results under *in vitro* studies were evaluated alone as well as in combination under field conditions to develop long-term strategies to combat black scurf of potato in Jammu. Fungicides viz. Thifluzamide, Penflufen, Pencycuron and Fluxapyroxad were found most effective in increasing plant vigor, plant emergence, percent disease efficacy and yield over control. Fungicides Pencycuron@0.25%, Thifluzamide@0.25%, Penflufen@0.083% and Fluxapyroxad @0.08% showed 92.68, 92.38, 87.90 and 87.33 per cent efficacy over control respectively. Biocontrol agents of *T. harzianum* @8gm/kg seed and *Pseudomonas fluorescens* 2.5ml /kg seed showed 22.24, 28.16 per cent efficacy over control respectively while organic amendments treatment of soil application of mustard cake @250kg/ha exhibited 15.63% efficacy over control. The fungicides Pencycuron, Thifluzamide and Penflufen at half doses in combination with *T. harzianum* and mustard cake showed 81.26, 73.81 and 70.33% efficacy over control respectively whereas a combination of these fungicides at half doses with *Pseudomonas fluorescens* and mustard cake showed 81.72, 76.46 and 74.52 per cent efficacy over control. The fungicides at half doses in combination with *T. harzianum* and mustard cake showed 12.63, 11.20 and 10.20 per cent increase in yield respectively over control whereas a combination of these fungicides at half doses with *Pseudomonas fluorescens* and mustard cake recorded 11.69, 10.44 and 9.16 per cent increase in yield respectively over control. Economic analysis of the Benefit:Cost ratio (BCR) indicated that the treatments Pencycuron Thifluzamide @0.25% and Penflufen@0.083% and Fluxapyroxad @0.080% showed highest 3.17:1, 3.10:1 and 3.11:1 BCR ratio respectively whereas these fungicides at half doses in combination with biocontrol agents and organic amendments show BCR ratio in a range of 2.68:1 to 2.74:1.

## IL 03(S4): Biogenic Nanoparticles elicit cellular, biochemical, and transcriptomic defense mechanisms against late blight of tomato

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The late blight of tomato, which is caused by the oomycete pathogen *Phytophthora infestans*, has emerged as one of the most destructing disease in India. The present study was targeted to evaluate the efficacy of *Trichoderma* derived selenium nanoparticles (SeNPs) to induce systemic resistance against late blight of tomato. The resistance mechanisms were further elaborated at cellular, biochemical, and transcriptomic levels. From the study, it was evident that the SeNPs primed tomato plants displayed enhanced growth parameters as against the control plants. Nano-primed plants that were artificially inoculated with the pathogen, exhibited a remarkable protection of 72.9% against late blight disease. The accumulation of cellular defense markers, namely lignin, callose, and hydrogen peroxide were found to be stimulated in the tripartite system under consideration. Additionally, the activities of biochemical defense enzymes such as lipoxygenase (LOX), phenylalanine ammonia lyase (PAL),  $\beta$ -1,3-glucanase (GLU), and superoxide dismutase (SOD) were upregulated in SeNPs primed tomato plants that were artificially challenged with *P. infestans*. This upregulation was further confirmed at the transcriptomic levels by qRT-PCR studies. Conclusively, this investigation has provided insights into the mechanisms of defense and resistance mechanisms incited by SeNPs against late blight of tomato, thus emphasizing its potential role as a nano-biostimulant fungicide.

#### IL 04(S4): Recent trends in the diagnosis of plant diseases in plantation crops

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India is the leading producer of plantation crops in the world. The plantation sector's contribution to our nation's export earnings is substantial. Moreover, the plantation industry provides direct as well as indirect employment to many livelihoods, supports various by-products and rural industries and plays a vital role in the conservation of the soil and ecosystem. The major plantation crops grown in India are coconut, arecanut, cocoa, rubber, tea, coffee, cashew, oil palm, and rubber. In the climate change cataclysm, many diseases are emerging and/or re-emerging as a major threat and shifting their host range to create havoc in the absence of its natural limiting factor in the plantation cropping system. In earlier days, morphological and microscopic characterization using standard taxonomic keys was used for pathogen identification. The presence of species complex in many pathogens may result in the misidentification of the species in recent years. Molecular characterization using multi-gene amplification aids in pathogen confirmation up to species and even subspecies level in some organisms. Dry spindle rot disease incited by *Lasiodiplodia theobromae* and *L. iranensis* was a major problem in coconut seedlings during recent years. Likewise, black spot disease caused by *Exerohilum rostratum* was recorded as a serious threat in the Coconut gene bank located at Kidu, Karnataka. *Lasiodiplodia theobromae* is an emerging pathogen of cocoa by causing severe charcoal pod rot and die-back diseases in cocoa. Recently, cashewnut leaf blight disease caused by *Neopestalotiopsis clavispora* is recorded as a major problem in cashew nurseries. *Pythium deliense* is reported to cause yellowing and wilting disease in black pepper. *Curvularia eragrostidis* is identified as a major threat to large cardamom cultivation in Sikkim state. The vein-clearing disease (kokke kandu) is identified to be caused by a novel aphid-transmitted nucleorhabdovirus from India. Association of *Phoma* spp. is reported as a major problem in small cardamom from the Western Ghats of India. Earlier reports showed that *Areca triandra*, a wild relative of cultivated arecanut is resistant to *Phytophthora* infection. But recently, we reported a new virulent strain of *P. palmivora* infecting all the crops in plantation-based cropping systems (coconut, cocoa, arecanut, palmyra, and oil palm). This particular strain of *P. palmivora* will definitely create a huge outbreak if not addressed properly. The emerging arecanut root rot/decay disease pathogen is identified as *Fusarium falciforme* (a member of *Fusarium solani* species complex) using multi-gene amplification. Further, a severe outbreak of the leaf spot disease recorded in all the arecanut growing tracts of Karnataka is identified as *Colletotrichum kahawae* subsp. *ciggaro* (a member of *Colletotrichum gloeosporioides* species complex) using multi-gene phylogeny. Pathogen detection using morphological tools may be insufficient to confirm the species' identity. In turn, molecular tools with the use of multi-gene profiling may result in the correct identification of the emerging pathogens associated with plantation crops. Such proper identification of pathogens may aid in the development of effective management procedures against such dreadful diseases.

## IL 05(S4): Emerging and reemerging rice pathogens: swotting through morpho-molecular characterization, virulence profiling, diagnostics, and pathogenomics

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Rice is an important food and commercial crop in the Karnataka state of India. It is being cultivated in both irrigated and rainfed ecosystems of the state. Rice production in Karnataka is affected by several biotic and abiotic constraints. The several biotic stresses, including fungi and bacterial disease, mainly limit its productivity. Several major diseases such as blast, sheath blight, and bacterial leaf blight are continued to appear in moderate to a severe form in all ecosystems in all seasons; in addition, several minor diseases such as brown spot, false smut, grain discoloration, sheath rot, stem rot are assuming the severe form in the recent past. Although the state occupies a significant area of rice and its cultivation is being threatened by several diseases, the information on the several pathogen-disease systems is either limited or unavailable. For the past ten years, our lab has attempted to address several research gaps in the paddy-diseases-pathogens system, such as the occurrence and distribution patterns of different rice diseases in different rice ecosystems, deducing the morpho-molecular diversity using multilocus (*actin*, *β-tubulin*, *calmodulin*, *translation elongation factor 1-α*, and ITS) sequence analysis for fungi and 16 rDNA and Insertion sequence-based markers for bacteria. The virulence analysis of *Magnaporthe oryzae* and *Xanthomonas oryzae* pv. *oryzae* studied from 2012-2022 using polygenic and monogenic differentials indicated the dynamics of pathotypes in the rice ecosystems of Karnataka. The data on the virulence profile of major rice pathogens was instrumental in initiating the resistance breeding program. We have also developed and standardized the LAMP assay for several rice pathogens, the LAMP assay for genotyping R genes, and a LAMP-based micro-device for the on-field detection of rice pathogens. We have reported the mating-type locus and avirulence gene distribution in the *M. oryzae* and *Ustilaginoidea virens* populations. The genomic resource generated for three strains (Uv-Gvt, Uv-3, and Uv-8) of rice false smut fungi *U. virens* enabled us to identify the genes involved in host-pathogen interaction. Using molecular and morphological techniques, we have identified the multiple fungal pathogens (*Bipolaris oryzae*, *Caruularia lunata*, *Setosphaeria rostrata*) associated with brown spot disease of rice. Also, we have generated genomic resources for all three pathogens for the first time in the country. We have identified the three pathogens associated with rice sheath blight disease in Karnataka and deduced the virulence profile of the rice-infecting *Rhizoctonia solani* population using our in-house selected host-differentials set. Using the culturomics and metagenomic approaches, we have identified the multiple pathogens associated with Grain discoloration of rice in different ecosystems of Karnataka. In a nutshell, at Rice Pathology Lab, Gangavathi, we have generated several leads on pathogen distribution patterns, virulence profile, morphological and molecular diversity, and pathogenomics that enabled us to understand the emergence of minor diseases into major forms and also the re-emergence of several major diseases in all the seasons of cultivation. The information generated in our study will help to design ecosystem-based management strategies for controlling rice diseases.



## ORAL PRESENTATIONS

### OP 01(S4): Biology and characterization of an emerging false smut pathogen *Ustilaginoidea virens* of rice (*Oryza sativa* L)

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Rice false smut (RFS) instigated by the fungus *Ustilaginoidea virens*, has emerged as one of the most devastating grain diseases in the mainstream of rice-planting regions worldwide. Improved method of pathogen isolation with more than 90% efficiency was developed. Different isolates of *Ustilaginoidea virens* collected from eight different states were characterized morphologically and at molecular level also. Morphologically, isolates showed variation in the size of the spore, colour and shape of the hyphae. The spore was globose, irregularly round to elliptical and warty on the surface with diameters ranging from 4.120 to 6.34  $\mu\text{m}$ . The maximum colony diameter was found in Uv407 (66.00 mm) and minimum was in Uv212 (17.50 mm). Isolates were further identified through Internal transcriber spacer (ITS) based amplifications. Genetic diversity were analyzed by using 12 SSR primers out of which 7 were found to be polymorphic and based on this data phylogenetic tree were constructed. The no of alleles per locus vary from 5 to 10. The maximum number of polymorphism was shown by UvSSR107, UvSSR 97 and UvSSR164 primer. The dendrogram generated based on polymorphic data revealed a considerable amount of diversity among the isolates grouping them in three clusters. The PIC ranged from .079 to 0.90. The value of Shannon information index ranged from 2.99 to 4.52. The pairwise population fixation index ( $F_{ST}$ ) value also indicated significant genetic variation among all compared geographical populations. Further, artificial inoculation of pathogen is the main problem for the detailed study of the pathogen. Improved syringe based inoculation method was developed for the artificial inoculation of the pathogen. High quality genome of highly virulent *U. virens* isolate UV2\_4G was sequenced using Nanopore and Illumina HiSeq 2000 sequencing platforms. The total assembled genome of Indian isolate UV2\_4G was 35.9 Mb, which comprised of 89 scaffolds with N50 700296 bp. A total of 358697 variants were identified in the genome, out of which 355173 were SNPs and 3524 were INDELS. Further, 7390 SSRs belonging to different repeat type were also identified in the genome. Out of 7444 proteins predicted, 7206 were functionally annotated. A total of 1307 CAZymes, 501 signal peptides, 1876 effectors and 2709 genes involved in host-pathogen interactions were identified. Comparative analysis revealed isolate UV2\_4G is distinct with 31 unique clusters. Study will be further helpful for the development of management practices against the pathogen.

### OP 02(S4): Integrated disease management on dry root rot safflower

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Safflower (*Carthamus tinctorius* L.), is one of the important Rabi oilseed crops of the country. Occurrence of dry root rot caused by *Macrophomina phaseolina* (Tassi.) Goid is one of the most devastating diseases. The pathogen being mostly soil born and sometimes seed born, cause pre-emergence seed rot as well as post-emergence seedling mortality. The field experiments were conducted on the Research Farm of Sorghum Research Station, Vasant Naik Marathwada Krishi Vidyapeeth, Parbhani, during Rabi 2019-20 and 2020-21; Those fungicides (systemic, non-

systemic & combi), bioagents, phytoextracts found most effective during *in vitro* studies were evaluated against dry root rot disease of safflower under natural field condition. Among 22 integrated disease management treatments imposed against dry root rot of safflower caused by *M. phaseolina* under natural field conditions. Pooled mean of the treatments imposed, *T. virens* (SA @ 28 gm/plot) + Mancozeb (ST @ 3 gm/Kg seed) + *T. virens* (ST @ 10 gm/Kg seed) + Sprint (SD @ 1.5 gm/Lit) + Garlic extract (SA @ 50 ml/Kg soil) was found most effective with significantly highest seed germination (92.89%), significantly least average mortality (12.01%) and highest average mortality reduction (82.39%) and highest mean ICBR (3.93) followed by Mancozeb (ST @ 3 gm/Kg seed) + *T. virens* (ST @ 10 gm/Kg seed) resulted seed germination 90.37%., average pooled mortality (18.18%)., average mortality reduction (73.29%) and ICBR 3.44 and least effective treatment is Garlic extract (SA) resulted seed germination (10.67 %).,average pooled mortality (50.85%)., average mortality reduction (25.54%) and ICBR 1.35.

### OP 03(S4): The key to India's food security lies with crop protection

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Invasive pests and diseases have in the recent past wreaked havoc in Indian fields. India loses more than two lakh crores of agricultural output to pests and diseases (approximately 20% of total production) each year. Pest and disease dynamics are constantly changing, and it becomes incumbent upon the public and private sector to cater to the differing demands. Crop protection chemicals are still the most extensively adopted management measure once the pest problem is reported. Despite agrochemicals being used in India for many years now, we are yet to achieve 50 per cent penetration. One of the major challenges that India faces includes pests and diseases that cause significant crop losses due to sub-optimal usage of pesticides, lack of quality pesticides or dearth of variety of new generation pesticides. Such factors compromise our food and nutritional security. Increase in pesticide consumption and bringing hitherto untapped areas of cultivation under its umbrella will help to boost agriculture productivity and feed our increasing population. At present, only 294 molecule are registered in India and about 75 molecules and their combinations are being used to protect 140 million hectare of diverse Indian agricultural crops. Indian farmers need far greater range of newer molecules to fight the battle against pests, diseases, weeds and other attacks. It is indeed a ray of hope. Greener and safer chemicals can play a significant role in crop protection. Plant disease forecasting is an underexploited area in India. Localized pest surveillance and early warning systems should be set up across the country to alert farmers so that remedial measures are initiated on time. Biopesticides and biocontrol agents present another dimension of crop protection. This assumes significance considering the resolve of many states in India to go completely organic. Indian biopesticide market is expected to deliver \$778 million by 2025 at a CAGR of 25.4%. The share of biopesticides in India is about 4.5% of total pesticides sale. The Indian biopesticides market is projected to witness a CAGR of 7.3% during the forecast period (2022-2027). Nanotechnology is a fascinating and rapidly advancing science and has the potential to revolutionize plant protection. Younger generation are looking for digital crop protection techniques. Several high-tech areas in crop protection such a digital doctor, customized spraying, Drones, IoTs, Tractor Sprayings, Nano pesticides, Improved application systems etc. are getting popular. Adoption of such new technologies by the farmers will lead to higher profitability and reduce in the long term his indebtedness. I foresee faster adoption of these techniques ushering in a Technological Revolution in crop protection Promoting the judicious use of pesticides and integrating cultural, agronomical, mechanical, biological, digital methods to manage pests, rather than trying to control them – these are some pre-requisites for quality food production. Large scale awareness campaigns with demonstrations for practical exposure to farmers on various methods of identifying and managing pests are required. The threats of

the future are immense and unknown. The crop protection sector must be dynamic enough to combat these threats in the most effective and productive way. The key to India's food security lies with crop protection.

### OP 04(S4): An overview of basic and applied research on diverse bacterial diseases on onion

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Bacteria from a diverse number of genera and species can infect onion foliage and bulbs and can cause pre- and post-harvest economic losses. The common bacterial genera and species that are encountered regularly in Georgia are *Pantoea* (*P. ananatis*, *P. agglomerans*, *P. allii*, *P. stewartii* subsp. *indologenes*, *P. vagans*), *Pseudomonas* (*P. viridiflava*, *P. marginalis*), *Burkholderia* (*B. cepacia* complex, *B. cenocepacia*, *B. gladioli*), *Rahnella* spp., and *Enterobacter* spp. Recently, three new bacterial species (*Rouxiella badensis*, *Pseudomonas allivorans* and *Pantoea eucalypti*) and one new pathovar of *P. stewartii* subsp. *indologenes* (pv. *cepacicola*) were associated with onion pathogenicity. Recently different pathogenicity and virulence factors in *Pantoea* spp., *Pseudomonas* spp. and *Rouxiella* spp. were identified and validated. The results indicate that pathogenic bacteria utilize diverse of genes/gene clusters that to infect onion. Multi-year assessments of bactericides, plant-growth regulators, thrips and weed management, cultural practices and varietal screens aided in identifying and optimizing integrated disease management practices that reduce losses due to bacterial diseases. Together, both basic and applied research on bacterial diseases of onion is continuously evolving and improving with the influx of novel information.

### OP 05(S4): Studies on rhizome rot of turmeric caused by *Pythium aphanidermatum* (Edson) Fitzp. in Central India

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The present investigation has been planned to know the causes of rhizome rot of turmeric in central India. Study includes collection, isolation, purification and pathogenicity, identification, *in vitro* and *in-vivo* evaluation of fungicides and biocontrol agents. A roving survey was conducted in turmeric growing region of Central India to know the incidence and severity of rhizome rot. The incidence of disease was ranged from 14.73 to 18.32 per cent and severity of disease was ranged from 20.23 to 34.57. Maximum incidence was observed in Panna (18.32%) and minimum in Jabalpur while maximum severity was observed in Panna district (34.57%) and minimum severity was observed in Jabalpur district (20.32%). The study of weather factors on development of disease revealed that rhizome rot of turmeric was favoured by wet and humid weather. The per cent disease incidence was negatively correlated with maximum temperature it was positively correlated with rainfall, minimum temperature and relative humidity. Among the twelve varieties tested for their disease reaction against *P. aphanidermatum* under field condition, Kasturi, Selam and Rashmi showed moderately resistant reaction against the disease with minimum disease incidence were recorded in Vietnam and Aama found moderately tolerant against rhizome rot. The result revealed that ridomil was found to be most effective against *P. aphanidermatum* at 0.15 and 0.2 % concentration while Thiram exhibited minimum per cent inhibition. The per cent disease suppression over control was calculated for all the treatments and it was maximum with ridomil (78.51%) and minimum disease suppression was recorded with Thiram (52.34%).

## OP 06(S4): Exploring stem and leaf rust resistance in large wheat germplasm lines and landraces

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Wheat is one of the oldest cultivated and most important food crop in the world. Production is often challenged by constantly evolving biotic stresses, especially stem, leaf and stripe rusts. Stem rust caused by *Puccinia graminis tritici* (*Pgt*) has historically been one of the major constraints in realizing stabilized wheat yields. The dynamic population of *Pgt* continues to adapt to deployed resistance genes rendering the majority of current varieties susceptible. Therefore incorporating newer resistance sources in developing wheat varieties is essential in order to prevent rust epidemics. Field evaluation of 4575 wheat germplasm, including released varieties, genetic stocks, advanced breeding lines, and landraces, was carried out for two years to identify sources of stem and leaf rust resistance. Four check varieties along with rust spreader rows were planted at regular intervals. Out of the total of 4575 wheat germplasm, 67 entries were found to be immune to stem rust. Out of these 67 genotypes, 52 were also immune to leaf rust. A total of 125 genotypes were found to be highly resistant ( $CI \leq 10$ ) to both rust diseases. About 957 genotypes were found to be highly resistant to stem rust. Interestingly, 72 landraces were found to be either immune or highly resistant to stem rust. These landraces were found to carry all-stage seedling resistance to the most prevalent and virulent rust pathotypes. These landraces may carry newer resistance genes. Identifying donor lines for stem and leaf rust resistance will help develop high-yielding rust-resistant varieties and identifying new gene/s, and quantitative trait loci through GWAS especially from landraces will help in the future development of high-yielding varieties.

## OP 07(S4): Exploring genetic resources to develop banded leaf and sheath blight resistant hybrids in maize

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Maize (*Zeamays* ssp. *mays*) is susceptible to various foliar diseases, Banded leaf and sheath blight (BLSB), Maydis Leaf Blight (MLB), Turicum Leaf Blight (TLB), bacterial stalk rot and post-flowering stalk rots such as charcoal rot and fusarium stalk rot. BLSB is an emerging and highly destructive maize disease, causing significant yield loss in *kharij* maize. It is caused by *Thanatephorus cucumeris* (telomorph), *Rhizoctonia solani* (anamorph) during *kharij* season, and is favoured by high humidity and hot environment. This disease is predominant in states of India such as Punjab, Haryana, Himachal Pradesh, Uttarakhand, Delhi, Bihar and Andhra Pradesh. Its wide host range, hard survival structures and non-availability of resistant donors further aggravates this disease. Punjab Agricultural University, Ludhiana has a rich reservoir of genetic resources developed from different heterotic pools; parental lines of released commercial hybrids; lines imported from USDA, The USA, CIMMYT, Mexico and collection from different research institutes of India. A set of 40 germplasm lines, being maintained through continuous selfing, were tested for their resistant reaction to banded leaf and sheath blight through well standardised artificial screening under field conditions. As there is no reported resistance source in cultivated maize, the wild progenitor teosinte (*Zea. mays* sub. *parviglumis*) scored 4.2 (MR) was also utilized to generate stable introgression lines in different maize backgrounds (from 2017-2021). The stable introgression lines in elite backgrounds were used to develop single cross hybrids and their disease reaction to BLSB. The study reports the generation of a single cross hybrid developed from  $\{(LM\ 14\ X\ Zea\ mays\ ssp.\ parviglumis)/LM\ 14*3(BC_3)-1-1-1-\otimes\} \times \{(LM\ 13\ X\ Zea\ mays\ ssp.$

*parviglumis*)/LM 13\*3(BC<sub>3</sub>)-1-1-1-⊗} during spring 2021 and testing against BLSB under artificial conditions during *kharif* 2022. The disease score of 4-5 (based on standard disease rating scale of 1-9) rated the developed hybrid moderately resistant (MR) for BLSB whereas its female parent {(LM 14 X *Zea mays* ssp. *parviglumis*)/LM 14\*3(BC<sub>3</sub>)-1-1-1-⊗} was MR (disease score 4.5) and male parent {(LM 13 X *Zea mays* ssp. *parviglumis*)/LM 13\*3(BC<sub>3</sub>)-1-1-1-⊗} as MS (disease score 6.0) based on testing against BLSB under artificial conditions during *kharif* 2021. Based on two year pool disease score (*kharif* 2021 & 22), inbred line PML 387, developed through tuxpeno pool, was identified as MR (mean score of 4.7). This is high seed yield line of late maturity group and can be utilised to breed BLSB tolerant hybrids. Other potential sources of resistance were LM 13 (5.75); LM 14 (5.4) and CML 563 (5.4). The study reported generation of novel genetic resources to develop resistance in maize against BLSB, a devastating disease of maize.

### OP 08(S4): Prevalence of blue mould rot of Indian gooseberry (*Emblia officinalis* Goertn.) caused by *Penicillium islandicum* (Sopp.) and its management

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Aonla or Indian gooseberry (*Emblia officinalis* Goertn. Syn. *Phyllanthus emblica* L.) is one of the most important indigenous fruit of Indian subcontinent. The blue mould rot caused by *Penicillium islandicum* adversely affects the fruit quality, quantity and ultimately reduces the marketable value. The major loss due to blue mould rot in aonla takes place from transit to the market. The earliest symptoms of infection due to *Penicillium islandicum* is seen as water soaked lesion on the fruit surface which enlarges in size followed by development of pin head size colonies of golden yellow colour. The older colonies turn olive green. In India, nearly 20 – 35 per cent of perishables are lost due to post harvest diseases and the detailed investigations on various aspects were carried out in the present study. Freshly infected fruits of aonla variety Chakiya showing typical blue mould rot symptoms were collected from Horticulture farm of CCS HAU, Hisar. The infected fruits showed soft, watery, slightly discoloured spots. The sporulating area had a blue, bluish green with abundant sporulation, usually surrounded by white mycelium and a band of water soaked tissues covering the whole fruit within 8-10 days. The shape of the fruit was found deformed. Fortnightly survey carried out from first week of October to 4<sup>th</sup> week of January revealed that the maximum per cent disease incidence of blue mould rot 6 and 7.50 % was observed in terminal markets as compared to Research Station Orchard of Rewari (Bawal) and Hisar Distt. respectively. In varietal screening against blue mould rot maximum per cent disease intensity was found in Chakiya (50.00%) and Banarsi (49.33%) while least per cent disease intensity was found in Desi (2.67%) and Kanchan (3.33%). Relative efficacy of five chemicals against blue mould rot (*Penicillium islandicum*) of aonla were tested *in vitro* and *in vivo* at 0.2M, 0.5M and 1.0M concentrations. The boric acid was found best treatment with 99.24 per cent growth inhibition at 1.0M conc. over control under *in vitro* condition. Boric acid was found most effective in reducing the blue mould rot per cent intensity in pre and post inoculation after five and ten days of inoculation under *in vivo* conditions. Bio-efficacy of ten plant extracts (@ 5, 10, 20 per cent conc.) were studied for the management of blue mould rot of aonla *in vitro* and *in vivo*. *In vitro* least mycelial growth was recorded in Neem leaf extract (15.25, 8.38 and 7.31 mm) showing 83.06, 90.69 and 91.88 per cent growth inhibition over control followed by Haldi (Turmeric) bulb extract. *In vivo*, Neem leaf extract (@ 20 per cent conc.) proved highly effective in reducing the per cent disease intensity (7.31 and 8.13%) in pre and post treatment after five days of inoculation followed by Haldi (Turmeric) bulb extract. Similar trend was also recorded in pre and post treatment after ten days of inoculation. But per cent disease intensity was higher as compared to pre and post treatment after five days of inoculation. Five antagonists were studied for evaluating their antagonism against *Penicillium islandicum* by dual culture method. Significantly highest per cent growth inhibition of *P.*

*islandicum* was noted in *Trichoderma harzianum* (83.06%). *T. harzianum* (6.0 and 6.31%) was found most efficient antagonist in reducing the blue mould rot followed by *Pseudomonas fluorescens* (8.19 and 8.81%) in pre and post inoculation respectively after five days of inoculation. Similar trend was also observed in pre and post treatment after ten days of inoculation.

### OP 09(S4): Mangrove and *Ampelomyces quisqualis* on the management of black gram powdery mildew

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Black gram (*Vigna mungo* L.), is one of the most important short duration pulse crops grown in India. Powdery mildew caused by *Erysiphe polygoni* is a major destructive disease causing drastic economic yield loss upto 50 per cent. The current investigation was undertaken to manage the *E. polygoni* causing powdery mildew by using mangrove leaf extract along with bio-agent (*Ampelomyces quisqualis*). The susceptible variety ADT-3 was raised in both pot and field for management practices. In the present investigation, Azoxystrobin 25% SC @ 0.1 % was found to be effectively reduced the incidence of black gram powdery mildew disease in both pot and field trials with minimum per cent disease index of 19.30 and 15.50 per cent after 1<sup>st</sup> spray and 9.37 and 6.98 per cent after 2<sup>nd</sup> spray followed by the foliar application of *A. quisqualis* @ 0.5% on 43 + 53 DAS plus *R. apiculata* @ 15% on 43 and 53 DAS significantly reduced the disease incidence with minimum per cent disease incident of 23.25 and 19.95 after 1<sup>st</sup> spray and 14.63 and 9.06 after 2<sup>nd</sup> spray in both pot and field trial respectively. Meanwhile, the control treatment was recorded the higher per cent disease index of 48.17 and 64.37 per cent. Further the same treatment also considerably increased the biometric of black gram.

### OP 10(S4): Influence of carbon and nitrogen sources on the growth of *Ustilaginoidea virens*, incitant of false smut of rice (*Oryza sativa*)

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The nutritional requirement, effect of carbon and nitrogen sources for the growth and sporulation of *Ustilaginoidea virens* (Cook.) Tak was studied. Different carbon and nitrogen sources were substituted the sucrose and sodium nitrate of basal Czapek dox agar medium, respectively and were evaluated for growth of *U. virens*. Among the carbon sources, glycerol was the best carbon substrate for fast mycelia growth (23.30 mm). The minimum average colony diameter was recorded in maltose (17.15 mm). The isolates also showed preferential utilization of carbon source, significantly maximum mean colony diameter of 30.85 mm was noticed by Uv-1. Among the nitrogen sources tested, the maximum colony diameter was observed with the medium supplemented with sodium nitrate (28.10 mm) and Uv-15 isolate showed maximum colony diameter (22.15 mm). Higher concentration of sucrose (2 %) for 24 hrs incubation period supported maximum germination of spores of *U. virens* (57.70 %) and sucrose was found to be superior in inducing germination than dextrose. The results of this study help to understand the physiological and biochemical requirements for the growth and development of the pathogen, which could serve as an input in disease management to minimize the effect of false smut disease on rice.

## OP 11(S4): Management of *Phytophthora* diseases in capsicum by employing combi-fungicides

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Capsicum (*Capsicum annuum* var. *grossum* Sendt) is an important spice and annual herbaceous vegetable crop. It is one of the highly remunerative vegetable grown worldwide especially in temperate regions of Central and South America, European countries, tropical and sub-tropical regions of Asian continent. Capsicum was targeted by many fungal diseases such as damping off, leaf spots, leaf blight, stem blight, fruit rot, powdery mildew and wilt. Among them, *Phytophthora* blight is a devastating disease of bell pepper virtually infect every plant parts resulting in root and crown rot, on aerial parts it causes leaf blight, stem blight and fruit rot. An integrated management strategy has been employed in order to mitigate the disease. Hence the present investigation is carried out to test the bio-efficacy of novel fungicide molecule against leaf blight, stem blight and fruit rot of capsicum. The results revealed that, among the implemented treatments valifenalate 6 % + mancozeb 60 % WG at 3000 g/ha was very effective in reducing leaf blight, stem blight and fruit rot diseases of capsicum with maximum fruit yield of 31.20 t/ha with 3.84 BC ratio. Further phytotoxicity was tested, which revealed that there were no visual phytotoxic symptoms observed during the experimentation.

## OP 12(S4): Current scenario of sugarcane diseases and their management in North West Zone of India

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Sugarcane (*Saccharum spp.* hybrid) is an important cash, food and bio energy crop of tropical and sub-tropical areas of the world including India and supporting world economy to a great extent. The crop remains in field from eleven to eighteen months and is affected by several fungal, bacterial, viral and phytoplasma diseases. Production and productivity of crop is hampered by these diseases in most of the sugarcane growing areas leading to considerable qualitative and quantitative losses in sugarcane. Among the several diseases recorded so far on sugarcane, some causes havoc among the sugarcane growers. Red rot (*Colletotrichum falcatum*), wilt (*Fusarium sacchari*), smut (*Sporisorium scitamineum*) and grassy shoot disease (SCGS) are of major economic importance which causes significant yield losses and results in low recovery of the sugar mills. Pokkah boeng (*Fusarium species*), yellow leaf disease (SCYL), top rot (*Acidovorax avenae subsp. avenae*) diseases though earlier minor diseases but now posing new threat to sugarcane crop in this region which also results in significant yield losses in cultivated varieties. Occurrences of minor diseases like mosaic (SCMV), rust (*Puccinia melanocephala*), brown spot (*Cercospora longipes*), Ring spot (*Leptosphaeria sacchari*) and eye spot (*Bipolaris sacchari*) diseases on sugarcane also a great challenge for future in this region. Red rot is the most dreaded disease which appears now in pre-dominantly cultivated early variety Co 0238 in north western part of India both in pre and post monsoon seasons from last few years. CF 08 and CF 09 races of red rot are most prevalent, now CF 13 is designated as new race from Co 0238 in this region. This variety is now highly susceptible to most of the diseases and insect pest due to monoculture in this zone which results in significant yield losses and low recovery. Earlier also several popular varieties like CoS 8436, CoJ 64 and Co 89003 succumb to red rot. Red strip phase of top rot appears during April-May and top rot phase observed

during monsoon season with heavy rains in severe form in some of the varieties particularly in CoJ 85. Similarly wilt also noticed in several varieties particularly Co 89003 which succumb to both wilt and red rot. Smut incidence is also increasing from last few years on most of the cultivated varieties in both plant and ratoon crop. Several genotypes/varieties have been identified/developed resistant and moderately resistant to red rot by CF 08 , CF 09 and CF 13 races with plug and nodal cotton swab methods of inoculations. Similarly smut, pokkah boeng and yellow leaf disease resistant genotypes/varieties identified which are helpful in breeding programme. Healthy seed production, regular monitoring, field hygiene and ratoon management helps in minimizing the spread of red rot and other diseases. Epidemiology, variability and integrated management practices of pokkah boeng were also developed which include use of bio rationales, bio agents and fungicides. Current status of major and emerging diseases prevalence in this region and new approaches to manage the diseases are summarized.

### **OP 13(S4): Exogenous delivery of dsRNAs derived from the two genes of S RNA of groundnut bud necrosis virus combating the virus accumulation and symptom expression in host plants**

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Groundnut bud necrosis orthotospovirus (GBNV, family *Tospoviridae*) is the most destructive tospovirus in India, impacting a variety of crops. The development of insecticide resistance in the vector thrips and the non-availability of a resistant variety make it more challenging. An alternative approach i.e., dsRNA-based induction of resistance through RNAi against different plant viruses has been carried out. In the present investigation, two dsRNA molecules were prepared from the NSs and NP genes, which encode the silencing suppressor protein and nucleocapsid protein of the S RNA of GBNV, respectively, by using the vector L4440 which was transferred to the *E. coli* strain HT115 (DE3). In the experiments, analyses of the determination of the effective dose of dsRNA, the efficacy of dsNSs, dsNP, and the combination of dsNSs + dsNP against the GBNV infection in cowpea and *Nicotiana benthamiana* were conducted. It was observed that 10 µg of dsRNA/ plant effectively reduced the viral infection in the plant. The disease severity data and qRT PCR analysis revealed that viral infection, as well as virus load, have significantly reduced in the dsNSs, dsNP and dsNSs + dsNP treated plants but, it was found that dsNP was more effective than dsNSs, and the dsRNA mixture (dsNSs + dsNP) was the most potent treatment in protecting plants from GBNV infection. In another experiment, dsN-treatment as co-inoculation and 1days post inoculation against GBNV infection in cowpea was conducted, the results showed that co-inoculation considerably decreased local lesions while dsN treatment given 1 day after inoculation was effective in reducing viral infection systemically.



## Session 5. Climate Resilient Agriculture and Disease Forecasting

### KEYNOTE LECTURES

#### KN 01(S5): Significance of Plant Growth Promoting Microorganisms for Plant and Soil Health under Changing Climatic Scenario

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Plant diseases are responsible for the loss of at least 10% of global food production, representing a threat to food security. The prevention of diseases mainly dependent on agro-chemicals especially from the past few decades. Despite the great effectiveness and ease of utilization of chemicals products, their use or misuse has led to hazardous effects to environment. Some microorganisms, the bio-control agents are able to colonize the soil surrounding plant roots, the rhizosphere, making them come under the influence of plant roots. Plant growth promoting Microorganisms (PGPMs) generally refers to a group of soil and rhizosphere free-living bacteria and fungi colonizing roots in a competitive environment and exerting a beneficial effect on plant growth as well as disease management. PGPM play key role not only in transforming nutrients in the soil but also giving protection against plant diseases. The beneficial effect of PGPM on plant growth involves the ability to act as phyto-stimulators or biofertilizers. PGPM could enhance crop yield through nutrient uptake and plant growth regulators. PGPM could also act as bio-control agents by the production of antibiotics and triggering induced local or systemic resistance. The exact mechanism by which PGPR stimulate plant growth is not clearly established, although several hypothesis such as production of phytohormones, suppression of deleterious organisms, HCN and siderophore production, activation of phosphate solubilization, volatile compound production and promotion of the mineral nutrient uptake and plant growth promotion are usually believed to be involved. The studies conducted on groundnut, chickpea, pigeon pea diseases at our department indicated that PGPMs can be used for plant growth promotion and management of diseases in these crops. Hence, there is a lot of scope for PGPMs in agriculture in general and plant disease management in particular. Sustainable agriculture based on environmentally-friendly methods, tends to use PGPMs as tool that could as a by-product reduce the use of chemicals. There is a great need for eco-friendly management of plant diseases through bio-agents such as PGPMs in worldwide.

#### KN 02(S5): Decision Making Tools for Integrated Disease Management

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Decision-support systems (DSS) are techniques that help decision makers utilize models to solve problems under complex and uncertain conditions. The decision-making process is the core of any successful integrated disease management programme. The complexity of decision-making process in IDM is much higher as compared to conventional agriculture as it involves multiple factors related to the host, pathogen and environment that have to be considered. Hence, for taking the most efficient and economic decisions, a farmer or a scientist needs the help of decision-making tools. This has led to the development of four such decisions making tools viz., warning services,

expert systems, decision support system and onsite devices. They differ in their objective, scope, architecture and complexity of data that they can handle. But the prime objective of these tools is to help the farming and the scientific community to take the best possible decision regarding plant disease management. The predicting conditions that warrant intervention is a key tenet of the concept of integrated disease management with the use of expert systems and disease models being characteristics of higher-level IDM. At present, their adoption is limited and does not justify the cost and effort required for their development. However, more efficient and user-friendly tools are being developed after rectifying the drawbacks of the previous ones. Their efficient utilization will help in successful plant disease management and help us achieve the goal of sustainable agriculture.

### **KN 03(S5): Disease dynamics and Soil Health under Conservation Agriculture: Challenges, Experience and Future strategy**

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As a technique in search of sustainability in the agricultural sector, No-till (NT) with crop rotation and residue retention is recognized worldwide as conservation agriculture (CA). It has demonstrated that conservation agriculture practices could have a major role in overcoming scarcity of farm labour and rising costs of production through mechanization. The adoption of conservation agriculture may provide an alternative production system and also enhance the resilience of climate change. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production. It was estimated that tillage produced about 12% more CO<sub>2</sub> than no-tillage in presence of residue indicating higher build-up in soil thus supporting microbial population. However, this agriculture practices having the presence of crop residues in the soil surface provide the residue- and soil-borne microorganisms including plant pathogens with a favourable habitat as observed by several researchers. On the contrary, several diseases were reduced under conservation agriculture practices mainly due to increase in population of soil antagonistic microflora and improved soil health. Spot blotch severity in wheat expressed as Area under disease progress curve (AUDPC) was negatively correlated with residue retention. Microbial population and enzyme activity were significantly higher in CA plots. No-tillage treatments irrespective of residue retention maintained higher microbial population round the year. Seasonal variation in population microbes was noticed. The crop residues on the surface acts as buffer layer protecting the soil microbes from the extremes of temperature and also reduces the evaporation loss from the bare soil surface. The improvement of the soil structure also allows the micro flora and fauna to thrive in a much better way due to the better aeration and improved water retention within the soil. Further, the adoption of crop rotation reduces the residue borne pathogens beside application of some specific biocontrol agents. In spite of the drawback on the higher incidences of some residue borne pathogens, the conservation agriculture practices may be considered as one of best available methods to mitigate the climate change and to maintain the sustainability of the soil.

## INVITED LECTURES

### IL 01(S5): Molecular epidemiology of viral disease complex of *Capsicum chinense* Jacq. in North Eastern Region of India

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King Chilli belongs to the family *Solanaceae*, is recognized as one of the hottest chilli in the world. Viral diseases continue to damage king chilli cultivation in NE India, few epidemiological data are available. The overall objective of our study was therefore to study the molecular epidemiology of viral disease complex of *Capsicum chinense* Jacq. in North Eastern Region of India. In this study, surveys were carried out in five major king chilli growing States of NE India namely Assam, Arunachal Pradesh, Meghalaya, Manipur, and Nagaland and epidemiological parameters associated with king chilli viral disease complex were assessed. King chilli leaf samples were used for molecular characterization of the king chilli viruses involved. Statistical analyses were performed using the molecular data obtained and epidemiologic data recorded in the field. This report describes the deployment of High Throughput Sequencing (HTS) in support of the diagnosis of a suite of novel and previously characterized plant viruses of regulatory significance in king chilli. Additionally, this report aims to compare the recently detected tentative virus species in relation to previous viruses reported from king chilli with respect to the greater diagnostic accuracy afforded by recent developments in diagnostic technologies.

### IL 02(S5): Mango diseases: Influence of climate change and integrated management

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Mango (*Mangifera indica* L.) – the king of all indigenous fruits in India is ranked as one of the preferred fruits in the international market because of its delicious taste and high caloric value. Mango is now grown in over 87 countries. Alphonso, Banganapalli, Langra, Mallika, Totapuri, Dasherri, Raspuri, Amrapalli are commercially important among the more than 1000 varieties grown in India. Impact of climate change on the altered scenario of diseases on the crops has been emphasised worldwide. There has been a shift in the flowering pattern and fruit production in mango and disease scenario in mango been changed. Though mango crop is known to suffer from several fungal diseases; some diseases that were considered as minor have become severe in mango during the recent years. Mango leaf blight (*Pestalotiopsis mangiferae*), Stem end rot (*Phomopsis mangiferae*) and black banded disease have become prominent. Post harvest rots are equally important because these not only deteriorate the nutritive value and quality in mango fruits but also render them unfit for consumption and trade resulting into great economic losses. *C. gloeosporioides* (anthracnose), *Lasioidiplodia theobromae* (stem-end rot) and *Aspergillus niger* (fruit rot) are the most important pathogens causing fruit rots in mango during ripening and storage. The infection of the pathogens occurs in the in quiescent form during the premature stage as well as during harvesting, transportation and storage (especially *A. niger*). *C. gloeosporioides* had recorded maximum associated frequency in increasing order with all the developmental stages of fruit (20 % with unopened flowers to 80% with the mature fruits) compared with *L. theobromae*, *Phomopsis mangiferae*, *Pestalotiopsis mangiferae*, *A. niger*, *Rhizopus arrhizus* and *Alternaria alternata* that were the other important associated fungi and are known to cause diseases in mango. Management of such diseases is mostly achieved through the pre harvest application of agrochemicals (fungicides) whereas post harvest treatments with such chemicals are discouraged because of health hazards due to residues. Hence, safer and non-injurious methods devoid of such chemicals are favoured and accepted. Field trials revealed

that as pre harvest treatment, application of Azoxystrobin was most effective in controlling rots that resulted in 10.00 & 8.00% fruits infected with anthracnose and stem end rot, respectively. Usage of the extracts obtained from Turmeric and Neem leaves recorded 16.00 % diseased fruits in each with anthracnose and 12.00 and 14.00 % fruits had stem end rot, respectively. None of the treatments recorded Aspergillus rot except control had the disease. In untreated control 36.00; 26.00 and 6.00% fruits were rotten due to anthracnose, stem end rot and Aspergillus rot, respectively. Post harvest treatment with Azoxystrobin preceded by the pre harvest application of Turmeric extract / Vitex negundo leaf extract were next in the order where 3.33% fruits had both anthracnose and stem end rot. In all the integrated treatments involving pre and post harvest application fruits were free from Aspergillus rot. Hot water treatment for 10 min at 52°C preceded by pre harvest application of Azoxystrobin resulted in complete control of storage rots. Mango fruits those did not receive any pre harvest treatment but were subjected to hot water treatment (Control) recorded 32.00%, 24.00% and 6.00% fruits infected with anthracnose, stem end and Aspergillus rot, respectively. Influence of climatic factors in view of disease progression and importance of integrated approach in managing diseases in mango has been discussed in the paper.

## ORAL PRESENTATIONS

### OP 01(S5): Management of stem rot of groundnut through biocontrol agents and chemical fungicides

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Efficacy of biocontrol agents and fungicides applied as seed treatment and soil application was assessed against stem rot of groundnut, a destructive soilborne disease in several groundnut growing regions in India. A field trial was conducted during *kharif* 2021-22, to assess the efficacy of biocontrol agents and fungicides against stem rot disease under coastal climatic conditions of Odisha. Significant reduction in severity index (%) of stem rot was recorded to 27 per cent with 'seed treatment of Carboxin 37.5%+Thiram 37.5% DS and soil drenching with Carbendazim 12% + Mancozeb 63%WP @1.5g/l' twice at 15 days interval (starting at first appearance of the disease), followed by 30.4 per cent with 'seed treatment of Carbendazim 12%+Mancozeb 63%WP @ +SD with Tebuconazole 25.9 %EC @1ml/l' (twice at 15 days interval) and 31.4 per cent with 'seed treatment of *Trichoderma viride* + *Pseudomonas fluorescens* and soil application with *T. viride* + *P. fluorescens* (twice at sowing and earthing up)' as compared to 49.7 per cent in untreated control. The highest pod yield of 1567kg/ha was obtained with 'seed treatment of Carboxin 37.5%+Thiram 37.5%DS and Soil drenching of Carbendazim 12%+Mancozeb 63%WP @1.5g/l' followed by 1479 kg/ha with seed treatment of *T. viride*+ *P. fluorescens* and soil application of *T. viride*+ *P. fluorescens*' (twice at sowing and earthing up) as compared to 986.6 kg/ha in untreated control. The study revealed that application of biocontrol agents for management of soilborne disease stem rot was statistically at par with use of chemical fungicide options and hence should be preferred for better plant and soil health.

### OP 02(S5): Evaluation of fungitoxicants against powdery mildew of ber

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Indian jujube or ber (*Ziziphus mauritiana* Lamk.) is one of the most common tropical fruit of India. Powdery mildew of ber incited by *Oidium erysiphoides* f. sp. *ziziphi*, Yan and Wang, is the most important disease that causes

maximum reduction in yield and quality of ber fruits. Ber is a hardy crop which grown in arid and semi-arid conditions, characterized by sandy soils, scanty rainfall (400-600 mm), thermal oscillations (5-35 °C) and low relative humidity. The cultivation of ber requires the least input and care. In present investigation, In vitro efficacy of systemic fungicides revealed that the maximum inhibition of conidial germination of *Oidium erysiphoides* f. sp. *ziziphi* was observed in propiconazole (91.23 %) which was on par with hexaconazole (90.92 %). However, least inhibition of spore germination over control was observed in tolfenpyrad (81.09 %) which was on par with azoxystrobin (81.33 %). In vitro efficacy of combi fungicides revealed that, tebuconazole 50 % + trifloxystrobin 25 % was the most effective fungicide with maximum inhibition of 92.86 per cent. The least effective fungicide was ametoctradin 27% + dimethomorph 20.27 % SC with 62.29 per cent inhibition. In vitro efficacy of various bio agents tested at different concentrations revealed that, maximum mean conidial germination inhibition was recorded with *P. fluorescence* (50.55 %). The minimum effective bio agent was *Trichoderma harzianum* with 47.53 per cent inhibition. The results of the field evaluation of fungicides and bio agents revealed that among different treatments imposed, maximum disease reduction of 87.40 per cent over untreated plot was noticed in tebuconazole 50 % + trifloxystrobin 25 % followed by tebuconazole with 85.26 per cent disease reduction over control while the minimum disease reduction over control was shown by *P. flouescens* followed by *B. subtilis* which recorded 57.32, 55.71 per cent disease reduction over control.

### OP 03(S5): Global warming vis-a-vis biotic and abiotic stresses in cotton crop in Indian Punjab

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Cotton being designated as “White Gold” is the most important commercial, “King of fibre” and foreign exchange exchequer crop, specifically grown in the South-Western Punjab. Presently, Global warming is putting hazardous impact on the Agricultural crops. The rising trend in temperature favoring the abiotic as well as biotic stresses in cotton crop too. The minimum temperature of 16°C is required at the germination stage (April 01 to May 15). During the *Kharif* 2022, sudden increase in the minimum temperature during the above said period from 15 to 26.2° C and in the maximum temperature from 36.6 to 46.8°C lead to the undesirable impacts on the germination, growth, pathological parameters and yield in cotton crop. Due to the high temperature, the abiotic stresses like poor germination, mortality of the seedlings, scorching of cotton leaves were the prominent symptoms widely noticed in the initial crop growth phase. Further, during the later growth stage stressed flowering and stunted growth were also noticed. Though, incidence of the Para wilt was comparatively low, but the “New wilt” also known as “Sudden wilt” emerged as the major abiotic stress in the cotton crop. Among the biotic stresses, incidence and the severity of the Cotton leaf curl virus disease (CLCuD) was recorded high as compared to previous years. It might be due to the excessive population of whitefly, increased area under summer moong being the alternate preferred host of the whitefly and emergence of new or more virulent strain of CLCuD dominating in cotton belt in Punjab. Due to severe attack of white fly, incidence and severity of sooty mould in cotton was also reported high. However, Fungal foliar leaf spots, Bacterial blight and Root rot were in declining trend. In addition to the heat stress, cotton plants were also found under nutrients stress resulting low immunity, hence more prone to abiotic and biotic stresses during the year under report. Leaf reddening and physiological droppings were also seen in the cotton fields. All these factors lead to yield reduction in cotton crop. The economic survey of cotton crop during the report period has also confirmed low productivity, thus, declining net returns over the previous years. Hence, the Global warming, resulted in encouraging the incidence level of existing stresses and became one of the major upcoming factor for declining in the cotton production in Punjab.

### OP 04(S5): Integrated management of root-rot (*Fusarium solani*) and root borer (*Emmalocera Depressella*) in bael (*Aegle marmelos* L.)

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Bael [*Aegle marmelos* (L.) Correa] is an important indigenous fruit of family Rutaceae and religious plant especially to Hindus in India. In India, bael plants are widely grown in eastern Uttar Pradesh, Rajasthan, Gujarat, Bihar, West Bengal, Madhya Pradesh and Haryana. The fruit pulp is the main source of natural antioxidants along with laxative and bioactive properties. Though, bael plants are hardy and tolerant to biotic and abiotic stresses in ancient era but in modern period these are also attacked by microbial pathogens and causing severe menace. Among these, root rot and root borer in bael is now becoming an important menace in Rajasthan and other parts of the country. An experiment on integrated management of root rot and root borer in bael was laid out during 2018-20, at CCSHAU Regional Research Station, Bawal in order to find out effective control. The treatments included insecticide, fungicide and bio-agent alone and in combination. The soil application of the above pesticides was done in the month of March, June, September and December. The observations on the number of dead plants were recorded. Pooled result of three years data revealed that two applications of carbendazim 50 WP (20 g/tree) + chlorpyrifos 20 EC (50 ml/tree) at the time of manuring and repeated after 15-20 days interval is for the control of root rot and root borer in bael was found significantly superior and followed by carbendazim 50 WP (20 g/tree) as compared to control. Pooled yield with carbendazim 50 WP (20 g/tree) + chlorpyrifos 20 EC (50 ml/tree) was also maximum (84.24 q/ha) as compared to control (34.71 q/ha). Carbendazim 50 WP (20 g/tree) + chlorpyrifos 20 EC (50 ml/tree) was also found cost effective with highest BC ratio of 6.21 in managing disease.

### OP 05(S5): Bell pepper disease segmentation using Deep Convolutional Neural Network (DCNN)

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Agriculture production plays a significant role in the country's economy. Diseases are quite natural and common among plants. Identification of diseases in plants is necessary for averting losses in the yield of agricultural products. Manual monitoring of plants requires expertise, immense effort, and excessive time. Automatic detection will not only help in reducing time and effort but will also help in detecting disease at an early stage, as soon as it will start appearing on plant leaves. Recently, image processing in agriculture has attained a surge of interest from researchers. This study presents a five-layered CNN model for the automatic detection of plant disease utilizing leaf images. In order to better train a CNN model 20,000 augmented images are generated. Experimental results demonstrate that the proposed Deep-CNN model can predict pepper bell plant leaf as healthy or bacterial with 99.99% accuracy. Robust results make the proposed Deep-CNN model a preliminary warning tool that can be applied as a disease identification system in a real cultivation environment.

### OP 06(S5): Effect of soybean yellow mottle mosaic virus on yield and seed quality parameters of soybean

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*Soybean yellow mottle mosaic virus (SYMMV)* belongs to the genus *Gammacarmovirus* (family: *Tombusviridae*) was recently described important virus pathogen in leguminous crops including soybean with symptoms of mosaic, mottle and veinal mild mottling. However, there is no information regarding availability of resistant sources and its effect on soybean production. Hence, the present study was conducted with 18 soybean varieties to screen and identify the susceptible and resistant varieties and its impact on yield and seed quality parameters. Fresh infection was established on French bean cv. Arka Sharat through agro-inoculation using SYMMV-full length clone. Mechanical sap inoculation of 18 soybean varieties with systemic SYMMV infected French bean leaves produced systemic symptoms like chlorotic spots, chlorotic blotches, mosaic, mottle, mild mottling and veinal mild mottling by 16-20 days of post inoculation. The percent disease incidence on a scale of 0-5 showed out of 18 varieties, one variety was found to be moderately resistant (SL-979); eight were moderately susceptible (SL-688, SL-744, DSB-34, MACS-57, MACS-124, MACS-450, MACS-1158, MACS-1281), seven varieties were susceptible (SL-525, SL-1028, SL-1104, DSB-23, MACS-13, MACS-58, MACS-1407) while two varieties (SL-958, JS-335) were recorded highly susceptible reaction. Detection of SYMMV using polyclonal antibodies in DAC-ELISA showed the absorbance values of 0.840 to 2.055 at 405nm with highest titre values in varieties SL-744, SL-958, SL-979 and SL-1028. RT-PCR analysis of these eighteen soybean varieties with coat protein specific primers gave amplification of 1065bp fragment. SYMMV had significant influence on growth, yield and seed quality parameters in these 18 varieties compared to control. Plant height was reduced in all the varieties where as number of pods and seed yield was significantly reduced in SL-1028, SL-1104, DSB-23, DSB-34 and JS-335. All the seed quality parameters were significantly reduced in variety SL-744 followed by JS 335 and SL-688. Even though SL 744 and SL 688 are moderately susceptible but seed quality was severely affected due to SYMMV infection.

### OP 07(S5): Diversity and phylogeography of fungal pathogens associated Avocado in South India

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The avocado is an important fruit crop grown in Western Ghats are subject to attack by number of pathogens cause huge loss to the avocado growers in this region. To know the incidence, diversity and their relationship with other fungal pathogens, survey was carried out in major avocado growing region of Karnataka, Tamil Nadu and Kerala states of India. The incidence of different fungal disease on avocado is ranged from 25 to 75% in all surveyed location in three states. Total 350 fungal infected samples (Fruit, leaf twigs and bark) were collected in major avocado growing region of southern India. The pure culture of fungal pathogen was isolated by standard tissue isolation method. The fungal pathogenicity and identity were confirmed based on micro-morphological, cultural characteristics and PCR amplification using universal primers. The sequence analysis showed that the avocado is infected more than three different fungal pathogens includes, *Colletotrichum*, *Pestalotopsis*, and *Neopestalotopsis* species are predominately associated fruit disease, whereas *Phomopsis* and *Diaporthe* are predominately associated leaf and twigs of avocado. The overall result showed that the avocado is infected by more than three different fungal pathogens on fruits and two on twigs and leaves.

### OP 08(S5): Epidemiology of bacterial blight of cluster bean caused by *Xanthomonas axonopodis* during kharif 2021

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Clusterbean (*Cyamopsis tetragonoloba* L. Taub.) belongs to the family Fabaceae, commonly known as guar, it is an important dry land, drought hardy, annual Kharif crop grow widely under rainfed (barani) condition for grain, green fodder, vegetable, green manuring and for seed purposes. It is a drought hardy leguminous crop because of its deep tap rooting system and has high capacity to recover from water stress. Being a leguminous crop, it enriches the soil fertility by fixing the atmospheric nitrogen. Out of cluster bean diseases, bacterial blight of cluster bean caused by *Xanthomonas axonopodis* is considered as one of the most serious disease. The disease is widely distributed in India during kharif season. Bacterial blight appears every year with great incidence in Haryana. Disease development and progression of bacterial blight on three different genotypes of cluster bean sown on three different dates viz., first fortnight of June, second fortnight of June and first fortnight of July during kharif 2021 was recorded. Disease severity in all cluster bean genotypes was observed maximum in IIIrd date of sowing ranging followed by IInd date of sowing; however in Ist date of sowing the disease intensity was lower. The correlation coefficients were calculated for all the cluster bean genotypes and date of sowing with weather parameters. Results showed that the disease development was positively correlated with RH morning, RH evening and rainfall for all the three varieties at all dates of sowing. These finding will be helpful in developing integrated disease management strategies for the control of bacterial blight of cluster bean.

### OP 09(S5): Screening of matromorphic progenies and their parental lines for powdery mildew and rust in Garden Pea (*Pisum sativum* L.)

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Garden pea is relatively a sensitive crop and thus prone to various diseases causing tremendous losses in its production and productivity. The major diseases affecting pea crop in North Indian plain/hill zones include powdery mildew (*Erysiphe pisi*) and rust (*Uromyces viciae fabae*) which cause heavy yield losses to the vegetable growers. Powdery mildew and rust has a negative impact on the total biomass yield, no. of pods per plant, no. of seeds per pod, no. of nodes in garden pea ultimately affecting both the quality and quantity of the crop and responsible for up to 80 per cent yield loss under favourable conditions. Identification of resistance donors of garden pea against these diseases, followed by their utilization in a resistance breeding program would be a component of holistic attempt for disease management in a reliable way. In this context, 22 pea genotypes (12 matromorphic progenies (Mat<sub>3</sub>) and 10 parental lines) were evaluated against powdery mildew and rust disease under sub tropical conditions of Jammu & Kashmir, a field experiment was carried out during the year 2020-2021 at the Experimental farm, SKUAST- Chatha, Jammu. The results revealed that only one matromorphic progeny i.e. Arka Apoorva x P-89 was found highly resistant with lowest values of percent disease index and disease incidence (0.0%) for powdery mildew and two matromorphic progenies viz., Arka Apoorva x P-89 and Mithi Phali (Mat<sub>3</sub>) with lowest values of percent disease index 0.67 and 0.74 per cent, respectively and two parental lines viz., Arka Apoorva (0.74%) and Mithi Phali (0.76%) were found resistant against rust disease. Therefore, matromorphic progeny Arka Apoorva x P-89 was found superior in terms of resistance against powdery mildew and rust disease and thus, can be promoted for cultivation on a large scale in the farmer's field under subtropical conditions of J&K.



## Session 6. Omics in Crop Protection

### KEYNOTE LECTURES

#### KN 01(S6): Application of omic tools to study dynamics and varying pathogenicity of sugarcane red rot pathogen *Colletotrichum falcatum*

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Red rot pathogen *Colletotrichum falcatum* causing rotting of stalk tissues is a devastating pathogen, able to cause huge yield losses to sugarcane production in India. The stalk infecting *C. falcatum* is a unique pathogen and we studied in detail on the pathogenicity by applying various omic tools. Initially, we established draft genome of *C. falcatum* to about 48.16 Mb in size with 12,270 genes. In the subsequent transcriptome studies, a total of 53,410,513 reads (24,732 transcripts) specific to *C. falcatum* were generated, and with prediction of 13,320 genes. The genes for virulence have been classified and grouped into candidate effectors, transition-specific and secondary metabolites, proteases, transporters and peptidases which revealed that *C. falcatum* transcripts encode a large number of secondary metabolites and membrane transporters. Gene enrichment analysis revealed that the number of transporters encoded by *C. falcatum* is significantly more as compared to that encoded by several other *Colletotrichum* spp. Phylogenomics analysis indicated that *C. falcatum* is closely related to *C. graminicola* and *C. sublineola* infecting related host plants, maize and sorghum, respectively. Further, to identify the genes that are specifically expressed during pathogenesis, we adopted RNA-Seq to sequence transcriptomic profiles of sugarcane cv CoC 671 challenged with three *C. falcatum* pathotypes Cf671, CfRoC and CfR1 varying in their virulence. In this study, to achieve comprehensive gene functional annotation, various tools like Diamond, KAAS, NCBI Blast, hmmscan, Blast2go from various database search applied and found that about 2,48,457 unigenes from the transcriptome of sugarcane. The annotated unigenes were further mapped using RSEM and the COG collection currently consists of 138,458 proteins, which form 4873 COGs and the current KOG set consists of 4852 clusters of orthologs, which include 59,838 proteins. The differential gene expression analysis for the comparative transcripts were carried out using DESeq2, EdgeR, in which different experimental conditions suggested that sugarcane challenged with Cf671 pathotype upregulates more during 72 hr of DPI compared to control which can be considered as point of breakdown of resistance, whereas in cases of CfRoC and CfR1 the genes were upregulated during 48 hr of DPI, which is purely for pathogen survival. These results provided a wealthy information on understanding *C. falcatum* pathogenicity mechanisms, hemibiotrophic stage shift, expansion/contraction of genes involved in several processes and the genes involved in virulence.

#### KN 02(S6): *Citrus tristeza virus*, a sleeping giant, responsible for mandarin (*C. reticulata*) decline in NE India: A challenge to combat through biotechnology-cross protection-based management system

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*Citrus tristiza virus (CTV)* is widely distributed in most of citrus growing countries of the world and destroyed millions of citrus trees worldwide including India. CTV, an *Toxoptera citricidus* transmitted closterovirus containing flexuous filamentous particles (2000 x 11 nm) with +ve sense ssRNA genome (~19.3kb with 12 ORFs encoding 19 proteins). CTV infects most of the cultivated citrus with symptoms like decline, yellowing, stunting and stem pitting with poor fruit yield and quality. CTV is a century old problem and killed more than one million trees in India. CTV occurs in all the citrus growing geographical zones and infects all the commercial citrus and its relatives. CTV incidence of 26.3-60% in India (47-56% in Northeast, 36.3% in Central, 36-50% in South and 16-60% in Northwest) was estimated. More than 120 CTV isolates covering all the citrus growing regions of India were characterized based on sequence analysis of 5'ORF1a and CP gene of CTV genome. Indian isolates exhibit extensive genetic diversity 78 to 99% nt identity falling into seven different genotypes. Complete genome (19253nt: HM573451) of a decline inducing CTV strain, Kpg3 of the Darjeeling hills of India was sequenced and analyzed. The Kpg3 is a recombinant and genetically related to Israel severe CTV isolate VT and also. Indian, Asian and International isolates were analyzed based on the sequencing of 3' half genome (8.4 kb, ORFs 2-11). The Asian isolates fell into six, whereas the Indian isolates into four genogroups. A new isolate, B5 and a distinct isolate, G28 were identified. Recombination is the major factor for evolution of diversified CTV in India. Codon usage biasness, negative selection and gene flow also play major role for evolution of CTV variants. Khasi mandarin (KM) (*C. reticulata*) is the most economically and widely cultivated citrus fruit in Northeast (NE) India, which is tremendously affected due to decline caused by CTV. Development and supply of CTV-free and immune KM planting materials are the important control measures. Efforts have been made to identify disease-free/resistant and immune KM mother plants against CTV and those plants will be used as KM mother stocks as source of bud wood. Many CTV strains, including severe/decline and mild, were identified in NE India; some of them remain as major and others as minor population. Genetically some (putative) CTV mild cross protecting strains (MCPSs) were identified by *in silico* CUB analysis using the CP and p23 gene sequences of CTV genome. MCPSs were evaluated through challenging by severe CTV strains through biological indexing. The mechanism mediating cross protection between the mild and severe strains is not clear. Bud wood and shoot tip grafting for developing disease free planting materials are very much important. CTV-free mandarin plantlets were developed and supplied to the farmers of NE India. For development of transgenic resistant citrus, several anti-sense (RNAi) and hairpin (ihp-RNAi) constructs for CP (p25) and suppressor (p23) gene of CTV were made in pBinAR and pRNAi-GG vector. Agrobacterium-mediated transformation protocol was developed using epicotyl explants of citrus seedlings with regeneration efficiency of 1.38% at 2.0 mg/l BAP in MS medium.

## INVITED LECTURES

### IL 01(S6): Three decades of *Phaseolus vulgaris* – *Colletotrichum lindemuthianum* interface in India: The road behind and the road ahead

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In India, common bean (*Phaseolus vulgaris* L) is a cash crop for small and marginal farmers and is known as "Grain of Hope" or "Poor Man's Meat". Nutritionally beans are rich in carbohydrates, proteins, vitamins, antioxidants, and minerals (Ca, Cu, Fe, Mg, Mn, and Zn). Locally known as "Rajmash", the *Rajmah Chawal* is a famous cosine of northern India. Common beans are native to Central and South America with a wide morphological diversity. China, Africa, Europe, and Latin America are considered secondary bean production centres. Domestication of common beans in different agro-climatic conditions have resulted their broader adaptability to wide range of environments

and agro-ecosystems. It is a self-pollinating legume crop with 22 ( $2n = 2x = 11$ ) chromosomes with a genome size of 473Mb. majority of beans planted in the northern India belong Andean gene and the climatic conditions of northwestern Himalayan region are suitable for planting beans but the yields are lower when compared with Brazil and the United States. Among the factors that affect the lower bean production in India, diseases caused by the plant pathogens top the list. Common bean anthracnose caused by the hemibiotrophic fungus *Colletotrichum lindemuthianum* is important because the disease can decrease bean production by 100% in favourable conditions. The fungus is pathogenically extremely variable with over 198 races reported from 25 countries. Previously 45 races were reported from India however during few years additional races were reported which increased the number of races to 71. Such increases in race number lead us to investigate whether sexual reproduction play any role in generating pathogenic variability. Our recent confertation among diverse races and isolates from northwestern region indicate that sexual reproduction is not happening in fungus. We then used as *nit* mutant system to answer the reasons for such a huge diversity and our preliminary results indicate that heterkaryanos obtained are stable enough and may be the main reason for generating new races. In the present talk, we will provide a comprehensive information using a meta-analysis approach. Additionally, we talk about the virulence index, resistance index, and frequency of each common bean anthracnose race so that we could understand the fungus evolutionary trajectory and reshape our breeding effort for its management. Plant disease resistance is eco-friendly and economically viable disease management option for marginal farmers of northern India. However, highly variable character of the fungus is responsible for the frequent breakdown of resistance. About 20 anthracnose resistance genes are reported and recently many of these have been fine mapped. In addition to major genes, common bean genotypes are shown to resist anthracnose by expressing the minor genes (QTLs). These advances occurred due to many genome wide association studies that were recently carried out in the pathosystem. Recently we identified an atypical adult plant resistance mechanism in northwestern common bean landrace KRC-8. Our inheritance study indicated that the anthracnose resistance in Baspa (KRC-8) is recessive. We have identified new quantitative disease resistance QTLs against diverse anthracnose races. Altogether, these studies indicate that the common beans grown in north-western Himalayas may contain novel anthracnose resistance genes. We have complied this information and I will try to provide a comprehensive overlook of molecular resistance mechanism in Indian common bean landrace. India ranks first in common bean production globally, but second after Brazil as far as the variability is concerned. The diversification of the common bean is abundant in the Himalayan region. In the present talk, we revisited the pathosystem and complied information (last 3 decades) of race spectrum, resistant sources against different races, Virulence and resistance index of each race and common bean genotype. The information obtained shed light on which races are prevalent and how the disease can be effectively managed by either deploying resistant sources or breeding the cultivars with right resistance gene pyramids. We will provide a comprehensive road map for future for understanding the common bean – anthracnose pathosystem in India.

### **IL 02(S6): T3SS-effector of *Xanthomonas oryzae* pv. *oryzae* subverts rice immune system through interacting rice key proteins during bacterial blight development**

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The bacterial blight (BB) caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo) is one of the major threats to rice production globally. Xoo employs T3SS-effectors to subvert rice immune to have unrestricted entry & spread inside the rice. We found that Xoo race 4, an Indian virulent strain, possesses 21 Xop and 18 TALE effectors. Both complete (tTALEs) as well as incomplete/pseudo/tALEs are identified. The functional analysis through loss-and-gain of effector revealed two effectors, namely XopF and XopR contribute tremendously during BB development. The

mutants, Xoo  $\Delta xopF$  or Xoo  $\Delta xopR$  showed significantly reduced ability for *in planta* colonization, BB intensity but induced more callose deposition. These mutants caused significant fold increase in rice PTI marker transcripts. The both the effectors are localized to the plasma membrane. XopF was demonstrated to interact with two rice proteins, namely photosystem-I reaction subunit V (PSI-G) and cyclophilin II. PSI-G interacts with many proteins of photosystem I, while cyclophilin II associates with proteins involved in protein-folding, signal transduction and ubiquitination. This suggests that XopF interacts with the interactors to accomplish its principal goal of subverting the plant immunity, either through interfering photosystem I or by destabilizing protection system for plant immune like cyclophilin. Altogether, our insight into the Xoo-effectors vs rice offers novel rice target (s) for their sensible application in BB resistance.

## ORAL PRESENTATIONS

### OP 01(S6): Genetic diversity analysis of stem rust (*Puccinia graminis* f.sp.*tritici*, Pgt) of wheat prevailing at Southern Hill Zone of India

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The Southern Hill Zone (SHZ) of India is considered as a hot spot for the survival of stem rust complex. Many variants of stem rust have been evolved from this area. Hence the present study was carried out to analyse the genetic variability of Pgt isolates using ITS region of rDNA gene and TEF-1 gene (translation elongation factor 1-alpha gene). Samples were collected from Nilgiri district of Tamil Nadu and multiplied on susceptible host (Agra Local). The DNA isolation techniques were standardized. The phylogenetic tree constructed for 17 isolates of Pgt using Maximum Likelihood method in MEGA 7 software separated them as six groups. Although all these isolates were subjected for amplification of TEF-1 gene, we succeed to amplify the tef region for eight isolates. The phylogenetic tree generated by ITS sequences clustered the eight isolates in to three main clades based on nature of virulence and locality with the low transition/transversion rate ratio ( $R = 0.345$ ) whereas TEF-1 gene separated eight isolates in to six main clades with high transition/transversion rate ratio ( $R = 1.629$ ). The results of the present study reveal that the ITS and Tef region analysis are useful to infer the phylogenetic relationship and the genetic diversity within the population of Pgt which will be useful to predict the shift in virulence pattern of Pgt population well in advance. TEF-1 gene sequences of Indian Pgt isolates of wheat submitted to NCBI database are first from India. The ITS sequences of Indian Pgt isolates submitted through our study is also higher in number since till date only one sequence of Pgt from Maharashtra is available in NCBI database.

### OP 02(S6): Transcriptome analysis of wheat–*Tilletia indica* interaction provides defense related genes

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Karnal bunt (*Tilletia indica* Mitra) is an internationally quarantined disease of wheat. Until now, very little information has been available on the molecular basis of resistance and pathogenicity of *T. indica*. To investigate the molecular basis of host–pathogen interaction, the transcriptome of *T. indica* inoculated resistant (HD29) and susceptible (WH542) genotypes of wheat were analyzed. Approximately 58 million reads were generated using RNA

sequencing by the Illumina NextSeq500 platform. These sequence reads were aligned to a reference genome of wheat to compare the expression level of genes in resistant and susceptible genotypes. The high-quality reads were deposited in the NCBI SRA database (SRP159223). More than 80,000 genes were expressed in both the resistant and susceptible wheat genotypes. Of these, 76,088 were commonly expressed genes, including 3184 significantly upregulated and 1,778 downregulated genes. 4,113 and 5,604 genes were exclusively expressed in susceptible and resistant genotypes, respectively. Based on the significance, 503 genes were upregulated and 387 genes were downregulated. Using gene ontology, the majority of coding sequences were associated with response to stimuli, stress, carbohydrate metabolism, developmental process, and catalytic activity. The KEGG analysis identified 208 pathways involved in 22 functional groups, mainly plant hormonal signal transduction, plant-pathogen interaction, phenylpropanoid biosynthesis, and translation during plant-pathogen interaction. Highly differentially expressed genes were validated in resistant and susceptible genotypes using qPCR analysis. Apart from the wheat, the mapping of *T. indica* was 7.07% and 7.63% of resistant and susceptible hosts, respectively, upon infection, which revealed significant pathogenesis-related genes. This first study provided in-depth information and new insights into wheat-*T. indica* interaction for managing Karnal bunt disease of wheat.

### OP 03(S6): Allelic test and molecular characterization in white rust resistant Indian mustard [*Brassica juncea* (L.) Czern & Coss] germplasm to identify new donors

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The white rust (WR) caused by *Albugo candida* is one of the major disease in Indian mustard (causes 23–89.9% yield loss). As majority of our native germplasm are highly susceptible to WR, the Indian breeding program for WR resistance mainly relied on East European resistant donors like Heera and Donskaja. Overdependence on only these two exotic sources further increases the risk of resistance breakdown and disease outbreak. Hence, the present investigation was aimed at identifying new resistance source from the available Indian mustard germplasm (5950 accessions). After repeated screening the numbers of accessions were narrowed down to a panel of 93 accessions. These 93 accessions on further rigorous screening for 11 seasons (2016-2022) under natural hot spot conditions at ICAR-IARI, RS, Wellington, The Nilgiris, along with 3 checks, yielded 7 accessions showing consistent as well as complete resistance. These seven resistant accessions obtained were crossed with well characterized East European resistant donors Heera (with locus AcB1.4.1) and Donskaja (with locus AcB1.5.1) to test the allelism in F<sub>2</sub> population where we found the presence of “New Resistant Locus” in the accession WRW28, apart from the AcB1.4.1 and AcB1.5.1. Further, the molecular characterization of 93 accessions using previously reported linked/genic markers (BjuA015829 - linked to AcB1.4.1; WR-D IV and WR-360 - linked to AcB1.5.1; WR-Tumida - linked to another resistance conferring loci AcB1.6.1) also indicated that the accession WRW28 may contain “New Resistant Locus” as it did not amplify any of resistant alleles of these three loci. Thus, the identified accession WRW28 will pave the way for mapping of newer genes for WR resistance and facilitate breeding Indian mustard varieties with broad based resistance to *Albugo candida*.

## OP 04(S6): Comparative proteomic analysis in Ascochyta blight resistant and susceptible chickpea

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Chickpea Ascochyta blight caused by *Ascochyta rabiei* resulting in a significant loss in chickpea yield worldwide. In the course of the establishment of the infection, the process is vital to sufficiently comprehend the infection process in plant-fungus interaction. Profiling of proteins and pathways responding to the *A. rabiei* infection were compared through comparative proteomic assay using 2D-MALDI-TOF (PMF). Chickpea leaf proteomes were compared before and after *A. rabiei* inoculation at 24h, 48h and 72h after inoculation in two contrasting cultivars, ICC 4991 (Susceptible) and PBG-5 (Resistant). Our analysis showed that chickpea's original protein expression status in the S and R genotypes was almost identical before *A. rabiei* inoculation. Distinct differences in protein expression were found between pH of 4 and 7. The identified biotic stress-responsive proteins involved in Pathogenesis related (PR) (45.83%), defense related (20.83%), ROS scavenging (12.50%), developmental/signaling (12.50%), antimicrobial and structural proteins (4.17%). The considerable proteins increased many folds and accumulated significantly in resistant chickpea were Vicilin-like antimicrobial peptides 2-2 (13.48 fold), Glucan endo-1,3-beta-glucosidase GI (10.48 fold), Peroxidase 34 (5.78 fold), Endoglucanase 17 (4.03 fold), L-ascorbate peroxidase, cytosolic (3.51), Chitinase 5 (3.25), Chitin-binding protein HM30 (3.02), Soybean toxin 27 kDa chain (2.79), Thaumatin-like protein (2.74), Phospholipid hydroperoxide glutathione peroxidase (2.17) and Polyphenol oxidase (1.6 fold) played a significant role in resistance mechanism against *A. rabiei*. The down regulated proteins in resistant chickpeas were non-significant in expression, which needs further study. This helps deeply understand the biologically complicated defense and infection mechanisms of *A. rabiei* on the host plant. This research was funded by Science and Engineering Research Board (DST-SERB), Government of India under Early Career Research (Grant No. ECR/2016/000855), India.

## OP 05(S6): Identification of novel QTLs/genomic regions associated with seedling and adult plant stage stem rust resistance in bread wheat (*Triticum aestivum* L.) through genome-wide association studies (GWAS) and their validation through KASP marker assays

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Stem/black rust (caused by *Puccinia graminis* Pers. f. sp. *tritici*) is one of the major diseases threatening wheat production. Genetic/host resistance is the most economic, reliable, environmentally safest and sustainable way to manage stem rust disease. To identify novel resistance QTLs, 35K Axiom Array SNP genotyping assays was performed on association mapping panel of 400 bread wheat germplasm accessions, including Indian landraces, in

conjunction with phenotyping for stem rust at seedling and adult plant stages. Association analyses using three GWAS models revealed 20 reliable QTLs for seedling and adult plant resistance. Among these 20 QTLs, five QTLs were found consistent with three models, *i.e.*, four QTLs on chromosome 2AL, 2BL, 2DL, and 3BL for seedling resistance and one QTL on chromosome 7DS for adult plant resistance. Total of 21 potential candidate genes, including a leucine rich repeat receptor (LRR) and P-loop nucleoside triphosphate hydrolase, which have a role in pathogen recognition and disease resistance was also identified. Furthermore, four QTLs (*Qsr.nbpgr-3B\_11*, *Qsr.nbpgr-6AS\_11*, *Qsr.nbpgr-2AL\_117-6*, and *Qsr.nbpgr-7BS\_APR*) were validated through KASP markers located on chromosomes 3B, 6AS, 2AL, and 7BS. Out of these QTLs, *Qsr.nbpgr-7BS\_APR* was identified as a novel QTL for stem rust resistance which has been found effective in both seedling as well as the adult plant stages. Identified novel genomic regions and validated QTLs have the potential to be deployed in wheat improvement programs to develop disease resistant varieties for stem rust and can diversify the genetic basis of resistance.

### OP 06(S6): Assessment of genetic diversity of virulence genes in the *Magnaporthe* population infecting millets in India

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Blast pathogen, *Magnaporthe* spp., that infects ancient millet crops such pearl millet, finger millet, foxtail millet, barnyard millet, and rice was isolated from blast hotspot locations in India using single spore culture technique and 136 pure isolates were established. Numerous growth characteristics were captured via morphogenesis analysis. Among the 10 investigated virulent genes, we could amplify MPS1 (TTK Protein Kinase) and Mlc (Myosin Regulatory Light Chain edc4) in majority of tested isolates, regardless of the crop and region where they were collected, indicating that these may be crucial for their virulence. Additionally, among the Avr genes studied, *Avr-Pizt* had the highest frequency of occurrence, followed by *Avr-Pia*. It is noteworthy to mention that *Avr-Pik* was present in the least number of isolates (9) and was completely absent from the blast isolates from finger millet, foxtail millet, and barnyard millet. A comparison at the molecular level between virulent and avirulent isolates indicated observably large variation both across and within them. The 136 *Magnaporthe* isolates were divided into four groups using molecular markers. Regardless of their geographic distribution, host plants, or tissues affected, the data indicate that the prevalence of numerous prototypes and virulence factors at the field level, which may lead to a high degree of pathogenic variation. This research could be used for the strategic deployment of resistant genes to develop blast disease-resistant cultivars in rice, finger millet, foxtail millet, pearl millet, and barnyard millet. Furthermore, the conclusion of this study can be utilized in the development of genetic resources for blast resistance in these nutrient-rich millets.

## Session 7. Industry, Academia and Farmers' Interface

### KEYNOTE LECTURE

#### KN 01(S7): Edible Mushroom: Key to Nutritional food for Human health care and Entrepreneurship development

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Edible mushrooms are a widely distributed food resource on earth which have long been known to be easily cultivable, affordable and are being consumed for their nutritional value as high protein and low fat contents. The most common cultivated mushrooms are *Agaricus bisporus*, *Calocybe indica*, *Volvariella volvacea*, *Pleurotus* species, *Lentinus edodes* and some more. They also have several medicinal and therapeutic properties. Many other mushrooms viz. *Flammulina*, *Ganoderma*, *Grifola*, *Trametes (Coriolus)*, *Auricularia*, *Tremella*, etc have been demonstrated to possess significant medicinal properties. Medicinal mushrooms have been shown to have profound health promoting benefits viz., immunomodulation, anti-atherosclerotic, anti-inflammatory, analgesic, chemopreventive, antitumor, chemo and radio protective, sleep promoting, antibacterial, antiviral (including anti-HIV), hypolipidemic, hypoglycemic, anti-fibrotic, hepatoprotective, anti-diabetic, anti-androgenic, anti-angiogenic, anti-herpetic, antioxidative and radical scavenging, anti-aging, estrogenic activity, anti-ulcer and many other exceptional nutritional and medicinal properties. Recent studies conducted all around the globe, are now confirming their medical efficacy and identifying many of the bioactive molecules such as, polysaccharides, triterpenoids, low molecular weight proteins, glycoproteins and immunomodulating compounds. The main medically important polysaccharides that have undergone extensive anticancer clinical trials include lentinan from *Lentinula edodes*, schizophyllan from *Schizophyllum commune*, PSK (polysaccharide-K) commercially sold as Krestin and PSP (polysaccharopeptide) from *Trametes versicolor*, and Grifron-D from *Grifola frondosa*. Thus, it is indeed nature's boon to human kind where so many beneficial traits are found to occur in a single group of organism. It has proved as potential source of food, nutrition and medicine for employment generation in tribal dominating rural India. Mushroom is capable of transforming rural life in to prosperity by trageting people from low income group to enhance their income and provide business opportunities mainly in the areas of mushroom spawn production, crop production, processing, value addition and preservation technology along with marketing. Thus we have to evolve, develop or innovate highly profitable business model which requires less land, less infrastructure, low know-how technology, environment friendly and double or triple income generation. We have to explore the commercial potentiality to export of mushroom products which are nutritionally fortified foods or value added food to consumers depending upon their taste and nutritional requirement. Considering the nutritional value and other positive health benefits of mushroom, Hon'ble Minister of State for Agriculture and Farmers Welfare Government of India has already notified to explore the feasibility of inclusion of mushroom under Mid Day Meal Programme.



## INVITED LECTURES

### IL 01(S7): Beauvericin, a magical secondary metabolite from *Fusarium* and its applications

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The genus *Fusarium* is ubiquitous and is found in soil, air and on plants. *Fusarium* is an important group of plant-pathogenic fungi known to affect a wide diversity of crops in all climatic zones across the globe. *Fusarium* is also known to affect animals as well as humans. In short, it is mostly known to people as disease causing agent. Being an important genus of economic interest due to the losses which it leads to worldwide, accurate and correct identification of its species has become a necessity. Unfortunately, so much time has passed since its discovery, still taxonomy of this genus is in state of flux, as morpho-taxonomic identification frequently fails in case of *Fusarium*. Phylogenetic studies in past few decades have revealed the importance of multi-gene phylogeny in species delimitation of *Fusarium*. Species of *Fusarium* are capable of producing interesting secondary metabolites, one of them being beauvericin (BEA). It is a potent bioactive compound that exhibits very effective anticancer, cytotoxic, antiplatelet aggregation, antimicrobial, leishmanicidal and insecticidal activities. In our study, phylogeny based on six gene regions, the internal transcribed spacer region, 28S large subunit, translation elongation factor 1-alpha, RNA polymerase second largest subunit, beta-tubulin and calmodulin gene regions was conducted to resolve the evolutionary relationships of 88 Indian *Fusarium* isolates. Further, all these isolates were screened for their ability to produce beauvericin. Isolate which produced maximum beauvericin was subjected to large scale fermentation. This extract containing beauvericin was used for the evaluation of different bioactivities, such as antibacterial, antifungal and anti-oxidant etc. The results will be discussed during presentation in which it was found that beauvericin is a very potent compound capable of producing numerous bioactivities useful in various sectors; agriculture, medicines and industries.

### IL 02(S7): Guggal gummosis: red alert for the survival of guggal plant

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Guggal (*Commiphora wightii* (Arn.) Bhandari) is an important medicinal plant. The gum from this plant has special medicinal value. Guggal plants are naturally grown in forest and wasteland areas of arid and semi-arid regions of Gujarat, Rajasthan and Karnataka. Guggals plants are now a Global Rare and Endangered species. The farmers grow guggal plants as field boundaries for the protection of crops against animals. These are propagated through cutting in the *Kharif*. Its resin, guggal-gum, is prescribed in Ayurveda for heart ailments, obesity and arthritis. Many of guggal's products are available in the market. Pharma companies used it in drugs for reducing cholesterol. Four to five years old plants are used for tapping gums. The plant exudates gum and dies slowly after one or two years. This is the major limitation for the successful cultivation of guggal and survival in nature. The major objective of this study was to find out the real cause of plant death after gum oozing. Infected plant branches and stems collected from the field for isolation of pathogen. Using different media for isolation of pathogen with different parts of infected plants at different pH and temperature. Bacterial growth was only observed on guggal bark decocted agar medium. It has been found out for the first time that bacterium is responsible for gum exudation and wilt of plants. The pathogenicity of the bacteria was confirmed. It is gram-negative and rod shape. The pathogen was identified as *Pseudomonas*.

### IL 03(S7): Medicinal Mushrooms: A Potential Source of Nutraceuticals

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India has witnessed an enormous change in its agricultural pattern due to the continuous increase in the population rate. Henceforth, rapid rise of the population brings forward the challenge of meeting the demands of quality food and achieving nutritional security. Wide spread malnutrition necessitated the search for alternative source of protein. The demand for functional food indicates the people's awareness for quality food. The unique aroma and excellent nutritive and medicinal values of mushrooms makes them universally accepted. Due to the production of a variety of secondary metabolites, chemical structures and bioactive components they are reservoir of valuable chemical resources. However, there is very little awareness on mushrooms as a healthy food and as an important source of biological active substances with medicinal value. For thousands of years, medicinal mushrooms as medicinal extract are being applied as alternative medicine. According to current estimates, mushrooms constitute at least 14,000 species worldwide and out of that 2,000 species are reported as edible. The worldwide mushroom industry has grown at a rapid rate since the late 1990s. World mushroom production has increased more than 25-fold during the last 35 years. Six main genera constitute more than 90% of the world's mushroom supply. *Lentinula edodes* is the major genus contributing 22% of the world's cultivated mushrooms. *Pleurotus* with 5 to 6 cultivated species constitutes about 19% of the world's output while *Auricularia* spp. contributes about 18%. The other genera, *Agaricus* spp., *Flammulina* and *Volvariella* spp. are responsible for 15%, 11% and 5% of the volume, respectively (Singh *et. al.*, 2020). China is the main producer of edible mushrooms. Mushroom farming in India is hardly 3 decades old and with an initial lag-phase it has started showing upward trend. In India mushroom production trend increases in recent years with more than 70,000 MT in 2003-04 to over 2,01,378 MT in 2019. Similarly, its productivity has increased from 6 kg/q compost in the year 1970 to 23 kg/q compost in 2020. The Medicinal mushrooms have been demonstrated to produce beneficial effects not only as a drug but also as a novel class of products variously known as functional food, nutraceuticals, dietary supplements that produce health benefits. Numerous studies have shown that regular intake of mushrooms or their products are effective both in preventing and treating specific ailments. The edible class of mushrooms that shows potential medicinal and functional properties includes *Pleurotus*, *Lentinula*, *Auricularia*, *Flammulina*, *Hericium*, *Grifola*, *Tremella* etc. The other species known only for their medicinal properties include *Ophiocordyceps* and *Ganoderma* spp. Mushroom nutraceuticals are the traditional preparations which were used in ancient times in the form of extracts, health tonics, concentrates, fermented beverages, tinctures, teas, soups, herbal formula, powders and health food dishes. *Ophiocordyceps sinensis* has long been used in folk medicine and is known to have remarkable medicinal properties. Since ages, it has been regarded as panacea of life, imparting youth, vigour and longevity. Other important functions include activation of the immune responses, controlling the blood sugar levels, treatment of Hepatitis B, improvement of the respiratory functions, improvement in the functioning of the heart, maintaining the levels of cholesterol, reduction of the tumor size in cancer patients, protection against free radical damage, reduction of fatigue, combats sexual dysfunction, helping in organ transplantation, improvement in the functioning of kidney and adrenal gland etc. It has been determined that there is perhaps a greater biodiversity of compounds within different strains of this single species. Due to the great difference in the concentration of native compounds, a wide range of quality is found in *Ophiocordyceps* cultivated from different strains and utilizing different culture methodology. Due to its peculiar characteristics, habitat, morphology and being a store house of medicinal properties, it is a highly prized mushroom. *Ganoderma lucidum* has gained wide popularity in recent years as a dietary supplement, not only in China and Japan, but also in North America and other parts of the world. The reason it attracts international attention as a valuable Chinese herb is due to the wide variety of its biological activities such as antitumor,

immunomodulatory, cardiovascular, respiratory, antihepatotoxic and antinociceptive effects. The diversity in the biological actions may be attributed to the fact that it is composed of different chemical entities including triterpenoids, polysaccharides, alkaloids, amino acids, peptides, inorganic elements, steroids, fatty and organic acids. *G. lucidum* products with different triterpenes and polysaccharides or combinations of these two groups are most likely to result in different pharmacological activities. However, there is lot more to be explored of this wonderful gift of nature and requires the attention of scientific community to exploit this mushroom to the benefit of mankind.

### **IL 04(S7): Prospects of entomopathogenic nematodes in India and their application in raising the socioeconomic status of marginal farmers**

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Indian economy is based on agriculture and agriculture products of which most of the agro-products are damaged by lots of pests. Large chunk of the agro-products (standing crops or store grain) are damaged by the various types of the insects. To control the insect pests, annually tons of pesticides are being used by farmers in their agriculture fields. The enormous use of pesticides is not only costly affair and increasing the production cost in agriculture but also its residual effects are harmful for animals and human beings too. To minimize the use of pesticides, it is essential to find out such control measures that could reduce not only the application of this huge quantity of the pesticides but also could be eco-friendly. Chemical control of *Helicoverpa armigera* and *Spodoptera litura* has often proven to be ineffective as this species has developed resistance to a number of pesticides and this needs to develop and application of alternative methods of control for such insects' pests. Two of the prominent genera of entomopathogenic nematodes i.e. *Steinernema* and *Heterorhabditis* having interaction with insects and are considered globally as highly pathogenic to insects. They can be applied, at Infective Juveniles stage, in conjunction with other biological and chemical pesticides, fertilizers and soil amendments. The locally available indigenous EPN isolates are much effective and their applications are beneficial against the insect pests. In India, EPN are on trial tests in lab as well as in field condition against many serious insect pests viz., rice leaf folder (*Cnaphalocrocis medinalis*); tobacco cutworm (*Spodoptera litura*); brinjal fruit borer (*Leucinodes orbonalis*); diamond back moth (*Plutella xylostella*); weevil (*Diaprepes abbreviatus*); silver-leaf whitefly (*Bemisia tabaci*) and sugar beet beetle (*Psylliodes punctulata*); cotton bollworm (*Helicoverpa armigera*); potato tuber moth (*Phthorimaea operculella*); spotted stalk borer (*Chilo zonellus*); rice yellow stem borer (*Tryporyza incertulas*); rice ear-cutting caterpillar (*Pseudaletia separate*); red hairy caterpillar (*Amsacta albistriga*); banana stem weevil (*Odoiporus longicollis*). *Steinernema* spp. (87 isolates) and *Heterorhabditis* spp. (21 isolates) have been isolated from the soils of western Uttar Pradesh are maintained in Chaudhary Charan Singh University, Meerut and are on trial for their efficacy tests. These species are specific to their insect hosts. The work on preparation of species specific formulations and their field trials, against white grubs, *Helicoverpa armigera* and *Spodoptera litura* are in progress. Farmers can initiate to develop the formulation by their own by established cottage industry and can monetary gain by reducing the application of pesticides in the agriculture fields as well as by selling the EPN based bio-pesticides. The future of EPN based bio-pesticide is bright in India because there is more demand of organic products in the market.

## ORAL PRESENTATIONS

### OP 01(S7): Multifaceted and dual-edged native *Trichoderma* for the management of *Fusarium* wilt disease in Subabul - a sustainable approach

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Fungal antagonism against plant pathogens are widely exploited for the biological management of plant diseases. *Fusarium* wilt disease is a major concern in Subabul resulting in both quantitative and qualitative wood loss to the paper and pulp industry. Hence, this study was performed to isolate and identify native *Trichoderma* from Subabul rhizospheric soil to select efficient candidates having antagonistic, disease control efficiency and PGPR attributes. Six antagonistic *Trichoderma* (ILP-1 to ILP-6) were isolated and their efficacy was tested against *Fusarium* under *in-vitro* by dual plate technique. Among the isolates, *Trichoderma* strains ILP-1 and ILP-2 were highly effective in inhibiting mycelial growth (70 - 90% inhibition) compared to control. This efficacy was mainly attributed to higher production of Siderophore and nutrient mobilization capacity (P & K). Further, delivery by amending with pot mixture in greenhouse experiment proved ILP-1 and ILP2 were found promising with conferred protection against wilt, enhanced survival rate (10-15%) and improved growth compared to untreated control. The application of local strain ILP-1 antagonist through bio-priming in pot mixture would have potential wilt control efficiency, enhanced survival rate and plant growth promotion in Subabul. This is a pioneer study in identifying native strains of *Trichoderma* towards sustainable management of wilt disease in Subabul to increase productivity and wood supply.

### OP 02(S7): Potential of local *Trichoderma asperellum* in minimizing the corynespora leaf spot disease and enhancing the biomass of Kalmegh (*Andrographis paniculata* Nees.)

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Kalmegh (*Andrographis paniculata* Nees.) is an important medicinal plant and commonly known as “King of Bitters”. The fresh and dried leaves of kalmegh and juice extracted from the herb are official drugs in Indian pharmacopoeia. Brimming with antioxidants, it is used as a wonder drug in tribal medicine and in Indian Siddha, Ayurvedic systems of medicine. The demand of this herb is increasing day by day in national and international pharmaceutical industries. Kalmegh is also prone to various diseases like leaf spots, rots, blights. Among various diseases Corynespora leaf spot caused *Corynespora cassicola* is major devastating disease which affects quality, quantity and its market value. Chemical control for the management of diseases in medicinal plants is not profitable due to less demand of chemical treated extract in market. Keeping in this view eco-friendly approaches was assessed for the management of Corynespora leaf spot of Kalmegh. The FYM enriched with *Trichoderma*, *Pseudomonas* followed by foliar spray of neem oil and copper oxychloride were tested in field against Leaf spot of Kalmegh. Among the different eco friendly treatments, significantly minimum disease severity (12.22%) was recorded in treatment soil treatment *P. fluorescence* @3 g/m<sup>2</sup> + *T. asperellum*@3 g/m<sup>2</sup> with 20 t FYM/ha + Neem Cake @ 2 t/ha followed by treatment soil treatment with *T. asperellum*@3 g/m<sup>2</sup> with 20t FYM/ha + Neem Cake @ 2t/ha and both were at par in disease severity. Significant maximum biomass (69.10 q/ha) was recorded in soil treatment *P. fluorescence* @3 g/m<sup>2</sup> + *T. asperellum*@3 g/m<sup>2</sup> with 20 t FYM/ha + Neem Cake @ 2 t/ha. Maximum PDI was recorded in control (47.77%). The result may imply that FYM enriched with *Trichoderma asperellum* and *Pseudomonas fluorescens* could be incorporated in organic production of kalmegh for the eco-friendly disease management and enhancing biomass of Kalmegh.

**Panel Discussion Session:  
GM Crops, Food Security and Plant Pathology**

**KN 01: At crossroad of introducing GM crops for food security and pest management in agriculture**

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GM technology is based on transfer of genes (transgenesis) or gene elements of known function from a related or non-related plant, animal or microorganism and their integration into random locations along the chromosome of the recipient plant. It makes it powerful tool for enhancing resistance against pests and pathogens. Introduction of Bt-cotton, the first and the only GM crop grown in India since 2002, has rejuvenated cotton cultivation. GM Bt-brinjal using the same gene (from a soil bacterium, *Bacillus thuringiensis*) met with a moratorium in 2010 in spite of tremendous scientific support. Recent approval of genetic engineering approval committee for environmental release of GM mustard for seed production has revived the debate over promotion of Indian agriculture through cultivation of GM crops. GM mustard, DMH-11 contains two genes transferred from a soil bacterium *Bacillus amyloliquefaciens* (Barnase-Barstar system) and a third gene (*bar*) from *Streptomyces hygroscopicus* that gives tolerance to an herbicide. It is stated that with more than 20 percent higher yield than the conventional varieties, DMH-11 can help reduce the import of edible oil which however has been contested by some scientists. It is time to introspect if enough has been done since 2010 to guard against the questions raised while banning Bt brinjal, like fixing the gaps in regulatory mechanism, develop deeper understanding of risk assessment for biosafety evaluation through consultation, long-term (chronic) toxicity studies and fear of contamination of diverse varieties with the transgenesis. GM mustard has an herbicide tolerance gene which can become an issue of discord under warning from medical experts. Worldwide, 30 countries grow GM crops on about 180 million hectares (ha) with ten countries having area more than one million ha each. Though there is general scientific consensus that there is no greater risk to human health from the food obtained from GM crops than conventional food, still it is mandatory to rigorously test GM crops for safety, on case-to-case basis, and environmental impacts before they are released for general cultivation. The legal and regulatory norms vary in different countries. Taking a clear stand on Bt-brinjal will bring clarity in the regulatory and implementing agencies in India, and pave a robust path for the release of GM mustard. India has missed an opportunity to take early advantage of GM technology, particularly for edible crops which many other countries have grabbed. We have been rather slow in adopting breakthrough discoveries as well as in developing GM regulatory approaches to control pests and pathogens and enhance farm production. During 2013, the Nobel prize winning technology called "gene editing", technically CRISPR-based gene correction, was reported for its fathomless potential to improve farm productivity. Such approaches involving tweaking own genes without introducing alien genes may be promoted with liberal government support in form of resources, policies and processes, so that agricultural research and farm productivity in India are looked for leadership globally.

**Platinum Jubilee Conference**  
**Plant and Soil Health Management: Issues and Innovations**  
February 2-4, 2023  
University of Mysore, Mysuru, Karnataka, India



# Poster Presentations



**Platinum Jubilee Conference**  
**Plant and Soil Health Management: Issues and Innovations**  
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## Session 1. Diagnostics: Issues and Innovations

### PP (S1)01: Effect of different media, temperature and pH on the radial growth and sclerotial formation of *Rhizoctonia solani* Kuhn causing web blight of mungbean

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*Rhizoctonia solani* Kuhn, is one of the most important pathogen of mungbean causing aerial blight which accounts for heavy losses in mungbean growing areas of MP. The proliferation of this soil borne pathogen depends on many biotic and abiotic factors. Three most common factors associated with the growth and sclerotia formation of pathogen is media, pH and temperature which has been studied in the present study. All the three factors significantly effect on the growth of the fungal mycelia and sclerotial production. The growth and sclerotia production occurred best on potato dextrose agar medium at pH.7.0 and temperature 30°C.

### PP (S1) 02: Development of recombinase polymerase amplification assay for rapid detection of large cardamom chirke virus

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Large cardamom chirke virus (LCCV) causing chirke disease of large cardamom is a major production constraint of this crop. Rapid and accurate detection of LCCV is important for managing the disease. In the present study an isothermal assay namely, reverse transcription-recombinase polymerase amplification (RT-RPA) was developed for the detection of LCCV. For a simple, rapid, and inexpensive RNA extraction, three crude RNA isolation methods were attempted, of which only the alkaline-PEG solution method gave consistent results. The method involved grinding the tissue using 1:30 (w/v) of PEG buffer containing NaOH and PEG. The contents were vortexed and used as the template in RT-RPA. Parameters such as the concentration of magnesium acetate, time, and temperature for the RT-RPA assay were optimized for both crude RNA as well as total RNA isolated using a commercial kit as templates. When total RNA isolated was used as the template, the sensitivity of detection of LCCV was up to 1 µl both in RT-RPA and RT-PCR. However, when crude RNA was used as the template, the sensitivity of detection of LCCV was up to 10<sup>-3</sup> in RT-RPA while it was 10<sup>-1</sup> in RT-PCR indicating that RT-RPA is 100 times more sensitive than RT-PCR. Thus, in the present study, RT-RPA assay using crude RNA was found to be more sensitive, less time-consuming, and inexpensive that is suitable for large-scale screening of large cardamom plants against LCCV for the selection of virus-free plants and could be completed in about 30 minutes.

### PP (S1) 03: Begomoviruses: Are they seed-borne or seed-transmitted viruses?

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The presence of Begomoviruses in the seeds, especially the *Mungbean yellow mosaic virus* (MYMV) in mungbean seeds was first time detected in 2010 by our group from Navsari, Gujarat (India). However, its seed transmission

was not observed, therefore, proposed its indirect route in 2015 by using whiteflies. Overlooking the differences between seed-borne and seed-transmission, a team from South Korea in 2015 claimed that *Sweet potato leaf curl virus* in sweet potato, and in 2016, the TYLCV in tomatoes are seed transmitted. Principally TYLCV was not the seed transmitted as required whiteflies for transmission. They used a cage to demonstrate it which needed validation. TNAU, in 2016 discussed that MYMV was seed-transmitted, but the emerging seedling remained asymptomatic. Why it was asymptomatic needs either correction or scientific justification. This overlooked fact has led to many claims of the erroneous first report of seed transmission of Begomovirus which has been thoroughly researched and rejected in 2020 and 2021. Misunderstanding needs clarification. Seed-borne term merely indicated that the pathogen and seed are associated, however, does not guarantee that the diseased seedling will be produced. It will be known as seed-transmitted if a seed-borne pathogen can give rise to infected seedlings. All the seed-transmitted viruses are seed-borne; however, all seed-borne viruses are not seed-transmitted. Accordingly, Begomovirus has been detected in the seeds, however, it has not been firmly explained that it can give rise to infected seedlings. Therefore, Begomoviruses are seed-borne but not seed-transmitted viruses and must be corrected in the future citation.

#### PP (S1) 04: Bio intensive management of soil-borne diseases of French bean

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French bean (*Phaseolus vulgaris* L.) is globally grown in nearly 1.58 million ha with a production of 23.28 million ton of which major production is from developing countries. The increasing incidence of soil-borne and foliar diseases, viz., root rot, rust, bacterial blight and angular leaf spot has become a major constraint for the profitable cultivation of bean since last few years. To find the bio intensive management of soil-borne diseases of French bean, the field experiment was conducted during rabi 2021 at Horticulture Research Scheme (Vegetable), VNMKV, Parbhani, Maharashtra India. The experiment was conducted with 7 bio-agent singly and combination with comprising one chemical fungicide and one control (without any seed treatment) were assessed to manage the soil borne diseases. The experiment was sown on 12.10.21 with the plot size 5 x 3 m with spacing 40 x 20 cm. The recommended practices were followed, critical observations of percent germination after 15 days of sowing, plant growth promotion at 25 days of sowings, root and shoot length percent mortality due to root rot, collar rot, wilt at 25, 50 and 75 days of sowing were taken. The observations on diseases revealed that lowest soil borne disease incidence (root rot, collar rot, wilt) on French bean was recorded in the treatment T<sub>5</sub> (Seed treatment by talk based *Trichoderma asperellum* + *Bacillus subtilis* (CRB-7) @ 10 g/kg seed and Soil drenching @ 1% in root zone at the time of earthing (11.26 %) followed by treatments T<sub>1</sub> Seed treatment by talk based *Trichoderma asperellum* (IIVR) @ 10 g/kg seed and Soil drenching @ 1 % in root zone at the time of earthing (12.81 %). All the treatments were found significantly superior over untreated control. Among all, the treatment T<sub>5</sub> recorded highest yield (87.11q/ha) followed by the treatment T<sub>1</sub> (85.62 q/ha) which was statistically significant overall other treatment, whereas control recorded the lowest fruit yield (67.3q/ha).

#### PP (S1) 05: Intercropping: A walkway for intergeneric movement of plant pathogens

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*Dracaena fragrans* cv. *Massangeana*, a member of the family Asparagaceae is characterized by its sword-shaped dark green leaves with a yellow stripe running along the centre, is among the dracaena cultivars fast gaining the

attention of commercial growers. In India, it is grown on a large scale in Kerala, Karnataka, and Kolkata as an intercrop and found to be more profitable than the main crop. As it is a shade loving plant, it can be grown well with the main crop. Intercropping can not only improve the health of the main crop but also generate additional income and employment to the farmers, without any adverse effect on main crop. In Kerala, intercropping of *Dracaena* between rubber, coconut, nutmeg and banana is practiced by the farmers nowadays. Hence, a study was taken up to identify the potential of fungal pathogens on *Dracaena* for their pathogenic ability on the maincrop. The study was conducted under laboratory condition by detached leaf method. Eleven fungi under genera *Colletotrichum* spp., *Fusarium* spp., *Pestalotiopsis* sp., *Phomopsis* spp. and *Diplodia* sp. isolated from *Dracaena* were tested for their pathogenicity on rubber, coconut, nutmeg and banana. All the pathogens tested showed characteristic symptoms on rubber, coconut and nutmeg and the symptoms appeared within 1-4 days after inoculation on the detached leaf. The symptoms observed varied from dark brown water soaked lesions with yellow halo and white mycelial growth of the pathogen with fructifications on the site of inoculation. However, on banana, out of the 11 pathogens tested only seven pathogens showed characteristic symptoms and four pathogens could not show any infection under lab conditions. From these studies it is concluded that, there is ample chances for these pathogens to be potential threat for the main crop. Sufficient management practices should be adopted while practicing intercropping of *Dracaena* in these cropping systems.

### PP (S1) 06: First report of *Lasiodiplodia theobromae* causing leaf spot on cattleya orchid from India

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Orchids have always gained attention among the floriculture crops owing to its demand for cut flower and ornamental plants. The orchids are superior among ornamental plants due to their attractiveness, long shelf life and high productivity and contributing a significant share in international floriculture trade both as cut flowers and as potted plants which is approximately 10% of the global fresh cut flower trade. Among different orchid genera, cattleya and its intergeneric hybrids are gaining popularity in cut flower trade. However, the cultivation of cattleya is often hindered by fungal, bacterial and viral diseases. Among the different fungal diseases, a leaf spot disease was found prominent in a nursery of cattleya orchid in Thiruvananthapuram district of Kerala. The symptom was characterized by greyish white irregular sunken leaf spot with thick brown margin. Later the lesions enlarged and coalesced to form blightening symptom. The pathogen was isolated from diseased sample and the Koch's postulates were proved upon artificial inoculation on healthy orchid leaves using mycelial bit inoculation method. Based on cultural and morphological characterization, the fungal pathogen was tentatively identified as *Lasiodiplodia theobromae*. Molecular characterization was carried out, DNA sequences were amplified using universal primers and upon BLAST, 97.07 per cent similarity was observed with *Lasiodiplodia theobromae* with an Accession no. KC442316.1. To the best of our knowledge, this is the first report of *Lasiodiplodia theobromae* causing leaf spot disease in cattleya from India.

### PP (S1) 07: Morphocultural and molecular characterization of *Fusarium* species associated with panicle blight of *Oryza sativa* L.

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Paddy (*Oryza Sativa* L.) is the most economically important food crop has been cultivated for centuries in about 120 countries worldwide among which China (about 214 million tonnes) and India (about 173 million tonnes) together account for more than 50 percent of both rice productions globally (world population review 2022). Fungal diseases associated paddy are causing severe problem and reduced productivity is also one of the effect of pathogen. During field investigation, paddy plants associated with sheath blight disease were collected from Mandya and screened for associated fungal pathogens. Along with known sheath blight fungus *Rhizoctonia solani*, there were several *Fusarium* species were recovered from infected materials. Those *Fusarium* species are investigated through morphological, cultural and multi-locus (ITS and *tef-1α*) barcoding of selected fungal isolates. Fungal isolates were grown on PDA medium and maintained for further investigation. Occurrence of macroconidia and microconidia were recorded and other associated characteristics features were recorded. A total of 12 *Fusarium* isolates were obtained from five spathe blight samples. Morphologically the isolates were identified to *Fusarium moniliforme*, *F. brachygibbosum* and *F. equiseti*. To further confirm the identity of the fungal isolates, genomic DNA was isolated of all the 12 isolates using CTAB, ITS-rDNA and translation elongation factor gene (*tef-1α*) gene were amplified and sequenced. Sequences were analyzed via nBLAST and phylogenetic analysis conformed the associated fungal isolates as *F. moniliforme*, *F. equiseti*, *F. incarnatum* and *F. brachygibbosum*. Further, the results were compared with our previous study on fungi associated with paddy seeds. The comparative analysis revealed that the *F. moniliforme* and *F. equiseti* were recorded previously on paddy seeds, which suggest that the seed borne nature of fungal diseases. However, cross inoculations studies are necessitated to confirm the same.

### PP (S1) 08: Elucidating the pathogen species associated with Canker disease of apple in India (*Malus domestica*) using multigene characterization

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Apple (*Malus × domestica* Borkh) is one of the commercially grown fruit in temperate regions of India. In recent years, Canker disease has become one of the most economically important diseases of apple and poses grave threat to the very existence of the apple industry in Jammu & Kashmir (J&K) and Himachal Pradesh (HP) region of India. In the present study all the major apple growing areas were surveyed during 2022-23 in J&K and HP. A total of fifty

isolates showing typical canker symptoms were collected. Under field conditions, stem bark symptoms primarily manifest as small, sunken, reddish brown lesions. However, as the lesions grew larger, they turned depressed and produced elliptical cankers with vertical and horizontal slits, partially or totally encircling the diseased trunk or branch. The pathogens isolated were characterized by morphological and molecular means using internal transcribed spacer (ITS)-rDNA and Tef-1 $\alpha$  gene. Morphologically, a dense aerial mycelium was produced by the fungus that was isolated from the stem bark canker, and the colonies were white to violaceous black in colour. The hyphae had thick walls, were septate, and were smooth and dark brown in colour. The pycnidia, which only form in the presence of light, are globose to subglobose and are evenly dispersed throughout the culture media. The conidia were fusoid to ellipsoidal, smooth, thin-walled, brown, unicellular, with an acute apex and a truncate or sub-truncate to rounded base. Sequence based analysis of ITS and Tef-1 $\alpha$  gene confirmed the species as *Botryosphaeria dothidea*, *Diplodia bulgarica* which were predominant in both the states. Other species found were *Diplodia seriata*, *Lasiodiplodia theobromae* and *Diplodia mutila*. All the generated sequences were submitted to NCBI GenBank and accession numbers were received. The Phylogenetic analysis based on both the genes clustered the two species in two different clusters along with the isolates from other regions of world of same species. The pot experiment was conducted with three replications to confirm the pathogenicity on two-year-old potted plants of apple cv. Red Delicious. The symptoms of canker on stem of the inoculated plants were similar to those observed in the field after 30 days of inoculation. This study would help in better understanding the role of *Diplodia/Botryosphaeria* species on symptom development, epidemiology and formulation of improved disease management strategies against apple canker.

### PP (S1) 09: Detection, vector identification and management of brinjal little leaf phytoplasma in Assam

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Phytoplasmas are cell-wall-less, non-helical and uncultivable prokaryotes causing plant diseases in many plant species. Roving survey was conducted during 2018 to 2022 in seven major brinjal growing districts of Assam namely, Biswanath, Darrang, Golaghat, Jorhat, Nagaon, Sibsagar and Sonitpur to study the incidence, detection, vector identification and management of brinjal little leaf phytoplasma in Assam. In this study, we identified that brinjal little leaf (BLL) phytoplasma from 16SrVI-D ('*Candidatus* Phytoplasma trifolii'-related strain) is the most common strain threatening brinjal production in Assam. Moreover, four different types of leafhoppers viz., *Amrasca biguttula biguttula* (Ishida), *Exitianus indicus* (Dist.), *Hishimonus phycitis* (Dist.), *Nephotettix nigropictus* (Stal) were collected during the survey out of which only *H. phycitis* could successfully transmit the disease with transmission efficiency of 80.00 per cent. The effect of antibiotic tetracycline hydrochloride on symptom remission and reappearance of BLL disease at three different concentrations viz., 300, 400 and 500 ppm were also studied, and the results elucidated that the effect was purely temporary remission of symptoms.

## PP (S1) 10: Virulence dynamics of *Xanthomonas oryzae* pv. *oryzae* and identification of effective resistance gene/s for resistance breeding program in the Tunga-Bhadra command paddy ecosystems of Karnataka

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Bacterial Leaf blight (BLB), caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo) is the most destructive disease of rice. Cultivation of resistant varieties is the most effective and economical method of BLB management due to the limited availability/efficacy of antibacterial chemicals against Xoo. For the successful development of resistant cultivars, the information on the virulence profile of the Xoo population and its dynamic in the target location is essential, as BLB resistance in the rice follows the gene-for-gene hypothesis. Virulence in Xoo is very dynamic and requires continuous monitoring over time to identify the changes in the virulence structure and distribution. In the present study, virulence profiling was carried out for 11 years, from 2012 to 2022, on a set of differentials consisting of 28 near-isogenic lines (NILs) possessing different BLB resistance genes and their combinations. Each year a freshly isolated pathogen strain from the field was used for artificial inoculation, and the disease on each NIL was measured based on a Standard evaluation scale of 0-9. Results revealed that all the single gene differentials had shown susceptible reactions in all 11 years except *Xa21* (IRBB 21). Similarly, only one differential with two gene combinations, i.e., IRBB 52 (*Xa4+Xa21*), showed resistant reaction consistently over the experimental period in all the years except 2015. Differential with three gene combination (IRBB-58, *Xa4+xa13+Xa21*) and Improved Sambha Mashuri (*Xa5+xa13+Xa21*) bearing triple gene combination has shown a resistant reaction in all the experimental years. All four gene combinations (IRBB-60, IRBB-64, IRBB-65) and a five-gene combination (IRBB-66, *Xa4+xa5+xa7+xa13+Xa21*) showed moderate resistance to resistance during 2012-2022, where *Xa4+xa5+xa13+Xa21* (IRBB60) combination was the most consistent with respect to resistance reaction from 2012-2022. Our study indicated *Xa21*, *Xa4+Xa21*, *Xa5+xa13+Xa21*, *Xa4+xa5+xa13+Xa21*, and *Xa4+xa5+xa7+xa13+Xa21* are the best gene/combination to be used in the breeding program to develop BLB resistant cultivars for TB command paddy area.

## PP (S1) 11: Diseases of cashew nut plants (*Anacardium occidentale* L.) and their management in India

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Cashew tree (*Anacardium occidentale* L.), a high-value nut crop is cultivated in more than 32 tropical and sub-tropical countries world-wide for its rich nutritious kernels. Indian average yield of cashew nut in farmers' holdings ranges from 500 to 780 kg/ha as against 3000 kg/ha registered in experimental research fields. Occurrence of pests and diseases has been reported to cause production losses even up to 30 per cent. More than 20 different diseases are prevalent in nursery and established cashew plantation worldwide. Some diseases are relatively severe on clones of cashew than on common tall seedling originated cashew plants. In India, four diseases - damping-off (*Pythium ultimum* Trow./*Rhizoctonia solani* J.G. Kühn), seedling wilt (*Sclerotium rolfsii* Sacc.), anthracnose foliar blight (*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.), and gummosis of twigs and trunk (*Lasiodiplodia*

*theobromae* (Pat.) Griffon & Maubl.) are reported to affect yield and quality of cashew if timely control measures are not provided. A successful disease management program depends on systematic adoption of clean crop production practices. Plant health clinical considerations ensuring clean root-stocks production, selection of appropriate clones in grafts production process, maintaining optimum plant density and canopy management that afford optimal air circulation and light penetration, use of approved fertilizers for optimal plant growth are important for achieving holistic crop protection. In this paper, the processes of disease development, damage symptoms, pathogen biology and epidemiology of important diseases of cashews are outlined. Integrated disease management approaches utilizing prevention, monitoring by scouting, cultural, biological and chemical options are discussed in detail.

### PP (S1) 12: Fusaric acid secreted by *Fusarium oxysporum* f.sp. *lycopersici* causes wilt disease in tomato

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The vascular wilt of tomato caused by *Fusarium oxysporum* f.sp. *lycopersici* (FOL) is an important soil borne disease with substantial loss of yield and economic loss of as high as 80 % under favourable conditions. Fusaric acid (FA), a secondary metabolite of FOL acts as virulence factor and plays a crucial role in wilt disease development. In order to develop a better protection strategy, characterization of the isolates and the study of their interaction with the host are necessary. In the present study, six isolates of FOL were isolated from wilt infected tomato plants from different locations of Uttar Pradesh. They were subjected to cultural, morphological and molecular identification and virulence studies. All of the different isolates produced micro and macro conidia of varying sizes, cell number and growth pattern. Severity and development of Fusarium wilt disease was recorded three weeks after pathogen inoculation under greenhouse conditions. Crude metabolite extract of all the isolates were subjected to GC-MS and were further screened for antibacterial and antioxidant activity, with selective FOLs showing antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* along with antioxidant activity. HPLC was used to evaluate the capability of the tested isolates to produce Fusaric acid and to investigate the possible correlation between FA accumulation and Fusarium wilt disease development on tomato plants. FOL-4 produced maximum FA while FOL-6 lacked the ability to produce FA. Based on the above characters and pathogenicity, isolates FOL-2 and FOL-4 were chosen for further work.

### PP (S1) 13: Assessment of Mating type alleles and fertility of *Magnaporthe* infecting foxtail millet in India

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*Pyricularia setariae* (Teleomorph: *Magnaporthe grisea*), a heterothallic fungus that causes foxtail millet blast, which is the most destructive biotic constraint of foxtail millet limiting production in most of foxtail millet growing areas in India. Compatible sexual recombination, which takes place between two strains of different mating types, will increase genetic variability. To assess the mating type, ten isolates of *P. setariae* were established from the samples collected from four major foxtail millet growing states of India (Karnataka, Odissa, Maharashtra and Uttarakhand). Mating type of each isolate was determined by pairing with male and female testers using three-way cross method

and also using MAT gene specific primers viz., MAT1-1 (Male) and MAT1-2 (Female). In three-way cross method, perithecia were observed at the junction of one isolate (FoxPs-2) with male tester and the frequency of isolates that did not mate or produce perithecia was high among the tested isolates. Out of ten isolates assessed one isolate (10%) showed mating MAT1-1, six isolates (60%) showed mating type MAT1-2, while two isolates (20%) isolates depicted hermaphrodite nature and the remaining one isolate (10%) belonged to unknown mating type. The mating type assay revealed that the both mating-types (male and female fertile) as well as hermaphrodite nature of fertility existed in foxtail millet infecting *Magnaporthe* population in India, which indicates the possibility of sexual recombination in field level and which may lead to high variability in pathogenicity and diversity in *Magnaporthe* population infecting foxtail millet in India.

### PP (S1) 14: First report of root rot disease caused by *Fusarium solani* in *Tabebuia* sp. in India

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*Tabebuia* (trumpet tree) is an economically important tropical tree which is highly valued for the quality of its wood, which is used for furniture, crafts, and packing, and for its use as an ornamental and shade tree in parks and gardens. The main objective of this study was to describe new disease reporting in India. The young plants of one year old showed symptoms like yellowing, necrosis of lower leaf margins, bark shredding and vascular brown discoloration in affected portion of the tissue and finally wilting. The root and soil samples were collected during the study in few parks in and around Bangalore during *Kharif* -2022. The pathogen was isolated from the roots and soils around the infected *Tabebuia* by using standard tissue isolation protocol and cultured on potato dextrose agar (PDA) under aseptic conditions. The isolated pathogen sporulated with both macro conidia and Chlamydo-spore, colony characters resembled morphologically as *Fusarium* sp. Furthermore, the genomic DNA was isolated using CTAB protocol and amplified with ITS1/ITS4, and phylogenetic relationship confirmed the presence of *Fusarium solani* as the cause of root rot disease. The DNA sequence was submitted to NCBI Genbank (accession number: OQ152039). Since *Fusarium* is a soil borne plant pathogen, the spread of the pathogen can be managed in the nurseries by applying FYM enriched with bio-control agents viz., *Trichoderma viride*, *T. harzianum*, use of plant based amendments viz., neem/pongamia cake, soil drenching around the infected plants with Carbendazim / Hexaconazole / Propiconazole at (0.1%).

### PP (S1) 15: Detection and characterization of virus(es) infecting major stone fruits in Kashmir

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Like other crops, stone fruit production is also hampered due to various abiotic and biotic stresses resulting in poor health of trees and low productivity. Viruses are one of the major constraints in the production of stone fruits.



Several plant viruses infecting stone fruit crops are extremely infectious and have sometimes-devastating effects on the host trees. Keeping in consideration the importance of stone fruits, economic losses caused by viruses, and a wide research gap in viral diseases of stone fruits in Kashmir, this research was proposed with the objectives to ascertain the status of viral diseases of stone fruits in Kashmir and to characterize the virus(es) using serological and nucleic acid-based techniques. Based on DAS ELISA and RT-PCR diagnosis, many of the economically important viruses were detected in stone fruits and the most widespread stone fruit viruses were Prunus necrotic ringspot virus (PNRSV) and Apple chlorotic leafspot virus (ACLSV). Mixed infections PNRSV, ACLSV, and Cherry virus A (CVA) were also detected. The study gave us insight about the prevalence, spread of stone fruit viruses in the fields of Kashmir valley, and laid the ground for further investigation to determine the extent of viral infection in particular for stone fruits and the possibility of other strains and other viruses in other fruit crops as well.

### PP (S1) 16: Morphological and Pathological diversity of sheath blight pathogen *Rhizoctonia solani* of rice in India

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The sheath blight pathogen *Rhizoctonia solani* Kuhn. causes widespread disease in rice-producing areas of India. Effective management of the disease is possible by taking into account the virulence diversity of pathogen. This research aims to determine the morphological characteristics and aggressiveness of 70 *R. solani* isolates collected from the traditional rice-growing areas of India. The morphological characteristics of isolates were varied, The colour of colonies was white to brown, producing sclerotia of different sizes and patterns starting from day 3 to till 15. The branching of hyphae forming an angle of 45°-90°, the branch was narrowing. The isolates were grouped into 23 pathotype groups based on disease response in seven rice genotypes differing in their resistance (PB1, PB1121, Swarna, Jaya, ILS-12-5, Tetep, and IRG 98). Pathotype group 20 is more prevalent as compared to other groups, consisting of 12 isolates, followed by pathotype 21. Pathotype 23 consists of 5 isolates that showed susceptible reactions in all genotypes. The expression of selected plant defense-responsive QTL namely qSHB 9.2 ( $\beta$ -1,3 glucosidase), qSB-9tq (glutathione s transferase) and qSBR11-1 (chitinase) were studied in contrasting genotypes differing in their tolerance to sheath blight pathogen as well as progressive infection time using isolates of three pathotype groups. Out of these three QTLs, qSHB 9.2 showed significant differences in expression both at genotype and isolate level and also It was found that characteristics of morphology and virulence were varied with no correlation with the isolate origin.

### PP (S1) 17: Comparative account on macrofungal diversity of dry deciduous and tropical semi evergreen ecosystems – A morphometric and molecular appraisal

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The present study reports the macrofungal resources in two university campuses: the University of Mysore (UOM, Karnataka) and the University of Hyderabad (UOH, Telangana). These campuses are well-known for their considerable land area with profuse vegetation. Regular field trials and documentation of macrofungi were carried out on the UOM campus during the wet seasons. Similarly, macrofungal resources of UOH were also studied. A total of 1,850 collections of macrofungi were made since last decade from the UOM, which yielded 380 species. From the UOH, over 150 collections were made, which consist of 96 morphotypes. From the UOH campus, a total of 56 species of macrofungi were identified and classified. This study represented several new species of macrofungi along with many new records to the Indian subcontinent. Identification was carried out by morphological examination, microscopic analysis, and molecular sequence of ITS-rDNA and nr-LSU sequence data analysis. Further, phylogenetic analysis was performed by retrieving reference sequences from the database and identity was established. The most common macrofungi in UOM include the members of Agaricaceae followed by Marasmiaceae and Xylariaceae. Similarly, more frequently occurring macrofungi from the UOH campus include Xylariaceae followed by Agaricaceae and Polyporaceae. Agarics, earth stars, bird's nest fungi, xylaria and termitomycetes are the most frequently recorded macrofungi. Many of them are ectomycorrhizal in association with several tree species. The present study reveals the importance of the university campuses as hotspots for the conservation of macrofungal resources, which serve immediate accessibility as teaching/research material and expose new and noteworthy macrofungi for future applications (e.g. nutrition, forestry and bioactive metabolites).

### PP (S1) 18: Morpho-cultural and molecular characterization of wild disease of Globe amaranth (*Gomphrena globosa*) caused by *Athelia rolfsii* (*Sclerotium rolfsii*) – a new record from India

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Globe amaranth is an important floriculture plant grown for the cut flowers. The outbreak of southern wilt disease was observed during 2019 in parts of the southern Karnataka. The disease incidence ranged from 9.54 – 21.13%. Disease symptoms include water-soaked lesions on the lower leaves, followed by quick wilting of the whole plant. The fungal pathogen was isolated on potato dextrose agar medium which produced white cottony mycelium with numerous reddish-brown sclerotia developed after 12 days of inoculation. A total of 16 fungal isolates were obtained from infected samples and their identity was established based on micro-morphological. Further, four isolates were used for molecular identification by sequencing the ITS-rDNA and *tef-1 $\alpha$*  gene showed which 100% sequence similarity with reference sequences. The associated fungal pathogen was identified as *Athelia rolfsii*. Further, pathogenicity tests were conducted on healthy plants in-vitro and in green house conditions. Typical foot rot disease symptoms were observed after 8 days of post-inoculation. The pathogen was re-isolated and its identity was confirmed. USDA host fungus database analysis showed 118 records for fungus associated with the host *G. globosa* of which 67 records are available for Asia region. In particular, there are 8 fungal diseases recorded for India which includes *Alternaria gomphrenae*, *Botryodiplodia theobromae*, *Cercospora apii*, *Cercospora gomphrenae*, *C. gomphrenae-globosae*, *Colletotrichum gloeosporioides*, *Nymbya gomphrenae* and *Pseudocercospora gomphrenicola*. However, recent survey revealed that the crop is severely affected with foot rot and leaf blight disease. Hitherto no reports are available on the association of *Athelia rolfsii* causing foot rot disease

of globe amaranth. This constitutes the first report on the association of *A. rolfsii* with foot rot disease of globe amaranth in India.

### PP (S1) 19: First report of *Stemphylium* spp. causing leaf spot on bell pepper

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Bell pepper (*Capsicum annum* var. *grossum* Sendt.) belongs to the family Solanaceae. It is a popular and remunerative vegetable crop cultivated widely across the globe. The productivity of the crop is directly related to the foliage of the crop, which is affected by many factors. Among them, the diseases caused by fungi are important. During the survey in 2021-22, the symptoms of the infection varied from white to grey irregular spots surrounded by yellow regions on the middle to lower leaves with the incidence of up to 100 per cent and the severity of 13.33 to 14 per cent was recorded. Later, the fungus was isolated by standard tissue isolation technique on Potato Dextrose Agar (PDA) at 24° C temperature. The fungus grown produced puffy grey mycelia with a bulged center with orange to red pigmentation. The conidia were elliptic with blunt ends having six to seven transverse septa and two to four longitudinal septa. The Koch's postulates proved by spraying conidial suspension on the cv. Massilia of bell pepper on 45 days old seedlings at 10 days after transplanting and the plants were incubated for 48 hours by covering the pots with polythene covers. The first disease symptoms observed six days after inoculation. After 10 to 15 days of disease appearance, the white spot cracks from the papery center and premature defoliation was observed. Based on the cultural characters and conidial morphology, it was reported as *Stemphylium* spp. and is the first report from India.

### PP (S1) 20: Cultural, physiological and molecular characteristization of *Asperisporium caricae* (Speg.) Maubl causing black spot disease on papaya

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The pathogen *Asperisporium caricae*, given the names Asp 1, Asp 2 and Asp 3 based on morphology and colony color variation from greyish white to black color, was isolated from the black spot infected samples. Among the different solid media tested for the growth of *A. caricae*, papaya leaf extract found to be superior with 8.93cm mycelial growth of the pathogen followed by potato dextrose medium with 8.33cm growth. Among the different nutrient sources tested, dextrose as carbon source and calcium nitrate as the nitrogen source enhanced the mycelial growth of *A. caricae* with 8.90cm and 8.87cm growth. Maximum mean mycelial growth of 7.97 cm was recorded at pH 7 and optimum temperature required for growth was 25°C and alternate cycles of light and darkness was required for highest sporulation of *A. caricae*. The epidemiological studies showed that severe disease incidence was observed from November to January and no disease incidence was recorded during summer. Pathogenicity test was proved and the virulent isolate Asp 2 was taken for molecular characterization and further studies. Partial genome sequencing at genus level was carried out using ITS region of virulent isolate Asp 2 using ITS 1 and ITS 4 universal primers which generated an amplicon size of 560 bp and deposited in NCBI (Accession number MK87940).

## PP (S1) 21: Morphocultural and molecular characterization of *Sclerotium rolfsii* and *Macrophomina phaseolina* associated southern blight and charcoal rot disease of Chia (*Salvia hispanica* L.)

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*Salvia hispanica* L. (Lamiaceae), commonly called “chia,” is an important food crop that has gained significance in recent times globally due to its nutritive value. During a field survey, chia fields were found associated with southern blight and charcoal rot disease. The symptoms initially appeared as tan lesions near the stem soil interface and the lesions were colonized by the fast-growing mycelium. Southern blight symptoms manifested and the whole plant wilted, with several numerous globose sclerotia developed all over the surface. The charcoal rot affected plant (root and stem) were turned grey to dark brown with numerous sclerotia and pycnidia developed all over the infected surface. Fungal mycelia developing from the infected tissues were inoculated onto fresh PDA plates to obtain pure cultures for further identification. Sclerotia were white at first and turned brown with age. The average number of sclerotia produced per plate counted. Charcoal rot Pycnidia were observed on the blight-affected leaves. Symptomatic leaf fragments (0.5 cm) were surface-sterilized with 2% NaOCl, placed on potato dextrose agar (PDA) and incubated. Fungal colonies formed many dark sclerotia after 10-12 days of incubation. Pycnidia that developed on necrotic tissues measured 182-210 µm and contained single-celled conidia. Based on these traits, the fungal pathogen was identified as *Macrophomina phaseolina*. Colonies were dark brown in color and were initially whitish on the PDA. The color of the fungal colony became dark as the culture aged. Semi-appressed mycelia were observed on the plates with abundant microsclerotia engrossed in the agar. Aggregation of hyphae formed black and round to oblong or irregular shaped microsclerotia. Thirty sclerotia from a representative isolate measured an average of 63 to 171 µm long × 57 to 128 µm wide. The morphological features matched the description of *Macrophomina phaseolina*. To further confirm the identity of the isolates, three representative isolates were subjected to molecular identification based on ITS-rDNA sequences. Briefly, genomic DNA was isolated from 12-day-old cultures using the CTAB method and ITS-rDNA was amplified using ITS1-ITS4 primers. An expected amplicon of >650 bp was obtained and later sequenced from both directions. The consensus sequences were analyzed through a BLASTn search that revealed 100% sequence similarity with reference sequences of *Athelia rolfsii* and *Macrophomina phaseolina*. The phylogenetic tree obtained by the neighbor-joining method using MEGAX showed a common clade with the reference sequences, thus confirming the identification based on sequence analysis and molecular phylogeny. Based on etiology, morphological, cultural, and molecular data, the pathogen was identified as *A. rolfsii* and *Macrophomina phaseolina*. Pathogenicity tests were conducted on chia plants grown in a greenhouse at 28 ± 2°C and 70% relative humidity and proved after re-isolation. The identity of the fungus was confirmed by morphology and molecular sequence analysis after re-isolation. Early diagnosis of this disease will help farmers to adopt suitable management practices to avoid loss.

## PP (S1) 22: Morphocultural and molecular characterization of stalk rot disease of maize caused by complex *Fusarium* species

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Recently, severe incidence of stalk rot disease maize was observed in several maize growing fields of Karnataka, Maharashtra and Telangana. A rowing field survey was conducted in major maize growing districts of Karnataka during the Kharif seasons from 2013 to 2019 to assess the incidence and severity of stalk rot. A total of 10 major maize growing districts were selected and the data collected was analyzed for the incidence and severity. The study revealed the prevalence of stalk rot of maize in all maize growing regions and the maximum mean severity was observed in Bellary and Koppal (>24 mean severity) and least was in Dharwad and Haveri (<5 mean severity). Similarly, maximum severity was observed in Shankarbande regions of Bellary followed by Halagere (Koppala) with maximum severity of >40. Several *Fusarium* species were isolated from stalk rot affected samples and were identified based on colony characteristics and morphological features. Further, the identity of all three *Fusarium* species was confirmed through molecular methods using ITS-rDNA (ITS1-ITS4) and TEF (EF $\alpha$ 1-EF1R) genes. The sequenced PCR products were subjected to phylogenetic analysis and the identity was established. The stalk rot of maize is now complex disease caused by more number of *Fusarium* species as a result the diagnosis is becoming very much critical and needs to be adopted for molecular screening in order to understand the population structure of pathogens associated with stalk rot disease of maize.

## Session 2. Phyto biome and Micro biome: Challenges and Advances

### PP (S2) 01: Genetic diversity of *Phytophthora* spp. infecting black pepper as revealed through RAMS and REP PCR analysis

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*Phytophthora capsici* and *P. tropicalis* are the two species of *Phytophthora* reported to be associated with foot rot disease of black pepper. High diversity among the species contribute to its wide host range and variability in virulence pattern. In the present study, the genetic diversity of *Phytophthora* species infecting black pepper was studied using RAMS (Random amplified microsatellites) and REP (Repetitive Extragenic Palindromic) fingerprinting. A total of 48 isolates, 24 each of *P. capsici* and *P. tropicalis* isolates collected from major black pepper growing states such as Karnataka, Kerala, Tamil Nadu and Goa were used in the study. Strong reproducible bands were scored and UPGMA clustering was performed using DICE similarity coefficient in NTSYSpc Version 2.10e. Genetic diversity parameters like percentage of polymorphic loci, Nei's gene diversity and Shannon diversity index was generated using POPGENE version 1.32 software. Analysis revealed a total of 160 loci of which 150 (93.75%) were polymorphic. The Kerala isolates were found to be more diverse with a Shannon diversity index of 0.441 followed by Karnataka isolates. UPGMA cluster analysis clearly grouped the *P. capsici* isolates into two sub-clusters (I and II) and *P. tropicalis* isolates into another two sub-clusters (III and IV). There was no significant correlation between the groups and the geographical origin of the isolates. All the isolates were genetically unique and the entire population was heterogenous. Further, fifteen isolates were selected for the cross-infectivity analysis with a variety of crops such as arecanut, tomato, pumpkin, vanilla, nutmeg, coconut, capsicum, cucumber and cardamom under *in vitro* condition and the results showed that black pepper isolates could infect nutmeg, tomato, pumpkin, cucumber and cardamom.

### PP (S2) 02: First report on the occurrence of *Lasiodiplodia theobromae* causing gummosis disease in Sikkim mandarin (*Citrus reticulata* Blanco)

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Sikkim mandarin is an ecotype of mandarin (*Citrus reticulata* Blanco.) grown in organic farming system in the state of Sikkim. This fruit crop has been affected by many diseases and pests. Gummosis disease is one of the important diseases of Sikkim mandarin however the identity of the pathogen and its aetiology and epidemiology has been unknown till date to ensure the proper management measures. The disease has not only claimed loss in fruit productivity but also in mortality of the trees. A survey was conducted in different mandarin growing regions of Sikkim between February to September, 2022. During this survey, infected trees with characteristic gummosis symptoms were observed in branches and trunks across different orchards. Direct isolation from symptomatic branches after surface sterilisation on sodium hypochlorite were inoculated on potato dextrose agar amended with PAR (PCNB, ampicillin and rifampicin). The pure fungal isolate from direct isolation were incubated on PDA at 24±2°C for 5 days. The morphological and microscopic characteristics identified the isolate as *Lasiodiplodia* sp. Molecular characterisation of the isolate using ITS r-DNA partial gene amplification using universal primers ITS 4

and ITS 5, resulted in 100% sequence similarity with *Lasiodiplodia theobromae* (family: Botryosphaeriaceae). Our study provides first evidence for the occurrence of pathogen *Lasiodiplodia theobromae* causing gummosis disease of mandarin grown in Sikkim.

### PP (S2) 03: Survival of *Myrothecium roridum* causing leaf spot and fruit rot in *Coffea arabica* L.

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Coffee is one of the economically important plantation crop in India. Many fungal diseases are also known to affect Arabica coffee (*Coffea arabica* L.) crop during different seasons. In the recent years, during monsoon there was a gradual increase in the incidence of leaf spot and berry rot in the Arabica coffee plantations caused by fungus *Myrothecium roridum*. Earlier, the same pathogen was known to cause leaf spot and stem necrosis of coffee seedlings at nursery. Hence, a laboratory experiment was conducted to study the survival ability of this pathogen. The Arabica coffee leaves showing typical leaf spot caused by *M. roridum* collected from the plantation was stored at room temperature. To know the viability of pathogen, at regular monthly intervals pathogen was isolated from stored infected Arabica coffee leaf samples by aseptically transferring the sporodochia to the Petri-dishes containing Potato Dextrose Agar medium. The result revealed that sporodochia in the stored infected Arabica coffee leaves were remained 100 per cent viable up to 9 months and they failed to form the fresh colonies later on indicating the viability of the sporodochia is up to 9 months under laboratory condition.

### PP (S2) 04: Evaluation of culture filtrates of endophytic microorganisms from tomato against *Ralstonia solanacearum*

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A novel approach to the biological control using endophytes has gained immense potential in disease management. The endophytes constitute a valuable source of secondary metabolites such as alkaloids, terpenoids, sterols and phenolic compounds which play a major role in plant defense mechanisms. Therefore an experiment was carried out to study the effect of secondary metabolites of endophytes from tomato against the bacterial wilt pathogen *Ralstonia solanacearum* both *in vitro* and *in vivo* conditions using their culture filtrates. *In vitro* evaluation of the culture filtrates of the endophytes was carried out inoculating the pathogen on five per cent culture filtrate amended Potato Dextrose Agar medium. Complete inhibition of the pathogen was observed in all endophytes indicating the inhibitory effect of their culture filtrates. In order to study the effect of secondary metabolites of endophytes on *R. solanacearum* under *in planta* condition, culture filtrates along with culture suspensions for comparison were used. The tomato seedlings dipped first in culture filtrate/suspension then in bacterial ooze showed lowest wilt incidence and among the two, seedling dip in filtrate was the effective one. The minimum wilt incidence was noticed with seedlings dipped first in culture filtrate of endophyte *Trichoderma viride*-2 recording 10.92, 15.68 and 19.84 per cent followed by *T. harzianum*-1 and *Bacillus subtilis*, which showed 12.5, 16.67 and 22.22 per cent at 7, 10 and 14 days after inoculation respectively. Thus the above findings clearly indicated the inhibitory effect of secondary metabolites of the endophytes on bacterial wilt pathogen.

## PP (S2) 05: The root lesion nematode (*Pratylenchus* sp.) infecting turmeric in Tamil Nadu: morphological and molecular characterization

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Root lesion nematodes (*Pratylenchus* spp.) are an invasive endoparasitic species with a worldwide distribution. In recent years, severe infestation of lesion nematodes has been reported in turmeric crops in several Indian states. The distribution, identity, and damaging potential on turmeric are poorly documented. The present study aims to study the species identity of RLN that are associated with turmeric in Tamil Nadu. Turmeric rhizome samples were collected with the help of Coimbatore centre of the AICRP on spices. NDH-98, a high-yielding variety, contained 850 mixed stages of root-lesion nematodes per gram of rhizome. The nematodes were extracted using the modified Baermann procedure and cultured in turmeric rhizomes (IISR Pragati). Morphological and molecular analysis was conducted on matured cultures to detect species distinctions. Morphological measurements of adult females (n=20) are as follows, the total body length (range 534 to 630  $\mu\text{m}$ , mean = 591  $\mu\text{m}$ ), the stylet (17.5 to 18.6, 17.5), tail (34.3 to 38.6, 34.3), body width (28.7 to 32.0, 28.7), a (20.9 to 24, 20.9), b (4.1 to 5.1, 4.7), c (17.2 to 18.0, 17.2), and V (80.5 to 82.5, 80.5). The females of the population have slightly offset lip region with two annules. The post-uterine sac in female was approximately 38.4  $\mu\text{m}$  long and was 1.2 times the body diameter. The spicules in males are slender and 17.8  $\mu\text{m}$  long. The morphology and morphometrics of the present population are within the range of Zimmermann's (1898) original description of *Pratylenchus coffeae* and of redescription of Castillo and Vovlas (2007). In order to confirm the species identity of the *Pratylenchus* species, the molecular analysis of 28S, ITS and mitochondrial COX1 subunit genes was carried out. For this, DNA was extracted from 100 nematodes using the Qiagen DNeasy tissue & blood kit (Qiagen, Germany) as specified by the manufacturer. The 28S, ITS, and COX1 genes were amplified using D2A/D3B, VRAIN2 F/VRAIN2 R and JB3/JB4.5 primers, and the products were sequenced. The ITS sequence showed maximum similarity of 83.19 with *P. coffeae* (AY561436) while the 28S rRNA sequence was 97.02% similar to *P. speijeri* (MW820015) and 93.22% similar to *P. coffeae* (MH136569). On the other hand, the mitochondrial gene, COX1, was 85.11% similar to *P. coffeae* (MN366418). However, phylogenetic analysis using Maximum Likelihood method showed maximum similarity with *P. coffeae*. However, the exact species identification requires further molecular analysis.

## PP (S2) 06: Isolation and identification of microbiome associated with grain discoloration disease of rice

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Grain discoloration (GD) disease of rice is a complex disease caused by many pathogens. Under field conditions, the GD is difficult to control due to its diverse pathobiome and unique time of onset, where the crop will be almost at the harvesting stage. Although the disease can be controlled using fungicides/bactericides, spraying is generally not recommended at the harvesting stage due to potential pesticide residue risk in the grains. Therefore, an alternative method to chemicals is the need of the hour. In recent times, bio-agents are gaining importance in disease management; however, their bio-efficacy is limited due to poor adaption to the disease niche on the plant surface.



Therefore, identifying effective bio-agents from the diseased niche and their subsequent application for disease management is gaining importance in the recent past. In this study, we have attempted to isolate and identify the microbiome associated with GD in the coastal ecosystem of paddy. We used the modified seed wash method with a serial dilution technique for isolation. The isolated microbiome was identified using morphological, cultural, and DNA-based markers. Using universal primers, the taxonomic identity of the pure cultures of all the isolated bacteria was done based on the nucleotide sequences of the 16s ribosomal gene sequences. Based on the BLAST analysis of the consensus sequences, 22 different bacterial species belonging to nine bacterial genera were identified. Different species identified were *Acinetobacter baumannii*, *Acinetobacter sp.*, *Alcaligenes faecalis*, *Bacillus cereus*, *B. subtilis*, *B. wiedmannii*, *Burkholderia gladioli*, *Lysinibacillus fusiformis*, *Microbacterium hydrothermale*, *Pantoea ananatis*, *Pantoea sp.*, *Pseudomonas alcaligenes*, *P. knackmussii*, *P. oryzihabitans*, *P. promysalinigenes*, *P. putida*, *P. taiwanensis*, *P. plecoglossicida*, *Sphingomonas melonis*, *Sphingomonas spp.*, *S. aquatilis*, *Stenotrophomonas maltophilia*. Among the nine distinct genera, the majority of bacteria isolates belong to *Pseudomonas* (no=10), followed by *Bacillus* (no=5), *Acinetobacter* (no=3), *Sphingomonas* (no=3). remaining identified genera are *Alcaligenes* (no=1), *Burkholderia* (no=1), *Lysinibacillus* (no=1), *Microbacterium* (no=1) *Pantoea* (no=7) and *Stenotrophomonas* (no=2). Several identified bacterial species are reported to be associated with disease resistance/biocontrol/growth promotion and, therefore, can be exploited for GD disease management.

### PP (S2) 07: Biosurfactant production and plant growth promotion by epiphytic and endophytic bacteria of rice

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Rice is a staple crop around the world, particularly in Asian countries. Bacterial isolates *Bacillus amyloliquefaciens*, *Klebsiella pneumoniae*, *Stenotrophomonas maltophilia*, *Microbacterium hydrocarbonoxydans*, *Bacillus cereus* used in present study were isolated from rice roots and rhizosphere soil from the agricultural fields of Professor Jayashankar Telangana State Agricultural University (JTSAU) and Indian Institute of Rice Research (IIRR), Rajendranagar, Hyderabad, Telangana, India. All the isolates were screened for biosurfactant production by oil spread assay, emulsification index. Antifungal activity of isolates was evaluated against phytopathogenic fungi, *R. solani*, *M. phaseolina*, *S. rolfsii*. Furthermore, these bacteria were evaluated for plant growth promotion in rice by paper towel, green house experiments. At the end of 21 days various parameters like root length, shoot length and plant biomass were recorded. Biosurfactant production in terms of emulsification activity was more than 65%. Bacterial treated rice seedlings recorded improved root and shoot length, plant biomass over control. Biosurfactant produced by the different bacterial isolates was characterized by different physio-chemical methods and used to evaluate their potential to combat phytopathogens in greenhouse conditions.

### PP (S2) 08: Endophytic fungal phytobiomes of *Grewia hirsuta*: Phylogenetic diversity and L-asparaginase activity

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Endophytic fungi are a group of diversified fungi that inhabit the internal tissues of living plants without causing any noticeable infections to the host. In recent years they have gained much attention because of their capacity to produce several bioactive compounds. L-asparaginase is a tetrameric enzyme from the amidohydrolases family,

that catalyzes the breakdown of L-asparagine into L-aspartic acid and ammonia. Since its discovery as an anticancer drug, it is used as one of the prime chemotherapeutic agents to treat acute lymphoblastic leukemia (ALL). The present work aimed to study the endophytic fungal diversity of the medicinal plant *Grewia hirsuta* and their ability to produce the L-asparaginase. A total of 1575 culturable fungal endophytes belonging to four classes Agaricomycetes, Dothideomycetes, Eurotiomycetes, and Sordariomycetes were isolated. The isolates were grouped into twenty-two morphophytes based on their morphological characteristics. Representative species from each group were identified based on their microscopic characteristics and evaluation of the ITS rDNA sequences. A phylogenetic tree obtained based on the maximum likelihood method revealed that the isolates can be assembled into various clades. Representative fungal endophytes were screened for extracellular production of L-asparaginase by rapid qualitative plate assay. Among the sixty-six fungal endophytes screened, thirty-two were identified as L-asparaginase producing isolates. The enzyme index varied from 1.00 to 6.07 mm. *Campylocarpon fasciculare* showed a maximum enzyme index of 6.07, followed by *Fusarium foetens* (5.31). The enzyme activities of fungal endophytes estimated by the nesslerization method were found to be in the range of 0.17-2.29 IU/mL. *Fusarium foetens* showed the highest enzyme activity of 2.29 IU/mL. The study revealed that *Grewia hirsuta* harbors diversified fungal endophytes that are capable of producing L-asparaginase.

### PP (S2) 09: Disease scenario of bell pepper in Southern Karnataka

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Bell pepper (Sweet pepper) scientifically called as *Capsicum annum var. grossum* Sendt belongs to the Solanaceae family. It is highly remunerative crop cultivated worldwide. Bell pepper is rich in vitamin C and extensively used in most of the cuisines. The crop is highly commercialized, and its production is challenged by many factors which includes both biotic and abiotic factors. Among the biotic factors diseases caused by fungi, bacteria, nematode and viruses are highly problematic in the bell pepper production and productivity. Hence, a roving survey was conducted during the period 2021-2022, in the four districts of Southern Karnataka viz., Kolar, Chikballapura, Bengaluru Rural and Mysuru to know the incidence and severity of diseases in bell pepper. The different diseases observed were bacterial leaf spot (4.75%), *Alternaria* leaf blight (20.45 %), *Cercospora* leaf spot (11.37 %), Anthracnose/fruit rot (8.25 %), Die back (1.5 %), *Phytophthora* blight (6.25 %), *Sclerotium* rot (0.33) Powdery mildew (8.33 %), Pepper mottling (6.25%) and Capsicum chlorosis (0.1 %). Among the diseases observed *Alteranria* leaf blight (20.45 %) is more severe followed by *Cercospora* leaf spot (11.37 %) and the least is Capsicum chlorosis (0.1%). Among the districts surveyed Bengaluru Rural recorded highest disease severity of *Alternaria* leaf blight (37.22 %) and *Cercospora* leaf spot (17.91 %) and the least disease severity of *Alternaria* leaf blight (5.18 %) and *Cercospora* leaf spot (2.96 %) was observed in Chikballapur district.

### Session 3. Eco-friendly plant and soil health management towards natural farming

#### PP (S3) 01: Study on Fusarium head blight of wheat under agro-climatic conditions of central India and its management

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During the rabi season of 2021, an intense roving survey was undertaken to assess the Fusarium head blight incidence and severity in agro-climatic condition of Jabalpur. The average disease incidence varied from 14.05 to 19.78 percent, with disease severity ranging from 18.71 to 36.19 percent. Harda district had the highest incidence (19.78) and severity (36.19) followed by Umariya lowest rate of occurrence (14.05) and severity (18.71). In seed treatments *Pseudomonas fluorescens* (1.00%) was found highly effective in reducing the 44.65 % disease incidence. Tebuconazole (0.15%) was most effective fungicide among all the tested fungicides and it inhibited 61.27 % disease incidence. In foliar application of different bio agents and fungicides, *Pseudomonas fluorescens* were found highly effective bioagents against the FHB of wheat. In *Pseudomonas fluorescens* treated plots, disease incidence was minimum recorded as compared to other bioagents it inhibited 49.23 % disease incidence. In chemical fungicide tebuconazole was most effective fungicide among all the tested fungicides, tebuconazole treated field plots inhibited 75.07 % disease incidence and also reduced the severity level. In respect to In-vitro efficacy of fungicides and bio-agents against Fusarium isolates, tebuconazole (0.15%) treated plates were recorded 96.58 % growth inhibition after 7 days inoculation. In bioagents Bacterial antagonists were tested in dual culture *P. fluorescens* (Pf) was found highly effective and it inhibited 66.63% growth of Fusarium isolates. Results revealed that mean incidence of Fusarium head blight of wheat was significantly positively correlated with temperature (0.537) and rainfall (0.523). During the anthesis stage of the crop, rainfall has a significant impact on the development of disease. Fusarium species associated with head blight is favored by high temperatures.

#### PP (S3) 02: Eco-friendly management of dry root rot of Safflower

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Dry Root rot is an important disease of Safflower (*Carthamus tinctorius* L.) caused by *Macrophomina phaseolina* (Tassi) Goid was observed in farmer's field of different districts of Marathwada region which cause severe economic yield loss. The study aimed at minimizing the indigenous usage of chemical fungicides and adopting the strategy of biological control and plant extracts for management of this devastating fungus. In this study, applying Dual culture technique and Poisoned food technique and using Potato dextrose agar (PDA) as basal culture medium was used to see how effective various bioagents and plant extracts were at managing *M. phaseolina*. Among the tested biocontrol agents against *Macrophomina phaseolina*, *T. virens* (86.42%) was found most effective which resulted in maximum inhibition of mycelial growth of the pathogen followed by *T. koningii* (82.72%), *T. asperellum* (79.77%). Among tested different Phytoextract @ 10, 15 and 20 per cent evaluated against *M. phaseolina*, *Allium sativum* (100%) was found most effective, resulted in complete inhibition of mycelial growth of the pathogen followed by *Z. officinale* (68.16, 75.19 and 80%) and *A. indica* (64.44, 69.52 and 72.22%). The *in vitro* results obtained from these studies were considered for further field evaluation against dry root rot disease.

### PP (S3) 03: Efficacy of bio-agents against *Phellinus noxius* (Corner) G. Cunn, the cause of coffee brown root disease

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Coffee is an important agricultural commodity traded worldwide and is ranked next to petroleum. Coffee cultivation is practiced in more than 80 countries across the world and affected by many diseases. Brown root disease of coffee is one of the economically important diseases of coffee caused by soil borne fungus *Phellinus noxius*. Biological management is the key component of plant disease management and is slowly replacing chemical pesticides. In the present study, nine bacterial bioagents and six isolates of *Trichoderma* were evaluated against brown root disease pathogen of coffee, *Phellinus noxius* by following dual culture technique. The experiment was conducted in completely randomized design with nine treatments and three replications. Antagonistic activity was assessed and inhibition percentage of pathogen was calculated. Results indicated that, among the bacterial bioagents, *Bacillus subtilis* was found superior and inhibit the mycelial growth of the pathogen up to 100% followed by *B. mycoidis* (80%), *Enterobacter intermedium* (46.25%) and least mycelia growth inhibition was observed in *B. lactolactis* (44.17%). Among *Trichoderma* isolates there was significant inhibition in mycelial growth of the pathogen in different levels. There was cent percent inhibition rate of the pathogen by the *Trichoderma* isolate CCRI-5. While, CCRI-2 (97.04%) and CCRI-3 (97.78%) were found statistically on par with the isolate CCRI-5. Whereas, the isolate CCRI-1 showed least inhibition rate of 54.07% over control. The effective bio-agents can be evaluated further in the field conditions for the management of brown root disease of coffee.

### PP (S3) 04: Integrated management of bitter gourd virus diseases

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Bitter gourd, (*Momordica charantia* L.) is one of the most popular vegetable of Cucurbitaceae family in the tropical and subtropical countries, including India. Bitter gourd is commonly attacked by number of fungal and viral diseases. Among the viral diseases Bitter gourd Yellow Mosaic Virus (BGYMV) is a Whitefly transmitted geminivirus. BGYMV causes yellow mosaic disease in bitter gourd. This disease attains significance because the virus causing this disease is capable of attacking the crop at all stages. There was a severe yield loss in bitter gourd plants due to the infection of BGYMV. Among the all measures to raise the productivity level from bitter gourd yellow mosaic virus, integrated management approach is need to avoid economic losses. To find the integrated approach the experiment was conducted during Summer 2021 at Horticulture Research Scheme (Vegetable), VNMKV, Parbhani. Maharashtra India (with T<sub>0</sub> Barrier crop with two rows of maize, mulching with silver plastic mulch, Sticky yellow traps in each plot). A total of 7 treatments comprising AMC, Buttermilk, Kaolin, Weed extract, two chemical insecticide and one control (without any spraying) were assessed as spray treatment to manage the white fly population. The spraying was done at 10 days interval as the viral symptoms appear. The experiment was sown on 11.02.21. The plot size was 4.5 x 3 m with spacing 1.50 x 75 cm. The recommended practices were followed, critical observations of diseases revealed that significantly lowest incidence (8.66 %) of yellow mosaic disease of bitter gourd was recorded in the treatment T<sub>6</sub> (T<sub>0</sub> + Spray of acephate @ 0.15 % + neem oil @ 0.2 % followed by pyriproxifen @ 0.1 % at 10 days interval) followed by treatment T<sub>5</sub> (13.47%) (T<sub>0</sub> + Rotational spray of T<sub>1</sub>, T<sub>3</sub> and pyriproxifen @ 0.1 % at 10 days interval). In respect of whitefly population, all the treatments were significantly superior over untreated

control. However, treatment T<sub>6</sub> have recorded significantly minimum number of whitefly population (2.05) followed by treatment T<sub>5</sub> (3.22). Among all the treatment T<sub>6</sub> recorded highest fruit yield (91.29 q/ha) which was statistically significant over all other treatment, whereas control recorded lowest fruit yield (54.62 q/ha).

### PP (S3) 05: *Trichoderma asperellum*, fungal biocontrol agent as an ecofriendly approach for the management of foliage pathogens of *Aglaonema* spp.

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Foliage plants are plants with attractive foliage and flowers that are produced in containers in shaded greenhouses and used primarily as living specimens for interior decoration or interiorscaping. The steady increase in foliage plant production in the recent years has been attributed to the sustainable approaches introduced for beautification of interior environments, purification of indoor air and also due to the ease in management of the plants. The genus *Aglaonema*, commonly referred to as Chinese evergreen, comprises of 21 species native to southeast Asia. *Aglaonema* is one of the most widely used plants in interiorscape due to its ability to tolerate low light and low humidity and its resistance to diseases and pests. However, being widely used under humid tropical environment, the plant is susceptible to various pathogens and diseases. On a survey, in Kerala during 2021-22, different diseases like leaf spots and leaf blights were noticed on the commercially important part of the plant. A variety of pathogens have been isolated and characterized which caused various types of spots and blights. Being an interior plant, ecofriendly management will be best suited for managing the pathogens which causes foliar diseases. Hence, *in vitro* studies using a potential fungal biocontrol agent (BCA), *Trichoderma asperellum* was conducted for identifying its potential to manage the pathogens. Dual culture experiment was conducted with fourteen pathogens isolated from the host on Potato Dextrose Agar medium. The BCA recorded complete inhibition and over growth on eleven pathogens viz. *Colletotrichum* spp, *Fusarium* spp., *Pestalotia* sp. And *Cornysespora* sp. with cent per cent (100%) inhibition compared to the control. Other four *Collectotrichum* spp. Tested, recorded inhibition ranging from 43.33 – 51.66 per cent. The BCA showed overgrowth, inhibition of hyphal growth and clear zone at the point of contact as mechanisms of inhibition against the pathogens.

### PP (S3) 06: Biocapsules: An insight into successful management of *Rhizoctonia* collar rot and web blight of cowpea

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Biocontrol agents viz., *Trichoderma asperellum* and *Pseudomonas fluorescens* have been studied over recent decades as a suitable alternative to diminish or substitute synthetic fungicides against soil borne diseases. The conventional commercial products of these bioagents have failed to attain its expected potency and have certain limitations with respect to shelf life, bulkiness, difficulty in transportation, chances of contamination etc. In the current study, the efficacy of novel capsule formulations of both *Trichoderma asperellum* and *Pseudomonas fluorescens* was evaluated under *in vivo* conditions against the soil borne disease, collar rot and web blight of cowpea caused by *Rhizoctonia solani* and were compared with other conventional (talc and liquid) formulations. During the experiment, it was noticed that symptoms of *Rhizoctonia* leaf and web blight appeared in all treatments. However, the lowest incidence was noticed in the treatment T<sub>12</sub> (copper hydroxide) (2g/l) followed by T<sub>3</sub> (Tricho

capsule-1) (1g/100 l), T<sub>11</sub> (PGPR mix II) (20g/l) and T<sub>9</sub> (IISR Tricho capsule) (1g/100 l) against control. On symptom appearance, spray and drench was given to all treatments and observations were recorded after 10 days. It was noticed that after the first application, there was a significant reduction in disease in all treatments except in control (T<sub>13</sub>). After second and third application, it was noticed that there was no incidence of *Rhizoctonia* leaf blight in cowpea plants which proves that capsule formulation with a minimum dosage (1g in 100 litres) of both bioagents were effective against soil borne pathogens which was on par with the conventional formulations.

### PP (S3) 07: Biodegradation of organophosphorus pesticide chlorpyrifos by *Trichoderma harzianum* isolated from agricultural soils

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Chlorpyrifos fall under the category of organophosphorus pesticides which are in huge demand in agricultural sector. Chlorpyrifos, been widely applied in agriculture in order to kill insect pests. Due to its slow rate of degradation, it can persist in soil with a significant threat to environment and non-target pests. overuse of pesticide has led to loss of soil fertility. Microbial degradation has been considered a safe and cost-effective method for degradation of pesticide residues from the environment. The present study aimed in isolation of chlorpyrifos degrading fungus from agricultural soil, enrichment culture technique was carried out to isolate chlorpyrifos degrading fungus in mineral salt medium, eight cultures were isolated and among eight *Trichoderma harzianum*. showed highest degradation in MSM media with 300ppm concentration of chlorpyrifos within 30 days of incubation, LCMS analysis showed complete disappear of chlorpyrifos peak, indicates the detoxification of chlorpyrifos. Hence *Trichoderma harzianum*. can be efficiently use for the remediation of chlorpyrifos in soil.

### PP (S3) 08: Effectiveness of indigenous isolates of *Trichoderma* in imparting drought tolerance in rice

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Effectiveness of indigenous isolates of *Trichoderma harzianum*, *T. viride*, *T. virens*, *T. hamatum* and *T. koningii*, was evaluated through seed treatment. The strains were isolated from rice fields at different localities in the district Aligarh. The rice cultivar Swarna Sub-1 was used to evaluate the effectiveness of *Trichoderma* in normal (100% water availability), drought (50% water availability) and severe drought condition (25% water availability) in a pot experiment. Under normal conditions, highest 36.1 and 41.3% increase in the shoot and root length respectively, was recorded with the treatment of *T. harzianum* AMUTH-3. The lowest increase in shoot and root length i.e., 6.7 and 8.2% respectively, occurred with *T. koningii* AMUTK-2. Under 50% drought conditions increase in shoot length and root length was 31.2 and 34.1% with *T. viride* AMUTVIR-2, whereas the minimum increase was with *T. koningii* AMUTK-2. Under severe drought condition *T. viride* AMUTVIR-2, was found highly effective in increasing the shoot and root length (22.4% and 19.4%, respectively) followed by *T. harzianum* AMUTH-3. *T. viride* AMUTVIR-2 was also found most effective in increasing fresh weight of shoot (24.6%) and root weight (31.7%) under normal conditions, while under 50% drought conditions, 20.4% increase in fresh weight of shoot and 17.8% in root were observed. At 25% of water availability, significant increase in fresh weight of shoot (15.7%) and root (13.3%) was recorded with *T. viride* AMUTVIR-2. The least effective treatment was found *T. koningii* AMUTK-2 in all aspects.

### PP (S3) 09: Management of Plant Disease in Natural Farming

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In natural farming, the focus is on the use of bio inputs prepared from farms and local ecosystems. The approach of natural inputs like cow urine and dung, jaggery, lime, neem among others are used to improve soil health, nutrients and reduce input costs, among other benefits. According to the approach natural inputs viz., cow urine and dung, jaggery, soil, lime, and neem among others are used to improve soil health, nutrients and reduce input costs, among other benefits is the elimination of chemical fertilisers and pesticides, the indiscriminate use of which pollutes the environment, and to promote "good agronomic practices", which means using science and technology to manage crops diseases. Government is promoting Natural Farming through a scheme named BPKP, which reduces the cost of cultivation, reduce disease and pest problem, reduces water requirement of crops, climate change resilient, reduces risks in farming and rejuvenation of farm lands, safe and healthy food for citizens. Utilizing the available Desi Cow as valuable resource helps in arresting the growing needs for fertilizer and reducing subsidy burden. In India, natural farming is "Rishi Kheti". The Rishi Kheti uses cow products viz., buttermilk, milk, curd and its waste urine for preparing growth promoters. Its is considered without any usage of chemical fertilizer and pesticides. Natural Farming mainly relies on the adoption of diversified multi-cropping systems, desi cow-based on-farm inputs for nutrient and soil enrichment and various botanical concoctions for plant protection. In this method, the disease is prevented rather than cured. In natural farming, the decomposition of organic matter by microbes and earthworms. In natural farming, important inputs include an indigenous beneficial microorganism, fermented plant juice, herbal nutrient, lactic acid bacteria, fish amino acid, and water-soluble calcium phosphate, Mulching: to circulate the air in the soil - oxygen is essential to the roots and microorganisms in the soil. BIJAMRITA is seed treatment reduced seed and soil-borne diseases, JIWAMRITA- Increase biological activity in the soil and makes the nutrients available to the crop and biological control of soil-borne diseases and increase resistance in plant against diseases, Agniastra Brahmastra and Neemastra used as an insecticide management of insect and vector of plant diseases finally reduced pest and diseases problem.

### PP (S3) 10: Rhizospheric microbes mediated defence responses against *Fusarium solani* in tea

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India is the second largest tea producer in the world next to China including the famous Assam and Darjeeling tea. Tea is the "State Drink" of Assam. But the tea plant is challenged worldwide by various diseases among which the dieback disease in tea caused by *Fusarium solani* is one of the most destructive diseases in all the major tea growing countries, due to its characteristic feature of infecting tender pluckable shoots. Crop loss caused by this particular pathogen accounts for more than 40% which in turn leads to huge economic losses. The present investigation was made to focus on isolation and screening of antagonistic bio-agents against the dieback pathogen through *in-vitro* assays, followed by pot trials. Further our work investigates the properties of the bioagents to induce systemic resistance in tea plants. The *in-vitro* assays revealed that isolates SSA5 (*B. amyloliquefaciens*) and SSA9 (*B. velezensis*) were most efficient in controlling the disease and were identified using 16S rRNA sequencing and selected for pot trials. During pot trials, the pathogen (*F.solani*) was introduced to tea seedlings pre-inoculated with

the two bio-agents and were analyzed for their disease suppression efficacy. Pots containing both the isolates SSA5+SSA9 recorded the highest inhibition of the pathogen over both the controls; A: only pathogen and B: *Trichoderma asperellum* and hence were selected for studying their ability to induce systemic resistance in the tea plants by production of various plant defence enzymes like peroxidase (PO), Polyphenol oxidase (PPO), Phenylalanine ammonia lyase (PAL) and  $\beta$ -1,3-glucanase. The results obtained reflects the prominent role of the bio-agents in providing immunity to the tea plant as the production of the above-mentioned enzymes decrease after 24 hours when only the pathogen was introduced whereas the plants inoculated with both the pathogen and the bio agents kept on synthesizing the enzymes till 72 hours post inoculation which later started decreasing.

### PP (S3) 11: Management of cotton boll rot complex through fungicides and bioagents

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Cotton is an important commercial crop in India with a production of 371 lakh bales of 170 kg lint from an area of 129.57 lakh ha and a productivity of 487 kg/ha in 2020-2021, which is far behind the leading countries. India is the largest cotton growing country and the crop is spread across 123.50 lakh hectares with a production of 340.62 lakh bales of cotton lint and average productivity of 469 kg/ha. Karnataka is reported to produce cotton lint of about 6.91 lakh bales with and an area of 18,33,000 hectares marking a average productivity of 451 kg/ha (Anon., 2022). Cotton crop is affected by a number of foliar diseases throughout the season. Boll rot complex is one of the major diseases of cotton which is responsible for loss of yield and quality. An experiment was conducted at Agricultural Research Station, Dharwad farm, University of Agricultural Sciences, Dharwad under rainfed conditions to know the efficacy of 7 fungicides and 2 bioagents for managing boll rot complex of cotton. Two control plots viz., one with the insecticide spray alone and the other with no spray were maintained. The experiment was laid out in replicated trial of randomised block with 11 treatments. The study revealed that among the treatments evaluated, trifloxystrobin 25 % + tebuconazole 50 % WG at the rate of 1.0 g/ lit (8.97 PDI), pyraclostrobin 5 % + metiram 55 % WG at the rate of 3.5 g/ lit (11.37 PDI) and tebuconazole 25.9 % EC at the rate of 1.0 ml/ lit (12.69 PDI) were found very effective against the disease as they reduced the severity of the disease and enhanced the yield. Maximum yield of 14.11 q/ ha was recorded in the plots treated with trifloxystrobin 25 % + tebuconazole 50 % WG at the rate of 1.0 g/ lit. Spray of biocontrol agents also reduced the severity of disease and increased the yield significantly over the control. Tebuconazole 25.9 % EC at the rate of 1.0 ml/ lit was found economical with the highest B: C ratio of 1.52:1. However, trifloxystrobin+ tebuconazole (1.43: 1) and pyraclostrobin+ metiram(1.43: 1) may be recommended as the components in integrated disease management of cotton, as the combi products are broadspectrum and can take care of other foliar diseases of Bt cotton than the solo products like tebuconazole alone.

### PP (S3) 12: Evaluation of antifungal activity of SFE of *Ailanthus excelsa* against powdery mildew of Sunflower

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*Ailanthus excelsa* which is usually called as tree of heaven is known to possess anti- fungal activity. The bio constituents such as flavonoids and phenols which are present in the leaves of *Ailanthus excelsa* is known to possess



anti-bacterial, anti-fungal properties. This experiment was conducted to study the fungicidal activity of *Ailanthus excelsa* against powdery mildew of sunflower. For evaluating its activity against powdery mildew spore germination technique was followed for different concentrations of leaf extract of *Ailanthus excelsa*. Results revealed that maximum inhibition of spore germination of 98.37 per cent was observed in 10 per cent concentration which was on par with 9 per cent concentration of leaf extract of *Ailanthus excelsa* and the minimum inhibition of spore germination was observed at 1 per cent (28.78%) concentration in case of powdery mildew caused by *Golovinomyces cichoracearum*. Under field conditions, PDI of 7.41 per cent was observed after second spray of SFE of *Ailanthus excelsa* whereas, 9 per cent of SFE of *Ailanthus excelsa* showed 8.15 per cent of PDI which was on par with 10 per cent concentration of SFE of *Ailanthus excelsa*. At 1 per cent concentration of SFE of *Ailanthus excelsa* showed 50.71 per cent of PDI after second spray. The yield was higher at 10 per cent concentration of SFE of *Ailanthus excelsa* i.e., 8.68 q ha<sup>-1</sup>.

### PP (S3) 13: Antifungal metabolite profiling of potential *Aspergillus niger* strain during interaction with guava wilt pathogen *Fusarium oxysporum* f. sp. *psidii*

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The best alternative, economical and eco-friendly approach to chemical pesticides for effectively managing plant diseases is bio-control agents. *Aspergillus niger* is a promising bio-control agent that exhibited efficacy against several soil-borne pathogens including guava wilt disease. In this present study, Gas Chromatography-Mass Spectrometry (GC-MS) analysis was undertaken to characterize volatile compounds of potential *A. niger* strain during interaction with guava wilt pathogen *Fusarium oxysporum* f. sp. *psidii* (FOP). The metabolites were extracted following liquid-liquid partition protocol using hexane and ethyl acetate solvent, further concentrated extract fractions were employed for GC-MS analysis. The hexane soluble fraction revealed the existence of hexadecenoic-acid-methyl-ester (4.41%), 10-octadecanoic-acid-methyl-ester (3.79%), dodecane (3.21%), undecane (3.19%), gibepyrone A (0.15%), 3-methylundecane (0.36%) and citroflex A (0.38%). Later, ethyl acetate fraction of *A. niger* revealed the existence of antifungal compounds via., acetic acid-ethyl ester (17.32%), benzopyron-4-ol (12.17%), 1,2,6-hexanetriol (7.16%) and 2-propenoic-acid-ethanediyl-ester (2.95%), 1-(3-ethyloxiranyl)-ethenone (0.98%), 6-acetyl-8-methoxy-dimethyl-chromene (0.96%) and 4-hexyl-2,5-dihydro-dioxo-furan-acetic acid (0.19%). Most of the identified chemical compounds were belongs to fatty acids, esters, alcohols, and phenols have antimicrobial action, and act on pathogens in several ways. Our findings collectively help us to understand the nature of metabolites and their role associated with the bio-control ability of *A. niger*. The field trials need to be conducted at different locations to confirm the robustness and potentiality of these metabolites to be used commercially.

### PP (S3) 14: Management of wilt of clusterbean (*Cyamopsis tetragonoloba*) by fungicides, botanicals and bio agent

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The clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] is belong to the *Leguminosae* (*Fabaceae*) family. Clusterbean is a popular annual legume crop that is also the primary source of guar gum. Clusterbean is mostly grown on upland sandy loam and loam soils which are well drained. It needs a temperature of 30 to 35°C to grow and flourish Wilt

disease of clusterbean caused by *Fusarium solani* a soil borne and seed borne fungus which promotes root rot, wilt and damping off in vegetables, legumes, oilseeds and ornamental crops. The pathogen creates wilt in seedlings until they reach maturity. Infected plants show girdling at the collar region later in their growth stage resulting in wilting of the host plant. The experiments were conducted during kharif 2019 and 2020 at SKN College of Agriculture, Jobner, Jaipur, Rajasthan. To see the effect of carbendazim fungicide had the lowest disease incidence in both *in vitro* and *in vivo* conditions. *In vivo* as a seed treatment (10%) and *in vitro* (5 and 10%) neem extract was found to be the most effective in controlling disease and increasing seed production. To see the effect *In vitro* and *in vivo* studies on the comparative efficacy of four biocontrol agents (two fungal and two bacterial) against *F. solani* were performed. The antagonism activity of *Trichoderma harzianum* was found highly effective followed by *Trichoderma viride* in both conditions against *Fusarium solani*. However, *Bacillus subtilis* was found least effective with weak antagonism in nature comparing to other bioagents.

### PP (S3) 15: Studies on bio efficacy of rhizobacteria and endophytes against *Sclerotium rolfsii* Sacc.-incitant of collar rot of soybean

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The present laboratory experiment was carried out at the Microbial Genetics Laboratory, UAS Dharwad during 2021-22. A total of 75 rhizobacterial cultures procured from Microbial Genetics Laboratory, three endophytes, three reference cultures viz., *Trichoderma harzianum*, *Pseudomonas fluorescens*, *Bacillus subtilis* collected from Institute of Organic farming, Dharwad and one fungicide (Carboxin 37.5 % + Thiram 37.5 %) WS were evaluated against *Sclerotium rolfsii* causing collar rot of soybean by following dual culture technique. Among the top 10 rhizobacterial isolates selected from primary and secondary screening and endophytes evaluated, the maximum mycelial inhibition of 76.79 per cent was recorded in rhizobacteria AUUB 209 (*Streptomyces enissocaesilis*) which was significantly superior over rest of the treatments followed by AUUD 626 (*Streptomyces racemochromogenes*) (64.75 %) whereas the least per cent mycelial inhibition was recorded in *Daldenia eschscholzii* (8.45 %). The fungicide (Carboxin 37.5 % + Thiram 37.5 %) at 2000 ppm recorded 98.82 per cent mycelial inhibition. Reference cultures *Trichoderma harzianum* and *Pseudomonas fluorescens* recorded 74.87 and 38.50 per cent inhibition respectively.

### PP (S3) 16: Induction of plant defense by the plant growth-promoting rhizobacteria-*Streptomyces* spp.

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Plant-rhizobacteria interaction and co-evolution developed adaptive strategies which may help the plant survive in nature. Plant rhizosphere soil isolates were investigated for the plant growth promoting and suppress plant disease. Actinobacterial strains which were isolated from plant rhizosphere (AUUB 209 and AUUD 626) were analyzed for elicitation of induced systemic resistance (ISR) and Systemic acquired resistance (SAR) in the Sorghum plant upon interaction with the pathogen *Macrophomina phaseolina*. Actinobacterial strains results in significant reduction of charcoal rot disease, increased the plant growth promoting traits like root length shoot length and finally strains were identified as *Streptomyces racemochromogenes* (AUUD 626) and *Streptomyces enissocaesilis* (AUUB 209) based on 16sr-RNA sequence analysis. Transcriptional expression of defense genes in sorghum was analyzed by

real-time PCR, gene expressions of Pathogenesis related protein (PR) -3, PR-10 Poly Phenol Oxidase (PPO) and Phenyl Ammonia Lyase (PAL) were observed in plants treated with rhizobacterial consortia (AUDT 626 + AUUB 209) were challenged with pathogen followed by the plants treated with rhizobacteria AUDT 626 upon challenge inoculated with pathogen. Whereas the maximum expression levels of stilbene synthase (STS) was observed in the plants treated with the AUUB 209 and challenged with the pathogen. It was indicated that the rhizobacterial strain AUUB 209 has specific role in induction of stilbene synthase gene in the sorghum plants against charcoal rot of sorghum. Rhizobacterial strains AUDT 626 and AUUB 209 can be a potential biological control agent by activating both induced and systemic resistance in the plant against charcoal rot pathogen.

## Session 4. Multidisciplinary interventions for plant disease management

### PP (S4) 01: Biochemical characterization of chickpea genotypes for Fusarium wilt resistance

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Fusarium wilt caused by *Fusarium oxysporum* f. sp. *ciceri* is one of the major constraints in chickpea production. The present study was aimed at identifying resistant donors for this disease and to elucidate the role of biochemicals in imparting resistance to the plants. Twenty-five chickpea lines were screened against fusarium wilt, out of which ten were found resistant (R), nine as moderately resistant (MR) and six as highly susceptible (HS). Biochemical analysis of reducing sugars, total phenols, peroxidase and polyphenol enzyme activity was assessed under both wilt free and wilt sick conditions to study the dynamics of these biochemicals. There was a significant reduction in the overall mean of reducing sugar contents in wilt sick soil conditions (60.228) over wilt free conditions (76.267). Percent reduction of reducing sugars in wilt sick plot over wilt free plot was found to be highest in HS genotypes (39.91) followed by MR (15.19) and R genotypes (11.17). It indicated utilization of sugars by the pathogen is more in HS genotypes. Higher amounts of reducing sugars were found in HS genotypes followed by MR and R genotypes under wilt free conditions indicating genotypes having highest reducing sugars are more vulnerable to this wilt and vice-versa. Higher quantity of total phenols (40.19) PO (134.48) and PPO (8.92) enzyme activity was found in genotypes grown in wilt sick plot as compared to total phenols (36.76) PO (123.01) and PPO (7.72) under wilt free conditions indicating their inducible nature due to host pathogen interaction. Under wilt sick conditions higher quantity of phenols and enzyme activity were found in resistant genotypes as compared to susceptible genotypes indicating that they are highly induced in resistant genotypes against Fusarium wilt. Resistance towards fusarium wilt is positively correlated with the amount of phenolic content and PO and PPO enzyme activity. Resistant sources identified in this study can aid in resistant breeding programs. Dynamics of different biochemicals in relation to disease reaction can also help in strategic disease management programs.

### PP (S4) 02: Cultivation of *C. militaris* on different agricultural waste substrates

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*Cordyceps* sp. is one of the medicinally important mushrooms, which has remarkable pharmacological activity and still requires a lot of research to make it available for mankind. It is an entomopathogenic fungus having an annual appearance which often grows parasitically on lepidopteron larvae and pupae of insects and spiders. Regarding the artificial cultivation of *C. militaris*, the main challenge is the growth rate of mushroom cells on the industrial scale preparation by making the cultivation time shorter together with increasing the cell inoculation density. This fungus is characterized by a very low growth rate when grown in a solid agar medium for inoculum preparation during the cultivation process. Thus, there is an enormous need to increase the growth rate of this type of fungus on a solid medium to reduce the time of inoculum preparation stage. Therefore different agricultural wastes were tried for

the successful cultivation of *Cordyceps militaris* in laboratory conditions. Seven different substrates such as paddy straw, wheat straw, poultry litter, sawdust, waste paper, coco peat and tea waste along with Brown Rice (Control) were tried in the investigation to evaluate their potential on yield and yield attributing parameters. Observations were recorded at spawn run stage, primordia formation, total number of stroma per bottle, length of the stipe, yield of stroma per bottle and fruiting body appearance. Among all the three treatments, the maximum number of stromata per bottle was produced in Tea waste (64.66) followed by Brown rice (43.66). But in the case of length of stroma, Poultry litter showed the longest stroma (7.76 cm) as compared to Brown rice (5.53 cm) and Tea waste (4.60 cm). The overall yield of the fruiting bodies (fresh weight per bottle) on Brown rice (15.03 g) was maximum, followed by Tea waste (10.00 g) and least in Poultry litters (2.83 g). Hence, control i.e. Brown rice showed a better result in fruiting body production as compared to other treatments.

### PP (S4) 03: Alternaria leaf blotch of apple in Mahabaleshwar, India

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Apple (*Malus x domestica* Borkh.) belongs to family Rosaceae it is one of the most economical important fruit crops of India. The crops affected by *Alternaria* leaf blotch caused by *Alternaria alternata* f. sp. *mali*. The fungus mainly infects the leaves and causes leaf blotch later which enlarge in circular rings reducing photosynthetic area and hence less accumulation of photosynthetic products for development of fruits. Plants also show premature leaf fall, decreased fruit quality and marketability due to severe infection. The aim of present study is the isolation and identification of *Alternaria* leaf blotch pathogen for effective chemical and biological management of this disease.

### PP (S4) 04: Microbial formulations and soil amendments for bacterial wilt management in brinjal

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Bacterial wilt of brinjal caused by *Ralstonia solanacearum* is an important disease of concern worldwide causing heavy yield losses. It is difficult to manage due to its soil borne nature, environmental and edaphic factors. In the present investigation we determined effect of application of soil amendments and microbial formulations on incidence of bacterial wilt of brinjal by influencing soil pH and electrical conductivity. The treatments were implemented individually and in combinations and observations were taken on changes in specific soil parameters and corresponding incidence of bacterial wilt disease. Whereas highest bacterial wilt incidence (62.15 %) was observed in non-amended control treatment, lowest incidence (8.04 %) was recorded with application of combination of Biochar, AMC, Vermicompost and Fermented cocopeat, followed by 24.11 % disease incidence in plots applied with Biochar, AMC and Vermicompost. The highest EC (0.047mS/cm) was recorded for neem-cake amended soil and lowest (0.013mS/cm) for control soil. Similarly, pH of 7.29 was recorded with application of biochar in compared to the pH of non-amended control soil was 5.6. The study of effect of amendments on plant growth under field condition revealed that the maximum plant height of 43.43 cm was with Biochar amendment

and lowest plant height (30.13cm) with Vermicompost and Fermented cocopeat amended soil. It was concluded that application of selected microbial and soil amendments in combination led to increase in rhizospheric soil pH and EC, reduction in wilt incidence and improved the plant growth, and this strategy should be considered for managing the bacterial wilt of brinjal.

### PP (S4) 05: Efficacy of Fungicides against *Alternaria* blight of Guar incited by *Alternaria cyamopsidis* (Linn.) Taub.]

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Guar or Clusterbean [*Cyamopsis tetragonoloba* (Linn.) Taub.] is an important leguminous crop and is being grown for vegetable, fodder, gum and green manure. The crop is affected by a number of bacterial, viral and fungal diseases. Among these diseases, blight caused by *Alternaria cyamopsidis* Rangaswami and Rao, is wide spread in guar growing regions of Rajasthan and causes considerable losses. Besides sporadic report and researches on this disease not enough information are available on management. Therefore, investigations were carried out at Rajasthan College of Agriculture (MPUAT, Udaipur), Udaipur, Rajasthan to control this disease *in vivo* and *in vitro* as well. Six fungicides viz. Carbendazim, Dithane M-45, Triadimefon, Blitox-50, Kitazin P and Captan were used for efficacy against the disease. Among these Dithane M-45 found best to control growth and sporulation of *Alternaria cyamopsidis* *in vitro* and reduction in per cent disease index in pot condition, followed by Captan was found *in vitro* as well as *in vivo* both.

### PP (S4) 06: Fumigants of botanical origin for pest management in yard long bean (*Vigna unguiculata* subsp. *Sesquipedalis* L.)

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Soilborne diseases and storage pests cause drastic yield reduction in yard long bean (*Vigna unguiculata* subsp. *Sesquipedalis* L.). Synthetic soil fumigants have been banned due to drastic effects on ozone, environment and human health. An alternative strategy is highly essential for the management of soilborne pests. Plants belonging to Alliaceae and Brassicaceae families possess in their tissues, sulphur containing fumigants which have the same pesticidal effect as synthetic fumigants (methyl bromide, formaldehyde etc.). Among the different botanicals tested for their biofumigation potential, fumigants from garlic bulbs exhibited the highest antifungal, antibacterial and insecticidal potential. Biofumigation using 1.5g of garlic bulbs completely (100%) inhibited the mycelial growth of soilborne fungi affecting yard long bean (*Sclerotium rolfsii*, *Fusarium oxysporum*, *Rhizoctonia solani*) and 2.0g of garlic bulbs inhibited the growth of soilborne bacteria affecting yard long bean viz., *Kosakonia oryzae* and *Klebsiella pneumoniae* *in vitro*. Bioagents viz., *Trichoderma* spp. were completely compatible with the biofumigant (garlic bulbs) whereas *Pochonia chlamydosporium*, *Paecilomyces lilacinus*, *Metarhizium anisoplaea* were partially compatible and *Pseudomonas fluorescens* as well as *Beauveria bassiana* were incompatible with the biofumigant. The major compounds in garlic essential oil were identified as tri sulfide di-2-propenyl (50.30%), trisulphide, methyl 2-propenyl (17.67%), diallyl disulphide (15.71 %) and tetra sulfide di-2-propenyl (4.38%). The fumigant toxicity of

garlic essential oil against the major storage pest of yardlong bean viz., *Callosobruchus chinensis* (pulse beetle) (LC50) was identified as 0.239 mg/L air and the contact toxicity of garlic essential oil against *C. chinensis* (LC50) was identified as 0.066 mg/cm<sup>2</sup>.

### PP (S4) 07: Integrated approach for the management of Enation leaf curl virus (ELCV) disease of okra

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Okra enation leaf curl virus (ELCV) is a member of the genus *Begomovirus* and family *Geminiviridae*. ELCV is an emerging serious virus disease of okra in India, transmitted by the vector whitefly (*Bemisia tabaci*) and can cause significant yield loss in okra depending upon the age of the plant at the time of infection. An integrated approach was developed for the management of ELCV disease of okra using strategies such as use of reflective mulches, seed treatment with insecticide and spray insecticides for management of vector. The results showed that treatment comprising of seed treatment with Thiamethoxam 30% FS (@ 4 g/kg of seed), sowing crop in the main field using silver agrimulch sheet and sequential spray of pyriproxyfen (5% EC) + fenpropathrin (15% EC), spiromesifen 22.9% SC, buprofezin 25% SC and neem oil at 10 days interval was found significantly superior over control in terms of per cent OELCV incidence (5.76%) and fruit yield (130.99 q/ha).

### PP (S4) 08: Characterization of multiple stress tolerant *Trichoderma asperillum* from the tomato rhizosphere

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Twenty-six isolates of *Trichoderma* spp. were isolated from the tomato rhizosphere from Padhana village, Karnal District Haryana. These isolates were evaluated *in vitro* for their abiotic stress tolerance to salinity (0.7 M NaCl), drought (10% PEG), high temperature (37°C), and biocontrol potential against common soil-borne pathogens *Rhizoctonia solani* and *Fusarium* spp. It was observed that all the isolates vary with respect to abiotic stress tolerance, though they were isolated from similar agroecology. Of all the isolates tested six isolates showed tolerance to salt, while twenty-one isolates showed drought tolerance *in vitro*, also, sixteen isolates exhibited growth at 37°C. Among all the isolates 'NCIPM/T-44', showed growth on 10% PEG (90.00±0.00 mm), 0.7 M NaCl amended PDA media (38.25±4.60 mm) as well as was able to grow at 37°C (34.00±2.12 mm), suggesting its potential application in drought and salt affected areas. Also, the isolate exhibited 75.56 % and 81.70 % growth inhibition against *R. solani* and *Fusarium* spp. respectively. Isolate NCIPM/T-44 was mass multiplied and formulated into a talc-based formulation (colony forming units (CFU): 1×10<sup>8</sup> gm/ml). Farmyard Manure (FYM) enriched with the talc-based formulation was applied in the field before transplanting the tomato crop. Survival of 'NCIPM/T-44' along with other native strains of *Trichoderma* spp. was monitored by determining CFU count periodically after every month. It was observed that two months after the application of the enriched FYM, the CFU count of *Trichoderma* spp. was the highest (16 ×10<sup>5</sup> /gm of soil) and it remained the same for the next month. Afterward, CFU was reduced sequentially and after the harvest of the crop lowest CFU was observed (2 ×10<sup>5</sup> /gm of soil). ITS 1-4 sequencing of the isolate followed by phylogenetic analysis of the sequences confirmed the species identity as

*Trichoderma asperillum*. The data suggest that following application of the enriched FYM *Trichoderma* spp. colonizes the rhizosphere and survives through the season, indicating its potential application in tomato crop.

### PP (S4) 09: Silver Nano Hydrogen Peroxide: A biocide for management of soil borne plant pathogens

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Soil borne plant pathogens can significantly reduce yield and quality of crops as they cause rots and vascular wilt infections. Pre-plant fumigants like methyl bromide, chloropicrin, or metham sodium are often highly successful in reducing soil borne inoculum however, they are expensive, strictly regulated, usually leave residues in soil and cause elimination of beneficial micro-organisms. To date, there are several reports that hydrogen peroxide exerts antimicrobial activity on wide range of microorganisms, indicating their consistency in interfering with the infection process of the pathogens. Hence, an effort was made to study the antimicrobial activity of silver nano hydrogen peroxide (SNHP) against selected plant pathogenic fungi and bacteria under *in vitro* conditions. It was noticed that silver nano hydrogen peroxide at all concentrations showed cent per cent inhibition against the soil borne pathogens viz., *Rhizoctonia solani*, *Sclerotium rolfsii* and *Phytophthora capsici*. An inhibition per cent ranging from 16.67 to 88.86 was noticed with *Fusarium solani*. However, the fungus, *Pythium aphanidermatum* did not show any inhibition with 0.1 and 0.2 per cent concentration but cent per cent inhibition was noticed with rest of the concentrations i.e., from 0.3 to 1.0 per cent. The zone of inhibition with the bacterial wilt pathogen *Ralstonia solanacearum* ranged from 1.5 to 4.5 cm where, the maximum inhibition of 4.5 cm against the organism was observed with 1 per cent concentration and minimum inhibition of 1.5 cm with 0.2 per cent concentration. Further, multi locational field studies should be conducted for validation and commercial use of silver hydrogen peroxide.

### PP (S4) 10: Efficacy of mixture of fungicides, insecticide and nutrients as concoction spray for management of coffee leaf rust disease

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Coffee leaf rust (CLR) caused by *Hemileia vastatrix* Berk. & Br. is considered as one of the most catastrophic plant diseases of all time in all coffee growing countries. In India for management of CLR disease planters are adopting the integrated management measures including spraying of fungicides. In recent years due to shortage of labor implementation of timely cultural operations in coffee plantations is become a challenging task and most of the operations are overlapping. This condition has forced the planters to combine certain activities like disease & insect pest management and supplementing nutrition by mixing fungicide, insecticide and foliar nutrients as concoction spray. Blind mixing of these agrochemicals may lead to phytotoxicity and also it may alter the absorption and translocation. Hence, to understand the compatibility of mixing of different agrochemicals were studied initially as a pilot study under laboratory conditions. Fungicides like hexaconazole and pyraclostrobin + epoxiconazole and insecticide chlorpyrifos + cypermethrin, foliar macro nutrient (NPK 19:19:19), micronutrients like chelated zinc (12%), di- sodium octa borate tetrahydrate and micronutrient mixture (Zn-3.0%, Fe-2.0%, Mn-1.0% & B-0.5%) were used in possible combinations. Physical and chemical properties like solubility, sedimentation, pH & EC of the pesticide and nutrient combinations were observed. The observations indicated that all tested combined solutions were soluble in normal cold water and very little sedimentation of filler material



observed in fungicide hexaconazole 75 WG combination treatments, pH ranges from 6.5 to 8.3 and EC ranges from 0.003 to 0.004 ds/m. In continuation of this, a field experiment was carried out for two consecutive years 2020-21 and 2021-22 with fungicide hexaconazole, insecticide chlorpyrifos + cypermethrin and foliar macro and micronutrients in different combinations to check their effectiveness and bio-efficacy for management of CLR disease at Central Coffee Research Institute, Chikkamagaluru district, Karnataka, India. Data on rust incidence indicated that mean minimum (0.64%) incidence was recorded in treatment hexaconazole 5 EC @ 2 ml/L and it persists up to 70 days after spray, followed by hexaconazole 5 EC @ 2 ml/L + 19:19:19 @ 5 g/L (2.22%), its longevity on plants was observed for 65 days, whereas maximum (11.90%) incidence was recorded in untreated control.

### PP (S4) 11: Disease detection and identification using the YOLO algorithm on Okra plants using Drone

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In agricultural fields, one of the most crucial problems is identifying leaf diseases. It is caused by food insecurity and economic loss. Thus, modern technologies are needed to tackle this problem, which will be highly beneficial for farmers as well. Manually, detecting crop diseases is very difficult for farmers and time-consuming. Only a few techniques are identified and detected biotic and abiotic stress. So, We are focusing on both the stress for leaf diseases. The major goal is to assist farmers by early detection of leaf diseases and spraying herbicides on diseased lesion parts using an Object Tracking drone device (OTDD). Therefore, it has been proposed to use a camera (field images) connected to a Raspberry Pi 4 model to collect disease spots on leaves. The input images are taken from a Raspberry Pi4 device for distinguishing between healthy and diseased leaves using YOLO models. By using this technology support, crop diseases due to both biotic and abiotic stress can be detected at their initial stage thus preventing huge yield loss. In the future, we can go for robotic devices for different crops and different diseases for large-scale farmers beneficial.

### PP (S4) 12: Management of sesamum phyllody disease in northern Karnataka

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Foliar spray of thiamethoxam 25 % WG @ 0.2 g/l recorded lowest disease incidence of 32.86 per cent followed by foliar spray of Imidacloprid 350 SC (0.3 ml/l) with disease incidence of 33.92 per cent. The next best treatments were fipronil 5 % SC (1 ml/l), NSKE 5 % (50 ml/l), red seaweed (*Kappaphycus alvarezii*) LBD1401 extract (1 ml/l), red seaweed (*Kappaphycus alvarezii*) LBD12S12 extract (1 ml/l) and seed treatment with imidacloprid 70 % WS (5 g/kg seed) with disease incidence of 38.62 per cent, 50.68 per cent, 56.26 per cent, 58.24 per cent, 82.50 per cent, respectively. The per cent disease incidence recorded in unsprayed control was 96.45 per cent. Foliar spray of thiamethoxam 25 % WG @ 0.2 g/l recorded highest per cent reduction of leaf hopper population over control (94.02 %) followed by foliar spray of imidacloprid 350 SC (0.3 ml/l) (90.03 %), fipronil 5 % SC (1 ml/l) (88.11 %). Among all the treatments, thiamethoxam 25 % WG @ 0.2 g/l recorded lowest average disease incidence of 21.48 per cent and per cent reduction over control at harvest was 71.07 per cent. Maximum yield per hectare was obtained by thiamethoxam 25 % WG @ 0.2g/l which recorded highest seed yield of 10.75 q/ha with the highest B:C ratio of

3.07. The studies revealed that foliar spray of thiamethoxam 25% WG @ 0.2g/l was found to be more efficient in managing both leaf hopper as well as sesamum phyllody, followed by foliar spray of imidacloprid 350 SC@0.3 ml/l.

### PP (S4) 13: Screening of minicore collection of sesamum against phyllody disease in northern Karnataka

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Screening was undertaken to evaluate the resistance of minicore collection of sesamum against phyllody disease under field conditions at College of Agriculture, Vijayapur during *Kharif* 2021. A susceptible check (DS-5) was planted after every 10 lines and along the four sides of the field to serve as a source of inoculum (infecter row technique). The per cent disease incidence was recorded at 15 days interval starting from 30 days after sowing up to maturity. The disease incidence for individual germplasm line was recorded on the basis of number of plants infected to the total number of plants examined. The reaction of different minicore accessions to the disease varied considerably under natural conditions. Out of 150 minicore accessions screened, 116 lines were immune with no infection, 7 lines were moderately resistant and 5 lines were moderately susceptible. No lines were found to be susceptible and highly susceptible to the disease. Seven lines remain ungerminated during the experiment.

### PP (S4) 14: Ergot disease of pearnillet (Bajra) and its management

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The ergot of Pearl millet was first reported from south 'Satara' area of Maharashtra in 1956. The damage caused by the disease depends upon the weather at the time of ear formation. Presence of toxic alkaloids in the ergot adds to the importance of the disease. The sclerotia contain 'ergo-toxin' which, when consumed in excessive quantities, proves to be toxic to life. But when taken in prescribed quantities it proves to be beneficial as it has some medicinal value too. The disease symptoms show only at the time of flowering. Small droplets of a light, honey coloured dew-like substance exudes from infected spikelet's. A few too many spikelet's may be found in a group which darkens with age and small, greyish or dark brown sclerotia are formed. These sclerotia replace the ovary or grain and are about 0.5-1.0 cm in length. In the management practices taken long crop rotation programme essentially helps avoid the disease incidence as this makes the pathogen inoculum present in soil wait the proper host for a long length of time. In the mean-time many of the soil-borne inoculum (mainly the sclerotia) become unviable. The most commonly used method to control this disease is using clean seeds. For this, the seeds are soaked in 20-30% salt solution. The sclerotia come on to the surface of the salt solution and float. Floating sclerotia can be collected by hand and destroyed. Growth of a fungus, namely, *Fusarium roseum* on *Claviceps fusiformis* as a mycoparasite can be used as highly potential biological control agent against the latter and the incidence of the disease can be effectively reduced employing this method.

### PP (S4) 15: Survey of wilt disease of chilli (*Capsicum annum*) from Maharashtra

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Chilli (*Capsicum annum* L.) is the most important spice and vegetable crop cultivated all over the world. It has great economical and medicinal potential value. According to FAOSTAT, 2021 India is top producer in the world. It is the most important cultivated cash crop in India. It increased the economy of the cultivar, such economically important cash crop suffering from various fungal diseases like Anthracnose, Damping-off, *Fusarium* wilt, *Cercospora* leaf spot, *Phytophthora* leaf blight and *Alternaria* leaf spot, among these wilt disease caused by *Fusarium* sp. is very harmful to the plant. Therefore, for getting a high yield there is an urgent need to manage this disease. In the primary study, survey was made on the disease incidence of wilt disease from some districts of Maharashtra, during the study, visited 55 different localities and isolated 23 isolates of the *Fusarium*. In the survey, it was found that the disease incidence was more in the Solapur district i.e. (70%) while it was lower in the Kolhapur district (30%). This work will definitely help in the field of disease management.

### PP (S4) 16: Growth response and disease incidence of chickpea to different soil samples in Maharashtra

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Pulses are the cheapest source protein. Chickpea is one of the most important pulse crop. Chickpea (*Cicer arietinum* L.) belongs to a family Leguminosae Pulses contribute 16-18 percent of total protein of Indian average diet. India is the largest producer of the chickpea in the world. Such commercially important plant suffering from various diseases due to this there is loss in the yield of the crop. Along with this physical and biological factors also affects on the growth of the Chick pea. Among the physical factors soil is one of the most important factor which directly affects on the growth and yield of the crop. In the present study investigated has been made on the effect different soil factors on the growth of Chick pea. During the study, total 20 soil samples collected from the different localities of the Maharashtra, analysed the soil parameters like pH, Soil texture, water holding capacity, soil temperature, Soil fungi and studied the effect of these selected soil samples on the growth of Chick pea (variety Vikrant). In the result it is found that Soil samples collected from Sangali district shown (M1) 90 % seed germination 20 to 30% disease incidence while 55 % seed germination and 60 % disease incidence observed in Soil sample ( R 3) of Ratnagiri district.

### PP (S4) 17: Cloning of sense and antisense sequence of Replicase gene of Sri Lankan Cassava mosaic virus to Binary vector

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*Manihot esculenta* commonly known as cassava belongs to family Euphorbiaceae, which is an important tuber crop and it provides staple food for millions of poor people around the world. In India, main constraints in cassava production are cassava mosaic disease which caused by two viruses viz., *Sri Lankan cassava mosaic virus* (SLCMV) and *Indian cassava mosaic virus* (ICMV). Yield losses due to this disease ranges from 25 – 88% depending on the

cultivars used. All the popular cassava cultivars in farmers field are highly susceptible and management options were very limited and difficult to contain due to field level transmission through whitefly (*Bemisia tabaci*). By utilising the recent advancement in the biotechnological approach, we intend to incorporate the hairpin RNAi gene construct having partial replicase gene of SLCMV. In order to achieve this objective, in the present study we have cloned sense and antisense RNAi construct of SLCMV in pBluescript vector. For this, virus silencing target sequence was selected using Reynolds criteria. This sequence was modified for cloning using restriction sites and then amplified using PCR. Sense and antisense of partial replicase gene along with intron was cloned into pKannibal vector. Details of this cloning is discussed in this paper.

### PP (S4) 18: Effectiveness of fungal and bacterial biocontrol agents as root-dip treatment against *Meloidogyne graminicola* on paddy

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An experiment was conducted under the CST-UP research project to determine the effectiveness of root dip treatment (RD) of indigenous rhizospheric isolates of fungal and bacterial biocontrol agents (10 g/L water) (BCAs) viz., *Trichoderma harzianum*, *Pochonia chlamydosporia*, *Purpureocillium lilacinum*, *Bacillus subtilis*, and *Pseudomonas fluorescens* against rice root-knot nematode, *Meloidogyne graminicola* in rice cv. PB-1509 was examined under pot conditions. The inoculation of rice with 1500 J2/kg soil of freshly hatched juveniles of *M. graminicola* resulted in recognizable symptoms such as hook like galls on the terminal portion of the roots, with an average of 104 galls per root system. The nematode infection caused a significant decrease in the plant growth (28-32%), number of tillers and ears (36%), panicle (34%), and yield (38%) over the un-inoculated control. However, RD of BCAs significantly increased (2-11%) the plant growth and yield (3-8%) cv. PB-1509, over un-inoculated control. Treatment with *P. chlamydosporium* was found to be most effective and significantly reduced the disease severity (44%) and soil population of nematode (26-60%) and increased the plant growth and yield (28-32% and 26%), followed by *P. lilacinum*, *T. harzianum*, *P. fluorescens* and *B. subtilis* over inoculated control. The results of the present study suggest that the paddy rice root-knot nematode problem may be successfully managed by RD treatment of BCAs. Plant growth was enhanced by the RD treatment of the BCAs in both nematode-inoculated and uninoculated plants.

### PP (S4) 19: Induced systemic acquired resistance against capsicum-infecting Cucumber Mosaic Virus (CMV)

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*Cucumber mosaic virus* (CMV) is one of the destructive viruses causing major yield losses in capsicum-growing fields worldwide. Inducing the inbuilt systemic acquired resistance (SAR) in the plant using elicitors is one of the alternative approaches for plant virus management. In the current study, we used salicylic acid in different concentrations as a foliar spray against CMV in capsicum. Minimum disease incidence and disease severity were recorded when plants were sprayed with 100 ppm salicylic acid (SA) 24 h before challenge inoculation. SA 100 ppm foliar spray not only delayed the virus symptoms but also reduced the virus concentration with enhanced growth and yield. There was a significant increase in the internal SA accumulation, a key activator of the SAR pathway. Salicylic acid foliar spray aided in inducing SAR, which is correlated with the expression of SAR genes, including

pathogenesis-related proteins and defense-related enzymes. SA treatment reduced the oxidative damage induced by the viruses by activating the antioxidant machinery. It also triggered the JA-mediated pathway. The enhanced biochemical component levels indicated enhanced plant health leading to increased growth and yield. The application of salicylic acid at 10 days intervals during fruit formation and development enhanced the growth and yield of the capsicum plant with protection from CMV infection under controlled conditions.

### PP (S4) 20: Management of tuber rot of sweet potato caused by carbendazim resistant isolate of *Sclerotium rolfsii* by using different agrochemicals

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There was quite a large variation in the MIC of carbendazim. Among the 20 isolates of *Sclerotium rolfsii* Sacc. causing tuber rot of Sweet potato both *in vitro* and *in vivo* i.e. 10 ug/ml to 500 ug/ml. Among the twenty isolates *Sclerotium rolfsii* Sacc. SR-10 was the most resistant having resistance factor 500 both *in vitro* and *in vivo*. To manage this resistant isolate different agrochemicals. [fungicides (Aliette, Benofit, Nagcopper, and Kocide), herbicides (Anadhi, Matin, 2-4 D, and Senchor), and insecticides (Actara, Admire, Armour, and Dantotsu)]. It was observed that all the used agrochemicals along carbendazim (500 ug/ml) completely checked the growth/infection of the resistant isolate SR-10.

### PP (S4) 21: Management of brown spot disease of paddy using a different combination of fungicides-nitrogen doses under transplanted and direct seeded crop establishments

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Brown spot (BS) disease is an important disease of rice, affecting millions of hectares worldwide every year. The BS has been proven to be associated with soil fertility; nutrition and fungicides are equally effective in managing the disease under field conditions. In several parts of the country, the crop establishment method is changing from transplanted (TP) to directed seeded rice (DSR) to save the production cost; however, facing higher incidence and severity of BS disease. Therefore, there is a need to standardize the management of BS in DSR paddy. The present study was conducted to identify the effective fungicides and to determine the nitrogen dose for controlling the BS disease of rice in TP and DSR. A field experiment comprising eight solo/combination fungicides under different nitrogen doses (75%, 100%, and 125% RDN) was laid out in a factorial-RCBD design. The experiment was conducted in both TP and DSR methods. In TP and DSR, the disease pressure was enhanced by spraying the pure culture of *Bipolaris oryzae*. The disease severity was recorded as per the standard protocol. In TP and DSR, the disease PDI ranged from 81.29-61.25 and 91.67-79.62, respectively, with an increase in the nitrogen level from 75-125% RDN in untreated check. The plots with different nitrogen levels (75-125% RDN) sprayed with different fungicides recorded the lower PDI compared to untreated checks in both TP and DSR. The plot applied with 75-125 % RDN and sprayed with trifloxystrobin 25% + tebuconazole 50% 75 WG at 0.4g/l recorded the least PDI of 19.73-29.34 and 25.64-32.40, respectively, in TP and DSR. We identified the best nitrogen-fungicide (N-F) combinations under TP and DSR conditions, i.e., 75% -125% RDN + trifloxystrobin 25% + tebuconazole 50% 75 WG at 0.4 g/l for effective

management of BS. In conclusion, fungicide trifloxystrobin 25% + tebuconazole 50% 75 WG at 0.4g/l reduced the disease severity and recorded the mean yield of 66.68 q/ha and 65.55 q/ha (mean of 75% RDN-125% RDN) in TP and DSR respectively, and can be routinely used for managing the BS under both TP and DSR.

### PP (S4) 22: Application of fungicides, insecticides, and herbicides in the management of fruit rot of ridge gourd caused by *Sclerotium rolfsii* Sacc., resistant to propiconazole (*In vivo*)

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A survey of fruit rot of Ridge gourd (*Luffa acutangula* L.) caused by *Sclerotium rolfsii* Sacc., was carried out from districts of Maharashtra (Sangli, Satara, Kolhapur, Solapur, Pune and Latur) and Karnataka (Bijapur and Belgaum) where the severity of disease infection is more. There was variation in the MIC (Minimum Inhibitory Concentration) of propiconazole to 14 isolates of *Sclerotium rolfsii* Sacc., causing fruit rot of ridge gourd, on Czapek's Dox agar plates. MIC on fruit (*In vivo*) was ranged from 25 µl/ml to 35 µl/ml, Isolate Sr-11 was highly resistant to propiconazole. In the use of propiconazole in mixture with some agrochemicals (*In vivo*). Agrochemicals like Fungicides (Matrix, Nagcopper, Aliette and Benofit), Insecticides (Dontotsu, Armour, Actara and Admire), and Herbicides (Sensor, Property, Aandhi and Super-hit) were used. various effects on the growth of *Sclerotium rolfsii* Sacc., were either inhibitory or reduced the growth of the pathogen.

### PP (S4) 23: Sensitivity of *Fusarium solani* towards carbendazim causing fusarium root rot of pea

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Pea (*Pisum sativum* L.) belongs to the family Leguminosae commonly called garden pea or matar. It is an excellent food source, having a great economic value as vegetable crops. Pea is susceptible to a number of soil-borne pathogens among these *Fusarium solani* is one of the most aggressive pathogen that limits the productivity. The aim of present study was to examine the efficacy of Carbendazim against *Fusarium solani*. There was variation in MIC of Carbendazim among 5 isolates of *Fusarium solani* on agar plates. MIC on agar plate ranges 50 µg/ml to 300 µg/ml. Isolate collected from Khatav showed 300 µg/ml. MIC while, isolate from Satara showed 50 µg/ml MIC *in vitro*.

### PP (S4) 24: Studies on *Rhizoctonia bataticola* (Taub.) Butler inciting dry root rot disease in pigeonpea

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Pigeonpea is the second most important pulse crop in India. The crop suffers from many diseases, of which dry root rot is gaining importance in recent years due to changes in climatic conditions. *Rhizoctonia bataticola* (Taub.) Butler was isolated using standard tissue isolation protocol from the infected tissues and pathogenicity was proved by blotter paper technique and sick pot method. The survey was undertaken in the Doddaballapura taluk of Bangalore district and disease incidence was recorded in the range of 0 to 25 per cent. Cultural studies revealed that highest radial growth was observed on Richard's agar and potato dextrose agar (PDA) and maximum dry mycelial weight was observed on Richard's broth. The optimum growth of the pathogen was observed at pH 6.0 and 7.0. The PCR amplification and sequencing of internal transcribed spacer (ITS) and specific regions confirmed *R. bataticola* as the cause of dry root rot disease. Among bioagents, *Trichoderma viride* (TV), *T. viride* (TV 2) and *Pseudomonas fluorescens* (Pf-O) were more effective in inhibiting the growth of *R. bataticola*. Contact fungicides captan, mancozeb and zineb; systemic fungicides, tebuconazole followed by propiconazole; and combiproductions, Mancozeb 63% + Carbendazim 12%, Iprovalicarb 5.5% + Propineb 61.5%, Tricyclazole 18% + Mancozeb 62% and Tebuconazole + Trifloxystrobin 75% were found to be effective against *R. bataticola*. Among sixty-seven pigeonpea genotypes, none of the entries showed a resistant reaction, whereas two genotypes viz., BRG 5×ICP 7035-1-3 and BGR5×TS3-R-10-1 showed a moderately resistant reaction and the remaining 65 genotypes showed a susceptible reaction.

### PP (S4) 25: Enhancing the Bio-control activity of natural mycoparasite *Ampelomyces quisqualis* against Powdery mildew disease in vegetable crops

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*Ampelomyces* sp. were amongst the first mycoparasite to be used as bio control agent against Powdery mildew disease of various crops. It has the potential to work as most advanced fungal bio-control agent on commercial scale, considering the economic importance and severity of powdery mildew disease. Current study focuses on isolation, purification and commercial development of wild strain of *Ampelomyces* sp isolated from *Abelmoschum esculentus* (Lady's finger), naturally infected with Powdery mildew caused by *Erysiphe cichoracearum*. Isolated wild strain of *Ampelomyces* sp proved its bio-efficacy against Powdery mildew caused by *Podosphaera xanthii* in *Cucumis sativus* (Cucumber plant), *Leveillula taurica* in *Cymopsis* sp.(Cluster beans), *Podosphaera xanthii* in *Luffa acutangula* (Ridge gourd) under green house conditions. *Ampelomyces* sp. ( $1 \times 10^6$  conidia/ml; 5 ml/lit) along with four commercial products were tested for bio-efficacy i.e. Jay Bio-Shakti-Bacillus subtilis ( $1 \times 10^8$  CFU/ml, 5 ml/lit), Jay Bio-Multi- *Trichoderma viride* ( $1 \times 10^8$  conidia/ml; 5 ml/lit), Commercial sophorolipid surfactant (20 %, 5 ml/lit) and Propiconazole (25 %; 1 ml/lit). Two foliar applications made at an interval of 8 days. *Ampelomyces* sp. ( $1 \times 10^6$  conidia/ml, 5 ml/lit) in combination with commercial sophorolipid surfactant (5 ml/L) showed maximum control of Powdery mildew in 3-4 days of time. Moreover, re-emergence of infection was not seen in all three selected vegetable crops. For commercial cultivation of *Ampelomyces* sp., modified Asthana and Hawker media, Potato semi-solid substrates, Rice and Bajra were tried. Potato semi-solid substrates found to support good aerial conidia production at  $26 \pm 02$  °C,  $60 \pm 05$  % RH of 10 days of incubation.

### PP (S4) 26: Management of downy mildew disease of pearl millet by biosynthesized zinc oxide nanoparticles

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The downy mildew of pearl millet (*Pennisetum glaucum* (L.) R. Br.) caused by the biotrophic fungi *Sclerospora graminicola*, recurrently causes a nearly complete loss of grain yield due to the complete or partial conversion of florets to leafy structures instead of grain, causing enormous monetary losses. The application of nanoparticles has become a major thrust for disease management in agriculture. In the present investigation, the efficacy of eco-friendly zinc oxide nanoparticles in controlling downy mildew disease of pearl millet was evaluated. The green synthesized nanoparticles were characterized by using FTIR, SEM, XRD, DLS, EDAX and UV spectroscopy. The highly susceptible pearl millet seeds 7042s were treated with different concentration of nanoparticles ranging from 10 - 25 ppm and significant enhancement in the seed germination, seedling vigour, plant height, fresh and dry weight of seedlings under laboratory conditions was observed. When compared to the untreated control, seed treatment with nanoparticles significantly induced systemic resistance against downy mildew disease. Seedlings raised from treated seeds recorded an early and increased hypersensitive response as a reaction to *S. graminicola* inoculation.

### PP (S4) 27: Standardization of methods for isolation, and maintenance of Pearl millet blast disease causing fungus *Magnaporthe grisea* under laboratory conditions

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Pearl millet (*Pennisetum glaucum* (L.) R. Br.) is a popular millet and an important crop in India and Africa, where it is commonly cultivated in arid and semi-arid regions. In recent years, Pearl millet blast caused by *Magnaporthe grisea* (T.T. Hebert) M.E. Barr. has become a major disease in the country. Efficient and suitable methods for isolation, storage, inoculum production can help in achieving the target of sustainable management of the disease. In this study, we aimed to develop suitable methods for isolation, storage of *Magnaporthe grisea* collected from the blast- infected leaf. In the present investigation the effect of media, photo-periods and isolation techniques influenced on mycelial growth and conidial production of *M. grisea* were studied. Oatmeal agar and host extract agar were found to be suitable for culturing different isolates of *M. grisea*. Highest radial growth of mycelia is seen on sixteenth day in media.

### PP (S4) 28: Silicon-dioxide mediate induced systemic resistance in pearl millet against downy mildew disease

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Downy mildew of pearl millet (*Pennisetum glaucum* (L.) R. Br.) caused by the biotrophic oomycete *Sclerospora graminicola* is the most devastating disease which impairs pearl millet production causing huge economic loss. Silicon di-oxide nanoparticle was synthesised and their characterization was done by using FTIR, SEM, XRD, DLS, EDAX and UV spectroscopy. Synthesized SiO<sub>2</sub> nanoparticle was used to evaluate for their efficacy against downy mildew disease of pearl millet with a range of concentration. SiO<sub>2</sub>Np was applied to pearl millet either as a foliar spray or as a combined application (involving seed coat and foliar spray). Both the application methods enhanced growth profile of pearl millet plants and increased yield. Sporangicidal assay of nanoparticles showed that 10-25ppm of nanoparticles treatment led to plasmolysis and inhibition of spore germination of *S. graminicola*. Analysis of defense enzymes showed that nanoparticles treatment significantly



enhanced the activities of glucanase, peroxidase, phenylalanine ammonia-lyase, and polyphenol oxidase in comparison to untreated control. These results indicate that synthesized Silicon di-oxide nanoparticles could promote growth and induce systemic resistance in pearl millet against *S. graminicola* and can be effectively used to manage downy mildew.

### PP (S4) 29: Assessment of root rots and wilts disease of *Santalum album* L. in different nurseries of Karnataka

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Sandal (*Santalum album* L) a tree species having cultural valued commercial wood covering wide area in recent past. Seedlings raised at the nurseries showed high mortality in the recon essence survey. To assess the cause for mortality nine sandal grown nurseries of five districts were surveyed during 2021-22. Root rot cum wilt in seedlings was ascertained based on the symptoms and *Fusarium solani* as the causal agent based on cultural characters. The disease was most prevalent in all nurseries except one. Maximum disease incidence (DI) was seen in the College of Forestry nursery, Ponnampet of Kodagu (64%). The least DI (6.80%) in Maderhally forest nursery and no incidence in Avalakuppa forest nursery (the highest producer of sandal seedlings) of Kolar district was recorded. Infected seedlings show below ground symptoms of decaying of roots, root rotting, slight pinkish discoloration at the tip of roots and thinning of main root. Above ground symptoms were curling of young leaves, paling of leaves, loss of turgidity, leaflessness, blackening of entire naked stem and wilting of leaves.

### PP (S4) 30: Holistic approaches to manage *Fusarium* head blight- a catastrophic disease of wheat

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Wheat (*Triticum aestivum* L.) is one of the strategic cereal crops for the majority of world's population. The recent climatic change scenario has resulted in the re-emergence of *Fusarium* Head Blight (FHB) of wheat, a devastating disease caused by *Fusarium poae* (Peck) Wollew. A major concern regarding the disease is yield loss and contamination of grains with the mycotoxin Deoxynivalenol (DON). A study was conducted during *rabi* 2021-22 to evaluate the molecules against FHB in northern parts of Karnataka. The effective fungicides, botanicals and bioagents screened priorly under *in-vitro* were evaluated under field conditions on the wheat variety UAS-304 at ARS, Arabhavi. Seed treatment with *Trichoderma harzianum* @ 10g/kg was kept common for all the treatments, while, carbendazim @ 1g/kg was used for seed treatment for the standard checks. The control plot was taken as untreated check. The first spray was given at anthesis and second spray after fifteen days interval. Results indicated that the seed treatment with *T. harzianum* @10g/kg and spray of hexaconazole @ 1ml/l at anthesis was the best effective treatment in reducing the percent spikelet infection with 67.01 per cent reduction over control, along with

the highest grain yield of 39.6 q/ha. Among the bioagents tested, *Pseudomonas fluorescens* @ 10g/l was recorded as the next best effective treatment with 43.30 percent reduction. Moreover, among the botanicals, Elixir (Turmeric+neem extract) @ 5ml/l was found effective with 32.77 percent reduction. The results infer that along with the triazole derivatives, the botanicals and bioagents may be considered as a promising strategy not only to control FHB, but also to obtain a better grain yield.

### PP (S4) 31: Bio-elicitor mediated systemic resistant in pearl millet against downy mildew disease

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Most rhizobacteria that promote plant growth offers plants immunity against a varied series of plant pathogens by triggering their defenses which lessen the plant's susceptibility to pathogenic attacks. *Bacillus subtilis* UOM\_16, a volatile organic compound (VOC) - Acetoin (3-hydroxy-2-butanone), was identified to initiate the ISR and protect Pearl millet against Downy Mildew disease. Pearl millet exposed to treatment had a positive effect on seed quality parameters by significantly improving seed germination and seedling strength compared to checks. Rapidity, extent and structure of cell wall strengthening processes including callus deposition, lignification, H<sub>2</sub>O<sub>2</sub> generation, NO localization, HRGP cross-linking and hypersensitive response were assessed and were significantly higher in elicitor-treated seedlings compared to control verifies with and without pathogen inoculation. The analysis of molecular induced resistance has been mediated by the ascending regulation of some of the important defense enzymes like peroxidase, glucanase, polyphenoloxidase, phenylalanine ammonia lyase, and the cell wall crosslinking protein hydroxyproline rich glycoproteins. In Greenhouse experiments, the protection offered by treatment reduces the severity of the diseases against *Sclerospora graminicola* in comparison to untreated plants. These active regulated defensive proteins could serve as bio-elicitor for vital markers of resistance against downy mildew disease in pearl millet.

## Session 5. Climate resilient agriculture and disease forecasting

### PP (S5) 01: Estimation of yield loss in paddy due to grain discoloration disease

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Grain discoloration (GD) is an emerging complex biotic stress to rice production in India. The GD can cause significant yield and quality losses in a disease-favorable environment. A wide range of pathogen combinations has been reported from a few locations in India. However, the severity of the disease on different rice cultivars grown across various ecological zones is not available. Therefore, a field experiment was conducted at ARS, Gangavathi, in Kharif-2021, where 43 popular rice cultivars from Karnataka were grown in augmented design (8 m<sup>2</sup> per each cultivar) to study the GD susceptibility and associated yield loss without any control measures. Data on different parameters such as total no. of tillers/ m<sup>2</sup>, total no. of infected tillers/ m<sup>2</sup>, per cent infected tillers, reduction in grain weight was recorded, and per cent yield loss was estimated. The experiment suggests that all 43 cultivars grown in different rice ecosystems of Karnataka are susceptible to the disease. Among the 43 cultivars tested, the highest yield loss (79.87 %) was recorded in cv. Selamsanna with 234.66 infected tillers/ m<sup>2</sup>, 70.32% infected tillers, and a reduction in grain weight of 3.47% followed by cv. CO-39 (yield loss, 35.03 %) with 196 infected tillers/ m<sup>2</sup>, 74.24% infected tillers, and a reduction in grain weight of 51.9%; cv. IR-64 (yield loss, 27.78 %) recorded 456.82 infected tillers/ m<sup>2</sup>, 100% infected tillers, and a reduction in grain weight observed was 44.44%. At the same time, the least disease severity was recorded from cv. Inton with 361.66 infected tillers/ m<sup>2</sup>, 99.04% infected tillers, and reduction in grain weight was 0.52 %; cv. HR-12 showed 164.66 infected tillers/ m<sup>2</sup> with 55.88% infected tillers, and a reduction in grain weight was found to be 3.01%. Hence, cv. Selamsanna and cv. CO-39 were considered more susceptible to the disease compared to cv. Inton and cv. HR-12. This study provided information on the universal susceptibility of all cultivated rice varieties of the state as well as the potential yield loss caused by the GD on different cultivars of the state. This information provided the need for developing appropriate management strategies to manage the disease in the farmer's field to reduce yield and quality loss.

### PP (S5) 02: Incidence of rice root-knot caused by *Meloidogyne graminicola* in Uttar Pradesh

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Extensive surveys were conducted to assess the disease incidence and frequency of occurrence of root-knot nematode, *Meloidogyne graminicola*, in paddy fields in thirteen districts viz., Aligarh, Bareilly, Behraich, Fatehpur, Hathras, Jyotiba Phule Nagar, Kanpur, Lakhimpur, Lucknow, Meerut, Mainpuri, Saharanpur, and Shahjahanpur in Uttar Pradesh. The root-knot nematode has become a severe pest of rice (both basmati and non-basmati) for the

last 2-3 decades in irrigated rice in U.P. because of intensive cultivation in the region under irrigated conditions. The nematode causes severe damage to rice in the nursery as well as the main field. The impact of *M. graminicola* on rice yield has been well established, and its attack may lead up to 20 to 90% yield loss. More than 360 paddy fields from thirteen major rice growing districts, were surveyed, where *M. graminicola* was associated with root-knot disease in paddy fields based on the symptomatology and morphological characteristics of juveniles and adults. The highest frequency of occurrence and disease incidence of rice root-knot was recorded in the tehsils of Aligarh district at the nursery (23 and 37%), vegetative (46 and 54%), and reproductive stage (48 and 58%, respectively) as compared to Hathras, Shahjahanpur, Lakhimpur, Kanpur followed by minimum in Jyotiba Phule Nagar district. However, the disease severity in the term of root-gall index and egg mass index was recorded highest in the koil tehsil of Aligarh district (2.6 & 1.8), (3.2 & 2.2) and (4.7 & 3.8, respectively) at the nursery, vegetative, and reproductive stage in paddy field. The soil population of rice root-knot nematode was also recorded as highest in all tehsils of Aligarh district at the nursery (3180 J<sub>2</sub>/kg soil), vegetative (3740 J<sub>2</sub>/kg soil), and reproductive stage (3580 J<sub>2</sub>/kg soil) in paddy fields and the minimum was found in the district Jyotiba Phule Nagar. The relative yield loss was recorded in Aligarh (26%) with a range of 10-40% among the tehsils in the district, followed by Hathras, Shahjahanpur, Lakhimpur, Kanpur, Meerut, Mainpuri, Saharanpur, Behraich, Fatehpur, Lucknow, Bareilly, and Jyotiba Phule Nagar. The present study shows that the disease occurrence and incidence of rice root-knot was severe in Aligarh compared to other districts. It is an indication of future threats to rice in this area. The financial assistance offered by the Council of Science and Technology, Uttar Pradesh (CST-UP) through a major is acknowledged.

### PP (S5) 03: Etiology, characterization and population dynamics of leaf blight complex pathogens on Wheat

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Wheat, the king of cereals, with an annual production of almost 770 million tonnes and a growing area of 221 million hectares, is consumed as a staple food by 35% of the world's population. Wheat production globally is threatened by the Helminthosporium leaf blight (HLB) complex, which can be devastating with up to 100% severity under favourable climatic conditions, resulting in more than 30% yield loss in wheat cultivars. Earlier studies have demonstrated that foliar blight complex is a combination of the diseases tan spot (*Pyrenophora tritici repentis*) and spot blotch (*Bipolaris sorokiniana*), although *B. sorokiniana* continues to be the dominating one in causing losses. We intend to explore the pathogenic flora associated with the foliar blight complex, their interactions and the impact of soil-borne inoculum. The results revealed the association of *Bipolaris spicifera*, *Exserohilum rostratum* and *Bipolaris oryzae* along with *Bipolaris sorokiniana* with the spot blotch disease complex in wheat across Indian Wheat growing zones. Through this study, we have established by morpho, molecular and pathological approach that these pathogens employed in the study contribute significantly to the disease complex. Since spot blotch disease is soil-borne and can be initiated by inoculum surviving in soil or on straw, soil inoculum was quantified using q-PCR in order to understand more about the persistence and propagation of the soil inoculum over time in the presence of two different wheat varieties, Sonalika and HD-2733. According to the results, the soil inoculum thrives and persists well for two months before declining. Additionally, compared to the susceptible variety Sonalika, the resistant variety's rhizosphere had significantly less inoculum. We believe that our study would emphasise the impact of these pathogens in reducing wheat productivity and quality under Indian conditions.

## PP (S5) 04: Biology and management of bakanae disease of rice under changing climatic scenario

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Bakanae disease of rice caused by *Fusarium fujikuroi* is an emerging problem of rice in India. The disease was considered of minor importance. Recently, high incidence of disease was reported in basmati and aromatic rice varieties of northern India and traditional rice varieties of Assam and Odisha. Disease is reported as of seed and soil borne nature and detailed study on soil borne nature of the pathogen under Indian conditions is not available. The population structure and survivability of this fungus under field conditions was investigated by collecting month wise soil samples starting with July from *Fusarium fujikuroi* inoculated rice field of Indian Agricultural Research Institute, New Delhi and processed further for population counting, q-PCR, analysis with specific primers and metagenome analysis of few samples. The results obtained from serial dilution method reflected that, the maximum numbers of colonies were found in the month of July and minimum was in month of June. Similar trend was found in q-PCR. The metagenomic analysis showed 1.84, 0.22, 0.24 and 0.09 abundance per cent of the *Fusarium* spp. in soil in the month of July, September, December and March respectively. Potential biocontrol agent *Talaromyces flavus* was identified against *Fusarium fujikuroi* and was integrated in management modules. Module developed was effective against two different environmental conditions i. e. Westernplain zone and North-Eastern plain zone of India.

## Session 6. Omics in crop protection

### PP (S6) 01: Complete genome sequencing of a divergent strain of cardamom mosaic virus

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The complete genome sequence of an isolate of cardamom mosaic virus (CdMV) from Idukki, Kerala causing mosaic (*katte*) disease in small cardamom was determined through reverse transcription PCR using nine pairs of primers and 5'/3' RACE (rapid amplification of cDNA ends). CdMV (Idukki) genome consisted of 8255 nucleotides with two open reading frames (ORFs). The large ORF, potentially coding for a polypeptide of 2638 amino acids is further processed into nine mature proteins through eight cleavage sites. The second ORF, PIPO (pretty interesting *Potyviridae* ORF) starting with C(A)<sub>6</sub> motif codes for a small protein of 56 amino acids. The viral genome contained additional 13 and 6 nucleotides at the 5' untranslated region (UTR) and coat protein gene, and a deletion of 13 nucleotides at the 3' UTR in comparison to KS isolate of CdMV from Sakleshpur, Karnataka. CdMV (Idukki) polyprotein contains all motifs specific for *Potyviridae* family and *Macluravirus* genus and lacks the P1 coding region, N-terminus of Hc-Pro coding region, and aphid transmission motifs. The complete viral genome and polyprotein shared an identity of 76% and 85% with the KS isolate of CdMV. The coat protein nucleotide and amino acid sequence shared an identity of 71-74% and 72-80% with different CdMV isolates including the KS isolate from Karnataka. The percent identity and phylogenetic analysis indicate that the present isolate is a strain of CdMV that is divergent from all known CdMV isolates. The analysis also showed that among macluraviruses, CdMV (Idukki) is closely related to the large cardamom chirke virus.

### PP (S6) 02: Genomic approaches to unravel the untold secrets of millet's for enhancing production and productivity

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A significant group of cereals known as millets are farmed all over the world for both human use and animal fodder due to their nutritional superiority of the millets compared to the regular staples like rice and wheat. Even though most millets are native to Africa, they are domesticated, grown, and consumed in a significant amount in developing countries. Millets are well known for their outstanding capacity to adapt to low farming practices with limited resources and survive environmental stress. However, biotic and abiotic stressors are becoming a major factor for reduction in millet crop production due to the changing climatic circumstances. The identification of genetic variation underlying phenotypic distinctions, the discovery of additional sources of diversity and novel features, and the elucidation of molecular and biochemical mechanisms involved in biotic and abiotic stress tolerance are now at the crux of crop development, lead by next generation genomics. The insertion of trait-associated genomic sections into crop varieties using molecular breeding or genetic engineering methods requires the development of genomic resources. In millets the draft genome sequences that are currently available for foxtail millet, pearl millet, finger millet, and broomcorn millet, and they offer a fantastic chance for their genetic assessment. Comparative genomics has been utilized to study blast resistance in finger millet, and several techniques have been employed to genetically enhance finger millet for robust resistance to critical diseases. There are several reported and sequenced R-genes

and quantitative trait loci (QTL) in finger millet that are related to the blast pathogen. For crop genetic improvement, a reliable genetic transformation system has been established and in case of pearl, foxtail, and finger millet, a successful *Agrobacterium*-mediated transformation system has already been developed. The millet transgenic study is anticipated to be accelerated to an extremely high altitude by a recently established *Agrobacterium*-mediated genetic transformation technology in foxtail millet with an approximate 27 percent gene integration frequency. Although there is a lot of germplasm that is resistant to diseases and abiotic stresses in places like India or Africa, there is a gap in the area because there are not enough genetic resources available. Genome assisted breeding, genetic engineering, and genome editing may become possible with the development of technologies leading to focused genome sequencing and resource development.

### Variability studies on *Fusarium* sp. causing Pigeonpea wilt in India

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A total of 50 *Fusarium* isolates were collected from major pigeonpea growing states of India and studied for cultural and morphological characteristics. Isolates were categorized based on growth rate, mycelial growth patterns, mycelial colour, zonations, pigmentation, spore size and septation. Among 50 isolates, 30 isolates of total were selected based on their cultural and morphological characteristics and studied for pathogenic variability on eight pigeonpea differential genotypes (ICP8858, ICP 8859, ICP 8862, BDN-2, ICP 9174 ICP 8863, ICP 2376 and BAHAR). Among these eight genotypes, four genotypes viz. ICP8858, ICP 8859, ICP 8862, BDN-2 reacted differentially to isolates and were not consistent in their pathogenicity. Genotypes ICP 9174 and ICP 8863 exhibited resistance reactions and ICP 2376 and BAHAR, exhibited consistent susceptibility to wilt disease. Based on the host differential reaction, isolates were classified into nine variants (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9). Among the variants, variant-2 (Bihar, Uttar Pradesh, Jharkhand, Maharashtra, Karnataka, Andhra Pradesh, and Telangana) and variant -3 were found in (Bihar, Maharashtra, Karnataka and Telangana) in most of the pigeonpea cultivation states, followed by variant-4 (Bihar, Delhi and Andhra Pradesh) and variant-5 in Telangana state. ITS-rDNA sequencing of 23 *Fusarium* isolates revealed that *Fusarium udum* was the dominant species causing pigeonpea wilt in India, followed by *Fusarium solani* and *Fusarium equiseti*. The results were notable in terms of *Fusarium* variants, which might be used to deploy location specific wilt-resistant cultivars for improved disease management tactics. This study will also aid in the development of broad-based pigeonpea wilt resistant varieties to suppress the potential epidemics.

Key words: *Fusarium*, ITS-rDNA, Pigeonpea, Variants, Wilt

### Molecular characterization of endophytes isolated from *Salvia hispanica* and preparation of silver nanoparticles using *Stenotrophomonas maltophilia*

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In this work, pure culture of two endophytic bacteria and an endophytic fungus was isolated from the root of *salvia hispanica*. The genomic DNA was isolated from endophytes and subjected to PCR amplification of the 16S rRNA gene and 18S rRNA gene in bacteria and fungi respectively. The PCR amplicons were sequenced using sanger's dideoxy method and sequence obtained was subjected to BLAST analysis which revealed that the isolated bacteria were *Stenotrophomonas maltophilia* and *Staphylococcus lugdumensis* and the fungus was *Fusarium solani*. In parallel, silver nanoparticles (AgNPs) were synthesized using *Stenotrophomonas maltophilia* and the formation of AgNPs was

confirmed by visible observation as a change in color of bacterial solution impregnated with silver. Further, the morphology of the AgNPs, average size, and physical and chemical property were characterized by scanning electron microscopy (SEM), X-ray diffraction (XRD), dynamic light scattering spectroscopy (DLS), and Fourier transforms infrared spectroscopy (FT-IR). The antimicrobial activity of AgNPs was evaluated against *Escherichia coli* by disc diffusion method and *Aspergillus Niger*. The secondary metabolites in the extracellular and intercellular fraction of *Fusarium solani* were analysis using liquid-chromatography (LC-MS) analysis.

## Effect of date of sowing and nitrogen levels on spot blotch disease of wheat caused by *Bipolaris sorokiniana*

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In India, wheat is grown in the Rabi season mostly under irrigated condition. The main constraints responsible for less yield of wheat in comparison to other country seem to non-availability of seeds of improved high yielding varieties to farmers, poor fertility, unirrigated land and other inputs. Experimental findings clearly indicate that yield loss due to spot blotch varied between 7 to 30 per cent and loss in 1000-grain weight between 3 to 23 per cent, depending upon the levels of disease. Delayed sowing favoured incidence of spot blotch irrespective of nitrogen level and more disease developed at higher nitrogen level in all the three date of sowing. Higher levels of nitrogen at all the three date of sowing increased yield and 1000-grain weight and with delay in sowing, yield and 1000-grain weight decreased significantly at all the three nitrogen level.

## Studies on Economically Important Diseases of Horticultural Crops

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India's production of horticultural crops consisting of fruits, vegetables, spices, medicinal plants and plantation crops in the crop year 2021-22 grew by around 2% to 341.63 million tonne (mt). In Andhra Pradesh, area under horticulture crops is 17.84 lakh hectares with a production of 31.23 million tonnes standing at 1st position in Chillies, Cocoa, Lime, Oil Palm, Papaya and Tomato, 2nd in Cashew, Mango and Sweet Orange in India. Emerging pests and pathogens pose significant challenges to horticulture crops. Panama wilt and foliar diseases of banana, *Phytophthora* sps inciting diseases in coconut, black pepper, papaya, gummy stem blight disease in cucurbits, viral diseases in tomato, chilli are some of the major constraints in the cultivation of horticulture crops. Viruses such as Cucumber green mottle mosaic virus have been reported from various countries taking heavy toll of the crop. Etiology of gummy stem blight in cucurbits was unravelled by various researchers across the country and multiple pathogens have been reported indicating the complex nature of the disease. Recommended practices for effective management of these diseases have been developed and farmers were sensitised through field level demonstrations and popularised through various media. For effective management of plant diseases incited by various phytopathogens, proper detection and diagnosis of the etiological agent is a prerequisite. Conventional and Advanced molecular diagnostic techniques are currently used for plant diseases diagnosis. Integrated disease management in horticulture crops encompassing the physical, cultural, biological, host plant resistance and chemical practices when employed will result in the acceptable yield and quality besides reducing the cost of cultivation



**SYMPOSIUM  
ON**

**PLANT HEALTH PROTECTION:  
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**Indian Phytopathological Society, South Zone Chapter**

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**Karnataka State Open University**

Venue: Vijnan Bhavan, University of Mysore, Mysuru, Karnataka, India

February 01, 2023



**MJ Narasimhan Academic Merit Award Contest (Southern Zone)**

**MJN 01(SZ): Isolation, identification, and functional characterization of the microbiome associated with sheath blight lesion of rice**

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In recent time use of endophytes for disease management is gaining importance in different parts of the world, including India. In rice, phylloplane and endophytic bacteria isolated from the leaf have been reported to show disease suppression of rice blast disease. However, no reports/attempts have been made to isolate the microbiome associated with Sheath Blight (ShB) of rice; therefore, our present investigation aims at isolation, identification, characterization, and an *in-vitro* and *in-planta* assay of microbiome against ShB disease of rice. In the present study, we isolated 20 different bacterial microbiomes from the ShB lesion of rice using the serial dilution method on three different media. All isolated microbiomes were morphologically characterized based on colony color, texture, elevation, and growth pattern. Further, based on 16S-rDNA gene-sequencing, we have identified 17 bacterial species belonging to *Achromobacter xylosoxidans* (Acc. No. OP456399), *Acinetobacter lowffii* (Acc. No. OP456385), *Bacillus altitudinis* (Acc. No. OP456422), *B. cereus* (Acc. No. OP456418, OP456415, OP456395, OP456397), *Exiguobacterium profundum* (Acc. No. OP456425), *E. aesturii* (Acc. No. OP456425), *Lysinibacillus fusiformis* (Acc. No. OP456421), *Microbacterium proteolyticum* (Acc. No. OP800110), *Methylobacterium rhodesianum* (Acc. No. OP456393), *Ralstonia monilicola* (Acc. No. OP456391), *Staphylococcus arlettae* (Acc. No. OP456426), *S. gallinarum* (Acc. No. OP456427), *S. hominis* (Acc. No. OP456419), *Stenotrophomonas maltophilia* (Acc. No. OP456428), *Brucella pseudogrignoneis* (Acc. No. OP456392), *Pseudomonas mendocina* (Acc. No. OP800109), *Paenibacillus* sp. (Acc. No. OP456394). The 16S-rDNA sequences of all 17 species were deposited in the NCBI GenBank. We have used all 17 species for studying the *in-vitro* antagonistic efficiency against *R. solani*; all 17 species effectively suppressed the mycelium of *R. solani* compared to the control. Among them, *B. cereus* and *S. maltophilia* showed 65.18%, 61.85%, and 61.85% mycelial inhibition, respectively, indicating superior biocontrol potential against *R. solani*. Further, six bacterial species which performed significantly better than other species were selected for in-planta bio-efficiency against ShB disease in a pot experiment. We used three different methods of pathogen-microbiome inoculation and found that all three methods effectively controlled the Shb in planta. However, there was a statically significant difference among the treatments. The inoculation with *B. cereus*, *S. maltophilia*, and *A. lowffii* showed an ShB reduction of 41.85%, 43.61%, and 41.97%, respectively, over the control. Interestingly, all three inoculation methods were equally effective in controlling the disease, indicating their potential biocontrol efficacy against the ShB of rice. This is the first study to report the microbiome isolation from the ShB lesion of rice and demonstrate the biocontrol potentials of three species. The outcome of this study has multiple applications, such as the development of biocontrol formulations against the ShB of rice.

## MJN 02(SZ): Deciphering the biocontrol potentials of *Coniothyrium minitans* against sclerotinia rot of cabbage

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Mycoparasites are the potential biocontrol agents for the effective management of sclerotial diseases. In this study, a total of twenty-one mycoparasitic fungi were isolated from the sclerotial bodies of *Sclerotinia sclerotiorum*, causing cabbage head rot in Tamil Nadu, India. All the isolates were further identified using the ITS regions. Among which the, *Coniothyrium minitans* TNAU-CM-1 showed maximum mycelial inhibition of 78.51% compared to control. The colonization and degradation of pathogenic sclerotia by pycnidiospore suspension of CM-1 isolate was screened on different days wherein sclerotial viability was lower in sclerotia-infested-sterilized-soil jars (SSJ), showing 80% of viable sclerotia at 14 days followed by 13.33% on 45 days than sclerotia-infested-unsterilized-soil jars (USJ) when compared to the control. Thirty antimicrobial compounds were identified in CM-1 isolate using GCMS analysis. Molecular docking was predicted against pathogenic virulence protein, succinate dehydrogenase (SDH) in comparison with synthetic fungicide (Boscalid), and the results showed that androsterone-acetate and ethyl-iso-allocholate had a higher binding affinity of -7.6, and -7.4 kcal/mol, respectively, than boscalid (-7.2 kcal/mol). Based on these observations, *C. minitans* CM-1 might be exploited as a bio-fungicide for the effective management of *S. sclerotiorum* in cabbage.

## MJN 03(SZ): Identification of host differentials and pathotyping of *Pyricularia setariae* (Nishikado) causing leaf blast on foxtail millet (*Setaria italica* (L.) Beauv).

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Foxtail millet is the second-most extensively cultivated millet in Asia, with high nutritional content. Despite its hardiness, the crop is challenged by many biotic and abiotic factors. Among biotic constraints, blast is one the major disease causing significant yield loss. A total of ten leaf blast samples having greyish centre with brown margin lesions were collected from major growing states of India and pathogen was isolated by spore drop technique. The isolates were identified as *Pyricularia setariae* by comparing with the original descriptions and BLAST results of ITS gene. Rice straw extract agar was found ideal media for growth and sporulation. In crossing method, perithecia were observed at the junction of FoxPs-2 and male tester. Mating type analysis through MAT gene specific primers revealed that, one isolate *MAT1-1* (male), six isolates *MAT1-2* (female) and two isolates *MAT1-1* and *MAT1-2* (hermaphrodite) and one isolate with none of the alleles. Out of the 95 genotypes screened at four different agroclimatic conditions of India, one genotype was highly resistant, 59 genotypes were resistant, 33 were moderately resistant and two were susceptible to leaf blast. A set of 12 putative host differentials showing differential reactions were identified based on greenhouse screening of 24 genotypes against four isolates from different locations. Based on disease reaction of isolates on the identified host differentials, 15 isolates were clustered into four major pathogenic groups (pathotypes). Host differentials and pathotypes of *P. setariae* would lay the basis and as donor for blast resistance breeding in foxtail millet in India.

### **MJN 04(SZ): Identifying the molecular mechanisms of bacterial effector proteins from *Xanthomonas oryzae* pv. *oryzae* causing leaf blight disease in rice**

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Rice (*Oryza sativa* L.) is an important food crop that is a major carbohydrate source for nearly half of the world's population. Bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is one of the most devastating diseases affecting entire rice acreages and causes severe yield losses of up to 80% depending on the stage of the crop, cultivar susceptibility, and environmental conditions. Through dual transcriptome analysis of contrasting rice cultivars (TN-1 and RP-Bio226), highly induced type 3 effector proteins were identified in *Xoo* infecting susceptible variety whereas none were found in the resistant variety. Disease resistance genes were found to be upregulated in RP-Bio226 upon infection with *Xoo* while on the contrary, no such genes were found in TN-1. Expression of highly induced effector proteins in *Xoo* was also studied by qRT-PCR at different time intervals after inoculation with *Xoo*. RP-Bio226 produced higher levels of ROS compared to the susceptible variety TN-1. The chlorophyll content was also significantly reduced in TN-1. The effector protein PthXo1 and its plant-interacting protein OsSWEET11 were further characterized by CRISPR technology. TN-1 variety was used for developing transgenic plants expressing sgRNA (single guide RNA) of OsSWEET11. The gene editing was confirmed in the transgenic plant (S21) and it showed resistant reaction to *Xoo*. Further, a novel small molecule was identified through *in silico* approach and its efficacy was evaluated against *Xoo* in TN-1 variety.

### **MJN 05(SZ): Interaction of AUUB 209 (*Streptomyces enissocaesilis*) and AUDT 626(*Streptomyces racemochromogenes*) rhizobacteria and *Sclerotium rolfsii* root rot pathogen on relative expression of defence related genes in soybean through qRT-PCR**

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The present investigations were carried out to assess the interaction of rhizobacteria and target pathogen in soybean ecosystem at Molecular Genetics Lab, UAS, Dharwad to gain the insights into molecular basis of host-pathogen interaction during 2022. Defence related genes were analysed for their expression levels in response to pathogen (*Sclerotium rolfsii* Sacc.) and rhizobacterial isolates (AUUB 209- *Streptomyces enissocaesilis* and AUDT 626 (*Streptomyces racemochromogenes*) through quantitative real time polymerase chain reaction. A total of five defence related genes viz., Pathogenesis related protein 1 (*PR 1*), Pathogenesis related protein 2 (*PR 2*), Pathogenesis related protein 10 (*PR 10*), Polyphenol oxidase (*PPO*) and Chalcone synthase (*CHS*) were selected and analysed for their expression levels under different treatments where rhizobacteria were applied as seed treatment (10g/kg seeds) and drenching at 35-40 days after sowing. The results revealed that the highest expression levels of *PR 1* (2.75 fold), *PR 2* (7.88 fold), *PR 10* (4.16 fold) and *PPO* (8.50 fold) observed in the treatment (Host + Pathogen + AUUB 209 + AUDT 626) and the highest (3.27 fold) *CHS* gene expression was recorded in the treatment (Host + AUDT 626). The positive check (Host + Pathogen + *Trichoderma harzianum*) recorded 2.42, 5.74, 4.15, 6.33 and 1.34 fold change of *PR 1*, *PR 2*, *PR 10*, *PPO* and *CHS* genes respectively. This is the first report on rhizobacteria and root rot pathogen interaction in soybean in India.

## MJN 06(SZ): Management of plant viruses in *Capsicum annuum* L. through Induced Systemic Acquired Resistance

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The research was done to assess the efficacy of salicylic acid (SA) foliar spray against the three major destructive viruses of the remunerative vegetable crop capsicum (*Capsicum annuum* L.). As a relatively long-lasting crop in a polyhouse, capsicum is more susceptible to adverse effects on yield, quality, and market value. The cultivated capsicum plant is susceptible to infection by a wide variety of viruses, among which *Cucumber mosaic virus* (CMV), *Chilli vein mottle virus* (ChiVMV), and *Chilli leaf curl virus* (ChLCV) are among the major devastating viruses causing yield losses of more than 50 – 95%. Salicylic acid was used as a foliar spray in different concentrations against the three viruses infecting capsicum plants. Minimum disease incidence and disease severity were recorded when plants were sprayed with 100 ppm salicylic acid 24 h before challenge inoculation. SA foliar spray not only delayed the virus symptoms but also reduced the virus concentration with enhanced growth and yield. There was a significant increase in the internal SA accumulation, a key activator of the SAR pathway. SA induced SAR, which is correlated with the expression of SAR genes. SA treatment reduced the oxidative damage induced by the viruses by activating the antioxidant machinery. SA also triggered the JA-mediated pathway. Also, the enhanced biochemical component levels indicated enhanced plant health. Salicylic acid is therefore an efficient inducer of resistance to CMV, ChiVMV, and ChLCV in capsicum plants.

## MJN 07(SZ): Deciphering the antagonistic, plant growth promoting activity and induction of host plant defense by *Streptomyces* spp. against charcoal rot of sorghum

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*Sorghum bicolor* (L.) Moench commonly known as Jowar is the most important crop of India cultivated in *Rabi* and *Kharif*. It suffers from biotic and abiotic stresses of which charcoal rot caused by *Macrophomina phaseolina* (Tassi) Goid is one of the most important disease infecting during post rainy season. An attempt was made to investigate the plant-pathogen-rhizobacterial interactions, which helped in formulating integrated biocontrol measures for enhancing the production of sorghum. Several rhizobacterial strains isolated from soil were subjected to preliminary *in vitro* screening for antagonistic nature against *Macrophomina phaseolina*. The results of experimentation clearly showed that AUDT 626 (*Streptomyces racemochromogenes*) and AUUB 209 (*Streptomyces enissocaesilis*) as potential antagonists against *Macrophomina phaseolina*. Further, the characterization of metabolites through LC-MS revealed that the isolate AUDT 626 and AUUB 209 produced the common antifungal metabolites *i.e.*, Carbazole and (Z)-Octadec-9-enoic acid. These rhizobacterial strains were also characterized for antimicrobial enzymes and for plant growth promoting traits. *In vivo* studies under controlled soil conditions and field conditions during 2019-20 and 2020-21 revealed that the supplementation of rhizobacterial consortia (AUUB 209 and AUDT 626) reduced the disease incidence significantly thereby increasing grain and fodder yield. In addition, rhizobacterial strains induced the activity of defense enzymes [Peroxidase (PO), Polyphenol oxidase (PPO) and Phenyl Ammonia Lyase (PAL)], defense compounds (total phenols and sugars) and antifungal enzymatic activity (chitinase). qRT-PCR analysis on relative gene expression of defense marker genes showed that the rhizobacterial strains individually or in combination induced both ISR (*PR* genes) and SAR defense genes (*PAL* and *PPO*). The isolate

AUUB 209 has specific role in induction of stilbene synthase gene (*STS*) unraveling the key characteristics of underlying the mechanism in this tripartite interaction.

### MJN 08(SZ): Molecular insights into floral malformations in pearl millet due to Downy mildew infection

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Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an important cereal and forage crop of arid and subtropical regions and one of the major constraints for its production is the 'green ear' or 'downy mildew' disease caused by the oomycetous, biotrophic obligate pathogen *Sclerospora graminicola* (Sacc.) Schroet. Systemic infection by the pathogen leads to stunted growth and modified panicles with leafy growths instead of seed setting (phyllody). In the present study we have characterized nine MADS box genes of ABCDE class of floral organ identity genes by degenerative PCR approach and cloning. To understand how the pathogen changes the inflorescence and branching architecture, differentially expressed proteins among the normal and malformed florets were analyzed by 2- dimensional Gel Electrophoresis based proteomic approaches. Expression profiling of each of the ABCDE class of genes involved in floral organ identity was analysed by quantitative PCR to elucidate their role in floral malformation. Detailed analysis by RT-PCR and 2D PAGE results provide us an insight into the molecular mechanism of floral development and malformation due to pathogen infection.

### MJN 09(SZ): Variability, molecular characterization and management of head blight of wheat caused by *Fusarium poae* (Peck) Wollenw.

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Wheat is one of the strategic cereal crops with paramount importance. *Fusarium* head blight (FHB) is a catastrophic disease of wheat which is becoming predominant in the recent times. Considering the seriousness of the problem, a study was undertaken, comprising a survey, cross inoculation studies, morphological and molecular studies, screening of the wheat genotypes for resistance, *in vitro* and *in vivo* evaluation of fungicides, botanicals and bioagents against the pathogen. The survey revealed that the highest FHB index was recorded in Belagavi district (12.20 %) followed by Bagalkote (11.89 %) and Dharwad (6.05 %). Pathogenicity test of *Fusarium poae* on maize proved that it may act as a collateral host for the pathogen in the absence of wheat. The morphological studies revealed the variations in length and breadth of macroconidia, microconidia and chlamydospores among the isolates. The molecular studies using the three sets of primers, ITS, Fg16 and Elongation Factor (EF1/4) revealed that all the ten isolates exhibited similarity to *Fusarium poae*. The evaluation of wheat genotypes in both *kharif* 2021 and *rabi* 2021-22 under artificial inoculated condition recorded resistant reaction in the genotype VL 3013. The *in vitro* studies revealed that among the chemicals, copper oxychloride, carbendazim and carbendazim

12%+mancozeb 63% resulted in complete inhibition of the pathogen. Among the botanicals tested, elixir (turmeric + neem extract) showed cent per cent inhibition and among the bioagents, the highest per cent inhibition of the pathogen was recorded in the endophyte *Neofusicoccum parvum*. In the field management studies, the seed treatment with *Trichoderma harzianum* (10 g/kg) and spray with hexaconazole (0.1%) was found most effective with 67.05 per cent disease reduction over control. The plant growth and yield parameters like yield (39.60 q/ha), net returns (Rs. 51,390/ ha) and B:C ratio (2.85) was recorded highest in the same treatment.



**APS-IPS Travel Sponsorship Award Contest (Southern Zone)**

**APS 01(SZ): Characterization of *Xanthomonas oryzae* pv. *oryzae* strains in Karnataka and improving *Xoo* resistance in rice through SWEET gene editing**

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Bacterial leaf blight of rice caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is one most destructive disease. The disease severity of this bacteria differs from geographical regions, strain (race) and the host genotype. However, the disease severity differs from place to place and efforts have been made to understand the virulence efficiency of different isolates of *Xoo* from different locations of Karnataka. All the isolates were cultured in the laboratory and were confirmed by 16S rRNA sequencing. We also isolated *Pantoea ananitis* capable of causing the symptoms of leaf blight disease and producing similar symptoms as shown by *Xoo* infection. The ClustalW analysis of the 16S rRNA gene sequences revealed two groups in the case of both *Xoo* and *P. ananitis*. The second group containing only two isolates *Xoo* 4 and *Xoo* 9 are more similar to the MH444307 isolate from Maharashtra and is delineated from the rest of the *Xoo* isolates. The 35 isolates of *P. ananitis* also formed into two groups and had more similarity with Japan isolate AB304809 followed by South Korean isolates HE672167 and HE716948 respectively. The isolates of *Xoo* and *P. ananitis* collected from different parts of Karnataka formed 2 major pathotypes of both *Xoo* and *P. ananitis* and were distinguished based on their reaction towards *Xa* genes in the monogenic lines. The resistance gene *Xa21* conferred resistance to more than 70 per cent of the *Xoo* and *P. ananitis* population. Further the amounts of exopolysaccharide (EPS) produced were quantified and varied depending on *Xoo* isolates. Isolate *Xoo* 3 produced a distinctly high amount of EPS (92.3 mg) followed by *Xoo* 6, *Xoo* 8 and *Xoo* 4 and on the contrary, *Xoo* 2 produced distinctly less amount of EPS. Further the multilocus sequence typing has been carried out based on the core genes of the *Xoo* genome assemblies and found to have high variation between the *Xoo* population of India. In order to impart resistance against bacterial leaf blight of rice we have targeted three SWEET genes namely *SWEET11*, *SWEET13* and *SWEET14* by CRISPR/Cas9 technology. We have successfully designed the guide RNAs for the respective SWEET genes and cloned in to the pRGEB32 vector and transformed in to the plants which are under evaluation.



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