Special National Symposium on

Extension Plant Pathology : Technological Backstopping to the Farmers/ Other Stakeholders

September 25-26, 2018

SOUVENIR CUM ABSTRACT

Organized by

Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Indian Phytopathological Society, New Delhi, India

in collaboration with

NABARD


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Directorate of Horticulture & Farm Forestry
Govt. of Chhattisgarh
संचालनालय उद्यानिकी एवं प्रक्षेत्र वानिकी

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Special National Symposium on "Extension Plant Pathology : Technological Backstopping to the Farmers/ Other Stakeholders"

Organized by

Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India
Indian Phytopathological Society, New Delhi, India

The publication has been brought out on the occasion of **Special National Symposium on "Extension Plant Pathology : Technological Backstopping to the Farmers/ Other Stakeholders"** organised by Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India and Indian Phytopathological Society, New Delhi, India on 25-26 September, 2018 and published by Organizing Committee.

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Governor of Chhattisgarh

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Raipur, 01 Sep 2018

Message

I am happy to know that Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur and Indian Phytopathological Society, New Delhi along with Directorate of Horticulture and Farm Forestry, Govt. of Chhattisgarh, Raipur is jointly organizing a Special National Symposium on "Extension Plant Pathology: Technological Backstopping to the Farmers/ Other Stakeholders. On this occasion a Souvenir is also being published.

It is a matter of great satisfaction that this University always plan and execute to serve the farmers interest of Chhattisgarh and our country as a whole. Scientific discoveries and technological devices have immensely facilitated in the increase in agricultural production and productivity in our country. We have to appreciate that there is need to further increase our production and productivity with minimum usages of chemical fertilizers in agriculture and allied sectors, in order to provide food, nutritional, and income security for the rising population.

I am confident that on this historic occasion the IGKV-IPS will rededicate itself to bring out more innovative ideas and practical methods to increase our agricultural production in harmony with the eco-system. I extend my best wishes for success in this endeavour.

Anandi Patel

(Anandiben Patel)

डॉ. रमन सिंह
मुख्यमंत्री
Dr. RAMAN SINGH
CHIEF MINISTER

Do.No. 196/Hcm/Js/um/ **VIP/20......**
Date.. 28/08/2018 **.................................**

महानदी भवन मंत्रालय
नया रायपुर छत्तीसगढ़-492002
Mahanadi Bhawan, Mantralaya
Naya Raipur, Chhattisgarh

Message

I is heartening to know that Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Indian Phytopathological Society, New Delhi, Directorate of Horticulture and Farm Forestry, Govt. of Chhattisgarh, Raipur are jointly organizing a Special National Symposium on "Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders.

This University has served the farmers by developing several useful technologies and guided them through its various developmental activities and played a key role in conserving the highly diverse and unique germplasm of plant species of Chhattisgarh particularly rice, lathyrus, linseed etc. I am sure the University in its upgraded capacity will play a major role in the research and development in India of which Chhattisgarh is also a part, and assure the support of the Government and people of Chhattisgarh in its future endeavours.

I wish the event and souvenir being published in this occasion a grand success.

(Raman Singh)

Brijmohan Agarwal
Minister
Agriculture, Animal Husbandry,
Fisheries, Water Resources, Ayacut,
Endowment & Religion Department
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No. QR/VIP .... Raipur, Date 02/06/18

Message

It's a matter of great honour to felicitate Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur who is jointly organizing a Special National Symposium on **“Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders"** in collaboration with Indian Phytopathological Society, New Delhi and Directorate of Horticulture and Farm Forestry, Govt. of Chhattisgarh, Raipur which is dear to the farmers of Chhattisgarh is for its painstaking research and development work .

I was very happy to read this Souvenir cum Abstract which elaborates all the research work done by the plant pathologist for the farmers of India. I personally acknowledge and applaud the pioneering development work done by the Indian Scientists. I am sure that the good work done by the agricultural plant protection scientists all around the country will be continued in a larger scale for the extension Plant Pathology and assure our continued support to the IGKV in its future endeavours. I once again congratulate the entire staff of IGKV – IPS in this momentous occasion.

(Brijmohan Agrawal)

Sunil Kumar Kujur, IAS
Additional Chief Secretary &
Agriculture Production Commissioner
Chhattisgarh Govt.

Message

It gives me immense pleasure and joy to congratulate Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, who is jointly organizing a Special National Symposium on **"Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders"** with Indian Phytopathological Society, New Delhi and State Directorate of Horticulture and Farm Forestry, Govt. of Chhattisgarh, Raipur for the welfare of the farming community as a whole to protect the crops from ravages of emerging insect pests and diseases.

I applaud their sincere efforts in publishing this Souvenir cum Abstract of the research papers to be presented during the Symposium which throws light on the magnitude of research and development work done by Plant Pathologists for the Indian farming fraternity. I am sure Plant Pathologists will make remarkable contribution in early detection of Plant diseases so that these diseases may be taken care of timely to minimise the profuse losses in yield and quality of the produce. I once again congratulate IGKV and wish the very best in their future endeavours.

(Sunil Kumar Kujur)

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डॉ. एस. के. पाटील
कुलपति
Dr. S. K. Patil
Vice Chancellor

No. PA/VC/IGKV/188/2018/46
Date : 31/5/2018

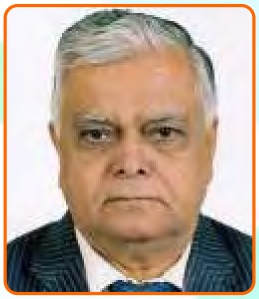
Message

Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur is the only agricultural university in state of Chhattisgarh which has the responsibility of agricultural education, research and transfer of technology to the farmers by the Directorate of Extension. IGKV conducts multidisciplinary research in agriculture and allied sectors viz. Horticulture and Agril. engineering. This University has successfully demonstrated several agricultural and allied technologies in the farmers field through 24 Krishi Vigyan Kendras which has the tremendous potential to double of triple the farmers income within 3-4 years. It has played a major role in promoting excellence in agriculture aiming to improve the overall production and productivity of major crops of this region by providing adequate plant nutrition and plant health management through various strategies including farming system approach, effective management of natural resources, encouraging quality seed production programmes and enhancing organic farming through integrated use of local resources.

I came to know that a Souvenir cum Abstract of the research papers to be presented during the symposium is to be brought out specially to mark the occasion of the Special National Symposium on “Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders. The concerted efforts of all the plant protection scientists, administrative, technical, and other supporting staffs have made this task possible. I congratulate and appreciate to all those who have contributed in one way or other to bring out this souvenir.

(S.K. Patil)

DR C.D. MAYEE,
Ph.D, IARI, AvH FELLOW Germany
Formerly, Chairman, ASRB, Agriculture Commissioner Govt India, Vice Chancellor, Parbhani and Director CICR



Message

It is my pleasure to learn that a Special Symposium on Extension Plant Pathology is being organized by Indira Gandhi Krishi Vishwavidyalaya, Raipur under the leadership of Dr M. P. Thakur in September, 2018 at Raipur. After working in nearly top ranking capacities in research, extension ,teaching and recruitment in the country during active years of my service, One thing that I noted was the lack of technology transfer in agriculture. There are several reasons for this as the communication of science and technology to the prime stakeholder is always riddled with difficulties. Fortunately series of technologies have been generated in the NARS but very few reached the cultivators. Several attempts through extension methodologies have been attempted to improve the situation but still it is a far away fro the target. KVK's are doing excellent jobs but they need to be supported through exhibitions, seminars, in local language literatures, IT methods and so on. Disease management is further difficult to be extended to the producers as several of the plant protection technologies have cost involvement and not easily acceptable to poor farmers. Hence a symposium on such an issue becomes relevant. I am sure that the disease management technologies for various stakeholders based on their income shall be discussed and advocated suitably in the proceedings of the Symposium.

Wishing a successful outcome of the intellectual get-to-gether.

Dr. C.D. Mayee

Asia-Pacific Association of Agricultural Research Institutions

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Message

It gives me great pleasure to note that Special National Symposium on "Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders" is going to be held during 25-26 September 2018 at IGKV, Raipur jointly organized by Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur and Indian Phytopathological Society, New Delhi where scientists, academicians, researchers, students, policy makers and farmers are going to participate. This is a very well thought of topic for deliberations as the national efforts are being made to augment the income of farmers.

The role of extension is of paramount importance specially in Asia-Pacific region where it needs increased focus and investment keeping in view the high number of small-holder farmers who are the key players in agricultural growth for helping to achieve the much talked about Sustainable Development Goals of the United Nations. The extension methodology for plant protection needs to be innovative keeping in view the various digital approaches that are now increasingly deployed globally. I am sure the Symposium will focus in these areas and come out with implementable recommendations.

I wish the Symposium a grand success.

(Ravi Khetarpal)
Executive Secretary
APAARI, Bangkok

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Message

It gives me immense pleasure to know that the Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, and Indian Phytopathological Society, New Delhiis jointly organizing Special National Symposium on "Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders. I am informed that a Souvenir cum Abstract is also being published on the auspicious occasion.

The theme of the symposium is of great value considering the issues of plant health management in the present era of climate change, changed patterns of land and water use and priorities for the production of safe food. On one hand, intensive cultivation of crops specially horticultural crops is boosting socio-economic condition of farming community while on other hand it is increasing vulnerability of plants and soil becoming sick. The growers are therefore, facing various plant health problems which are now causing serious economic losses to the crops. Therefore, the role of plants pathologist has significantly increased from proper disease diagnosis of plant health problems to appropriate management of these problems. This may help Institutions and to guide the farmers in early diagnosis of plant diseases and their remedies. I am sure that the present symposium will certainly address the related issues and suggest suitable guidelines for further research priorities.

I hope the symposium will provide an interesting platform for the deliberations.

(A.K. Singh)

UNIVERSITY OF AGRICULTURAL & HORTICULTURAL SCIENCES
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Dr. M. K. Naik
Vice Chancellor

Message

It is a pleasure to know that the Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur and Indian Phytopathological Society, New Delhi is jointly organizing a Special National Symposium on "Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders" from 25 -27 Sept 2018. The present symposium would be useful in identification, diagnosis, IDM, mass production and proper uses of bio agents, organic cultivation, mushroom cultivation, policy issues and industrial linkage to achieve sustainability in food production.

I believe that this symposium would provide a useful platform to the learned scientists for fruitful discussion and interaction among scientists, agriculturists and farmers sharing their scientific knowledge on latest developments and technologies in management of crop diseases and valuable recommendation to make agriculture more profitable and eco friendly.

I extend my best wishes to the esteemed delegates for a meaningful and wonderful symposium with a great success in achieving the welfare of farming community.

(M K Naik)

भारतीय कृषि अनुसंधान परिषद
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Krishi Bhavan, Dr Rajendra Prasad Road, New Delhi 110001

P.K. Chakrabarty, *PhD., FNAAS*
Assistant Director General
(Plant Protection & Biosafety)

Message

It gives me immense pleasure to know that the Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur in association with Indian Phytopathological Society, New Delhi is organizing a **Special National Symposium** on **"Extension Plant Pathology: Technological Backstopping to the Farmers/ other Stakeholders**. IGKV is a rapidly progressing university and has demonstrated its strength by securing 12th position at the national level as per the recent ranking of Agricultural and deemed Universities by the ICAR. The theme of the symposium being organized at Raipur is conceived based on the challenges to plant health management in the present era of climate change, changing cropping patterns and priorities for the production of safe food. Despite use of Fifty five thousand tons of pesticides presently in India it has been estimated that about 30-35% of crops are lost due to various pests including diseases, insects, weeds, vertebrate pests, etc. at pre and post-harvest stages. This results in whopping reduction of 70-75 million tons of food grain at the present rate of production, which otherwise could have met the food requirement of 30-35 crore people, if protected appropriately. Besides, the Ministry of Fertilizers is spending over Rs 70 thousand crore through subsidy on fertilizers every year. Most of this amount may go waste in case the crops, produced with the use of fertilizers, are not adequately protected from pests and diseases judiciously. Through appropriate Extension Pathology farmers can be imparted proper knowledge to practice judicious use of pesticides by adoption of appropriate pesticide application technology, so that the losses incurred from pests including diseases may be minimized. In this context organizers have coined a title that is apt in the present day context to serve the plant protection needs of farmers.

I am informed that a **Souvenir cum Abstract** for papers selected for presentation in the symposium is being published on this occasion. I hope that the deliberations and discussions held among the scientists and Extension Pathologists on various facets of plant pathology including detection, diagnosis and management of plant diseases during the symposium will help deliver judicious ways and means to manage plant diseases in a better way using recent Information and Communication technology. I wish the symposium and the organizers every success towards this National endeavour.

(P.K.Chakrabarty)

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Prof. (Dr.) R.N. Pandey
President

Message

It is a matter of great pleasure that Special National Symposium on "Extension Plant Pathology: Technological Backstopping to the Farmers/Other Stakeholders" is being organized jointly by Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Indian Phytopathological Society, New Delhi and Directorate of Horticulture and Farm Forestry Govt. of Chhattisgarh on September 25-26, 2018 at IGKV, Raipur. The symposium is planned to hold the sessions on the seven theme areas related to plant pathogens, biological and chemical management of plant diseases, plant protection equipments, Mushroom production as agri-business; and Farmers, producers, entrepreneurs, scientists and policy makers interactions.

Plant Pathology in our country has advanced very well. There is urgent need to disseminate the refined latest technologies of crop protection for the benefit of the farmers and other end users for improving their socio-economic status. Extension agencies are playing the role for dissemination of the technologies to their users.

The planning of the symposium is quite timely and hope that this will provide a common platform to academia, students, KVK personnel, farmers and other stakeholders to share their rich experiences and knowledge about the latest development and to draw a road map for future course of action, by the policy makers for their implementations.

I take this opportunity to express my gratitude with thanks to Dr; S;K; Patil, Hon'ble Vice Chancellor of IGKV Raipur and Shri Sunil Kumar Kujur, IAS ACS & Agril. Production Commissioner, Govt. of Chhattisgarh for their encouragement and support to organize the symposium. I also thank profusely to the members of Organizing Committee and other members who have put their untiring efforts to organize the symposium successfully.

Once again, I take this opportunity to thank and congratulate all those who have put their efforts to make the symposium a success and wish the symposium a grand success.

(R.N. Pandey)

August 29, 2018

Indian Phytopathological Society

Division of Plant Pathology
Indian Agricultural Research Institute
New Delhi-110 012, India

Dr. Dinesh Singh
Secretary

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No. IPS/Sec/2018/00150

Dated: June 26, 2018

Message

It is a matter of great pleasure that Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh), India is organizing Special National Symposium on **"Extension Plant Pathology: Technological Backstopping to the Farmers/State Officials"** in collaboration with Indian Phytopathological Society, New Delhi and Directorate of Horticulture and Farm Forestry, Govt. of Chhattisgarh, Raipur during September 25-26, 2018.

Now a day, many new research in the field of plant pathology is going on to protect the crops from various diseases to reduce the losses. The advanced knowledge related to diagnostic of plant diseases and their management methods should be reached to farmers and other users in effective manners. The aim of the special symposium is to provide a common platform to academia, students, KVK personnel, state Govt. agencies and other stakeholders to share their rich experiences and knowledge on diagnosis and management of plant diseases. It will helpful to draw a road map for future work in technological backstopping in the field of Extension Plant Pathology to the farmers/other stakeholders.

I am confident that the symposium will lead to some fruitful and actionable recommendations, which will help policy maker to implement it for the benefit of plant health across the country.

Best wishes for success of the symposium.

(Dinesh Singh)

Programme at a Glance

Extension Plant Pathology: Technological Backstopping to the Farmers/ Other Stakeholders

September 25-26, 2018

Day-1, Tuesday, Date: 25.09.2018			
Events	*Time*	*Venue*	*Chairman/Co-chairman/ Rapporteurs*
Break fast	8:00 to 9:30 am	Community Hall	
Registration	9:30 to 10:30 am	Swami Viveknand Auditorium	
Inaugural Function	10:30 am to 11:30 am	-do-	Chief Guest : Dr. A.K.Singh Chairman : Dr. S.K.Patil Rapporteur : Dr. A.S. Kotasthane
Tea Break	11.30-11.40 am	-do-	
Session 1: Identification, diagnosis and management of plant diseases caused by plant pathogens	11:40 am to 1:30 pm	SV Auditorium	Chairman : Dr. S.S. Chahal Co-Chairman : Dr. Jagdish Kumar Dr. Rashmi Aggrawal Rapporteur : Dr. A.K.Jain
Session 2: Production and application of bio-control agents for disease management	11:40 am to 1:30 pm	College Seminar Hall	Chairman : Dr. M.K. Naik Co-Chairman : Dr. Om Gupta Dr. H. B. Singh Rapporteur : Dr. K.D. Thakur
Lunch	1:30 to 2:15 pm	Community Hall	
Group photograph	2:15 to 2:30 pm	In front of Agriculture College	
Session 3: Plant protection equipments, their maintenance and use in successful disease management	2:30 to 4:30 pm	College Seminar Hall	Chairman : Dr. A. P. Suryawanshi Co-Chairman : Dr. S. S. Shaw Dr. A. K. Bhowmick Rapporteur : Dr. Ajay Verma
Tea Break	4:30 to 4.45 pm	College Seminar Hall	
Session 3: Plant protection equipments, their maintenance and use in successful disease management	4.45 to 6.30pm	College Seminar Hall	Session continued
Session 4: Chemical pesticides in effective management of plant diseases	2:30 to 4:30 pm	SV Auditorium	Chairman : Dr. S.M. Paul Khurana Co-Chairman : Dr. C. Chattopadhyay Dr. Rajesh Verma Rapporteur : Dr. S.K. Tripathi
Tea Break	4:30 to 4.45 pm	SV Auditorium	
Session 4: Chemical pesticides in effective management of plant diseases	4.45 to 6.30pm	College Seminar Hall	Session continued
Cultural Night	7:00 to 8:30 pm	SV Auditorium	
Dinner	8:30 to 9:30 pm	-	

Day-2, Wednesday, Date: 26.09.2018			
Events	*Time*	*Venue*	*Chairman/Co-chairman/Rapporteurs*
Break fast	8:00 to 9:00 am	Community Hall	
Session 5: Organic cultivation of crops using microbes	9:00 to 11:15 am	SV Auditorium	Chairman : Dr. R.P. Thakur Co-Chairman : Dr. R.M. Gade Dr. P.K. Mukherji Rapporteur : Dr. A.S. Kotasthane
Tea break	11:15 to 11:30 am	-do-	
Session 6: Mushroom production technology: An important agri-business	11.30 to 2.00 am	SV Auditorium	Chairman : Dr. R.P. Singh Co-Chairman : Dr K.C. Agrawal, Dr. S.S. Sharma Rapporteur : Dr. H.K. Singh
Lunch	2:00 to 2:45 pm	Community Hall	
Session 7: Farmers, producers, entrepreneurs, scientists and policy makers interactions	2:45 to 4:45 pm	SV Auditorium	Chairman : Dr. J.P. Sharma Co-chairman : Dr. M.P. Srivastava Dr. Apurba Choudhary Rapporteur : Dr. Chandra Bhanu
Valedictory Function	4.45 to 5.45 pm	SV Auditorium	Chief Guest : Shri Brijmohan Agrawal, Hon'ble Agril. Minister President : Dr. S.K. Patil, VC, IGKV Guest of Hon. : Shri Shyam Bais Shri Sunil Kumar Kujur, IAS Rapporteur : Dr. C.P. Khare
Tea break	5:45 to 6:00 pm	-do-	

Programme Details

Detail of Technical Programme

Detail of Speakers during Special National Symposium

(25-26th September, 2018)

Session 1: Identification diagnosis and management of plant disease caused by plant pathogen

Presentation	Title	Speakers	Page No.
Lead Lecture	Modern frontiers of plant protection	Dr. Jagdish Kumar, Director NIBSM, Baronda, Raipur	1-3
Lead Lecture	Forecasting for effective disease management in crops	Dr. V.S. Thakur, Solan, Himachal Pradesh	3-5
Lead Lecture	Early detection of fungal pathogens and strategies for their management	Dr. B.N. Chakraborty, Past President, IPS, Siligudi	5-6
Lead Lecture	Recent advances in detection and diagnosis of diseases inflicted by fungal pathogens	Dr. Rashmi Aggarwal, Head, IARI, New Delhi	6
Lead Lecture	Biodiversity of plant pathogens, symptoms, diagnosis and control-some glimpses	Dr. C. Manoharachary, Hyderabad	6-7
Lead Lecture	Identification, detection and diagnostics of diseases of plant quarantine importance	Dr.S.C. Dubey, NBPGR, New Delhi	7-8
Invited Lecture	Recent advances in detection and diagnosis of bacterial diseases of crops	Dr. Dinesh Singh, IARI, New Delhi	8-9
Invited Lecture	Advances in diagnostics for management of viral diseases in horticultural crops	Dr.V.K.Barnwal, IARI, New Delhi	9-10
Invited Lecture	Detection, diagnosis and management of nematode diseases	Dr. Archana U. Singh, , IARI, New Delhi	10-11
Invited Lecture	Detection, diagnosis and management of viral diseases of quarantine importance	V. Celia Chalam, NBPGR, New Delhi	11-12
Invited Lecture	Seed health testing: A phytosanitary requirement towards quarantine and conservation of germplasm in India?	Dr. Jameel Akhtar, PS Division of Plant Quarantine), ICAR-NBPGR, Pusa Campus, IARI, New Delhi	12-13
Invited Lecture	Challenges in management of soil-borne pathogens of chickpea in Central and Southern India	Dr. D.R.Saxena, PS, RAK, Sehore	13-14
Invited Lecture	On the identity of stem end rot pathogens in mango	Dr. A.K. Saxena, IIHR, Bangalore	14
Invited Lecture	Detection, diagnosis and management of important diseases minor millets	Dr.A.K.Jain, Professor, JNKVV, Rewa	15
Invited Lecture	Recent advances in diagnosis and management of wheat diseases	Dr. Vaibhav Singh, IARI , New Delhi	16
Oral	Detection and genetic variability of *Candiatus* Liberibacter asiaticus prevalent in North East India	Dr. Susheel Kumar Sharma, ICAR, RC NEH, Manipur	16-17
Poster	Poster Presentation (P01 to P49)	-	17-43

Session 2: Production and zpplication of biocontrol agents for disease management

Presentation	Title	Speakers	Page No.
Lead Lecture	Role of Plant Growth Promoting Rhizobacteria in sustainable Plant Disease Management	Dr M. K. Naik, Shivamogga	44-45
Lead Lecture	Safety and security of crops from diseases caused by pathogens through extension approach	Dr. M.N. Khare, Jabalpur	45
Lead Lecture	Management of soil borne diseases using biological agents	Dr. R.N.Pandey, Anand	46
Lead Lecture	Bio pesticides in management of plant diseases: Regulatory requirements and IPR issues	Dr.H.B. Singh, BHU, Varanasi	47
Lead Lecture	Pulses : Emerging disease scenario under climate change and management strategies	Dr. Om Gupta, Dean JNKVV, Jabalpur	48-50
Lead Lecture	Present status and future prospects of consortial application of bioagents in crop protection	Dr. Pratibha Sharma, SKNAU, Jobner-Jaipur (Rajasthan), India.	50-51
Lead Lecture	Industrial production bio-capsule based formulations of bio-fertilisers and bio-pesticides used for plant health management	Dr Sirish Taunk, SRT Agro Science Pvt. Ltd., Durg	51-52
Invited Lecture	Commercial production of bio control agents used for plant disease management	Dr.R.K.S. Tiwari, IGKV, Bilaspur	52-53
Invited Lecture	Wilt diseases of ornamental crops and their management	Dr.V. Devappa, Professor & Head(Plant Pathology), College of Horticulture, UHS, Campus, Bengaluru	54
Invited Lecture	Management of soil borne nematodes diseases using biological agents	Dr. Rakesh Pandey, CIMAP, Lucknow	54-55
Invited Lecture	Characterizations of *Pseudomonas fluorescens*	Dr. K.D.Thakur, PDKV, Nagpur	55
Invited Lecture	Success story of Biomix (a microbial consortium) in improving plant health of turmeric	Dr. K.T. Apet, Prabhani	55
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Oral	*Catenaria anguillulae* Sorokin: Media for its different types of studies	Dr. Bijeeta Thangjam, BHU, Varanasi	56-57
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Oral	Evaluation of different antibiotics, bioagent and botanical against *Xanthomonas axonopodis* pv.*citri*	Dr. S. B. Bramhankar, CoA, Nagpur	59
Oral	Bio-efficacy of *Beauveria bassiana* and *Metarhizium anisopliae* against Pyrilla (*Pyrilla perpusilla*) in Sugarcane under field condition	Dr. Shyam Singh, IGKV, Kawardha	59-60
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Invited Lecture	Role of traditional / modern storage structures in minimizing storage pest problems of food grains	Dr. A.K. Bhowmick, Professor & Head, Entomology, JNKVV, Jabalpur	78
Invited Lecture	Selection of pesticides with label claim, pre-harvest intervals and reduction of residues in vegetable crops	Dr. Gajendra Chandrakar, IGKV, Raipur	78-79
Invited Lecture	Role of modern storage structures in minimizing storage pest problems of food grains	Dr. S. Patel, IGKV, Raipur	79
Invited Lecture	Pesticide formulation, safe and judicious use of pesticides	Dr. S.B. Das, JNKVV, Jabalpur	80
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Lead Lecture	Integrated pest management of sucking pests vector of plant diseases	Dr. Rajesh Verma (Entomologist), Dean, RAK College of Agriculture, RVSKVV, Sehore	85-87
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Invited Lecture	Recent advances in management of sugarcane diseases	Dr. S.N. Singh, Professor & Head, JNKVV, Jabalpur	88
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Invited Lecture	Fourth generation fungicides for disease management	Dr. S.K. Tripathi, Professor, JNKVV, Rewa	90-91
Oral	Survey, etiology, screening of local germplasm, management of Taphrina leaf blotch (*Taphrina maculans* BUTLER) of turmeric by new generation fungicides and validation under farmers fields	Dr. Ajit Kumar Singh, CoA, IGKV, Raigarh	91-92
Oral	*In vitro* evaluation of systemic and nonsystemic fungicides against *Colletotrichum gloeosporioides* and *Alternaria alternata* causing fruit rot of pomegranate	Dr. Sunita J. Magar, CoA, Latur	92-93
Oral	Integrated pest management of chickpea by adaption analysis in eastern plateau and hills region of Chattisgarh plain zone of Balaghat district of Madhya Pradesh	Dr. P. K. Gupta, JNKVV, Jabalpur (M.P)	93
Oral	Evaluation of fungicide Trifloxystrobin 3.5% + Propineb 61.3% WG in different dosage for the management of blast disease (*Pyricularia grisea*) of rice in Bastar region of Chhattisgarh	Dr. R.S. Netam, IGKV, Jagdalpur	93-94
Oral	Which Side? Pesticide or No Pesticide	Dr. Sanjeev Kumar, JNKVV, Jabalpur	94-95
Oral	Potato late blight : Successful management through integrated approach	Dr. Noorulla Haveri, KVK, Kolar (ICAR)	95
Oral	Effective management of sesame and niger diseases	Dr. K.N. Gupta, JNKVV, Jabalpur	95-96
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Lead Lecture	Understanding and solving the problem of guava wilt for guava growers	Dr. A.K. Misra, Former Project Coordinator, Subtropical Fruits and Head, Division of Crop Protection, CISH, Lucknow	124-125
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Lead Lecture	*Trichoderma:* Biocontrol and beyond	Dr. P.K. Mukherji, BARC, Mumbai	126
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Invited Lecture	Multiplication of *Trichoderma* sp. using local substrate and its effect on plant growth	Dr. A.S. Kotasthane, IGKV, Raipur	129
Invited Lecture	Utilization of microbial technologies for eco friendly crop production	Dr. S.B. Gupta, Prof. & Head, Agril. Microbilogy, IGKV, Raipur	130
Oral	Role of microbes in organic farming and sustainability of agriculture system	Dr. V. K. Yadav Department of Plant Pathology, College of Agriculture, JNKVV, Ganj Basoda	130-131
Oral	Organic inputs management to overcome disease infection and higher productivity of chilli in Sagar District of Madhya Pradesh	Dr. Ashish Kumar Tripathi, KVK, Sagar (MP)	131
Oral	Host specific plant growth promoting activity of IAA producing and phosphate solubilizing fluorescent *Pseudomonas*	Priyanka, CoA, Raipur	131-132
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Lead Lecture	Enhancing nutraceuticals potential of Lentinus edodes mushroom from a pharmaceutical point of view	Dr. Satyawati Sharma, IIT, New Delhi	144
Lead Lecture	Present Scenario of mushroom production in Chhattisgarh	Dr.M.P.Thakur, DI, IGKV, Raipur	145-146
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Invited Lecture	Seasonal production of button mushroom *Agaricus bisporus* in India	Dr. D. Bahukhandi, IARI, New Delhi	149-150
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Oral	Yield Performance of Paddy Straw Mushrooms(*Volvariella volvacea*) at Different Locations of Chhattisgarh	Upendra Kumar Nag, CoA, Raipur	156-157
Oral	Oyster mushroom home growing kit: A alternative marketing strategy adopted by women self help groups of district Gariyaband, Chhattisgarh	Tushar Mishra, KVK, Gariyaband	157
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Technical Session-I :

Identification, Diagnosis and Management of Plant Diseases caused by Plant Pathogens

Lead Lectures
LL 01: Modern frontiers of plant protection

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Biological stresses that affect metabolism of crops and livestock to reduce the expression of genes that are responsible for high yield of crop commodities and productivity traits in animals influencing the national agricultural productivity. Various processes of the invasion of biotic stresses in crops are genetically controlled by both pests (insect, mites, diseases, nematodes) and their hosts. Such pests along with weeds, vertebrate pests including rodents are major causes for crop yield reduction. In general, crops are lost to the tune of 25% due to insects, due to diseases including that of nematodes up to 20%, vertebrate pests including rodents about 6-8% etc. Added pressure is that global population is likely to reach 7 billion by 2025 and 10 billion by 2050. The agricultural production has to be increased from these lands that are under stress. The research in stress tolerance response in crops and animals has increasing importance, not only because agricultural production need to keep pace with increasing demand for agricultural produce from dwindling resources, but also due to possible changes in pest scenario with climate change that may make the environment much more hostile for agricultural production than what is today. India has 33% irrigated land and 67% area is under rainfed/ dryland crops and cultivation, where farmers are resource poor, and they are vulnerable to biotic stresses. Farmers from remote parts of the country are unable to deploy various modern tools to manage biotic stresses on their fields, which creates more pressure to sustainability of resource poor, less knowledgeable farmers. Poor access to tools and products of modern tool box of crop/animal health management is retrogressive to ambitions of growth in agriculture. Biotic stresses that emanated from intensive agriculture were primarily due to anomalous expansion of nutritious food source, and the crop husbandry practices with commercial scale production plan did upset the natural food chain and agri-biodiversity by selecting a few organisms in the agro-ecologies. In comparison to dryland and rainfed agro-ecosystems, irrigated crop production ecologies were more ravaged by various biotic stresses. The avoidable crop loss in India is estimated to be about 18-20% due to all the types of pests. Upsurge in pestilence has been in recent times was due to weather aberrations too.

Pesticides are chemical toxicants that are designed to check pest-build up when deployed at the identified dosage and time of application using the right applicator. However, in the excitement to enhance the production and commercial agriculture tended to ignore the natural balance of food chains and webs, the sudden spurt in pestilence became the order of the day. India adopted integrated pest management (IPM) as the policy drive to manage the various crop pests. The ideology of integration of all pest suppression tools in the IPM tool box brought in balanced approach to restore natural balance of food chains and webs in the agricultural farms. Today diseases such as potato late blight, rice blast and wheat rust are fairly contained due to intense focus on developing tolerant crop varieties and other management tools. Similarly, the extensive cultivation of GM cotton could reduce the pestilence due to pulse pod borer in pulses. Large-scale intensive break out of mites, aphids, jassids and other pests has been reduced due to combination of modern chemistry of pesticides that have environmental friendly formulation chemistry. Such pesticides can be therapeutic and could enable restoration of natural agro-ecological food webs. Hence the upsurge of diseases and other pests did get suppressed to farmers' advantage of reduced pestilence in farms.

New frontiers of plant protection research required to sustain agricultural production in India

The source of the insecticidal toxins produced in commercial transgenic plants is the soil bacterium *Bacillus thuringiensis* (Bt). Bt strains show differing specificities of insecticidal activity toward pests, and constitute a large reservoir of genes encoding insecticidal proteins, which are accumulated in the crystalline inclusion bodies produced by the bacterium on sporulation (Cry proteins, Cyt proteins) or expressed during bacterial growth (Vip proteins). Deployment of transgenic crops expressing a single specific Bt toxin can lead to problems in the field, where secondary pest species are not affected, and can cause significant damage to the crop. Introduction of additional Bt cry genes into the crop can afford protection against a wider range of pests. Commercial use of transgenic cotton containing two Bt genes began in 1999, 3 years after the release of the original single Bt variety. Cotton plants expressing both Cry1Ac and Cry2Ab proteins were more toxic to bollworms (*Helicoverpa zea*; target pest) and two species of armyworms (*Spodoptera frugiperda* and *Spodoptera exigua*; secondary pests) than cotton expressing Cry1Ac alone in laboratory trials. Modification of Bt toxins by site-directed mutagenesis to increase toxicity toward target pests has been employed as an alternative to the "domain swap" approach. The key role of domain II in three-domain Cry proteins in mediating interactions with insect receptors has been exploited by mutation of amino acid residues in the loop regions of this domain. Mutation of Cry1Ab increased its toxicity toward larvae of gypsy moth (*Lymantria dispar*) by up to 40-fold. Potential exploitation of lectin genes to confer insect resistance in transgenic plants has targeted hemipteran plant pests, which are not affected by known Bt toxins but have been shown to be susceptible to lectin toxicity. Expression of the Man-specific snowdrop lectin (GNA) in transgenic rice plants using constitutive or phloem-specific promoters gave plants that were partially resistant to rice brown plant hopper (*Nilaparvata lugens*) and other hemipteran pests. Reductions of up to 50% in survival were observed, with reduced feeding, development, and fertility of survivors.

Bacterial cholesterol oxidase has an insecticidal activity comparable to Bt toxins, dependent on its enzyme activity, which is thought to promote membrane destabilization. Expression constructs containing part or all of the coding sequence of the protein, or the coding sequence fused to a chloroplast-targeting peptide, resulted in production of active enzyme in transgenic tobacco. Avidin has a strong insecticidal effect on many insects, although susceptibility varies widely between different insect species (apparently based on biotin requirements). Expression of avidin in transgenic maize initially aimed to produce the protein as a high-value product, but maize seed containing more than 0.1% avidin (of total protein) was fully resistant to larvae of three different coleopteran storage pests. Genes encoding two Cyt P450 oxidases and a UDP glycosyltransferase from sorghum (*Sorghum bicolor*) have been transferred to *Arabidopsis*, resulting in the production of the cyanogenic glycoside dhurrin from Tyr. The resulting plants produced hydrogen cyanide on tissue damage and showed enhanced resistance to attack by the flea beetle *Phyllotreta nemorum*, a specialist feeder on crucifers. Other secondary metabolites that have been produced in transgenic plants include the alkaloid caffeine (in tobacco; by the introduction of three genes encoding N-methyl transferases. Engineering volatiles emitted by plants offers possibilities for new methods of crop protection. Volatile composition has been altered in tobacco by RNA interference (RNAi) - mediated suppression of a cytP450 oxidase gene expressed in trichomes, and in Arabidopsis by constitutive overexpression of a plastid dual linalool/nerolidol synthase. The transgenic plants deterred aphid colonization but were not wholly resistant. Volatiles can also be used as attractants for natural enemies of pests; for example, *Arabidopsis* plants transformed with the maize terpene synthase gene TPS10 emitted the sesquiterpene volatiles normally produced in maize and attracted parasitoid wasps that attack maize pests. Volatiles used by insects to communicate with each other can also be exploited; the sesquiterpene (E)-b-farnesene is an alarm pheromone in aphids and attracts aphid predators and parasitoids. When *Arabidopsis* was transformed with an (E)-β-farnesene synthase gene from mint (*Mentha piperita*), the resulting plants showed significant levels of aphid deterrence in choice experiments and were attractive to the aphid parasitoid *Diaeretiella rapae*.

Disrupting gene function by the use of RNAi is a well-established technique in insect genetics based on delivery by injection into insect cells or tissues. The observation that RNAi could also be effective in reducing gene expression, measured by mRNA level, when fed to insects has led to development of transgenic plants producing double stranded RNAs (ds RNAs) exhibiting partial resistance to insect pests. Transgenic maize producing ds RNA directed against V-type ATPase of corn rootworm showed suppression of mRNA in the insect and reduction in feeding damage compared to controls. Similarly, transgenic tobacco and *Arabidopsis* plant material expressing ds RNA directed against a detoxification enzyme (Cyt P450 gene CYP6AE14) for gossypol in cotton bollworm caused the insect to become more sensitive to gossypol in the diet.

Nanotechnological applications in plant disease management still infancy. However, there have been some examples where nanotechnology have been used for nanosized silica silver, (Si Ag) particles which were successfully used for contorlling fungal pathogens *viz. Pythium ultimum*, *Magnaporthe griseaus*, *Botrytis cinerea*, *Colletotrichum gleosporioides* , *Rhizoctonia solani* and also bacterial pathogens such as *Xanthomonas campestris*. Iron nano particles coated with carbon have been used for treating specific plant parts (local applications). A product of nanotechnology "Nano- Gro" has been launched as plant growth regulator and immunity enhancer. Another product "Nano-5" is available in the market as natural mucilage organic solutions for controlling several plant pathogens and pests.

LL 02: Forecasting for effective disease management in crops

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Forecasting of plant diseases is the prediction for the occurrence/outbreak of diseases in a specified area in advance, so that suitable control measures can be undertaken before time to avoid losses. It involves a teamwork and require time, energy and money. It is used as an aid to timely application of chemicals. Forecasting diseases is a part of applied epidemiology; hence, knowledge of epidemiology is necessary for accurate prediction and warnings. The factors of epidemic and its components should be known in advance before forecasting is done. Amongst the first warning services to be established for growers, were the grapevine downy mildew forecasting in France, Germany and Italy in 1920s. Subsequently, forecasting based disease management has been developed for many diseases and being practiced for different crops in various countries of the world *viz.* grapevine downy mildew (Australia, France, Germany, Greece, Italy, Romania, Spain, Russia, Yugoslavia), cucurbits downy mildew (USA), potato late blight (Australia, Brazil, Finland, France, Germany, Greece, India, Japan, the Netherlands, Norway, Peru, Russia and UK), tobacco blue mould (Canada, USA), apple scab (Australia, Canada, India, Netherlands, New Zealand, USA), sugar beet root rot (USA), corn bacterial wilt (USA), sugar beet curly top (USA) etc.

The input data for forecasting requires information about host factors such as prevalence of susceptible varieties in the given locality, response of host at different stages of growth to the activity of pathogen (seedling/adult stage susceptibility) and density as well as distribution of host over an area of cultivation. Dense populations of susceptible variety invite quick spread of an epidemic. Growing susceptible varieties in scattered locations and that too in a limited area are less prone to epiphytotic. The pathogen factors such as amount of initial inoculum, spore germination, infection, incubation period and sporulation on the infected host, re-dissemination of spores, overwintering stages, inoculum potential and density in the seed, soil, and air has a greater role in disease forecasting. Host-parasitic relationship and pathogen generations and cycles leads to disease dynamics and epiphytotic. All these host and pathogen factors are jointly influenced by prevailing environmental factors such as temperature, humidity, leaf wetness, light intensity, wind velocity, sunshine, etc its time and durations finally amounts to epiphytotic.

There are few requirements, which must be satisfied before a useful and successful disease forecast is made. The disease must cause economically significant damage in terms of yield loss or quality. Damage assessment is essential to develop strategy for controlling a disease e.g. in general annual estimation of yield loss due to barley powdery mildew ranges from 6 to 13 per cent. Potato late blight can cause a yield loss of 28 percent if the disease reaches the 75 per cent stage by mid-August. Disease like apple scab reduces the quality of the produce, lower the value of the harvested crop and cause considerable financial loss to the growers. Control measures must be available at an economically acceptable cost. The disease must vary each season in the timing of the first infections and its subsequent rate of progress. If it does not, there is no need for forecasting. The criteria or model used in making a prediction must be based on sound investigational work carried out in the laboratory and in the field and tested over a number of years to establish its accuracy and applicability in all the locations where its use is envisaged. Growers must have sufficient manpower and equipments to apply control measures when disease warning is given. Long-term warnings or predictions are more useful than short-term warning or predictions.

Disease forecasting requires field observations on the pathogen characters, collection of weather data, variety of the crop and certain investigations and their correlations. Usually the disease forecasting is done based on primary inoculum, weather conditions, correlative information and through computer applications. Presence of primary inoculum, its density and viability are determined in the air, soil or planting material. Occurrence of viable spores or propagules in the air can be assessed by using different spore trapping devices. Spore trapping is useful for understanding epidemiology of a disease and behaviour of the pathogens. This helps in developing models on dispersal of pathogens or on epidemiology of the disease and to formulate methods of management.

In case of soil-borne diseases, the primary inoculum in the soil can be determined by monoculture method. Presence of loose smut of wheat, ergot of pearl millet and viral diseases of potato can be detected in the seed lots at random by different seed testing methods. Seed testing methods can be used to determine potential diseases incidence and enable decision to be made on the need for chemical seed treatment. The extent of many virus diseases is dependent on the severity of the preceding winter, which affects the size of vector population in the growing season.

Weather conditions *viz.,* temperature, relative humidity, rainfall, light, wind velocity etc., during the crop season and during the inter crop season are measured. Weather conditions above the crop and at the soil surface are also recorded. Weather data of several years are collected and correlated with the intensity of the diseases. The data are compared and then the forecasting of the disease is done. Forecasting criteria developed from comparisons of disease observation with standard meteorological data have been provided foe diseases like *Septoria* leaf blotch of wheat, fire blight of apple and barley powdery mildew. Computer based system gives the results quickly and simulation of epidemics has made it practically possible to use the forecasting systems such as EPIDEM to simulate epidemics of early blight of tomato and potato, EPIVEN for apple scab, TOMCAST for tomato diseases and BLITCAST for late blight of potato.

In case of horticultural crops, *Marssonina* blotch development in apple is based on leaf wetness duration *i.e.* minimum for 6 h on mature leaves and 18 h on young leaves at 20 ^{0}C temperature and 70 per cent relative humidity at least continuously for 5-6 days, induce yellowing and leaves defoliation start within 3-5 days. Forecasting of apple scab involves ascospore maturation and quantity (no. of mature ascospores discharged per cm^{2}of overwintered leaves i.e. minimum 20 asci from 20-25 pseudothecia to start the disease), ascospore concentration in the air and the duration of infection periods. Recently, Mashobra-Diseases-Forecast mechanism indicating the effect of temperature and rainfall during winter, that a unit change *i.e.* 1.0C increase in the effect of temperature followed by rain/moisture is responsible for epidemic conditions and increase in scab incidence by 4.766 units and 22.09 units disease intensity which amounts for 85.54 per cent severity on leaves and 44.86 per cent on fruits and *vice versa*. Hence, a computer based Mashobra –Disease-Forecast programme predict the annual epidemic and non-epidemic conditions with an input of integrated management options.

However, the farmers need more precise, accurate, sensitive, simple and practical forecasts that may help them to determine whether a plant infection is likely to occur, whether to spray a crop immediately or to wait for several more days for spray. For further improvements in forecasting of diseases latest techniques such as Geographical Information System and Geographical Positioning System can be utilized for spatial and temporal analysis of the development of plant disease epidemics over relatively large geographical areas and locating diseases.

LL 03: Early detection of fungal pathogens and strategies for their management

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Disease diagnosis is an art as well as science. We use the scientific method to perform and interpret tests for the detection of pathogens. The art lies in synthesizing information on symptom development, case history, and the results of laboratory tests to determine the most likely cause(s) of disease. Understanding the difference between the terms "diagnosis" and "detection", which are mistakenly used interchangeably, is crucial. Choice of diagnostic test(s) can greatly influence the diagnosis. Many techniques that differ in sensitivity, specificity, reliability and cost effective are available for the detection of plant pathogens. Over the past few decades, immunological (ELISA formats, DIBA, Western blot, indirect immunofluorescence) and PCR based molecular diagnostic methods have increasingly received attention as an alternative or complement to conventional methods.

Innovative strategies have been developed using agriculturally important microorganisms for biotic stress alleviation in cereals, pulses, horticultural and plantation crops. Induced immunity in plants following application of bioinoculants (AMF, BCA, PGPR, PGPF) have been demonstrated. Time course accumulation of *chitinase (CHT), β-1, 3 glucanase (GLU)* and phenyl alanine ammonia lyase (PAL) increased markedly in treated plants in comparison to healthy control following challenge inoculation with fungal pathogen Immunolocalization of chitinase and glucanase in bioinoculant treated and pathogen inoculated leaf tissue was further confirmed by transmission electron microscopy using PAb of chitinase, glucanase and gold labelled conjugates. Microarray analysis were done to compare up regulated and down regulated gene expression among untreated pathogen inoculated, bioinoculants treated and pathogen inoculated plants as well as untreated uninoculated ones.

On the other hand, the use of spent mushroom substrate (SMS) as well as spent mushroom compost (SMC) as soil amendment has been recognized in recent times in growing crop as a possible means of enhancing sustainable agriculture which are generally non-toxic to the cultivated crops and provide the balanced nitrogen and carbon source for the growing plants. SMS further degraded in the soil humus which is very important to maintain soil structure, good aeration, and water holding capacity and maximize the fruit crop productivity. The addition of spent compost to agricultural field has been found to be an effective soil manure and conditioner and has been found to increase the yield of some leafy vegetables crops. The yield and quality of different crop systems increase upon using the SMS as manure alone or combination with inorganic fertilizer soil amendment with spent composts of button mushroom (*Agaricus bisporus*) was found to be an alternative approach for management of dry root rot disease of mandarin plants caused by *Fusarium solani* in Darjeeling hills. Spent composts significantly reduced fungal wilt of citrus plant under green house conditions.

Disease severity was reduced by application of SMC which was evident with increased activity of defense enzymes (PAL, POX, and β-1,3-glucanase and chitinase). Cellular localization of β-1,3-glucanase and chitinase were also confirmed by indirect immunofluorescence using PAbs of chitinase and glucanase and FITC conjugates. Moreover, spent mushroom compost improved all agronomic characteristics of citrus plants such as plant height, number of shoots per plant, root length as well as flowering and fruiting. The ability of SMC to reduce disease severity and enhance plant growth could be attributed to the alteration of physical structure of soil and enhancement of plant friendly microbes by the compost.

LL 04: Recent advances in detection and diagnosis of diseases inflicted by fungal pathogens

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Management practices in crop health and food safety are critically linked with detection of plant pathogens at the early stages of the diseases. At present specific, fast and sensitive technologies which should be simple and grower friendly are very valuable, requiring no specialized staff for diagnosis of a disease in the field. This is essentially required in the recent scenario of changing climatic conditions, which is causing the appearance of a pathogen in areas where years ago they were unexpected. In this paper some of the diagnostic tools currently being used for fungal plant pathogens will be discussed along with some novel tools/techniques developed. Laboratory based techniques such as polymerase chain reaction (PCR), immunofluorescence (IF), fluorescence in-situ hybridization (FISH), enzyme-linked immunosorbent assay (ELISA), flow cytometry (FCM) and gas chromatography-mass spectrometry (GC-MS) are some of the direct detection methods. Indirect methods include thermography, fluorescence imaging and hyperspectral techniques. Biosensors based on highly selective bio-recognition elements such as enzyme, antibody, DNA/RNA etc are being developed as new tools for the early identification of crop diseases. Some of the promising techniques that can be applied to in-field molecular detection of plant pathogens and how these techniques can change the way farmers and pathologists are diagnosing plant diseases further impacts the management. Loop mediated isothermal amplification and recombinase polymerase amplification, are already being successfully used for routine diagnosis. However, most technologies still need validation in the plant pathology field, where they have a promising future for in-field diagnosis when combined with simple DNA extraction methods, reagent stabilization techniques and their integration into portable devices. The accurate and fast diagnosis can be used to improve disease control decision making. Molecular methods have been developed in our laboratory to detect several pathogens infecting wheat and rice, which shall be discussed during the presentation.

LL 05: Biodiversity of plant pathogens, symptoms, diagnosis and control- Some glimpses

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Agriculture has shown phenomenal growth after green revolution and in recent past due to biotechnological applications, innovations in agricultural technologies, development of disease resistant varieties, adoption of plant protection measures including integrated disease management and also farmers commitment to boost crop production such as cereals, pulses, oilseed crops, fruit crop and others which have been offering food and nutritional security. However, the growing population requires around 50% of more production than existing one. Approximately, 32% losses have incurred de to fungal, viral, bacterial, mycoplasmal, phytoplasmal, nematode and other factors.

Accurate identification of symptoms, proper estimate of the severity of disease, identification of pathogen, culturing of pathogen, establishment of Koch postulates, disease index and severity, impact on crop productivity, recognition of virulence, inoculums potential, epidemiological inferences, host/ pathogen variation and related issues and challenges are of utmost importance. Reliable identification of the pathogen upto species/ formae specialize, pathover, biover and races from important aspect along with proper identification of symptoms. Ultimately, having understood all the above, clear-cut disease control has to be envisaged to the farmer. Farmer has to get satisfied at field level then only the future needs of food production can be achieved.

Identification and diagnosis of plant pathogens in the process off early infection can help for the control of the disease. Viral, bacterial, mycoplasoial and fungal diseases need to be identified initially by studying the symptoms and the respective pathogens based on morphotaxonomic criteria. In recent times, DNA probes such as RAPD, RFLP, ISSR, LSU, URP, ELISA, PCR, Q-PCR etc have been developed besides serological, biochemical, histo-chemical, DNA array and membrane based technologies. All these are aimed at proper evaluation of pathogen and disease in shorter time.

Farmer is interested in the early and rapid detection of disease and its control. Exclusion of pathogen, crop rotation, good cultural practice, judicious use of fungicides, maintaining soil health, breeding for disease resistance, phytosanitation, use of biocontrol agents, and transgenics etc are some of the disease control measures which are in vogue.

LL 06: Identification, detection and diagnostics of diseases of plant quarantine importance

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The National and International exchange of germplasm has immense importance for their utilization in evolving high yielding varieties. However, exchange of germplasm always carry an inherent risk of introducing exotic/new pathogens/pest or virulent races/ pathotypes/ biotypes in the areas where they do not exist. To avoid entry and further spread of such pathogens, a regulatory mechanism under Destructive Insect Pest Act 1914 i.e. Plant Quarantine (Regulation for Import into India) Order 2003 (PQ Order 2003) is available. More than 1000 quarantine pests and 31 exotic weed species have been mentioned in the PQ Order 2003. ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi is authorized by the Government of India for conducting quarantine processing of plant genetic resources being introduced into the country for research purposes. During quarantine clearance, planting materials are tested for the presence of pathogens including those listed in PQ Order 2003 as well as pathogens assessed during pest risk analysis for the crops not covered under PQ Order. Reliable diagnosis and detection are critical for quarantine pathogens to avoid their introduction and further spread. Traditional detection techniques are based on disease symptoms, morpho-taxonomy, biochemical tests, transmission assays, host range and grow-out test etc. but they are time-consuming, requires skilled taxonomists for reliable identification and are sometimes not sensitive enough to detect low levels of infections. Molecular techniques including enzyme linked immuno-sorbent assay (ELISA), polymerase chain reaction (PCR), real-time PCR, multiplex PCR, and microarrays, loop-mediated isothermal amplification, and non-destructive testing methods based on biosensors have been developed and are being used for sensitive and specific detection of plant pathogens. High throughput sequencing platforms (Next generation sequencing) and lateral flow assays are also have potential for detection of pathogens. Large number of pathogens were intercepted during quarantine processing in germplasm imported from various countries even after declaration of freedom from pests in phytosanitary certificates. Therefore, highly sensitive and practically feasible detection technologies are required for quarantine testing for bio-securing the nation.

Invited Lectures

IL 01: Recent advances in detection and diagnosis of bacterial diseases of crops

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Bacteria are a second important pathogen after fungi to cause various plant diseases. In India, more than 200 bacterial diseases of plants are known and out of these, 75 diseases are of economic importance. They damage the crops by reduction of assimilating surface by yellowing and necrosis, death of organs complete plants, malformation and growth reduction. Losses caused by bacterial diseases are mainly economic, but may also be personal or aesthetic. The estimated loss due to bacteria is varied from disease to disease, environmental conditions and also place to place. However, the losses due to some important bacterial diseases caused by *Pseudomonas syringae* pv *glycinea* (64%), *Ralstonia solanacearum* (9%), *Xanthomonas axonopodis* pv. *malvacearum* (5%) and *Xanthomonas campestris* pv. *campestris* (1%). In 1978, only nine plant pathogenic bacteria have been reported; whereas now 39 bacteria genera (economically important genera: *Agrobacterium, Arthrobacter, Candidatus* Liberibacter, *Clavibacter, Dickeya, Enterobacter, Erwinia, Janthino bacterium, Leifsonia, Candidatus* Phytoplasma, *Pseudomonas, Ralstonia, Streptomyces, Xanthomonas, Xylella* and *Xylophilus)* are reported because of development of new tools and techniques for characterization and identification of bacteria. In any plant diseases management, correct diagnosis is play a vital role. There are 8 steps in diagnosis such as assessment of symptoms (leaf spot, excrescences and galls, tumours, wilting, necrosis rotting bacteria embedded in slime), isolation pathogenic bacteria, pure culture isolated bacteria, identification of pure culture, pathogenicity, reisolation from inoculated plants, reidentification of reisolate and diagnosis report. Three decades ago, detection and diagnosis techniques available for bacteria were based on microscopy, isolation, biochemical characterization, serological techniques (mainly IF), biossays and pathogenicity tests. The most commonly serological assays for bacteria detection and identification are agglutination, enzyme-linked immunosorbent assay (ELISA), immunofluorescence, lateral flow strip tests or flow-through assays immunodiagnostic assays using *Ralstonia solanacearum* specific. Molecular techniques based on hybridization or amplification, and especially on PCR, have been developed for the most important plant pathogenic bacteria. Although PCR can reach high sensitivity and specificity, its introduction for routine detection has been hampered by a lack of robustness. For PCR, the sequences of most published primers for phytobacteria have been reported to most important plant pathogenic bacteria. The time required until the final result is usually less than 24 h whereas that required for conventional microbiological detection of bacteria is of the order of several days in the case of a negative result and 5–10 days in the case of a positive result due to the tests necessary to confirm it. Fluorescence in situ hybridization Fluorescence in situ hybridization (FISH) is a technique applied for bacterial detection that combines the simplicity of microscopy observation and the specificity of hybridization. Its use in detection of plant pathogenic bacteria is recent and is dependent on the hybridization of DNA probes to species-specific regions of bacterial ribosomes. In practice, however, the detection level is 10^3 cells/ml. Liquid enrichment also allows the detection of *R. solanacearum* in a viable but non culturable state (VBNC) from water samples at low temperature. When the sensitivity of detection is not good enough, a nested PCR can be helpful, but it requires two rounds of amplification in different tubes, resulting in a high contamination risk. Several interesting alternatives with single closed tubes have been developed in order to avoid this problem. Enrichment of target bacteria on semi selective media also has been used to enhance the sensitivity of PCR reactions; such test often termed BIO-PCR to improve sensitivity of the primer. Molecular marker has been developed based on hrp gene and locus specific to *R. solanacearum* amplified at 323 bp and found sensitive to detect up to 100 cfu/ml. To improve the sensitivity of PCR primer, enrichment of targeted bacteria is done by incubating samples on general or selective media followed by PCR with specific primers has been used earlier to detect bacteria from asymptomatic tomato, soil and irrigation water and also distinguished between it and other saprophytic bacteria isolated endophytically from same host. Multiplex PCR allows the simultaneous and sensitive detection of different DNA or RNA targets in a single reaction. On the other hand, PCR detection protocols can be designed to verify the presence of more than one pathogen in plant material by looking for common specific sequences in two or moreof them or to detect related bacteria on multiple hosts. A multiplex polymerase chain reaction (PCR) protocol has been developed for simultaneous detection of *R. solanacearum* and *Erwinia carotovora* subsp. *carotovora* from potato tubers. A set of oligos targeting the pectatelyase (pel) gene of *E. carotovora* subsp. *carotovora* and the universal primers based on 16S r RNA gene of *R. solanacearumare* used. The standardized multiplex PCR protocol could detect *R. solanacearum* and *E. carotovora*subsp. *carotovora* up to 0.01 and 1.0 ng of genomic DNA, respectively. Loop-Mediated Isothermal Amplification (LAMP) method proved to be the best approach for amplifying nucleic acid with high specificity, efficiency, and rapidity without the need for thermocycling. The principle is based on strand displacement activity followed by amplification using a unique DNA polymerase and a set of four specially designed primers that recognize a total of six distinct sequences on the target DNA. Species-specific primers were designed by targeting the *R. solanacearumfli* C gene coding for flagellar proteins. Amplification performed for 60 min at 65^{0}C resulted in production of magnesium pyrophosphate, which increased the turbidity of the solution, permitting visual assessment. Among molecular techniques, multiplex PCR is increasingly used because it improves the efficiency of diagnostic PCR. In the near future multiplex PCR will probably be adapted for the simultaneous detection of bacteria of one particular crop and for the simultaneous detection of other major plant pathogens such as viruses, viroids, bacteria, and fungi in the same reaction to save time and money.

IL 02: Advances in diagnostics for management of viral diseases in horticultural crops

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The infection of viral pathogens is a serious concern in many of horticultural plants such as fruits, vegetables and ornamentals which are characterized by perennials growth habits and are propagated by vegetative propagation. Due to perennial growth habits of these crops the initially infected propagating material accumulate the viral load over the years and the polyetic viral diseases cause serious losses to the production and productivity. Therefore, use of virus free clean planting material is of prime importance to improve the quality and reduce the losses induced by viral diseases in vegetative propagated crops. To ensure the production of virus free quality planting material, reliable diagnostic assays such as enzyme linked immune sorbent assay (ELISA) and PCR/RT PCR are often used. ELISA is a simplified, cost effective, sensitive method that can be subjected for large scale screening. However, availability of diagnostic reagents such as polyclonal antibodies and conjugates are major constraints for development of ELISA. Expressed and purified recombinant coat protein of several viruses infecting banana, grapevine, potato and orchids have been utilized as an alternative to purified virus preparation for production of diagnostic reagents and standardization of

ELISA kits on large scale. The other common method of virus diagnostics *i.e.* The PCR/RT-PCR based assays are more sensitive than ELISA but they are laborious, time consuming and require well equipped laboratories and skilled manpower. To overcome the complexities of PCR/RT-PCR based virus detection, a novel and rapid isothermal amplification methodology, recombinase polymerase amplification (RPA) assay was developed in 2006.The rapid speed, sensitivity and simplicity of RPA makes it an ideal technique for plant virus indexing on a large scale. RPA does not require purified DNA template and can be easily performed using a very small amount of crude sap extract. It can be performed at a constant low temperature (37°C-42°C) dispensing the use of expensive thermal cycler. In comparison to conventional PCR which takes around 3 hours for analysis, RPA amplification and analysis of amplicons can be easily done within one hour. RPA is superior to other isothermal amplification techniques such as loop mediated isothermal amplification (LAMP).The RPA reactions can be monitored in three ways; i) Basic RPA reactions can be checked by agarose gel electrophoresis, ii) Exo-RPA reactions can be monitored in real-time instrument using exo probes and iii) Device free detection is possible with lateral flow (LF)-RPA reactions which use LF-probes allowing to view the RPA products directly on LF strip. RPA has been successfully used for detection of few plant DNA/RNA viruses and bacterium. It has been developed and evaluated for specific diagnosis of banana bunchy top virus, cucumber mosaic virus and citrus greening bacterium. Our study has indicated that the rapid speed, sensitivity and simplicity of RPA makes it an ideal technique for plant virus indexing on a large scale in resource constrained laboratory and can be of immense use for production of virus free planting material.

IL 03: Detection, diagnosis and management of nematode diseases

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Plant- parasitic nematodes are one of the major limiting factor in crop production throughout the country. They are distributed all over the world in different kinds of habitats and found in nearly every biological niche that supports life. They damage the crops not only by feeding on plants but also by interacting with various other organisms. Sasser and Freckman (1987) have indicated an annual crop loss due to phytonematodes on worldwide basis to the tune of $100 billion. Losses estimated due to nematode attack to different cultivated crops all over the world by FAO is around 400 million dollars. The yields of okra, tomato and brinjal are reduced by 27.3 percent respectively due to *Meloidogyne incognita* infestation @ 3-4 larvae g/soil under field conditions Large number of plant parasitic nematode is recorded from the rhizosphere of many crops like Root-knot nematode (*Meloidogyne* spp.), Reniform nematode (*Rotylenchulus reniformis*), cyst nematode (*Heterodera* & *Globodera* spp.), lesion (*Pratylenchus penetrans*) etc. Among all the plant parasitic nematodes, root-knot nematode (*Meloidogyne* spp.) are the major phytonematodes causing damage to crops. Visible symptoms of nematode attack often include reduced growth, varying degrees of chlorosis, wilting and sometimes death of plants. The four most common species *viz*., *M. incognita*, *M. javanica*, *M. hapla* and *M. arenaria* leads to the formation of conspicuous root galls or knotted root system, which could be easily recognized by naked eye. *M. incognita* and *M. javanica* are widely spread whereas *M. hapla* is encountered under temperate conditions and attack potato and other vegetables while *M. arenaria* infects chillies and groundnut. Root lesion infected plants by *Pratylenchus* spp. show gradual decline or lack of plant vigour with stunting leading to rapid wilting. On the roots, there is formation of lesions and necrosis, which provides site for other micro-organisms to infect, grow and reproduce, thereby leading to other disease complexes. Thus, nematodes either alone or in combination with other pathogens like fungi, bacteria, viruses, mycoplasma, etc. then the intensity of disease often gets aggravated hence, constitute an important constraint to world agricultural production.

The symptoms caused by the plant parasitic nematodes are mainly divided into two types i.e., above ground and below ground symptoms. The above ground symptoms are non-specific and may be mistaken for the micronutrient deficiencies in the soil. This include stunting, yellowing, wilting, patchiness, chlorosis, wilting, delay in flowering and fruit formation, reduction in plant size, yield etc. The below ground symptoms are small galls/knots seen on the roots which at a later stage coalesce to form very large galls, bushy appearance of secondary roots, total reduction in root system and Lesions and "Dirty Roots".

Therefore, the idea of keeping the nematode population below the economic damage level by adopting different available tactics is advised to the growers. The young tender seedlings of various crops are very much vulnerable to attack by nematode while the older plants achieve some degree of tolerance. The different management practices adopted for controlling nematodes are Cultural methods (Fallowing, deep summer ploughing, use of cover crops/trap crop, time of planting/harvesting, selection of healthy Propagating material, Crop rotation and use of organic amendments), Physical methods (Solarization and hot water treatment), Biological methods (use of Fungi, bacteria, etc), Chemical method, Use of Resistant Varieties and Integrated nematode management. Individual methods of nematode control have either proved ineffective or uneconomical against plant-parasitic nematodes. Therefore, integration of various suitable tactics may be an eco-friendly, economically viable and practically feasible approach for managing nematode problems. Hence, suitability of different practices in case of agricultural crops should be adopted based on feasibility, utility and compatibility in the IPM programme and thus successfully managing nematode population. However, effective extension awareness programmes have to be launched among the farming community for imparting a clear understanding of nematode damage.

IL 04: Detection, diagnosis and management of viral diseases of quarantine importance

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The global movement of seeds and other planting material has the potential to introduce new pests including viruses which may pose potential risk to the agriculture of importing country. Viruses are one of the important yield reducing factors in crops. The National Plant Protection Organizations assume responsibility for protecting their countries from the unwanted entry of new viruses and for coordinating programmes to eradicate those that have recently arrived and are still sufficiently confined for their elimination to be realistic. The exclusion can be achieved by a combination of regulatory and technical approach that can ensure biosecurity for a 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 agricultural commodities meant for commercial purpose. The imported germplasm material including transgenics are subject to quarantine processing at the ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), 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 including viruses. The strategies for exclusion of viruses in quarantine at ICAR-NBPGR include post-entry quarantine growing/ inspection, electron microscopy, ELISA and RTPCR. A large number of viruses were intercepted during the past two decades including 19 viruses: *Barley stripe mosaic virus*, *Bean mild mosaic virus, Bean pod mottle virus*, *Broad bean mottle virus, Broad bean stain virus, Broad bean true mosaic virus*, *Cherry leaf roll virus*, *Cowpea mottle virus, Cowpea severe mosaic virus,* Dioscorea latent virus, *Garlic virus C*, High plains virus, *Maize chlorotic mottle virus*, *Pea enation mosaic virus*, *Peanut sunt virus*, *Pepino mosaic virus, Raspberry ringspot virus, Tomato ringspot virus* and *Wheat streak mosaic virus* not reported and 21 viruses not known to occur on particular host(s) in India. The introduction of 19 exotic viruses was averted. Availability of antisera, viral genome sequences, detecting an unknown/ exotic virus etc., are the key challenges in virus detection in quarantine. Also strengthening of infrastructure, capabilities and methodologies for detection of viruses in bulk samples is essential. The present findings highlight the importance of pest risk analysis and adopting the reliable techniques for virus detection in minimizing/ eliminating the risk of introducing destructive exotic viruses, along with imported seeds and other planting material. Since viruses are not easy to be controlled by chemical or physical means, their detection in imported material and their interception will ensure biosecurity of Indian agriculture from transboundary introduction of plant viruses through quarantine.

IL 05: Seed Health Testing - a phytosanitary requirement for disease-free import and conservation of plant genetic resources in India

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Seed health testing (SHT) has major applications in quarantine for exchange plant genetic resources (PGR) as well as conservation of PGR in the National Genebank, ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), New Delhi, India, for long-term storage. Seed health testing for quarantine involves testing of seed and other planting materials during transboundary movement under PGR exchange which always carries an inadvertent risk of introduction of exotic pathogens or their more virulent races into new areas as evident from several examples of dangerous pathogens getting entry into new areas along with the introduced planting material. The glaring of such introduction are late blight of potato (*Phytophthora infestans*) from Central America (Peru) to Ireland in 1845, powdery and downy mildews of grapes (*Unicinula necator and Plasmopara viticola)* from Central America to France in 1847, flag smut of wheat (*Urocystis agropyri*) from Australia to Mexico, chestnut blight (*Cryphonectria parasitica*) from orient countries including Japan and Korea to USA, coffee rust (*Hemileia vastatrix*) from Sri Lanka to India in 1875, Karnal bunt of wheat (*Tilletia indica*) from India to USA in 1996 and bunt of wheat (*Tilletia caries*) from India to Mexico in 1970, etc. lead to profound economic and social consequences in the past. Whereas, conservation of PGR involves testing of indigenously collected/ multiplied seed to make them free from associated pathogens. In order to enrich PGR diversity, ICAR-NBPGR imports every year ~ 100,000 samples of germplasm and international trial material for research use both by public and private sector. Critical laboratory examinations with specialized tests during seed health testing for quarantine as well as conservation of PGR ensured the detection and identification of associated quarantine pathogens in different host from various sources such as *Fusarium oxysporum* f. sp. *cucumerinum in Cucumis sativus* from USA; *Monographella nivalis* in *Triticum aestivum* from Germany, Hungary, Italy, Mexico, Sweden, Turkey, UK and USA, in *Hordeum vulgare* from Italy; *Peronospora manshurica* in *Glycine max* from Belgium, Brazil, Canada, Colombia, Costa Rica, Ghana, Hungary, Indonesia, Israel, Italy, Japan, Korea, Malaysia, Nepal, Papua New Guinea, Poland, Romania, Russia, Taiwan, Thailand, USA and Zimbabwe; *Phomopsis longicolla* in *Helianthus annuus* from USA; *Uromyces beticola* in *Beta vulgaris* from Belgium, Denmark, Holland, Hungary, Germany, The Netherlands, Sweden, UK, USA and SSR; *Xanthomonas campestris* pv. *campestris* in *Brassica spp.* From many countries; *X. vesicatoria* in *Solanum lycopersicum* from Thailand; *Ralstonia solanacearum* in *Citrullus lanatus* from USA*; Broad bean stain virus* in *Pisum sativum* from Spain and in *Vicia faba* from Syria and Bulgaria; *Cherry leaf roll virus* in *G. max* from *Taiwan, Sri Lanka, Thailand* and *USA and in Phaseolus vulgaris* from *Colombia; Cowpea mottle virus* in *Vigna subterranea* from *Ghana* and *in V. unguiculata* from Philippines; *Aphelenchoides besseyi* in *Oryza sativa* from China, Japan, Philippines, Vietnam, USA*; Rotylenchus minutus* in *Hypoxis hemerocallidea* from Swaziland; *Pratylenchus penetrans* in *Malus domestica* from Netherlands. Huge losses would have occurred due to these diseases if not intercepted in quarantine examinations. Therefore, seed health testing assumes special importance and plays a pivotal role in disease-free import as well as conservation of indigenously collected/ multiplied PGR.

IL 06: Challenges in management of soil-borne pathogens of chickpea in Central and Southern India

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Chickpea is an important source of protein for millions of people in the developing countries, particularly in South Asia. India is the principal chickpea producing country in the world with a total production of 9.38 million tones and it is cultivated in an area of 9.63 million ha with an average yield of 974 kg ha^{-} (Anonymous, 2017). In India, about 80 per cent of chickpea is grown in Central and Southern states. The major chickpea growing States in these regions are Madhya Pradesh, Maharashtra, Karnataka and Rajasthan. Besides these Andhra Pradesh, Telengana and Chattisgarh also significantly contribute in chickpea production. Different types of chickpea like desi, kabuli, gulabi are grown in these regions of the country.

Major threats to chickpea cultivation in these areas are soil-borne diseases causing vascular wilt (*Fusarium oxysporum* f. sp. *ciceris*), dry root rot (*Rhizoctonia bataticola*) and collar rot (*Sclerotium rolfsii*). These diseases attack the crop at various stages of plant growth causing death of the plants causing losses to the growers. Success has been achieved in managing vascular wilt through identification of resistant sources and their utilization in breeding wilt tolerant varieties, however, dry root rot and collar rots are difficult to manage due to lack of stable sources of resistance. The over all effect of these diseases is the drying of chickpea plants commonly termed as 'Wilt complex'.

Therefore, it is the utmost need to understand the symptoms of these diseases individually, by the extension pathologists and the stages of the crops, when these pathogens attack. In the presentations, symptoms produced by each of these pathogens are discussed in detail. Wilt appears at seedling and flowering stages, while dry root rot at pod formation and collar rot can be seen at seedling stage, as well as at the adult stage of the crop. Farmers generally complain regarding drying of wilt resistant chickpea varieties in their field, while agricultural scientists says these are wilt resistant varieties. This drying is commonly due to dry root rot or collar rot for which resistance is not available. To avoid this controversy, extension pathologists need to bring exact situation before the cultivators. The symptoms of the individually diseases should be demonstrated to the farmers and extension personals. An interactive app "Chana Mitra" developed by Indian Institute of Pulses Research, Kanpur can help the farmers and extension pathologist. The renowned scientists of the country answer the queries through this app. Management of these diseases needs specific focus, based on agro-climatic conditions of different States. Major challenges in managing these diseases are the prevalence of races of *Fusarium oxysporum* f. sp. *ciceris,* cropping pattern and change in climatic conditions. Chickpea varieties developed so far for these areas have performed well, but due to change in climatic conditions, there are reports of emergence of new diseases. For examples, the incidence of dry root rot is increasing due to higher temperature and terminal droughts at the pod formation stage of the crop, particularly in rain-fed conditions. This disease is more severe in the legume *vs* legume cropping system in west Madhya Pradesh and parts of

Maharashtra and Karnataka. Collar rot is common where chickpea is grown after paddy in east Madhya Pradesh, parts of Andhra Pradesh and Telangana. To manage dry root rot and collar rot in chickpea a combined approach is required from the preceding crop, because of wide host range of these pathogens. Major emphasis should be given on field preparation, management of crop residues, addition of bio-agents with farmyard manure, seed treatment with *Trichoderma* spp. with compatible fungicides and management of soil moisture and the use of multiple disease resistant varieties. The details have been discussed in the presentation.

IL 07: On the identity of stem end rot pathogens in mango

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Mango (*Mangifera indica L.*) is deemed to be the king of all indigenous fruits in India Because of its delicious taste and high caloric value; it is ranked as one of the better fruits in the international market. The crop suffers from a number of diseases, among them 'post harvest rots' are most 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. It is estimated that in India 40% of the mango crop is lost in between harvest and consumption. Moreover, impact of climate has resulted not only in the alterations in the crop behaviour in mango but also in the disease pattern. Diseases that were considered not economically important and minor earlier have become severe and the exact identity of the associated pathogen is not exactly known. Among them stem end rot (SER) has become very serious. The extent of the disease varied between 5.60 (Srinivasapura, Karnataka) – 34.00% (Hessarghatta, Karnataka) in mango var. 'Alphonso' The infection of the pathogens occurs in the field in quiescent form during the premature stage as well as during harvesting, transportation and storage. The disease is characterised with the development of dark epicarp around the base of the pedicel in the initial stage. Subsequently the affected area enlarges to form a circular black patch which extends rapidly under humid atmosphere and turns the whole fruit completely black within two or three days. The pulp of the diseased fruits become brown and somewhat softer. Associated pathogen with stem end rot with mango fruits (var. Alphonso) were isolated following 'tissue isolation technique' and cultural and morphological characters were studied on different growth media. For molecular characterization genomic DNA was isolated from reference isolates of different stem end rot causing pathogens following Raeder and Broda (1985). The isolated DNA was used for molecular analysis using Internally Transcribed Spacer (ITS) 1 and 4 primers forward and reverse. Out of the 50 bit used for the isolation of associated organism with stem end rot disease, 24 (48%) isolates confined to Group 1 whereas 16 (32%) confined to Group II and only 04 (08%) to Group III. Based on their characteristics the organisms were identified as *Lasiodiplodia theobromae* (Group I), *Phomopsis mangiferae* (Group II) and *Neofucicoccus parvum* (Group III). Associated organism proved pathogenic on inoculations to healthy fruits and Koch's postulate was proven in each case. Temperature regime of 25°C was most suitable for the organisms. Amplification of the PCR products obtained from molecular analysis recorded their respective length (approximately) as 550bp (*Phomopsis mangiferae*), 540bp (*Lasiodiplodia theobromae*) and 460bp (*Neofusicoccus parvum*) and the identity of different associated organisms (pathogens) was further confirmed on blasting respective gene sequences in NCBI gene bank with gene sequence homology of 99% in case of *L. theobromae* and *P. mangiferae* and 96% for *N. parvum.* This is the first report on the gene sequencing of the SER pathogens in mango from the country.

IL 08: Detection, diagnosis and management of important diseases of minor millets

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The disease free crop is a pre-requisite for increasing qualitative and quantitative production and to prevent the spread of the disease into newer areas. Though, minor millets are known to suffer less due to diseases, but under changing climatic conditions during crop growth stages and cropping pattern, few minor diseases are becoming major resulting in enormous losses in yield. In India, six minor millets namely finger millet, little millet, kodo millet, foxtail millet , barnyard millet and proso millet are in cultivation and are grown in about 1.79 m ha with productivity of 1101.5 kg ha^{-1}. These crops are highly nutritious and possess high medicinal value. Mostly minor millets are suffering with fungal pathogens. Seasonal and regional occurrence of few bacterial, viral and nematode diseases is also reported. Phanerogamic partial root parasite, *Striga* spp. are also a problem in light and low fertile soils under stress conditions. Blast caused by *Pyricularia grisea* in finger millet and *P. setariae* in foxtail millet is a major problem. In recent years, it is also reported in little millet. Brown leaf spot caused by *Drechslera* spp. is appearing in later stages of crop growth in finger millet, foxtail millet, barnyard millet and proso millet. Rust of foxtail millet, little millet and finger millet are also important and causes considerable yield loss if appears at early stages of crop growth. *Cercospora* leaf spot of finger millet is restricted to Himalayan region in India and Nepal. Smuts are major disease problem in kodo millet, little millet and barnyard millet. Sometimes, also occurs in foxtail millet, proso millet and finger millet. Downy mildew and green ear is a serious problem in foxtail millet and finger millet. Foot rot caused by *Sclerotium rolfsii* is especially severe in heavy rainfall areas and irrigated finger millet. Banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani* is an emerging disease of all the six minor millets and causing significant yield loss. Udabatta in finger millet, foxtail millet and kodo millet is reappearing. A number of environmental variables like rainfall, rainy days, temperature, humidity, sunshine hours, light and wind speed influence positively or negatively the incidence of various diseases. Timely detection and proper diagnosis is important for the effective management of the diseases. Use of resistant cultivars is the most viable and economical way to mitigate the losses caused by diseases. Cultivars of different minor millets possessing resistance for different diseases or multiple disease resistance were identified. Improved varieties of kodo millet JK 41 and GPUK 3 were found least affected with *Striga* incidence. Late maturing cultivars of little millet namely OLM 203, CO 2 and germplasm were found resistant to grain smut. Similarly late maturing cultivars were shown resistance against BLSB in foxtail millet and little millet. Seed treatment with Carboxin or Carbendazim @ 2 g kg^{-1} seed was found effective to control the head smut in kodo millet and grain smut of barnyard millet as well as little millet. For the management of banded leaf and sheath blight in kodo millet and little millet, seed treatment with Hexaconazole or Validamycin @ 0.1% significantly reduced the disease incidence with higher grain yield. Non conventional chemicals were also reported to induce the resistance against BLSB in kodo millet and little millet. Foliar spray of salicylic acid and sodium fluoride @ 200 ppm reduced the BLSB severity in little millet 50.5 and 49.3% and increased the grain yield 26.3 and 25.1%, respectively. Soil application of value added *Pseudomonas fluorescens* + *Trichoderma viride* + *Bacillus subtilis* @ 335 g each of talk based formulation mixed in 25 kg FYM, incubated for 15 days and applied over an area of 1 acre at the time of sowing was most effective to reduce the BLSB by 69.2%. Soil application of *P. fluorescens* and soil application of *T. viride* @ 1 kg per acre were equally effective to reduce the disease by 63.7 and 58.4%, respectively. Studies on survival of the pathogen, host range, epidemiological studies and integrated approach will help for effective management of minor millet diseases.

IL 09: Wheat blast disease: Identification and management strategies

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Wheat blast, caused by *Magnaporthe oryzae* pathotype *Triticum* (MoT) although not yet present in India, however, the recent outbreaks in South-Asia, particularly in Bangladesh during Mid-February 2016 posing a serious threat to wheat producing areas in neighbouring South-Asian countries sharing borders with Bangladesh. In the light of probable invasion of wheat blast disease into India, management strategies are formulated jointly by DAC&FW of GoI, ICAR, SAUs and State Departments of Agriculture during 2016-17 and 2017-18 crop seasons to prevent the entry of wheat blast from Bangladesh and South American countries where wheat blast occurs. Active survey and surveillance programs are being conducted with the team of wheat scientists in wheat growing areas along Indo-Bangladesh borders in West Bengal &Assam and along West Bengal borders in the states of Jharkhand & Bihar. Trap plot nurseries are also established at strategic locations in West Bengal and regularly monitored for presence of blast disease. Vigilance on disease is also kept in other parts of the country. Strict quarantine measures are in place to restrict entry and import of wheat seeds from blast endemic regions (Bangladesh and South American countries). As a preventive measure, "No Wheat Zone" up to five kilometre distance from Bangladesh borders in India is maintained and "Wheat Holiday" is declared in two major wheat growing districts, Nadia and Murshidabad of West Bengal. The BSF is trained to stop any illegal movement of wheat seed material across the borders from Bangladesh. An adhoc IPM program for wheat blast management is formulated to combat with emergency situation. Promising Indian wheat varieties and advanced lines was evaluated for their resistant against blast pathogen in Bangladesh, USA and Bolivia, and some of the entries were found quite resistant. HD 2967 and HD 3086 growing under North Eastern and Western Plains Zones were found resistant. Awareness among farmers and agriculture state department officials is created through organizing various awareness & training programs and digital media. Anticipatory breeding program for blast resistance is initiated.

Oral Presentation

OP 01: Detection and genetic variability of *Candidatus* Liberibacter asiaticus prevalent in North East India

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Citrus greening (huanglongbing: HLB) is economically most important destructive disease of citrus. Systematic studies on the prevalence, distribution and genetic characterization of CLas isolates prevalent in citrus pockets of NE India in general and Manipur in particular were lacking. Present study reports the widespread prevalence of HLB disease in the major citrus groves of NE India. Systematic surveys were carried out at different citrus growing pockets of NE India (Manipur, Nagaland, Tripura, Mizoram, Arunachal Pradesh and Sikkim) to assess the prevalence and existing diversity of CLas causing huanglongbing (HLB) disease based on the symptomatic response of the different *Citrus* spp. Out of the 194 samples collected, 114 samples were tested positive for HLB (58.76%) in PCR using specific primers targeting 16S rDNA. 58 CLas isolates sampled from different citrus groves of NE India were characterized for partial 16S rDNA gene sequences. CLas isolates from NE India had genetic divergence up to 2.3% among them, up to 3.4% compared to CLas isolates from other parts of India and up to 9.8% with the CLas isolates from other parts of the world. 41 CLas isolates were further characterized for outer membrane protein (OMP) gene sequences, which showed genetic divergence up to 7.1% among them. Phylogenetic analysis based on OMP gene showed 13 groups, all of which were represented by CLas isolates prevalent in NE India. Concatenated multi-locus sequence analysis (16S rDNA and OMP gene sequences) indicated the overall concurrence with the OMP gene based diversity. Genetic variability based on tandem repeat numbers (TRN) profiling in CLIBASIA_01645 loci of HLB-associated-*Candidatus* Liberibacter asiaticus was studied in the newly sampled citrus groves from the hilly terrains of North East (NE) India, a geographically locked region. All 55 CLas isolates sampled from different citrus cultivars of NE India, yielded single amplicon group (SAG), but remarkable genetic variability. The TRN in HLB-associated CLas isolates varied from 0-21. In the citrus cultivated on NE hilly terrains, the CLas genotypes with TRN5 and TRN9 were most frequent (total frequency: 36.36%) and TRN9 was present in all HLB-infected citrus cultivars in all the states. When the samples from previous study were added, the TRN7-type CLas genotypes were predicted as most prevalent in whole NE India (24.05% frequency) followed by TRN5 genotypes (15.18% frequency), as compared to the citrus groves from rest of India where TRN5 was most prevalent (29.1% frequency). This indicated that the region-wise distribution of CLas varied; nevertheless Class II (TRN>5≤10) genotypes were most prevalent in India. Present study conclusively reported the occurrence of high genetic variability in TRNs of CLas population in NE Indian citrus groves which have evolved probably to adapt to specific ecological niche.

Poster Presentations

P 01: Development of multiplex PCR for simultaneous detection of *Alternaria brassicicola* and *Xanthomonas campestris* pv. *campestris* from *Brassica* seeds

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Dark leaf spot of crucifers caused by fungal pathogen *Alternaria brassicicola* and black rot of crucifers caused by bacterial pathogen *Xanthomonas campestris* pv. *campestris* are the important diseases causing major yield losses in crucifers across the world. The infected seeds are the major sources of primary inoculum of these two pathogens. A highly specific and sensitive multiplex PCR protocol has been developed for simultaneous and rapid detection of *A. brassicicola* and *X. campestris.* pv. *campestris* in a single reaction. A set of primers namely Aba28sF and Aba28sR based on SSR marker were developed for *A. brassicicola* whereas hrp region based primers namely Hrp-XCC-FP and Hrp-XCC-RP were developed for *Xanthomonas campestris* pv. *campestris.* The annealing temperature for primers were optimized at 62°C and specific bands of 201 bp for *A. brassicicola* and 769 bp for *X. campestris* pv. *campestris* were obtained in multiplex PCR. The detection sensitivity of the primer pairs were performed by dilution of genomic DNA and results revealed that it could detect up to 0.1 ng μl^{-1} of template DNA of both the pathogens. These primers are specific to *A. brassicicola* and

X. c. pv. *campestris* and there is no cross amplification with other related fungal and bacterial pathogens. The multiplex PCR assay described could be utilized for a reliable diagnosis with simultaneous detection of *A. brassicicola and X. campestris* pv. *campestris* associated with brassica seeds.

Key words: *Alternaria brassicicola,* Multiplex PCR, *Xanthomonas campestris* pv. *Campestris*

P 02: Survey on prevalence and severity of diseases in major soybean growing areas of Chhattisgarh

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Soybean is grown on wide range of soils, agro-climatic and cultural conditions. Therefore, survey work on *Fusarium* wilt disease is more advantageous, in order to know the distribution and severity of disease in soybean growing areas of Chhattisgarh. Soybean plant infected with several pathogens like *Sclerotium rolfsii, Rhizoctonia* sp. and *Fusarium* sp. among these *Fusarium virguliforme* (*Fusarium solani* f. sp. *glycine* (Tassi) Goid. is a new emerging disease in soybean growing areas of Chhattisgarh state becoming a serious in respect to yield loss as well as disease incidence causing wilt of soybean (*Glycine max* (L.) Merrill)". The isolates of *Fusarium* were collected from different soybean growing areas of Chhattisgarh *viz.,* Raipur, Durg, Rajnandgaon, Kawardha, Bemetara and Mungeli. Survey results revealed that per cent disease ranged from 3.36 to 36.30 per cent in different locations. The maximum disease incidence of 36.30 was recorded in Bemetara followed by 20.25 % in Kawardha, 11.34 % in Mungeli, 8.90% in Rajnandgaon, 5.85 % in Raipur. Whereas less disease incidence was recorded in Durg (3.36 %) incidence. The severity of disease was high under rainfed condition and it was low under irrigated condition. Such variations are mainly due to available soil moisture and prevailing soil temperature conditions in particular locality. Survey for incidence of wilt in Chhattisgarh, the major hot spot areas for wilt complex is Bemetara. The disease is severe under rainfed conditions because of low soil moisture and its uneven distribution. Further, *S. rolfsii, Rhizoctonia* sp. and *Fusarium* sp. are aerobic organisms and needs low moisture for its growth and infection. Host plants become predisposed to infection under these conditions. The high incidence and severity of disease in rainfed condition might be because of favourable conditions.

P 03: Screening of chickpea genotypes against root rot and wilt diseases

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Chickpea (*Cicer arietinum* L.) is one of the major legume crop widely grown in the Indian sub continent. India is the largest chickpea producer as well as consumer in the world. India grows chickpea on about 8.11 million ha area producing 5.90 million tonnes, which represents 38 per cent and 50 per cent of national pulse acreage and production, respectively (Anonymous 2015-16). The production of chickpea in the Indian sub continent and in other Asian countries is severely affected by many plant pathogenic fungi, bacteria, viruses, and nematodes which cause diseases such as Fusarium wilt, dry root rot, Ascochyta blight, collar rot, bacterial blight, filiform virus and root nematode (Nene *et al*., 1996).The crop is subjected to infection by several fungi, among them Fusarium wilt is an important disease and is considered relatively more serious disease in most of chickpea growing countries with yield losses ranging from 10 to 90 % (Singh and Dahiya, 1973).

A field experiment was conducted at four villages of Kurud and Dhamtari block of district Dhamtari *viz*., Kosmarra, Mujgahan, Bodra and Bhendsar. Four isolates of *Trichoderma* were evaluated for their antagonistic potential, ecological behaviour and control of root rot and wilt of chickpea. The isolate ThrAN-5 (*Trichoderm harzianum*) was most effective in mycelial growth inhibition of *Fusarium oxysporum* f. sp *ciceris*, whereas TvAN-3 was best against *Rhizoctonia solani*. ThrAN-5 of *T. harzianum* had highest competitive saprophytic and rhizosphere colonizing ability in chickpea seedlings followed by TvAN-3, ThrAN-13, and TvAN-10 of *T. viride*. Seed and soil application of *Trichoderma* isolates significantly increased the germination/field emergence and lowest disease incidence as compared to non treated control under green house tests. The highest field emergence, lowest wilt and root rot disease incidence and corresponding highest yield was recorded with seed and soil application of ThrAN-5 followed by TvAN-3, ThrAN-13, and least effect was recorded with TvAN-10 under field conditions.

P 04: Morphological and cultural variability in *Rhizoctonia solani* inciting root rot of soybean

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Soybean occupies third place among the nine oil seed crops of India. *Rhizoctonia solani* Kuhn (telomorph) causes pre- and post-emergence damping off of root, root rot, stem rot and foliar blight of soybean (*Glycine max*) in wide range of food crops because of its poly-phagous nature and high saprophytic ability. In present studies efforts have been made to identify variability in *Rhizoctonia solani*. In total, ten isolates of *Rhizoctonia solani* were collected from different district of M.P from infected soybean plants and isolation was done on selective media, which were found to have different cultural and morphological characters like, colour of culture (white, grey, brown), growth pattern (fluffy, submerged, cottony) and colony edge (smooth, undulating, wavy). Screening of ten isolates of *Rhizoctonia solani* in vitro revealed that, all the isolates of *Rhizoctonia solani* differ significantly in their growth at different incubation period. Overall isolate I_4 exhibited maximum growth at all the incubation periods. Among the five tested culture media, all the isolates gave maximum growth on PDA, but isolate I8 exhibited maximum (32.0 mm) growth on Oat meal agar against other. However, minimum growth was recorded on water agar medium. Further, all the isolates exhibited maximum growth at pH 6 after 96 hours of incubation period and there after growth decreased with increase in pH. All the ten isolates of *R. solani* were found variable and diversified. However, differences among the growth of isolates were found statistically significant.

P 05: Studies on variability of *Macrophomina phaseolina* causing charcoal rot of soybean

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Charcoal rot caused by *Macrophomina phaseolina* (Tassi) Goid is the most common root rot disease found in soybean. Charcoal rot was responsible for significant yield reduction in drought prone areas. Sixteen (16) isolates from various districts of Madhya Pradesh were collected and variability was studied on cultural, morphological and pathogenic behaviour on eight differential host. The isolates I_{13} (Indore KVK) and I_{16} (Tikamgarh, KVK) of *Macrophomina phaseolina* were categorized under slow growing and two I_{10} (Jabalpur, khamariya) and I_1 (Jabalpur, Adhartal) as fast growing isolates. On the basis of colony character I_5 (Sagar KVK) and I_{15} (Rewa KVK) showed whitish grey and feathery and I_3 (Ganjbasoda, Farmer field), I_7 (Narsinghpur, Farmer field), I_8 (Jabalpur Farmer field) and I_{10} (Jabalpur, khamariya) had dark black and feathery growth. Categorization according to number of sclerotia / microscopic field. Lowest number was produced by I_{14} (Garakhota, Farmer field) and I_{15} (Rewa, KVK) were as highest number by I_{11} (Jabalpur, krishi nagar farm) and I_{13} (Indore, KVK). Variation in size of sclerotia indicated that only one isolate I_{16} (Tikamgarh, KVK) fell in to the category of small sclerotia. Two isolates I_8 (Jabalpur, Farmer field) and I_{15} (Rewa, KVK) produced large sclerotia. Other isolated had medium sized sclerotia. All the 16 isolates had show highly virulent (HV) reaction to JS 95-60. Three isolates i.e. I_{11} (Jabalpur, krishi nagar farm), I_7 (Narsinghpur, Farmer field) and I_9 (Gadarwada, Farmer field) has shown maximum aggressiveness against chickpea. Out of 16 none of the isolates could cause mortality more than 70 per cent in chilli and urd bean. Only four isolates I_2 (Ganjbasoda, KVK), I_4 (Narsinghpur, KVK), I_7 (Narsinghpur, Farmer field) and I_9 (Gadarwada, Farmer field) had shown highly virulent in all crop. In mungbean 3 isolates were designated as virulent and other 13 as highly virulent. In tomato per cent seedling mortality ranged from 47.8 to 90.9 per cent, out of 16 isolates only one isolates I_{15} (Rewa KVK) fell in to the category of virulent (V). Mortality percentage varied from 35.0 to 100.0 per cent in tomato. Only two isolates I_1 (Jabalpur, Adhartal) and I_{12} (Jabalpur, krishi nagar farm) fell in to the category of virulent (V). All the sixteen isolates were highly virulent (HV) to soybean and chickpea and showed variable reaction in soybean, chickpea, mungbean, urdbean, sesame, chili, tomato and cowpea. Four isolates I_2 (Ganjbasoda, KVK), I_4 (Narsingpur, KVK), I_7 (Narsinghpur, Farmer field) and I_8 (Jabalpur, Farmer field) highly virulent to all the crops.

P 06: Variability in *Colletotrichum* spp. and screening for resistance against pod blight of soybean

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The genus *Colletotrichum* comprises ~600 species attacking over 3,200 species of monocot and dicot plants. *Colletotrichum* species are fungal pathogens that devastate crop plants worldwide. The genus *Colletotrichum* includes a number of plant pathogens of major importance, causing diseases of a wide variety of woody and herbaceous plants. It has a primarily tropical and subtropical distribution, although there are some high-profile species affecting temperate crops. Only a small number of *Colletotrichum* species have been associated with the teleomorph, *Glomerella* and generally these teleomorphs are rarely observed in nature . In the present investigation single spore isolates were derived from different naturally infected hosts, which allowed us to demonstrate morphological variability in the fungus. Attempts were made to induce the teleomorph and to determine the mating system in this fungus. Using forward and reverse sequence information derived by using ITS1-ITS4 (8S–26S rRNA) intervening sequence specific primers of C1 (Pigeon pea), C3 (Bean), C5 (Chilli), C8 (Cowpea) and ITS4-ITS5 (rDNA (nuclear rRNA gene) sequence specific primers) of C3(Bean) phylogenetic tree based on ITS alignment was constructed which expressed sequence variation. Similarly phylogenetic tree based on information derived by using C 28487-C 23032 (28S rDNA gene) specific primers against C6 (Mungbean), C9 (Brinjal) isolates resolved sequence variation. Anthracnose occurs throughout the soybean production areas of the world. We also report here in ten entries (IVT-24, IVT-26, IVT-39, TMAS-38, RSC-10-52, IVT-04, RSC-10-70, IVT-13, NRS-125, RSC-10-71) resistant to anthracnose of soybean out of 138 screened.

P 07: Prevalence and identification of Pokkah Boeng Disease caused by *Fusarium moniliformae* var. *subglutinans* on sugarcane in Kabirdham, Chhattisgarh

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Pokkah boeng caused by *Fusarium moniliformae* var. *subglutinans is more prevalent during Rainy Season in this region. The words* Pokkah Boeng is used in Javan (Japanese Term) which means malformation or distorted of apical portion of the plants. *It is* reduce the quality of yield of crop as well as sugar contents in cane which is depending upon the severity of disease and rainfall. This disease is occurs in all over the countries where sugarcane are grown. Pathogen of this disease is spread by wind during rain, infected cane sets used for sowing and many insect by carrying of spores with adhesives of their body parts such as wings, legs etc. This disease was well-known in sugarcane for long time but severity of disease observed during last four year in Kabirdham district in the farmer's field. Pokkah boeng disease is now days playing a very important role due to its economic threats in Kabirdham. Therefore, field survey was conducted during 2014-15, 2015-16, 2016-17 and 2017-18 in five village of each block *viz.*, Kawardha, Bodla, Pandariya and Lohar in the month of May, June, July, August, September and October. Observations were recorded on disease incidence, disease severity and type of symptoms by randomly selected field. Results indicated that the disease was increase progressively in every year in the farmer's field. Observations showed increasing trend of disease incidence and severity of the disease ranged from 3 - 30 per cent Initial symptoms were observed as chlorotic near the base of the young leaf and in some plants were showed on the other parts of the leaf blades. Young leaves were showed wrinkling, twisting malformation or distortion and shortening. Base of the affected leaves were showed narrower and other portion remain normal. Irregular reddish stripes and specks were noticed within a chlorotic part on the mature leaves. Affected area showed as irregular necrotic, reddish to brown on leaf blade, leaf sheath and midribs. Some plant showed entire top died and cracking on the stalk just like sharp knife cut. Concluded that the Pokkah boeng disease now days comes under minor disease of sugarcane but on the basis of the our observations in future it is going to be major problems due to its rapid dispersal and increase of disease during last years in this region.

P 08: Screening germplasm for resistance to bacterial blight of rice caused by *Xanthomonas oryzae*

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Rice is cultivated under diverse ecologies, generally rice crop is affected by more than 17 diseases and certain diseases are more common on rice varieties than on conventional varieties. Among the different diseases brown spot, sheath blight, blast, stem rot and bacterial leaf blight are considered important in various parts of rice growing areas of the world. Bacterial leaf blight is caused by *Xanthomonas oryzae* occurs mostly during the wet season and it can reduces crop yield by up to 50% (Latif *et al.*, 2011).

Keeping this in view 1200 Rice germplasm were received from multilocation evolution trial on Rice germplasm conducted during *Kharif*, 2014-15 at IGKV Raipur under the supervision of IIRR, Hyderabad, Telangana. The accessions were evaluated for the bacterial leaf blight disease. The development of disease symptoms was critically recorded with regard to time taken for expression of disease symptoms, none of them were found immune against bacterial leaf blight. Rice accessions along with the susceptible check Swarna and resistance check Improved Samba Mahsuri were artificially inoculated with the virulent isolate of *Rhizoctonia solani* by inserting five sclerotial bodies with bits of mycelia inside the leaf sheaths raised in earthen pots under field condition. Only one accession showed resistance (Scale 3) reaction in IC 579030 and moderately resistance (MR) (scale 5) reaction recorded in 14 rice germplasm namely IC 203541, IC 203568, IC 206031 ,IC 211213, IC 248013, IC 248069, IC 276864, IC 449972 ,IC 462040, IC 462116, IC 462171, IC 578444, IC 578539, IC 578997for bacterial leaf blight.

Keywords: Bacterial leaf blight, Rice germplasm, Resistance, Screening.

P 09: Evaluation of different varieties of bottle gourd against downy mildew under field conditions

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Pseudoperonospora cubensis, the causal agent of cucurbit downy mildew, is responsible for devastating losses worldwide. Downy mildew of Bottle gourd has been successfully controlled for many years through host resistance. The occurrence of downy mildew were first observed from last week of August and gradually increased during the crop period. Disease severity and incidence reached at maximum in September. Cultivation of resistant or tolerant cultivars is one of the best options to minimize the losses due to diseases. Nine bottle gourd (*Lagenaria siceraria*) varieties; (Amrit, Mahima, Manya, NS-443, Anmol, Ankit, Naveen, Andaz, Latto, were evaluated for resistance against Downy mildew (*Pseudoperonospora cubensis).* Among the nine varieties of bottle gourd evaluated, three (Amrit, Anmol, NS-443) were resistant, two (Latto, Manya) were susceptible and rest of the varieties were highly susceptible against downy mildew.

P 10: Genetic variability of chickpea (*Cicer arietinum* L.) genotypes against *Pratylenchus thornei* and *Rhizoctonia bataticola*

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Root Lesion Nematode (RLN; *Pratylenchus thornei* Sher and Allen) is a threat to chickpea production, either alone or in presence of *Rhizoctonia bataticola*. The effects of inoculation of 22 chickpea genotypes with *P. thornei* alone or with joint inoculation with *R. bataticola* were investigated in a pot experiment. Culture of *P. thornei* was developed under aseptic conditions on chickpea (JG 62). The populations developed on roots were inoculated @ 1000 *P. thornei*/genotype with four treatments: Nematode alone, Nematode + DRR fungus, DRR alone and untreated. Treatments were replicated five times. Observations were recorded after 40 days of inoculation from soil and roots of each treatment. During the course of investigation, the extents of damages developed by RLN and DRR individually as well as their combinations were recorded. The study revealed, above the four times rate of reproduction due to *P. thornei* was noticed in JG 62 over the ICCV2 and JG11, suggested that JG 62 is more vulnerable to RLN as well as DRR, while the ICCV 2 and JG11 showed resistance.

Key words: RLN, DRR, Plant height, shoot weight and root weight

P 11: Characterization of *Xanthomonas axonopodis pv. citri* causing citrus canker

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Citrus canker caused by *Xanthomonas axonopodis* pv. *citri* is one of the most important disease of citrus. In the present study, ten isolates of *X. axonopodis pv. citri* were isolates from different regions of Vidharbha. Biochemical tests were conducted to differentiate the isolates. All isolates were found positive for starch hydrolysis, KOH test, catalase test, H_2S production, gelatin liquefaction, indole production, acid and gas production tests to performed to characterized the *X. axonopodis* pv. *citri* bacteria. The result of all bio-chemical test confirmed that, *Xanthomonas* is gram negative bacterium.

P 12: Assessing the suitability of integrated disease management approach against wilt disease caused by *Fusarium oxysporum* in chickpea crop

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Chickpea (*Cicer aritinum L*.) is the world third most important pulse crop. India rank first in terms of chickpea production and consumption in the world. During 2013-14, Chickpea occupied 10.32 million ha area and contributed 9.88 million tonnes to the National food basket with an average productivity of 967 Kg/ha. Low yield of chickpea is attributed to its susceptibility to several biotic constraints. Chickpea wilt incited by *Fusarium oxysporum* f. sp. *ciceri* is one of the serious diseases causing annual loss of about 10 per cent in yield. It is observed up to 61% at seedling stage and 43% at flowering stage. The seeds harvested from wilted plants are lighter, wrinkled and duller than those from healthy plants. The yield losses vary between 10% and 100% depending on the agro climatic conditions. The on farm trial (OFT) was carried out on farmer's field in adopted villages of Krishi Vigyan Kendra, JNKVV, Harda (M.P.) during Rabi season, 2014-15 & 2015-16. The technology demonstrated was Seed treatment with *Trichoderma viride* 4 gm along with Vitavax 1 gm per kg Seed + deep summer ploughing up to 9''-10'' (T2) and Seed treatment with metalaxyl 2 gm per kg seed and soil application of *Trichoderma viride* @ 4-5 kg per ha (T3). On farm trials were conducted at twelve farmers' field covering 05 ha area. The average chickpea yield in T_2 was 14.60 q/ha and average yield in T3 was 14.90 q/ha with cost of cultivation of T_2 i.e. 18720/ha and average cost of cultivation of T 3 was Rs. 17350/ha. However, the average yield from farmers practice was 12.20 q/ha with cost of cultivation of Rs. 16000 /ha. With adoption of above protection technology, yield increased of T_2 was 19.6 % and yield increased in T 3 was 22.13 % as compared to farmers practice (T1). Farmers got average net return of Rs 6400/ha from T_2 and Rs 8910/ha from T_3 with B:C ratios of T_1-2.89 T_2-2.96 and T_3-3.26 respectively.

Keywords: Chickpea crop, Farmer's income, IDM approach, Productivity, Wilt disease.

P 13: *In vitro* evaluation of fungicides, botanicals and bioagents against *Erysiphe cichoracearum*; an incitant of cucumber powdery mildew

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Cucumber is the oldest vegetable cultivated throughout the world and around 50-55% losses have reported due to powdery mildew and downy mildew. In present study various systemic, combi fungicides, bioagents and botanicals have evaluated in lab condition by following factorial design. Results reaveals that among the systemic fungicides tasted amistar showed highest inhibition (94.51 per cent at 0.15 per cent concentration) and in combi fungicides native (87.78 % at 0.15 per cent). *In vitro* efficacy of fungicides revealed that maximum inhibition of conidial germination was observed with azoxystrobin and it was found significantly superior over all the other fungicides tested with maximum conidial germination inhibition (94.51 %) followed by tebuconazole (90.54 %). Minimum inhibition of conidial germination was recorded in myclobutanil (78.83 %) at 0.15 per cent concentration. *In vitro* efficacy of combi fungicides revealed that tebuconazole 50 % + trifloxystrobin 25 % (Nativo) found to be significantly superior over other treatments and showed maximum inhibition (87.78 %) at 0.15 per cent followed by captan + hexaconazole (Taquat) which recorded 74.65 per cent inhibition at 0.15 per cent. Minimum conidial germination inhibition was observed with carbendazim + mancozeb (Saaf) (56.02 %) at 0.05 per cent..

P 14: Screening of rice culture of *Pyricularia grisea* for blast disease reaction in Bastar region of Chhattisgarh

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Twenty five cultures consisting of international differentials, donors and commercial cultivars were screened during the crop season 2015 to 2017 for monitoring the blast reaction on different host genotypes at SG College of Agriculture and Research Station farm Jagdalpur, Bastar. A set of twenty five culture viz:, C101 LAC, C101 A51, C104 PKT, C101 TTP, RIL – 10, RIL – 29, *O. minuta*, BL-122, BL-245, A 57, C101 PKT, Raminad -STR -3, Zenith, NP – 125, USEN, Dular , Kanto – 51, Shi-tia-tao , Calaro, Tadukan , IR – 64, Tetep, HR – 12, Rasi and Co - 39. Genotypes RIL – 29, *O. minuta*, IR – 64 Raminad -STR -3, and Tadukan showed resistant to moderately resistant reaction in all the crop season. In respect to crop season 2017 genotypes Zenith, Tetep, Calaro, C101 LAC, C101 TTP and Dular observed resistant to moderately resistant reaction. Genotype IR-64 constantly showed resistant reaction. The susceptible checks like HR-12 and CO-39 were constantly showing susceptible reaction at our location.

Key words: Rice Blast, *Pyricularia grisea,* screening resistance

P 15: Pathogenic and genetic diversity of *Rhizoctonia solani* in major rice growing areas of Chhattisgarh

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Rhizoctonia solani is a persistent problem in Chhattisgarh to rice cultivation, so a purposive sampling survey was conducted during *Kharif*-2016 in twelve major rice growing districts of Chhattisgarh covering three agro-climatic zones to study the diversity in pathogen in the state. In the present study forty one isolates of *R. solani* AG1-IA collected and studied for pathological and genetic variability. The pathogenic variability of all isolates was determined by detached cut leaf method on rice cultivar, TN-1 and observation were taken by measuring relative lesion height (RLH). RLH produced by *R. solani* isolates varied widely and grouped into three categories based on their growth rate *viz.,* slow (<1.5mm/hr), moderate (1.25-2.5mm/hr) and fast growth rate (>2.5mm/hr). Isolates *viz.,* RS-CG-02 (Balrampur), RS-CG-10 (kawardha), RS-CG-21 (Rajnandgaon), RS-CG-40 (Bastar) showed fast growth rate and produced 100% RLH at 108hr. Isolates *viz.,* RS-CG-17 (Durg), RS-CG-23 (Rajnandgaon), RS-CG-41 (Bastar), recorded slow growth rate and has taken more than 150 hr to attend 100% RLH. Molecular characterization of genetic diversity in test isolates was studied by using 4 RAPD (Randomly amplified Length Polymorphism) and 8 ISSR (Inter simple sequence repeats) DNA markers. PIC value of RAPD data ranged from 0.80 (RBa-3) to 0.88 (RBa-5) and PIC values of ISSR data ranged from 0.72 (UBC-809) to 0.87 (UBC-841). Combined data set of RAPD and microsatellite primers were analyzed with UPGMA resulting seven clusters with 20-59% genetic similarity. Majority of the isolates formed cluster specific to the similar agro ecological zones where isolate number RS-CG-41 collected from Jagdalpur block showed slow growth rate and did not share any of the cluster. Out of all the DNA markers used UBC-841 (ISSR) and RBa-2 (RAPD) markers detected more genetic variability when compared to other DNA markers. Present study demonstrated the existence of considerable variation of *R. solani* at block/district level in Chhattisgarh. The results will be useful in devising location specific integrated disease management to manage the disease effectively at farm.

Key words: Sheath blight, *Rhizoctonia solani*, Pathogenic, RAPD, ISSR

P 16 : Screening of pearl millet genotypes and germplasm lines against blast disease caused by *Pyricularia grisea*

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Pearl millet belongs to family Poaceae is a staple cereal grown on about 29.0 m ha in the arid and semi-arid tropical regions of Africa, Asia and Latin America with India having the largest area. Among the eight pearl millet genotypes screened during *kharif* 2012 for disease resistance against blast (*P. grisea*) of pearl millet under natural epiphytotic conditions using 0-9 scale. Among the genotypes KBH-1008, KBH-1969 and Kaveri-Fouzi were found to be susceptible While, the genotypes *viz.* GHB-558, 88M33, KBH-563, TMBH-602 and TMBH-603 exhibited highly susceptible reaction. And among the sixteen pearl millet A/B lines maintained in the breeder's block at RARS, Bijapur. Results revealed that, most of the A/B lines exhibited susceptible to highly susceptible. The A/B lines *viz*., ICMA94111, ICMA95222, ICMB95222, ICMA95444, ICMA96222 and

ICMA97444) were found to be susceptible with a PDI ranging between 10.5 to 18.0 per cent. Among the highly susceptible A/B lines *viz.,* ICMA94555, ICMB94555, ICMB96222, ICMB97444, ICMA98444, ICMA99222, ICMB99555 and CPBLT-109 were recorded PDI ranging from 32.0 to 72.0 per cent.

P 17: Survey on pearl millet blast disease severity in major growing areas of Northern Karnataka

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Pearl millet belongs to family Poaceae is a staple cereal grown on about 29.0 m ha in the arid and semi-arid tropical regions of world. Blast which causes significant yield loss among the fungal diseases. A roving survey was carried out for the severity of blast of pearl millet during September – October, 2012 (*kharif*) in three major pearl millet growing districts of northern Karnataka viz. Bijapur, Bagalkot and Koppal, the highest disease severity was recorded in Koppal district (76.1%) followed by Bagalkot (37.3%), while the least severity was observed in Bijapur (31.1%) district. In Koppal district, the highest disease severity was recorded at Kudarimothi village (84.8%) of Koppal taluka, whereas least severity was recorded at Elakalgada (63.5%) village. The highest severity in Bijapur district was observed at Kavalagi village (69.4%), whereas the least severity was observed at Muttagi village (17.7%) in Basavana Bagewadi taluka. In Bagalkot district, the highest disease severity was recorded at Choudapur village (43.6%) and the least severity was recorded at Bevoor (27.8%) of Bagalkot taluka. Among the surveyed areas Koppal district stand as "hot spots' for blast of pearl millet with all most all talukas *viz*. Kushtagi (78.7%), Yalburga (77.0%) and Koppal (72.8%) recording higher severity of blast.

P 18: Evaluation of culture media for the growth of *Pyricularia grisea* causing blast of pearl millet

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Pearl millet (*Pennisetum glaucum*) is an important grain and forage cereal of India which is traditionally known as bajra. Blast expectant by *Pricularia grisea* has established a key position among the diseases and now it's one of the major biotic constraint in the cultivation of Pearl millet. In the light of above effect laboratory studies was carried out to describe the cultural characteristics such as colour and texture of the blast pathogen *Pyricularia grisea* on different media viz., Pearl millet potato agar, Rice potato agar, Malt agar, Water agar, Pearl millet dextrose agar, $CaCo_3$ agar, Pearl millet potato dextrose agar, Carrot dextrose agar, Potato carrot agar, Yeast extract agar, Oat meal agar, Asthana ana Hawker's medium, Czapeck's dox agar, Richard's agar medium, Host extract+2% Sucrose agar, Control. Among all media the highest mean mycelia growth of the fungus *Pyricularia grisea* was recorded on Czapeck's dox agar medium (87.1mm) followed by Pearl millet potato dextrose agar medium (86.5mm), Pearl millet potato agar medium (83.0mm), Yeast extract agar (81.1mm) and least mean mycelial growth of the *Pyricularia grisea* on water agar (37.7mm), Malt agar (41.0mm), $CaCo_3$ agar (45.6mm). Czapeck's dox agar medium significantly superior over Pearl millet potato agar medium, Yeast extract agar medium where as it was statistically at par with Pearl millet potato dextrose agar medium. In general, among all media the Czapeck's dox agar media and Pearl millet potato dextrose agar media are more suitable for cultural study of pearl millet blast fungus *Pyricularia grisea*.

P 19: Performance of promising hybrids and varieties of pearl millet against blast (*Pyricularia grisea*)

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Pearl millet (*Pennisetum glaucum*) is an important nutri-cereal for human as well as a forage/fodder crop for livestock. It is the only cereal crop that is capable for adopting harsh climate condition and marginal soil. Blast incited by *Pyricularia grisea* (Cooke) Sacc. has occupied a key position among the pearl millet diseases resulting severe losses in high yield potential hybrids/ varieties particularly cultivated for fodder purpose. The disease can be best managed through host plant resistance. A total of Fifty promising pearl millet hybrids and varieties were evaluated in two replications at research farm of agriculture college of Gwalior during Kharif 2017 against blast under favourable condition. Disease severity was recorded at the hard dough stage using a 1–9 progressive scale developed at International Rice Research Institute (IRRI), Philippines for blast. The tested entries showed a great variation in response to blast as their blast PDI range from 0.0 to 99.99% .Three entries viz. GHB538 ,MPMH17 and NHB5061 were absolutely free from the disease. In respect of blast reaction these three entries were significantly superior over rest of the 47 entries. The maximum blast PDI (99.9 %) was recorded in the susceptible check ICMB95444.The pressure of blast was so high that the entire foliage of susceptible check was completely covered with the symptoms which resulted in premature drying and death of plants before the formation of earheads.

P 20: Development of chickpea wilt incidence in relation to soil edaphic and aerial environments

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Correlation between incidence of chickpea wilt (*Fusarium oxysporum* f. sp. *ciceri*) and soil edaphic factors on four lines *viz*. JG-315, IGP-187, IGP-29 and JG-62 being resistant to highly susceptible revealed that there was a significant strong correlation between disease incidence and soil temperature and soil moisture (%). All the four entries showed positive correlation with soil temperature, while negative correlation with soil moisture. Coefficient of determination (R^2) showed that both the factor contributes 54.70% (JG-315), 56.32%, (IGP-187), 54.88% (IGP-29) and 39.42% (JG-62) in development of wilt. Pot experiment was carried out in environmental growth chamber with combination of three different levels of temperatures *viz*., 20, 27 and 34, two different levels of relative humidity *viz*., 60, 80% and two inoculum load (5 and 10%) to find out the effect of temperatures, relative humidity and inoculum load on incidence of wilt. All the three factors *viz*., areal temperature, relative humidity and inoculum load exhibited positive correlation with wilt incidence. Statistically, aerial temperature (0.7226**) and inoculum load (0.6435**) showed significant positive correlation with wilt incidence, while relative humidity (0.1315) was found to be non-significant.

P 21: Impact of sheath blight disease on seeds, seedlings and plant vigor

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Rhizoctonia solani causing sheath blight of rice is reported to survive through soil and collateral hosts. Although it infects seed in field, role of seed-borne inoculum in disease development is not properly understood. However, only little information is available on the role of seed-borne inoculum in disease development in the field (Roy, 1989; Acharya and Gupta, 1996; Silvalingam *et al.* 2006). During the present investigation seed samples of two varieties were collected from healthy seeds (*i.e.* seeds harvested from healthy plant panicles) and diseased seeds (*i.e*. seeds harvested from plant panicles with 7 to 9 disease score of sheath blight) and were sown both under green house (pots) and field conditions. The seedling growth assessed in terms of seedling vigour index at 21 days and 30 days after sowing. The germination percent, root and shoot length of individual seedlings also be measured. The results showed that the seedling vigor index was more in healthy plant seeds than the diseased plant seeds at both observation periods. They were also statistically significant. Highest percent germination of two varieties (81.75 and 88.75) were recorded when the seeds from healthy plants panicle. The root and shoot length were also affected in diseased plant seeds during the same period of observation. The seedling vigour index calculated clearly revealed that healthy plant seeds in both the varieties *i.e.,* Swarna (2259.12) and Mahamaya (3174.47) was more than the corresponding diseased plant seeds (*i.e*., 1549.92 and 1921.37, respectively). The reduced growth of root, shoot and seedling vigour from diseased seeds showed that due to the survival of pathogen in diseased plant seeds and its transmission from seed to emerging seedlings, the *Rhizoctonia solani* pathogen is internally seed-borne in nature.

P 22: Survey for severity of rice blast disease in different rice growing area of Chhattisgarh

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Rice blast disease caused by *Pyricularia oryzae* Cavara has become the one of major fungal disease covering in major rice growing area and the first time a survey was conducted during *Kharif* - 2016-17 in different rice growing districts of Chhattisgarh State, to determine the disease incidence, occurrence, disease severity and spread of rice blast disease in three agro climatic zone *viz*., Bastar Plateau Zone (Zone-I), Chhattisgarh Plains Zone (Zone-II) and Northern Hills Zone (Zone-III). The assessment of rice blast was carried out in thirteen major rice growing districts viz., Jagdalpur (Bastar), Dantewada, Narayanpur, Bilaspur, Janjgir-Champa, Kanker, Bemetara, Raipur, Dhamtari, Gariyaband, Balrampur, Surajpur and Surguja from August last week to October 2016 and September first week to October 2017. Among the thirteen districts, percent disease index was varied from 20% to 87.78%. The highest percent disease index (PDI) was recorded (87.78%) in Jagdalpur (Bastar) with

Swarna cultivar which is followed by Surguja (85.56%) and Balrampur (84.44%) and lowest PDI was recorded (20%) in Surajpur (Maheshwari) and Bastar (Safari). The PDI of leaf blast among different cultivars and locations were found to be varied from each other. The results indicate that, the mean blast PDI recorded in Chhattisgarh plain zone was 35.49 per cent, in North hills zone 47.16 per cent, and in Bastar Plateau was 47.25 per cent. The more severity of rice blast disease might be due to the highly favorable factors like application of excessive doses of nitrogenous fertilizers, intermittent drizzles, cloudy weather, high relative humidity (>90%), low night temperature (<26 C), more number of rainy days, longer duration of dew, slow wind movement and availability of collateral hosts. Thus, their serve as basic to evaluate location specific integrated disease management strategy against rice blast disease.

Key words: Rice blast, Severity, Incidence, Percent Disease Index and Assessment.

P23 : Gene pyramiding: An effective measure for bacterial leaf blight resistance in rice (*Oryza sativa* L.)

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Bacterial Leaf Blight (BLB) disease of rice caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is one of the main reasons limiting production of rice in Asia ensuing to an average of 20 to 30% and in some Asian countries, up to50% rice yield losses. Resistant rice cultivars, mainly based on a single resistant gene were developed, however long term cultivation of rice varieties carrying single resistance gene result in a significant shift in pathogen- race frequency and consequent breakdown of resistance (Mew *et al.,* 1992). The occurrences of new races have demanded stacking of several resistance genes into high yielding local cultivar background to confer a wider spectrum of resistance, which enable them to survive attacks from several pathogens at a time as well as unfavourable environmental conditions. Pyramiding of multiple resistance genes in the background of modern high yield varieties is a tangible solution to overcome resistance breakdown.

So, in this investigation effort has been made to screen the 92 BC_2F_3 segregating lines possessing broad spectrum durable resistance by transferring bacterial blight resistant genes viz., *xa5*, *xa13* and *Xa21* from IRBB59 in to a popular rice variety *Karma Mahsuri* to identified resistant potential under artificial inoculation at field conditions. Gene pyramiding is difficult to achieve using conventional breeding alone because linkage of some undesirable trait that is very difficult to break even after repeated backcrossing. So we use marker assisted selection (MAS) to achieve bacterial leaf blight resistant lines.

Out of 92 plants 60 plants showed presence of *Xa*21, 55 plants showed presence of *xa*13 and 38 plants showed presence of *xa*5 gene individually. In twenty-two plants, all the three genes viz., *xa*5, *xa*13 and *Xa*21 present which were highly resistant at field condition also. Thirty plants showed combination of two resistant genes, where twenty-one plants showed presence of *xa*13 and *Xa*21, six plants showed the presence of *xa*5 and *Xa*21 and three plants showed the presence of*xa*5 and *xa*13.

These twenty-two plants were advanced in to BC_2F_4 generation and validate for the presence of three genes viz., *Xa*21, *xa*13 and *xa*5. At the same time background selection was done. A set of 72 polymorphic SSR markers were used for background selection, where only 22 were found polymorphic to the parents. Based on 22 polymorphic markers the recurrent parent genome ranges from 45.45% to 95.45%. Three plants with highest recurrent parent genome were plant number 28 with 86.36%, plant number 86 with 90.90% and plant number 19 with 95.45%. Thus, through marker assisted selection (MAS) the present study reports successful pyramiding of bacterial leaf blight resistance genes *xa*5, *xa*13 and *Xa*21 in rice variety *Karma Mahsuri*. The resistant lines could be used further in the breeding programme for development of bacterial leaf blight resistant rice varieties.

P24 : Reaction of chickpea differential genotypes against *Fusarium oxysporum* f.sp. *ciceri* and identification of wilt resistant sources

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Chickpea (*Cicer arietinum* L.) is an important pulse crop, which belongs to family leguminoceae. Vascular wilt of chickpea causes serious disease in Madhya Pradesh. Chickpea entries/varieties used in the present investigation were obtained from All India Co-ordinated Research Project on Chickpea (AICRP), Jabalpur. Chickpea entries/varieties were evaluated for wilt resistance in the multiple disease sick field under AICRP on Chickpea located at Seed Breeding Farm, J.N.K.V.V., Jabalpur. The investigations were undertaken to know the reaction of chickpea differential genotypes against *Fusarium oxysporum* f.sp. *ciceri* and identify the wilt resistant sources. Host plant resistance under wilt sick field led to conclusion that among 18 released varieties screened for vascular wilt, 14 entries namely JG 315, JG 218, JG 322, JG 11, JG 16, JG 63, JG 226, JG 412, JG 6, JG,12, JG 14, JAKI 9218, Vijay, Vishal were found resistant, 02 entries as tolerant (JG 130, ICCV 10), 01 as susceptible (Digvijay) and one JG-74 was highly susceptible to vascular wilt and among the 12 promising lines screened for vascular wilt, 08 lines namely JG 33, JG 24, JG 25, JG 32, JG 30, JG 31, JG 23, JG 34 were found resistant, two promising lines as moderately resistant i.e. JG 26, JG 28 and two promising line were found tolerant i.e. JG 27, JG 29 to vascular wilt. These to wilt resistant entries may be utilized in resistance breeding programme after further confirmation on their level of resistance on the basis of pot studies as well as under field conditions.

Keyword; Chickpea (*Cicer arietinum* L.), Vascular wilt ,*Fusarium oxysporum* f. sp*. Ciceri* ,Genotypes, Resistant Sources

P 25: Multilocation evaluation of near isogenic lines (NIL'S) carrying different blast resistance genes

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Rice blast disease incited by the fungus *Pyricularia oryzae* is considered as a major limiting factor in the global rice production because of its wide distribution and destructiveness under favourable conditions. It causes severe yield losses upto 80-100%.The present study was conducted in four different agro-climatic regions *viz.,ICAR*-IIRR Hyderabad (Telangana), KVK Dhamatari (C.G.), RMDCARS Ambikapur (C.G.) and SGCARS Jagdalpur (C.G.) during *Rabi* 2017 and *Kharif*, 2017. In this experiment, sixteen introgressed lines *i.e.,* MSP-1, MSP-2, MSP-3, MSP-4, MSP-5, MSP-6, MSP-7, MSP-8, MSP-9, MSP-10, MSP-11, MSP-12, MSP-13, MSP-14, MSP-15 and MSP-16 (developed by ICAR-IIRR, Hyderabad) were evaluated along with donor parents, recurrent parents, resistant and susceptible checks. These lines were gene pyramided with broad spectrum of blast resistant genes *i.e.,Pi1, Pi2* and *Pi54.* The results confirmed that, MSP-1 and MSP-7 (*Pi1*), MSP-3, MSP-9, MSP-14 and MSP-16 (*Pi54*), MSP-6 and MSP-12 (*Pi1, Pi2* and *Pi54*), MSP-8 and MSP-13 (*Pi2*) and MSP-11 (*Pi1* and *Pi54*) lines showed resistant reaction to blast disease at four locations. While MSP-4 (*Pi1 and Pi2*), MSP-10 (*Pi1 and Pi2*), MSP-15 with (*Pi2*) genes were moderately resistant at KVK Dhamtari. Similarly, MSP-2 (*Pi2*) at SGCARS Jagdalpur and MSP-5 (*Pi2 and Pi54*) at RMDCARS Ambikapur and IIRR, Hyderabad showed moderately resistant reaction respectively.

Key words: Rice blast, Resistance genes and Introgressed lines.

P 26: Study on genetic variability among the isolates of *Alternaria brassicae collected from* Northern Madhya Pradesh

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The production of oilseed *Brassicas* is greatly hampered by several fungal diseases, out of them *Alternaria* blight incited by *Alternaria brassicae* is one of the most devastating disease of rapeseed-mustard. Variability studies are important to document the changes occurring in populations and individuals as variability in morphological and physiological traits and indicate the existence of different pathotypes. The isolates were collected from five districts and designated as A1 (Gwalior), A2 (Morena), A3 (Datia), A4 (Bhind) and A5 (Sheopur) for binary coding to analyse the Similarity Distance Matrix. Isolates of five districts viz., Gwalior, Morena, Bhind, Datia and Sheopur were cultured on Potato dextrose agar medium to study their cultural characteristic and genetically variability from 7 days old culture. Genomic DNA for different fungal isolates having concentration of DNA 20-25 ng/µl was used for amplification of RAPD primers. All the three Primers set showed significant polymorphism among the fungal isolates. The distance matrix analysis was drawn phylogenetic tree by PCR data showed genetic distance among the fungal isolates. The phylogenetic tree clearly showed three major cluster in isolate of *A. brassicae* illustrated in dendrogram framing, isolate A1 was completely different from rest of the isolates and made separate cluster. All other samples were also significantly different from each other i.e. A4 (78%), A5(37%) and A2&A3(94%).

Keywords: *Alternaria* blight, variability, polymorphism and *Alternaria brassicae.*

P 27: Effect on germination, emergence, vigour and viability of soybean seeds from *Mungbean yellow mosaic virus* infected plants

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Soybean (*Glycine max* (L.) Merrill) is valued due to high quality protein (40-42%) and oil content (18-20%) and an account of its ability to fix biological nitrogen 270kg/ ha as compared to 150 kg N/ha by other

pulses. An epidemic of MYMV disease was observed under Jabalpur (22^{0} 49' and 20^{0} 80' North Latitude and 70^{0} 21' and 80^{0}58' East Longitude at an altitude of 411.78 MSL) conditions. Higher rainfall (116.80mm) with greater number of rainy days (04) during 31^{st} standard week having maximum temperature 29.8 C and minimum 23.6 C with average relative humidity 80% triggered the higher population of vector whiteflies (20-30/leaf) resulted in more than 70% plant population affected by the viral pathogens. Influence of the disease was determined on soybean seeds from healthy and infected (more than 60%) plant canopy. Infection seeds were hand harvested, collected and employed for investigations on sowing seed qualities. A loss in seed germination was found in the range of 25.10 to 35.83% in samples from farmers field and Breeders seed production units. Least (28.89%) loss was recorded in JS 20-69 whereas, maximum (44.41%) loss was noticed in seed emergence in the samples of JS 335. Seed vigour was affected, 45.38% loss was noticed in seeds from diseased seeds. Due to infection of MYMV, around 37.2% loss in 100 seed weight was calculated in JS 335 while only 9.8% loss was recorded in JS 20-69. A slight change in seed morphology and seed color was recorded, however, no change in seed viability and seed coat cracking was observed. Various standard seed techniques were employed for the determination of impact.

P 28: Application of bio agents for control of plant diseases

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Biological control is the control of disease by the application of biological agents to a host animal or plant that prevents the development of disease by a pathogen. With regard to plant diseases the bio control agents are usually bacterial or fungal strains isolated from the end sphere or rhizosphere. Viruses can also be used as bio control agents and there is a resurgent interest in the use of bacterial viruses for control of plant diseases. The degree of disease suppression achieved with biological agents can be comparable to that achieved with chemicals. Our understanding of the ways in which bio control agents protect plants from disease has developed considerably in recent years with the application of genomics and genetic modification techniques. We have uncovered mechanisms by which bio control agents interact with the host plant and other members of the microbial community associated with the plant. Understanding these mechanisms is crucial to the isolation of effective bio control agents and the development of bio control strategies for plant diseases. This review looks at recent developments in our understanding of bio control agents for plant diseases and how they work.

Keywords: - Biological agent, Pathogen, Fungal strains, Plant diseases

P 29: Investigation of sheath blight disease (*Rhizoctonia solani* Kuhn) of paddy (*Oryza sativa* L.) under south Gujarat condition

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Sheath blight disease of ice caused by the soil borne fungal pathogen *Rhizoctonia solani* is a one of the major production constraints in rice growing countries of the world. Although various cultural practices have been used to manage the disease, it is advantageous and important to screen rice germplasm and identify resistant rice cultivars for more effective disease control. Out of forty four screened genotypes, nineteen genotypes were found moderately resistant against sheath blight pathogen under artificial inoculation condition. *In vitro* interaction by dual culture technique showed strong antagonistic activity of *Trichoderma viride* against sheath blight pathogen. Clove extract of garlic exhibited maximum inhibition of mycelial growth of pathogen by poisoned food technique. Fungicide propiconazole (Tilt 25 % EC) and tebuconazole (Folicur 25.9 % EC) were proved highly fungitoxic to *R. solani* by poisoned food technique. Propiconazole (0.025 %) recorded minimum per cent disease intensity and highest per cent disease control followed by hexaconazole (0.005 %) under *in vivo* condition.

Key words: Sheath blight, *R. solani*

P 30: Status of linseed diseases in Chhattisgarh State

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Linseed disease survey was conducted in different districts of Chhattisgarh state from 2007-08 to 2017-18 for 11 years. The crop was assessed visually for *Alternaria* blight, wilt, powdery mildew and phanerogamic parasite (*Cuscuta*). Mean disease incidence (%) estimated and then its range was worked out. During survey it was found that mostly farmers used local land races to grew linseed that leads more disease incidence. Intervention of resistance varieties should be used to combat linseed diseases so that productivity of linseed remains stabilized. The incidence of wilt, powdery mildew, *Alternaria* blight and *Cuscuta* was 6 to 47.2 %, 2 to 69.5 %, 10.5 to 60 % and nil to 53.33 %, respectively over the years. It was also observed that disease incidence gradually decreased from 2010-11 to 2017-18. These results confer that mostly the farmers from Chhattisgarh adopted disease resistant varieties to grow linseed crop.

P 31: Significance of extra cellular enzymes in bioremediation : A review

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Environmental pollution is one of the most serious problems affecting humanity and other life today. Environmental pollution is defined as “the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected.” Any use of natural resources at a rate higher than nature's capacity to restore itself can result in pollution of air, water, and land. The environment is continuously polluted by a large array of hazardous chemicals with different structures and different toxicity levels. They are highly persistent and adversely affect human and environmental health, because of their carcinogenic and mutagenic effects. Bioremediation is a process that uses living organisms mostly microorganisms and plants to degrade, reduce or detoxify waste products and pollutants. Most bioremediation processes involves oxidation-reduction reactions where either an electron acceptor (commonly oxygen) is added to stimulate oxidation of a reduced pollutant (e.g. hydrocarbons) or an electron donor (commonly an organic substrate) is added to reduce oxidized pollutants (nitrate, oxidized metals, chlorinated solvents, explosives and propellants).

Extra cellular enzymes include a large range of oxidoreductases and hydrolases. Both these enzymes may work as a degradative function and transform polymeric substances into partially degraded or oxidized products that can be easily up-taken by cells. These latter in turn provide to their complete mineralization. Extra cellular enzymes, (cell-associated or cell-free enzymes) may behave as powerful catalysts in the

biodegradation of harmful pollutants. In some cases, specialized microbial cultures are added (bioaugmentation) to further enhance biodegradation.

P32: *In-planta* expression of pathogenesis related genes in rice cultivars in response to sheath blight caused by *Rhizoctonia solani* Kuhn

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Sheath blight disease of rice caused by *Rhizoctonia solani* is one of the major constraints for the rice production in India and throughout the world. Till now, there is no specific resistance/defence gene was identified in rice against *R. solani.* Pathogenesis related (PR) genes are one of the most important defence genes in the interaction of rice with *R. solani.* In present study, PR genes in defence responses against a virulent isolate of *R. solani* (AG-I-1A) in tolerant (Whazhuophek) and highly susceptible (IR-50) varieties of 40 days old seedlings were observed. Assay on whole plants had showed that disease severity and growth behaviour of *R. solani* was more in susceptible variety than on tolerant. The expression scripts of the PR genes were calculated by using the Quantitative Real Time PCR (RT-PCR). Results showed that the expression rate of 9 out of 12 investigated genes were higher in tolerant variety than that of the susceptible variety. The expression levels of PR-1, PR-3, PR-9 and PR-10 genes were 56.14%, 95.85, 31.48%, and 66.1% higher folds in Whazhuophek than that of IR-50 respectively at 72 hours of post inoculation with *R. solani*. The results of this study suggest that these genes are involved in defence response of rice against sheath blight pathogen and provide tolerance to the plant. For the first time, the induction of PR-1, PR-2, PR-3, PR-4, PR-5, PR-9, PR-10, PR-12, PR-13, PAL, PPO, LOX and CHS genes were observed in rice against *R. solani.* This result will be useful in improving tolerance in rice cultivars against sheath blight pathogen.

Keywords: PR genes, *Rhizoctonia,* RT-PCR, rice

P 33: Integrated disease management of citrus gummosis caused by *Phytophthora* spp.

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Citrus gummosis' caused by several *Phytophthora* spp. is one of the serious constraints to citrus production in Manipur. During the survey, maximum disease incidence (30%) was recorded in Kachai village of Ukhrul district of Manipur. It was also observed that the orchards facing problem of water stagnation were having higher citrus gummosis infection. Evaluation of different plant extracts and cow urine by poisoned food technique showed that all plant extracts and cow urine tested were found significantly effective in reducing mycelial growth of *pathogen* over untreated control. However, cow urine in all the concentrations recorded highest mean mycelial growth inhibition (100%) followed by *Lantana* (85.42%) and *Pogostemon* (84.58 %) respectively. All the five *Trichoderma* spp. showed differential antagonistic potential against the pathogen and it was observed that *T. harzianum*, *T. atroviride and T. asperellum* could come in contact with the pathogen on fifth day of incubation. The pathogen was 75 % overgrown (Class II) by the antagonists *T. harzianum*, *T.*

atroviride and T. asperellum T. koiningi while the antagonists T. ovalisporum and T. koiningi could not overgrow the pathogen forming 1 cm and 0.3 cm inhibition zone (Class VI) against the pathogen. All the test fungicides significantly inhibited the mycelial growth of the test pathogen over the untreated control in all the four concentrations. Among them, Amitoctradin + dimthomorph, Dimethomorph, Metalaxyl + mancozeb and propineb were found most effective and significantly superior among all the treatments with 100 per cent inhibition of mycelial growth of the pathogen followed by Metalaxyl + cholorothalonil (96.87%). Integrated management studies showed that the T2 treatment (T2) i.e Removal of gummosis infected portion + Bordeaux pasting (1:1:10) + 0.2% (amitotradin+ dimethomorph) was significantly superior over all other treatments with disease severity of 5.55%.

P 34: Disease decision support system: Their impact on disease management in paddy crop with special reference to Chhattisgarh State

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The proposed decision support system uses the knowledge of disease symptoms evident in the plants diagnose the diseases. The system has been developed in the ASP.NET and SQL server environment. Visual and text based symptoms of most of the diseases of paddy have been included in the knowledge base of the decision support system. The system first find out the symptoms of disease through picture and confirm it by more unique symptoms of picture and recommends the necessary control measures. Similarly, text based system also provided extensive knowledge. It was found to be consistent and sound. The system was validated using various qualitative and quantitative (statistical) methods. The system was exposed to competent extension workers to measure the enhancement on their decision making skills compared to decision generated by decision support system. It was found that enhancement was more than 80%. Paired t-test also showed the significant difference between before and after exposer of the system. This system can be used as knowledge repository of major diseases of paddy crop. It can also be used as educational tool for students for practical experience with real scenario.

Key words: Decision support system, Disease management, Paddy, Chhattisgarh.

P 35: Diagnosis of the post-harvest rot of ginger in Assam

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Ginger (*Zingiber officinale* Rosc.) fourth most important spice in India with the production of 683.16 thousand tons from an area of 138.20 thousand ha and productivity of 4.943 thousand tons/ha (Spice Board India, 2013-14). Assam produces 32.1 thousand tons of ginger with an average productivity of 7.64 t/ha. (Spice Board India, 2015-16). Ginger needs to be stored at least for a period of 8-9 months (From Dec-Jan to Sep-Oct) for using as raw under Assam condition. Total post-harvest loss of ginger in Assam has been reported to be 30 per cent due to storage rot. Rotting in storage are of two types *viz.* dry rot and soft rot. The infected ginger showing typical symptoms of rotting were collected from markets, cold storage and households. From infected ginger, six fungi and one bacteria were isolated by using PDA (Potato Dextrose Agar) among which two fungi and one bacteria have shown positive Koch's Postulates results during pathogenicity test. The Fungi were identified as *Fusarium oxysporum* and *Pythium sp* based on their microscopic characters. The occurrence of *Fusarium oxysporum* was more during isolation than other pathogens. The bacteria isolated from infected ginger using NA (Nutrient Agar) also confirmed as a pathogen after pathogenicity test following Koch's Postulates. Bacterial colonies appeared as white with pink centres on TTC (Triphenyl Tetrazolium Chloride) medium. Based on the results of biochemical tests like levan production test, oxidase test, KOH test, nitrate reduction test, citrate utilization test the bacteria was identified as *Ralstonia sp.*

P 36: Screening of chickpea (*Cicer arietinum* L.) genotype against dry root rot through blotter paper technique *In-vitro* condition

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Chickpea (*Cicer arietinum* L.) is an important pulse crop, which belongs to family leguminoceae, ranking third among pulse crops in India. In order to find out the resistant genotype of chickpea, test lines were scored at the end of the incubation period by examining the seedlings for the extent of root damage and were scored for the disease. In order to find out the resistant genotype against dry root rot 98 chickpea (desi) entries were evaluated In-vitro conditions among them five entries *viz* GJG 0910, IPCK 06-78, CSJK-42, IPCK 06-56, GNG 1969 were found to be resistant. Exhibiting, less than 10 percent disease incidence whereas 42 entries were found to be moderately resistant. The disease incidence ranged from 10.1 to 20 percent .In this trial 61 (Kabuli) entries were evaluated, out of which 14 lines *viz* GNG 1969, CSJK 68, Vihar (PhuleG95311), RVSSG 11, GNG 2112, HK 06-171, Kripa (Phule G 0517), IPCK 08-136, BG 3012,HK 08-206, JGK 13, AKG 2002-1K, IPCK 08-130, BG 3027 were found resistant .whereas 25 entries were found moderately resistant showing 10.1-20 percent disease incidence.

P 37: Screening of pearl millet hybrids, varieties and land races against downy mildew incited by *Sclerospora graminicola* (Sacc.) Schroet.

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Downy mildew or 'green ear' is a very destructive disease of pearl millet in Asia and Africa wherever pearl millet is grown as a food and fodder crop. The disease is soil borne in nature and caused by a fungus *Sclerospora graminicola* (Sacc.) Schroet. The disease was considered of minor importance till 1970, as its incidence was sporadic on local cultivars. The first epidemic of downy mildew occurred in 1971 on the first popular pearl millet hybrid, HB 3, resulting in severe grain loss of about 4.6 million metric tonnes. Because of continued large-scale cultivation of the susceptible hybrids, the disease caused serious epidemics during 1974, 1984, 1987 and 1988. Availability of data on grain loss is incomplete due to greater variability from field to field, farmer to farmer, and from season to season. On the basis of a few localized estimates in India the average annual yield losses can reach up to 40%.Use of downy mildew resistant cultivars has been most economical and effective means of managing this disease in farmer's field. Well planned intensive research during the past three decades has resulted in the development of highly effective field and lab screening technique, identification of several sources of resistance and development of several downy mildew resistant cultivars. In the present investigation a set of forty promising pearl millet hybrids, varieties and land races were screened against downy mildew and were compared with standard and local susceptible check "7042S". Downy mildew susceptible cultivar "local susceptible" was used as infector rows (Inoculum donor) with a view to develop maximum disease pressure. These rows were planted three weeks earlier than the test rows. The field was also surrounded by the infector rows. The indicator rows (local susceptible and 7042 S) were also planted along with the test rows to assess the level of disease pressure. The two years pooled data reveals that only eight entries viz., 86M64, 86M86, 86M88, Nandi 61, Pratap, Mahalaxmitilak, Krishna 9119 and Kaveri Super boss were completely free from the disease upto 60 DAS. Other 16 entries viz., KBH-108, MP 7792, 86M36, 86M84, GHB 538, GHB 744, ICMV 155, ICMV 221, JBV-2, NBH 3685, Pac-909, LG-1281, Shriram Hybrid 5141, Proagro 9444, Proagro 9450 and Indo Us 9999 showed very low incidence of downy mildew, while more than 55 and 95 percent downy mildew incidence was recorded in susceptible check at 30 and 60 days after sowing respectively.

P 38 : Role of critical environmental parameters favouring for infection and development of pearl millet blast.

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Blast incited by *Pyricularia grisea* (Cooke) Sacc. has become wide spread and destructive disease of pearl millet particularly in the crop cultivated for fodder purpose. Earlier it was considered a minor disease in the country but from last one decade it has become important in many of the high yielding hybrids. More than 50 species of grass family are infected by blast pathogen including rice, wheat, barley, oats, pearl millet, finger millet and foxtail millet (Tanweer *et al.,* 2015). The pathogen is highly variable in nature but certain strains were specific in its host range. It produces highly palatable and nutritious forage. The crude protein content of green pearl millet forage varies from 6 to 20%. The fresh forage is fairly well digested by ruminants, with DMD being about 66-69%. In pearl millet silage, crude protein content is low (from 4% to 10%) due to protein losses, and the rumen degradable fiber fraction is low (Guimaraes *et al*., 2010). An experiment was laid out at experimental farm of College of Agriculture, Gwalior on five different dates of moderately blast susceptible cultivar JBV-2 was planted in five different dates at weekly interval starting from the last week of June during 2015-16 and 2016-17. The experiment was conducted in RBD design with four replications. Spacing was maintained as 30 cm row to row and 10 cm plant to plant. Fertilizers @ N 80 kg, P 40 kg and K 40 kg /ha were applied as basal dose before sowing. The progressive blast infection on the tagged plants will be recorded at weekly interval simultaneously. The meteorological parameters data on temperature, relative humidity (RH), rainfall and number of sunshine hrs were also recorded separately weekly interval during crop season in year 2015-16 and 2016-17 from the Meteorological Department of College of Agriculture Gwalior. Symptoms appeared after inoculation on plant. .Progressively development of symptoms on plant was recorded at weekly interval. There after correlation and regression studies will be carried out in between the leaf blast severity and individual metrological parameters. The role of meteorological parameters on the infection and development of blast was studied. The infection and development of blast positively and significantly influenced by maximum relative humidity (r = 0.724**), minimum relative humidity (r = 0.650**), rainfall (r = 0.884**) while it was negatively and significantly influenced by maximum temperature (r = -0.463*) and minimum temperature (r = -0.638**). The evaporation and duration of sunshine hrs did not influenced it significantly. The average maximum and minimum relative humidity should be more than 65 and 30 percent respectively whereas the maximum temperature should be less than 34.5 c. In assessing the percentile contribution rainfall (62.201) had contributed the highest proportion followed by maximum relative humidity (43.138), minimum temperature (18.593) and maximum temperature (13.465). Whereas, evaporation and sunshine hours did not influenced the disease significantly.

P 39: A techniques for a rapid membrane- based viral DNA isolation method for molecular diagnosis of graft transmissible pathogen in citrus

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Citrus is a widely distributed crop all over the world. Citrus is an important fruit crop in India. It is grown in about 0.50 million ha with an annual production of 0.39 million tones. Citrus is infected by a number of graft transmissible pathogen which include *Citrus tristeza virus* (CTV), *Indian Citrus ring spot virus* (IRSV), *Citrus yellow mosaic virus* (CYMV), *Citrus exocortis viroid* and the Citrus greening bacterium *(Candidatus liberibacter asiaticus).* These pathogen cause severe yield reduction in citrus and their detection in propagating material is an important component in bud- wood certification programme. Their reliable detection in infected citrus plants is now commonly done by PCR. A membrane based highly simplified DNA template preparation was standardized for detection of CBMV. The Unified nucleic acid extraction protocol is non-phenol chloroform based extraction protocol and was comparable with commercial DNA extraction kit for PCR detection of DNA pathogens in Citrus. The study has demonstrated that bark tissues of infected citrus plants can be common sources of nucleic acid template preparation for detection of this pathogens. Membrane based DNA template protocol is a novel approach in PCR detection of virus and greening bacterium and will be highly useful for survey, Sanitary and bud wood certification as well as for phytosanitary purpose in citrus.

P 40: Studies on aggressiveness of *Colletotrichum truncatum* isolates *on soybean collected from different regions of Chhattisgarh*

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Soybean is an important crop in Chhattisgarh mostly cultivated in kharif season, which is quiet remunerative for farmers. It is affected by several diseases, but among the fungal diseases, anthracnose caused by *Colletotrichum truncatum* is a serious disease and one of the major constraint, limiting high yields of soybean crop. *Colletotrichum i*solates from soybean plants with anthracnose symptoms were isolated from different regions in Chhattisgarh. Variation was observed in the aggressiveness of the tested isolates. It is apparent from the results that there was no much considerable difference on initiation of symptom (DAI) and appeared from 4-5 days depending on isolates. It is clear from the data that Ct4 and Ct6 isolates initiated the symptoms within 4 days while the other isolates developed in 5 days. Isolate Ct6 showed >70 % disease intensity producing typical symptoms on pods with acervuli and categorized as highly pathogenic isolate. Similarly Ct3, Ct7 and Ct10 isolates exhibited symptoms after 5 days of inoculation with disease intensity ranged between 51 to 70 % with a characteristic margins on developed spots and also grouped under strongly pathogenic group. Isolate Ct1, Ct4, Ct5 gave moderate pathogenic reaction and ranged between 21-50% while other isolate Ct2, Ct8, Ct9 were found as weakly pathogenic. Rest of the isolates were less efficient as compared to other isolates.

P 41: Identification, diagnosis and management of plant diseases caused by plant pathogens Integrated disease management in pomegranate at Bagalkot District

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Plant diseases and their management is an important concept in minimizing crop loss and subsequent increase in agricultural production. Pomegranate, the boon commercial fruit crop to the farmer turned as a big bane after the outbreak of bacterial blight. In recent years, from the year 2002, bacterial blight of pomegranate by *Xanthomonas axonopodis* pv. *punicae* became a serious disease. The disease spreads severely overall the pomegranate growing areas resulting in severe yield losses both in terms of quality and quantity. For management of bacterial blight of Pomegranate, integrated disease management (IDM) practice developed by UAS, Dharwad was demonstrated under Front Line Demonstration by ICAR-Krishi Vigyan Kendra, Bagalkot at Kaladagi village in the year 2016-17 and 2017-18. Method demonstration in farmers field at Kaladagi village comprising clean sanitation, removing water shoots, applying bleaching powder, spraying micronutrients, copper oxychloride @ 3g/lit, streptocycline @ 1g/lit, *Pseudomonas fluorescens* @ 5g/lit, pasting of stem and branches with Bordeaux mixture @ 1% were carried against oily spot disease of pomegranate, which benefited growers. The incidence of bacterial blight of pomegranate and yield in IDM practiced fields and Non IDM fields during the year 2016-17 and 2017-18 was recorded. Mean Percent Disease Index (PDI) on fruits in IDM practiced fields was 26.34 with yield of 13. 80 t/ha and BC ratio 3.65. However, the disease incidence in Non IPM fields was 39.35, with yield 10.30 t/ha and BC ratio 2.65. In IDM practiced field there was reduction of disease by 13.05 percent and increase in the yield levels by 25.36 per cent. The IPM practice was found very effective in reducing the disease incidence and has benefited pomegranate farmers of Bagalkot District.

P 42: Detection of *Tomato leaf curl virus* and evaluation of tomato varieties against leaf curl disease

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For the detection and identification of *Tomato leaf curl virus* four samples including one healthy and three infected samples of tomato crop were collected. The young leaves and twigs of tomato plants showing typical symptoms of leaf curling were collected from three locations *viz*., severely infected experimental plot in

Horticultural Instruction cum Research Farm, College of Agriculture, Raipur (C.G) and from farmer's fields of Rasni and Nisda villages of Arang Block. The total genomic DNA was extracted from the samples and quantification was done by nano drop method, and subjected to PCR with eight sets of primer. Out of eight sets of primers in four set of DNA (three infected and one check) only two primers *viz*., AV1 and ToLCV MP were amplified in samples collected from experimental plot in Horticultural Instruction cum Research Farm, College of Agriculture, Raipur (C.G) and from farmer's fields of Rasni village of Arang Block. With comparison from standard ladder expected annealing position of these primers *viz*. AV1 and *ToLCGV MP amplified DNA fragments of approximately 800 bp and 200 bp, respectively, were obtained from ToLCV infected leaves.* Twenty three commercial varieties/ hybrids with one susceptible check variety *viz*. Punjab Chhuhara was evaluated against tomato leaf curl disease during *rabi* 2015-16. Among the twenty three varieties evaluated eleven varieties *viz*. Bharani, Bhagyawan, Abhilash, Karan, Kareena, Priya-6636, Karishma, VNR-3357, Lakshmi, Saksham and NS 962 were resistant. Of them eight varieties *viz*. MHTM 256, Arundhati 809, Anvitha, Kohinoor, VNR-3348, Nun 7610, Kundan and Arka Rakshak were identified as moderately resistant. However one variety i.e. Red Ruby was regarded as moderately susceptible and remaining three varieties *viz*. S-22, Pusa Ruby and Punjab Chhuhara were susceptible against tomato leaf curl disease. The per hectare total yield was recorded maximum in Arka Rakshak (472.82 q) followed by Abhilash (425.92 q), Bharani (401.94 q), Bhagyawan (382.41 q) and Priya-6636 (351.85 q) and the minimum was observed in Punjab Chhuhara (41.26 q). The largest fruits were obtained from MHTM 256 (62.29 mm) with minimum in Punjab Chhuhara (36.42 mm) and longest fruits were harvested from Karan with polar diameter of 56.19 mm. Out of twenty three commercial varieties evaluated, the maximum total soluble solids content was found in Kundan (4.93 °Brix) followed by Red Ruby (4.60 °Brix), Karan (4.56 °Brix), Arundhati 809 (4.33 °Brix) and Bharani (4.29 °Brix). The minimum total soluble solids content was recorded in Nun 7610 (3.47 °Brix). The days to first flowering, 50% flowering and first fruiting were observed minimum in NS 962 and maximum by Kundan.

P 43: Single spore isolates of *Colletotrichum* spp. derived from different hosts and it's identification of resistance against soybean anthracnose

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The genus *Colletotrichum* comprises ~600 species attacking over 3,200 species of monocot and dicot plants. *Colletotrichum* species are fungal pathogens that devastate crop plants worldwide. The most important disease reported to cause economic losses to selected my ten crop (*viz.* Soybean, Mungbean, Peagon pea, Cowpea, Chilli, Bellpeper, Turmeric, Dragon fruit, Beans, Brinjal) is anthracnose incited by *Colletotrichum,* causing yield losses of 16-100 per cent. Only a small number of *Colletotrichum* species have been associated with the teleomorph, Glomerella, and generally these teleomorphs are rarely observed in nature (Sutton 1992). In the present investigation single spore isolates were derived from different naturally infected hosts, which allowed us to demonstrate morphological variability in the fungus. Attempts were made to induce the teleomorph and to determine the mating system in this fungus. *In vitro* evaluation of hexaconazole, NF (new formulation), thifluzamide and azoxysrobin were highest percent inhibition of 60% at 50 ppm of NF and lowest percent inhibition of 19.5% at 500 ppm of azoxystrobin (Ingle *et al*. 2014). Anthracnose occurs throughout the soybean production areas of the world. We also report here in ten entries (IVT-24, IVT-26, IVT-39, TMAS-38, RSC-10-52, IVT-04, RSC-10-70, IVT-13, NRS-125, RSC-10-71) resistant to anthracnose of soybean out of 138 screened.

P 44: Evaluation of culture media to select the most suitable medium for the growth of *Sclerotinia sclerotiorum*

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Six artificial media were evaluated for their influence on the growth of S. *sclerotiorum* and the data is presented that potato dextrose agar was found best because it showed maximum growth of the fungus (85.25 mm) followed by mixed meal agar (69.25 mm), Sorghum meal agar (65.75 mm), pearl millet meal agar (60.75 mm), pea meal agar (57.75 mm), at the stage of seventh day. While, corn meal agar was found comparatively less suitable as it showed the minimum growth of the fungus mycelium (51.50 mm). In all the tested media the growth of the fungus was initiated in the second day after inoculation. The trend of pathogen growth in all the media during 3rd to 7th day was almost similar. Potato dextrose agar medium was significantly superior over all the tested media.

P 45: Existence of diverse symptomatic and pathogenic isolates of *Chilli veinal mottle virus* in the chillies of Manipur

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King chilli (*Capsicum chinense* var Umorok) is wide known for its high capsaicin content. High economic value and favourably grown in the NE India, this chilli landrace has strong potential to uplift the economy of NE India. Concomitant changes in viral vectors intensity and its diversity along with the global agro-climatic condition has severe impact in the cropping system worldwide. Frequent incidence of virus-like disease in chilli plantation has been a major bottleneck in the farmer's venture of large scale plantation. Molecular technique of reverse transcription (RT)-PCR has revealed mottling, puckering, shoestring, thinning of lamina, vein banding and mosaic of lamina are typical symptoms of ChiVMV infection in chillies. Varied symptom expression was recorded depending on chilli variety and its collection site and their pathogenicity difference was further confirmed through transmission studies. Viral indexing covering 11 district of Manipur revealed the potyvirus presence these districts with a high incidence of 77.57% (81 positive out of 127 samples screened). Genetic relationship study incorporating taxonomically important regions of ChiVMV (CP and NIB) confirmed the distinctive nature of the viral isolates prevailing in the state of Manipur. The present analyses concluded that ChiVMV is an emerging disease in chilli plantations of NE India and require urgent interference using modern detection tools to control and for easy management of this potyvirus through development of easy, fast and reliable tools.

P 46: Molecular diagnosis of bacterial wilt (*Ralstonia solanacearum*) infecting eggplant in Orissa

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India ranks in second position in the total world production of eggplant/ brinjal (*Solanum melongena*) after China. Major eggplant growing states in India are West Bengal, Orissa, Bihar, Gujarat, Karnataka, Maharashtra, Madhya Pradesh and Assam. Eggplant is prone to attack by several pests including bacteria, fungi, nematodes and insects. In this study, we have molecularly characterized the bacterial wilt (*Ralstonia solanacearum)* infection in eggplant plant collected from Bhubaneswar (Orissa) in India. Bacterial wilt symptomatic five plants were collected from brinjal field in Bhubaneswar during karif 2016 season. The samples were disinfected with 70% ethanol and macerated in sterile distilled water. Macerates were streaked on Kelman's triphenyltetrazolium chloride (TZC) agar media and incubated on 28°C for 48 hrs. After 48 hrs, on TZC medium cream colored, irregular shaped, highly fluidal with pink pigmentation colonies observed. These characters were consistent with *R. solanaceearum* as described by Kelmen (1954). Total genomic DNA of the bacterium were extracted as described by Chen and Kua, 1993) and subjected to PCR amplification using the *R. solanacearum* specific universal primer pair 759/760 (Opina et al 1997). An expected single 280-bp fragment amplified in all the samples, which further confirmed the identity of these strains as *R. solancearum.* To reconfirmed isolate of bacterium, the amplicon was eluted from gel and sequenced in sequencer. In NCBI blast, the nucleotide sequence was 100% similar with *Ralstonia solanacearum* strain QK-5 (EU348763) and the sequence was submitted in NCBI database under Acc. No. KY393266. To determined phylotype of strain used specific multiplex PCR with phylotype specific primers (Nmult:21F1/2,Nmult:22InF, Nmult:23AF, Nmult:22RR) described by Prior and Fegan (2005), revealed that all the five strains belonged to phylotype I as a 144-bp amplicon were observed in agarose gel. On the basis of above finding concluded that the bacterial wilt infected eggplant collected from Bhubaneswar was *Ralostonia solanacearum*, Phylotype I.

P 47: Effect of various temperatures and pH on growth and sporulation of *Alternaria* spp.

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Early blight disease Caused by *Alternaria* spp was observed on different crops viz,. Tomato, Potato, Chilli, Cumin, Cauliflower, Brinjal, Sesami, Onion and Datura in major growing area of Jabalpur. The variations were found in Growth and sporulation at different Temperatures and pH. The optimum temperature was observed favouring redial growth and sporulation of *Alternaria* spp was 25 -28°C. Lowest temperature had an adverse effect on fungal colonization and sporulation. Among the nine isolates of *Alternaria species. Alternaria* spp grew rapidly producing flat, downy to wooly colonies, covered by grayish, short aerial hyphae. The surface is grayish white at the beginning which later darkness and becomes greenish black or olive brown with a light border. Direct correlation of temperatures with mycelial growth and sporulation in present scenario of climate change is the priority among the *Alternaria* species. Among the various pH levels tested, the pH of 6.5 favored mycelial growth and sporulation of the fungus.

Keywords: *Alternaria*, Temperature, pH, Growth and Sporulation

P 48: Biodiversity of *Fusarium* species and their impact on the health of food grain

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The genus *Fusarium* Link with its different species are known to attack variety of food grain both in field as well as storage and the results found to be responsible for major cause of deterioration and poisoning of the food grains. It is certainly reveals that maximum numbers of *Fusarium* spp. have been recorded and 13 species, 35 strains were isolated from the food grain such as cereals, pulses, oil seeds and spices. However, important *Fusarium spp.* and their different aspects like enzymatic nature and discolouration role in deterioration in food grain is very significant.

The impact of *Fusarium spp.* on the production of different toxins were remarkable when they were associated with the food grains and their toxicity response, which may result into mycotoxicosis when consumed by animals and human beings (Monoharachary 1986). The toxins or fusotoxins like Moniliformin, Zeralenone, T-toxin, Fusaric acid, Fumonisins, Trichothecene, Fusarin-C, Fumagillin, Deoxynivalenol (DON), Nivalenol (NIV) and Diacetoxyscirpenol (DAS) were produced by the species of *Fusarium* among these the Deoxynivalenol (DON), Nivalenol (NIV) and Diacetoxyscirpenol (DAS) were detected. The attention is given for the alternative management of *Fusarium* species by adopting the fungitoxic extract of plant parts to management of *Fusarium* spp.

P 49: Studies on the biology of most prevalent onion thrips (*Thrips tabaci* Lindeman) (Thysanoptera: *Thripidae*) on onion

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Study was conducted at the Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) during *rabi* season 2013-14 and 2014-15 to recognize studies on the biology of most prevalent onion thrips *Thrips tabaci* L. (Thysanoptera: Thripidae) on onion. The thrips laid singly minute, kidney shape and translucent white in colour inside the leaf tissues with its pointed ovipositor. During the year 2013-14, average incubation period varied from 4.45 ± 0.50 days. The larvae passed through two instars. The average larval period varied from 5 to 7 days with an average of 6.24 ± 0.66 days while pre-pupal and pupal period were 2.23 ± 0.75 and 3.58 ± 0.50 days, respectively. The average pre-oviposition, oviposition and post-oviposition period were 3.38 ± 1.11, 22.77 ± 5.68 and 3.31 ± 1.08 days, respectively. The average fecundity of female was 55.21 ± 11.66 eggs during entire life spam. The average longevity of adult was 28.92 ± 6.83 days. The infestation of onion thrips is increasing and expanding in many crops resulting in spread of viral diseases. To manage this menace, it is vary important to understand the biology of onion thrips to keep them under check.

Technical Session-II :

Production and Application of Biocontrol Agents for Disease Management

Lead Lectures
LL 01: Role of plant growth promoting rhizobacteria in sustainable plant disease management

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Free living; root colonizing bacteria have been studied for the past century as possible inoculants for increasing plant productivity. Plant growth promoting rhizobacteria (PGPR) are characterized by a number of functions which include improvement of plant establishment, increased availability of plant nutrients, enhancement of nutrient uptake, improvement of soil structure and protection against diseases.

More specifically, fluorescent Pseudomonads have received attention owing to their catabolic versatability, root colonizing ability and their capacity to produce a wide range of secondary metabolites. There are a varieties of biocontrol mechanism to suppress fungal and bacterial pathogens by fluorescent *Pseudomonas* sp. by producing antibiotics, siderophores, hydrocyanic acid (HCN), enzymes and phytohormones. Antibiotics produced by species of *Pseudomonas* are deleterious to the growth or metabolic activities of other microorganisms. Antifungal compounds include 2, 4-diacetyl phloroglucinol (Phl), pyoleuteorin (Plt), pyrrolnitrin (Prn), HCN and phenazines (Phz) contribute to disease suppression in various host pathogen systems.

The use of fluorescent Pseudomonads for inducing systemic resistance against phytopathogens has been well documented. Various isolates of fluorescent *Pseudomonas* promoting the growth and vigour of rice and chilli seedlings have been identified. An increased activity of PAL, total phenol and β-1,3 glucanase due to application of *P. fluorescens* isolates in chilli plants challenge inoculated with *F. solani* wilt of chilli both at short durations and long durations. The treatments of rice seeds with an endophytic isolates (EP-5) recorded maximum PAL activity in rice against sheath blight fungus. However, when the rice seedlings were root-dipped, the PAL activity was maximum on the 7^{th} day after challenge inoculation. *P. fluorescens* (EP-5) was clearly a top performing isolate as it showed higher activity of defence related PAL enzymes.

With regards to formulations, talc was best suited for both *P. fluorescens* and (Pf-4) *P. putida* (RFP-13) isolates with 12×10^7 and 10×10^7 cfu/g respectively up to 300 days of storage. The powder formulation available was less expensive as they were developed from the low cost agriculture/industrial wastes or by-products and their handling was also easier. The shelf life of two isolates, of *P. fluorescens* (EP-5) and *P. putida* (RP-46) the two potential DAPG positive ones was for ten months with average population of 19×10^7 and 13×10^7 cfu g in the talc formulations respectively.

It is essential to work out the compatibility of bioagents with other insect pest and disease management chemicals since the bioagents are to be integrated as one of the inputs and practiced in agro-ecosystem approach. Among fungicides, *P. fluorescens* (EP-5) and *P. putida* (RP-46) isolates were compatible with hexaconazole, tricyclazole and propiconazole however they were incompatible with isoprothiolone. The isolates were compatible with carbofuran imidacloprid, whereas incompatible with fipronil and buprofezin. Further the isolates were compatible with plant products such as neem seed kernel extract.

The present day trend is to adopt IPM schedule where in the various components of fungicides, insecticides, bioagents and other inputs are integrated and put into use in the same ecosystem. The formulation of bioagents was used as an integral component for IPM demonstration on chilli under farmers field as a participatory approach in 25 acres area. *P. fluorescens* was used for seed treatment, soil application and foliar sprays among the interventions. The interventions were made throughout the season by continuous monitoring of pests and diseases by a team of plant pathologists and entomologists. The average incidence of leaf spot, powdery mildew, root rot, wilt, fruit rot and aflatoxin contamination in chilli was brought down significantly in the IPM plot.

Similarly, the leaf curl index, the mites infestation, percent fruit damage, and thrips infestation got reduced in the IPM plots as compared to non IPM plot. On the contrary, the population of beneficial insects such as coccinelids and predatory mites were higher in the IPM plot compared to non IPM plot. The number of pesticide sprays was brought down significantly with an overall average yield of 31.26 q/ha in IPM plot as against 24.6 q/ha in non-IPM plot fetching a net gain of Rs. 54662 per ha over non-IPM apart from preventing untold ecological damage

LL 02: Safety and security of crops from diseases caused by pathogens through extension approach

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Extension Plant Pathologist has to play role to educate farmers on the possibility of diseases in crops grown from sowing till harvest, hence he needs to have basic and applied knowledge of the subject. The role of disease cycle and life cycle must be very clear as well as about production technology of concerned crops. Safety is important up to full emergence of the crop. Precautions are needed to avoid seed and seedling damage due to seed and soil borne pathogens resulting in seed rot, pre-emergence losses, post-emergence losses and survival of pathogens in the environment for further attack. The cultural practices are necessary like proper land preparation, crop rotation, inter and mixed cropping, plant population, date of planting, soil treatment, soil solarization, irrigation level, fertilizer application etc. Seed treatment with bioagents or chemicals should be done. When proper crop stand is obtained it is necessary to keep close security of the crop not to allow damage due to biotic or abiotic factors. Attention is needed of disease cycle of important diseases to check recurrence of diseases. In case the disease gets initiated further spread should be checked by providing barriers like application of antagonistic microbes, spray of botanicals or chemicals as per need. It is better to grow crops in pathogen free areas. The movement of people, animals and machinery to the farm and within the farm should be controlled to avoid transmission of pathogens through soil as contaminant. The fields should be kept neat and clean by removing the old crop refuge, weeds etc. An Extension Plant Pathologist should have good knowledge of the crop canopy to differentiate a normal and diseased crop. A very critical knowledge is essential about fungicides, systemic and non-systemic, dosage for treatment of large and small seeds, selection of fungicides based on the type and location on and in the seed. The mode of seed to plant transmission of the concerned pathogen needs consideration. For spray on the crop, chemicals need to be selected along with dosage which may control the disease, save the crop but may not be phytotoxic. The pollen must remain safe. Some crops are shy to the chemicals if used at early growth stages and some turn phytotoxic if there is open sun with higher temperature.

When visiting fields for diseases, one should see the crop critically. Certain times symptoms are not evident but signs may be seen. One should never loose patience. If needed, samples may be collected for examination in the laboratory for correct identification for further action. One may observe a new disease then all the pathological investigations are done in the laboratory and as per need the material is passed on to other staff for further action. Extension Plant Pathologist should be fully aware with communication skills and extension technologies which help in dialogues with farmers in transfer of recent advancements in crop production techniques. An Extension Pathologist forms a link between the cultivator and the University and works as an ambassador of the University. His excellent approach and devotion is always admired.

LL 03: Management of soil borne diseases of crops using biological agents

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Different crops *viz.* pulses, oilseeds, vegetables, cereals, horticultural, spices, floriculture, cash crops are cultivated by farmers suffers with many diseases caused by fungi, bacteria, viruses, phytoplasma, nematodes, etc. Among these pathogens, some of the fungal pathogens *viz. Fusarium* spp, *Macrophomina phaseolina*, *Rhizoctonia solani*, *Pythium* spp. *Phytophthora spp.* etc, and most of the namatodes are soil inhabitant in nature and may cause > 70% crop yield losses. Often these pathogens are unable to manage with fungicides due to many reasons. In last twenty five years, researches in management of the soil borne diseases of these crops through biological agents have made fruitful recommendation to the farmers. *Trichoderma* spp. *viz. T. asperellum*, *T. asperelloides, T. harzianum, T. viride, T. virens, T. koningii,* etc. have been proved quite beneficial for the management of biotic stresses *i.e.* seed and soil borne diseases of the crops particularly wilt (*Fusarium* spp.), root rot (*M. phaseolina*, *R. solani*), collar rot (*A. niger*), stem rot (*S. rolfsii*), etc. which cause huge qualitative and quantitative crop yield losses. *Trichoderma* spp. not only act as biocontrol agents, but also stimulate plant resistance to biotic and abiotic stresses (temperature, drought, salinity, etc.) and help in plant growth and development resulting in an increase in crop production. The biocontrol activity involving mycoparasitism, antibiosis and competition for nutrients, also induces defence responses or systemic resistance responses in plants. Several mechanisms by which *Trichoderma* may influence plant development have been proposed, such as the production of phytohormones, the solubilisation of sparingly soluble minerals, reduction in pollutant toxicity (organic or heavy metal), and the regulation of rhizospheric microflora. *Trichoderma* spp. can be found all over the world in different eco-system as decomposer of waste organic matters as they produce cell wall degrading enzymes *viz.* cellulase, protease, chitinase, xylanase, endoglucanase, etc. A number of commercial formulations of *Trichoderma* spp. are available for the use of the farmers through the technologies of seed treatment, seed biopriming, enrichment of organic manures, cakes etc. The bacteria *i.e. Pseudomonas fluorescens Bacillus* species, *B. subtilis, B. amyloliquefaciens, B. pumilus, B. licheniformis* and *B. megeterium* were exploited for biological control of the plant pathogens. Similarly, biocontrol nature of thermophylic fungus *Aspergillus versicolor,* phosphate solubilizing bacterium *Bacillus firmus* antagonistic to *M. phaseolina* have been demonstrated.

Different soil borne nematodes also cause huge crop yield losses due to imparing the nutrient supply to plant due to sickness of the roots. Predacious species, *Arthrobotrys oligospora, Verticillium chlamydosporium*, *Paecilomyces lilacinus, P. fumosoroseus Poochonia* sp. have good biocontrol potentiality against root-knot nematodes caused by *Meloidogy nearenaria, M. incognita*, *Heterodera schachtii*, etc. There are many success stories of the biological control of the seed and soil borne diseases of crops, wherein the efficient, quality bioagents with proper delivery system have been applied by the farmers.

LL 04: Biopesticides in management of plant diseases: Regulatory requirements and IPR issues

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Biopesticide formulation based on microorganisms namely fungi, bacteria, viruses, nematodes etc. are known as microbial pesticides. Biopesticides are naturally occurring biologically safe microorganisms, used for the management of pests and diseases. The global market demand for microbial based bioinoculants is increasing annually. The estimated market for biopesticides has grown at a rate of 14% and is predicted to generate US$ 1.88 billion worldwide by 2020 and US$ 1.95 billion by 2022. Currently, it is estimated that nearly 80% of the global market revenues are recorded in Europe and Latin America. However, the acceptance and diffusion of biopesticides in Indian agricultural market is quite evident with the Indian contribution to the global biopesticide market being 2.89% during 2005, and a meager improvement to 5% by 2016.

Intellectual property involves inventions, fictional and creative work, industrial designs for article, symbols, etc. utilized as a part of trade. Today, it is widely accepted that any new result of a man's brain work need to be secured as private property. All patentable inventions must satisfy essential criteria that are, the invention must be novel and not obvious, it must have some industrial use, and the description part of the patent application must enable a person skilled in the relevant area of technology to put the invention into practice. The Indian patent system is governed by the Patents Act, 1970 as amended by the Patents (Amendment) Act, 2005 and the Patents Rules, 2003, as amended by the Patents (Amendment) Rules 2006 effective from 5 May 2006.

During the late 1970s with the advancement in recombinant gene technology, patenting microbes came into the existence including the famous genetically engineered superbug which catabolizes petroleum oil. His claim on the superbug was previously rejected by the USPTO but later in a case of Diamond *vs*. Chakrabarty, US Supreme Court gave the verdict in the favor of A.M. Chakrabarty. In 1981, motivated by the decision given by US Supreme Court in Chakrabarty case, Japanese Patent Office and European Patent Office also started issuing patenting microbes. Under Indian Patent Act 1970, Amendment 2002, implemented form May 20, 2003 microbe's development can be patented in India.

Several PCT and US Patent have been awarded to our group for novel agriculturally important microorganisms. A *Trichoderma harzianum* strain useful as nematode inhibitor, fungicide and plant growth promoter and a process for the isolation have been patented in 2002 (US Patent No. 6,475,772). In 2004 PCT patent awarded to the synergistic fermented plant growth promoting biocontrol composition (PCT WO 2004-087618A1). Another PCT patent has been awarded in 2005 to synergistic bioinoculant composition comprising bacterial strains of *Bacillus subtilis* or *B. lentimorbus* from cow milk (PCT WO 03/020038A1). In the year 2007, US patent has been awarded to a synergistic fermented plant growth promoting, bio-control composition (US Patent No.7,297,659B2). Likewise, bacterial strains of accession no. NRRL B30486, NRRL B30487 and B30488 and method of producing the composition have been patented in 2006 (U. S. Patent No. 7097830 B2). US patent was awarded to the rapid composting of bovine dung using *Trichoderma* of Accession No. NRRL 30598 having ability to promote plant growth.

Under the present political, technological and socio-economical situation it is very complicated to build up our national system of IPR in according to those of developed nations. Patenting life forms bring with them imperious issues of pious and ethical values. Thus, it would be a great favour to our nation to file, document, keep and modify new microbes isolated from different parts of the country.

LL 05: Pulses: Emerging disease scenario under climate change and management strategies

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Pulses play a pivotal role in nutritional security and soil ameliorative properties have been an integral part of sustainable agriculture since time immemorial. Globally, India has the largest area under pulse crops; however, their productivity is quite low which is associated with risk of crop failure due to several biotic, abiotic stresses and poor crop management practices. The loss in pulses production due to diseases and pests could be avoided by adopting resistant varieties, good crop management/ integrated pest management.

Soils host a huge diversity of microbes which varies with the season more in spring and fewer in winter and summer. The top layer of soil have more microorganisms than lower layers and are abundant in rhizosphere. Climate variability and changing climate patterns are alarming the equilibrium of host-pathogen interactions resulting in either increased epidemic outbreaks or emergence of new pathogens or less known pathogens causing severe yield losses. Climate variables (temperature, humidity, and greenhouse gases) are the key factors for these changes. The plant pathogens are among the first organisms to experience the climate change for its population dynamics i.e. multiplication, virulence, survival, dispersal. Global climate change responsible for the emergence of new disease or existing minor once becoming as major. Efforts are being made to discuss the different climate variables on diseases, pathosystems and the mitigation strategies for their management.

Chickpea and pigeon pea are the two largest cultivated pulses in India, largely grown in rain-fed environments that are most vulnerable to climate change. Increasing temperature, atmospheric CO_2, altered precipitation patterns and increase in the frequency of climate extremes are likely to influence the distribution, establishment, survival and spread of pathogens. Changes in the disease spectrum of chickpea and pigeon pea have been monitored through extensive surveys. Analysis of long-term disease and weather data sets indicated emergence of new diseases and shift in the occurrence and distribution of diseases of chickpea and pigeonpea. In chickpea, frequent out-breaks of diseases such as dry root rot (*Rhizoctonia bataticola*) and collar rot (*Sclerotium rolfsii*) and in pigeonpea. *Phytophthora* blight (*Phytophthora cajani*) and *Alternaria* blight have been observed. With increased temperature and more frequent moisture stress, *Rhizoctonia* blight is becoming more intense in typically tropical-humid areas, while viruses and rusts dominate in warm but dry zones. Data collected in India during the preceding years showed higher incidence of dry root rot in chickpea varieties that are resistant to Fusarium wilt in years when temperatures exceed 32°C. This is consistent with greenhouse experiments where different soil moisture levels and temperatures were manipulated, showing that *R. bataticola* infected chickpea plants and caused dry root rot faster at 35°C coupled with soil moisture levels less than or equal to 60%. By contrast, cooler temperatures and wetter conditions are associated with increased incidence of stem rot on soybean (*Sclerotinia sclerotiorum*), blights in chickpea, lentil, pigeonpea, and pea, and anthracnose (*Colletotrichum* spp.) in lentil and chickpea. Recent studied indicated increased incidence and frequent outbreaks of Phytophthora blight of Pigeonpea (*Phytophthora cajani*) in India over the last decade and can be attributed to high intermittent rainfall during the crop season.

The impact of elevated CO_2 levels (550 and 700ppm) in comparison to ambient level (350-380ppm) was studied on disease development in chickpea and pigeonpea under specifically designed facilities such as Open top chambers (OTC) and Free Air CO_2 Enrichment (FACE) and CO_2 controlled incubators at ICRISAT. Advancement in the incubation period and increased incidence of diseases such as Phytophthora blight and sterility mosaic disease in pigeonpea and dry root rot in chickpea was observed. However, no significant difference was found in wilt disease of chickpea and pigeonpea. It is established fact that temperature, moisture and greenhouse gases are the major elements of climate change. Current estimates indicate an increase in global mean annual temperatures of 1°C by 2025 and 3°C by the 2100. The carbon dioxide (CO_2) concentration is rising @ of 1.5 to 1.8 ppm / year and is likely to be doubled by the end of 21st century. Variability in rainfall pattern and intensity is expected to be high. Greenhouse gases (CO_2 and O_3) would result in increase in global precipitation of 2 ± 0.5°C per 1°C warming. Overall, changes in these elements will result in: i) warmer and more frequent hot days and nights, ii) erratic rainfall distribution pattern leading to drought or high precipitation and iii) drying of rain fed semi-arid tropics in Asia and Africa.

Disease outbreaks occurs with changes in climatic conditions (temperature and moisture) that favour the growth, survival and dissemination of pathogens. A change in climatic condition can help or force the disease to expand its normal stage to new environments and leads to epidemic with increased temperature. Dry root rot of chickpea is becoming more severe in rain fed environments. Climate change could have multiple effects on the epidemiology of plant diseases including the survival of primary inoculum, rate of disease progress during growing season, duration of epidemics, stages and rates of development of pathogen, effects on host resistance, changes in the physiology of host pathogen interactions.

Plant pathogens in spite of sound management technologies still results losses due to the climate variability. There is a shift in cropping pattern in pulses during last three decades. Chickpea has shifted from highly productive irrigated condition in Northern India to rain fed areas in Central and Southern India. This has made diseases viz., Ascochyta blight, Botrytis grey mould less frequent with wilt and root rots are becoming important in newer niches. Changing climatic conditions and abrupt rise in temperature at flowering and pod filling (March-April) accompanied by rains make the crop vulnerable to BGM attack.

Global climate change especially increased CO_2temperature and moisture levels are thought to influence or change all the elements of a disease triangle. This increase in temperature can modify host physiology and resistance, increase CO_2 would affect the physiology, morphology and biomass of crops by promoting the development of some rusts and other foliar disease. eg. Ascochyta blights, Stemphilium blight, Green mould. High moisture (rain fall) favors most of the foliar diseases and soil borne pathogens such as *Phytopthora*, *Pythium*, *Rhizoctonia solani* and *Sclerotium rolfsii.* This change in climate has also been observed with other disease, such as *Alternaria* blight of pigeonpea which has become more prevalent in recent years in semi-arid tropics regions. Climate change can have positive, negative or neutral impact on disease management due to more pathogen, generations per season & evaluation of pathogenic races it will causes alternation in the disease geographical and temporal distributions.

Climate change could affect the efficacy of crop protection chemicals in one or two ways. Firstly changes in temperature and precipitation may alter the dynamics of fungicide residues on the crop foliage, secondly morphological or physiological changes in crop plants resulting from growth under elevated CO_2 could affect uptake, translocation, and metabolism of systemic fungicide: eg. increased thickness of the epiculticular wax layer on leaves could slower or reduced the uptake by the host, whereas increased canopy size could negatively affect spray coverage. Disease management is largely dependent on use of costly and hazardous chemicals apart from use of agronomic practices, disease resistant varieties and biological means of management.

Disease development is the cumulative effect of various factors that affect the host and pathogen. A slight change in microclimatic conditions can affect the outcome of the plant pathogen interaction. The effects of climate change differ in different plant pathogen systems. Under worst case scenario, several crops may require more fungicides spray treatments or higher application rates thus increasing costs for farmers, prices for consumers and the likelihood of the development of fungicide resistance. By evaluating the efficacy of current physical, chemical and biological control methods under changing climatic conditions and research convening new tools and strategies (Plant breeding) for coping with the predicted charges will be of great importance. Fungicide may continue to serve as common disease suppression agents although alternative measures such as cultural methods and biological control should be developed.

The persistence of plant protection chemicals in the phyllosphere is highly dependent on weather conditions. Changes in duration intensity and frequency of precipitation will affect the efficacy of chemical pesticides. Temperature can directly influence the degradation of chemicals and other plant physiology and morphology, indirectly affecting the penetration, translocation, persistence and modes of action of many systemic fungicides.

The disease is the result of interaction among a susceptible plant, a virulent pathogen and suitable environment, and both plant and pathogen are influenced by environment. Exposure to altered atmospheric conditions can modify fungal disease expression. Temperature is one of the main factors in ecosystem with the rain to determine the incidence and severity of disease, but effect may be positive or negative (change in the environment). This require us to anticipate what might happen in the future. By anticipating the future, we can prepare ourselves for problems caused by climate change especially those related to agricultural activities, which generate the greatest amount of food consumed by humans.

LL 06: Present status and future prospects of consortial application of bioagents in crop protection

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A microbial consortium is a group of different species of microorganisms that act together as a community. For developing a consortium one can choose microorganisms in the form of combinations of biocontrol strains are expected to result in a higher level of potential to suppress multiple pests. Biocontrol agents offers or induce multiple disease resistance mechanisms in plant system directly or indirectly and also perform multifaceted mechanisms like mycoparasitism, hyperparasitism, antibiosis, induced systemic resistance, competition for space and nutrients against several plant pathogens. Consortial application of bioagents may improve the microbes to perform under different environmental conditions against disease control or plant growth promotions. Microbial consortia are much more efficient than single strains of organisms with diverse metabolic capabilities. Due to several soil and environmental related issues, microbial consortial application can be effective in the plant disease management.

Development of microbial consortium will be big challenge to the researchers besides its diversity in environment and selection and identification of microbial agents should be compatible with each other and also environmentally adoptable for the modern climate change scenario. Functional analysis of host system will provide detailed information about up regulations and down regulations of growth promoting genes responsible for the disease resistance and growth promotions. And also the consortial applications can be tested against abiotic and biotic stress conditions. Xu *et al*., 2011 reported that only in 2% of the total 465 published work studied, found to be synergistic effects among BCAs and rest have antagonistic (or nonsynergistic) interactions among BCAs. Last five years there is a increase in the publication of such publications. Thus, both theoretical and experimental studies suggest that, when microorganisms are applied in combination, antagonistic interactions among BCAs are more likely to occur than synergistic interactions.

The application of numerical hypothesis of Bliss independence and Loewe's additivity for investigating synergistic effect among microorganisms needs to be assessed. Research is needed to establish under what spatially heterogeneous conditions the combined use of biocontrol agents may lead to synergistic interactions and reduced crop losses (Jambhulkar *et al*., 2017). Biological control system is the future for organic farming, if application of appropriate bio-agents for plant growth and disease management is prepared. It can definitely supplement the chemical control system by reducing the cost of plant protection and is also able to minimize the harmful effects of excessive and repeated use of pesticides and fungicides.

LL 07: Industrial production bio-capsule based formulations of bio-fertilisers and bio-pesticides used for plant health management

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SRT Agro Science is a Private Ltd Company manufacturing of Bio-fertilizers and Bio- pesticides. It has a vision and fore-sightedness to take it to a newer heights of success by expanding and diversifying their current operations. The company has expertise in vivid areas like procurement of raw materials, production techniques, promotion activity and sales. The company was earlier manufacturing all the bio products in a powder formulation and later switched over to liquid formulation but recently the company has entered into a bio-capsule formulation technology for manufacturing of all biofertilisers and biopesticides based on the novel patented technology developed by ICAR-Indian Institute of Spices Research, Calicut (Kerala). Bio-capsule technology is a novel technology for applying beneficial microorganisms based through bio-fertilisers and bio-pesticides in the form of a hard gelatine capsule. It can be easily stored, transportable and easy in application by the farmers during crop practices. This technology has a great promise to bring comfort, accessible and entrustment for the farmers. The main focus is to ensure the best quality in all the products for better crop management, crop quality and crop yield and also to cut down the prices hence reducing the burden on farmer and maximising the profit as conceived by the Hon'ble Prime Minister of India in his dream project of doubling the farmers income by 2022. Encapsulation is done based on the efficacy of different microbes fulfilling the requirements of different nutrients like Nitrogen from Azotobacter (Azoto Caps) and Azospirillum (Azoss Caps), Gluconacetobacter diazotrophicus (Aceto Caps), Rhizobium (Rhizo Caps), phosphorus from phosphate solubilising bacteria (P.S.B. Plus), potash from potash solubilising bacteria (Potash Grow), NPK consortia (NPK Grow Caps) and zinc solubilising bacteria (Zinc Grow).

Similarly, the company also has a range of biopesticide products based on the novel patented technology developed by ICAR-Indian Institute of Spices Research, Calicut (Kerala) and suitable for management of variety of diseases, insect pests and mites attacking/infesting different crops. Trichoderma viride is developed in the form of Indofa Caps and is highly effective against several soil borne and seed borne fungal pathogens *viz*., *Rhizoctonia solani, R. bataticola, Pythium* spp., *Fusarium* spp., *Phytophthora* spp., *Sclerotium rolfsii, Alternaria* sp. etc. *Pseudomonas fluorescens* is a non pathogenic saprophyte that colonises in soil, water, plant surfaces and suppress plant diseases caused by seeds and roots from fungal infections and is marketed in the form of Bacillus Caps. *Paecilomyces lilacinus* is an entomopathogenic fungus developed in the form of Pacliq Caps and is highly effective against different stages of plant parasitic nematodes infesting crop plants. Likewise, *Beauveria bassiana* is an entomopathogenic fungus developed in the form of Traps Caps and is highly effective against larvae of different lepidopterus insects *viz*., boll worms, Helicoverpa, Army worm, Spodoptera etc. *Bacillus thuringiensis* is a protein synthesizing and spore producing bacteria developed in the form of BT Caps and is also highly effective against larvae of different lepidopterus insects *viz*., boll worms, Helicoverpa, Army worm, Spodoptera etc. In the same manner, *Verticillium lecanii* is an entomopathogenic fungus developed in the form of Life Line Caps and is highly effective against different stages of sucking pests *viz*., aphids, white flies, leaf/plant hoppers mealy bugs, transmitting different viral diseases. Similarly, *Verticillium lecanii* and derivatives of actinomycetes is developed in the form of Acarida Caps and is highly effective against sucking pests mainly mites.

Invited Lectures

IL 01: Commercial production of biocontrol agents used for plant disease management

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The increased concern for environmental awareness of chemical hazards has evoked a worldwide interest in microbial control of plant pathogens. Globally, there are about 1400 biopesticide products being sold. Region-wise, the United States of America consumes maximum biopesticides (40%) of the global production followed by Europe and Oceanic Countries (20% each). As of early 2013, there were approximately 400 registered biopesticide active ingredients and over 1250 actively registered biopesticide products. It has been estimated that there are at least 32 commercial companies active in biopesticide production, with an additional 32 IPM centres under the Ministry of Agriculture also producing selected biocontrol agents. Despite the promising impacts of biopesticides, the Indian biopesticide industry is growing at a very slow pace. A rough estimate by the experts indicated a less than 2 per cent market share for Bio-pesticides in India. In India, biopesticide production is currently dominated by antagonistic fungi and bacteria such as T*richoderma harzianum / viride*, *Pseudomonas fluorescens* and *Bacillus subtilis* (Rabindra, 2005; Singh *et al*., 2012). The biopesticides are the sunrise sectors for developing Agri- entrepreneurship due to scopes of supply and demand with the continuous use of these inputs in agricultural production systems and can be help in employment generation and uplift of socio-economic conditions of the resource poor farmers for nation's prosperity.

Government of India has adopted Integrated Pest Management (IPM) as cardinal principle and main plank of plant protection in the overall crop production programme and grants-in-aid has been earmarked to the States and Union Territories for the establishment of 29 State Bio control Laboratories (SBCLs) in different states. In Chhattisgarh, State Bio control Laboratory was established at Bilaspur under Indira Gandhi Krishi Vishwa Vidyalaya with all forms of modern equipments and instruments with potential to produce 2000 kg material of bio pesticides per day. Commercial production of biopesticides has been started with permission from Central Insecticides Board and Registration Committee, New Delhi and produced nearly, 18000 Kg of *Trichoderma viride* and *Pseudomonas fluorescens* during 2014-15 and 2015-16 (Ann., 2016).

A number of government agencies, including the Ministry of Agriculture and the Department of Biotechnology, are engaged in supporting research, production and application of biocontrol agents. However, in spite of these efforts, their use in India is very small. Despite the promising impacts of biopesticides, the Indian biopesticide industry is growing at a very slow pace. Poor quality of microbial pesticides commercially available at higher cost and adverse effect on viability due to long travel as well as poor transportation facilities are major concerns. Therefore, a major goal has been to develop for local sourcing of biopesticides as a means of ensuring availability at a low cost to benefit poorer farmers, and as a base for expanding an Indian biotechnology industry. Creation of awareness among the farmers and extension personnel and development of entrepreneurship are important issues regarding the commercial production of biocontrol agents.

Entrepreneurship development involving rural and urban youth is the future need to promote commercial production of biocontrol agents used for plant disease management. Bio control laboratories being run by ICAR institutes and Agricultural universities can play the role of incubation centres providing training to youth, facilitating laboratories to work in and produce biocontrol agents in mass scale. Further, financial assistance can be provided through schemes launched by central and state governments i. e. Atal incubation scheme, Skill development programme etc. Thereafter, commercial production of biocontrol agents can be taken up by an entrepreneur individual setting up biocontrol laboratory with all forms of equipments and instruments and following the process to get registration at CIB and obtain manufacturing license from respective states.

Commercial production of biocontrol agents can be taken up by self help groups (SHGs) as source of their livelihood and income generating activities. Self help groups (SHGs) can also be trained in bio control laboratories as mentioned earlier. Further, financial assistance can be provided by the Department of Agriculture under ATMA scheme or under RKVY or by NABARD or by Jila Panchayat through schemes launched by central and state governments i. e. Atal incubation scheme, Skill development programme etc. for establishment of biocontrol laboratory at their respective places. Responsibility to get registration at CIB and obtain manufacturing license from respective states and development of market net work is to be also taken up by the same institute. On above said model, nine production units were established involving 96 tribal women in nine self help groups to start production of *Trichoderma harzianum* under guidance of Indira Gandhi Krishi Vishwa Vidyalaya between 2006-2009. Mother culture was provided and continuously monitoring being done during the production of Trichodetma. In three years, Rs 8.927 lakhs of *Trichoderma* were sold by different self help groups through department of Agriculture and other private firms to farmers of Chhattisgarh. There was increase on the monthly income of beneficiaries involved in the production of Trichoderma from 10.25 to 39.61 per cent.

Commercial production of biocontrol agents can also be taken up by self help groups (SHGs) of farmers or individual farmer for their own use. Farmers should be provided extensive training through audio- visual aids and thereafter farmers should be assign to produce biocontrol agents in large scale under the supervision of scientists. Thereafter, biocontrol agents multiplication unit should be established at their respective places. This model was adopted by the farmers of Chhattisgarh. During 2015-2017, *Trichoderma viride* and *Pseudomonas fluorescens* were commercially produced by the groups of farmers as well as individual farmer and used as seed, seedlings and soil treatments in different crops *i.e.* rice, mustard, wheat, chickpea, vegetables and fruits. During 2015-16, 270 kg talc based *Trichoderma harzianum* for seed treatment and 2500 kg FYM based *Trichoderma harzianum* and *Pseudomonas fluorescens* were produced whereas, during 2016-17, 612 kg talc based *Trichoderma harzianum*, 50 kg FYM based *Trichoderma* and 231 kg *Pseudomonas fluorescens* were produced from different production units installed at various places of Chhattisgarh and used by the farmers themselves.

To take -up the commercial production of biocontrol agents and to encourage the entrepreneurship, large number of pilot plants should be established at village and block level using effective technologies and efficient indigenous strains of bio pesticides developed by state agricultural universities located in different parts of country. The scientist involved in the programme should provide help in technology transfer, consultancy, training and quality control to rural population. In view of labour intensive nature of the biopesticides production programme, rural population should be involved and received adequate financial support as well as encouragement by state and central governments to set up bio pesticides production units.

IL 02: Wilt diseases of ornamental crops and their management

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In the present scenario, different species of Fusarium affects the various ornamental crops and cause the wilt diseases in Jasmine, Crosandra, Gladiolus, Carnation, Chrysanthemum and China aster; *Ralstonia solanacearum* causes bacterial wilt in Geranium and anthurium and *Verticillum dohlia* causes wilt in China aster. Ornamental plant diseases can significantly affect the aesthetic quality of many plants in the landscape. Not only do some of these diseases impact appearance in this season, but they also impact overall plant health and survival during seasonal weather changes. These pathogens are soil-borne and carried from season to season through planting materials. Sometimes the pathogens are carried in the vascular portion of the plant without showing any external symptoms. Conditions such as high temperature, high soil moisture and high levels of nitrogen in the soil are known to enhance the disease in the field. The wilt diseases are most severe in light sandy soils and in soils containing ammoniacal and organic sources of nitrogen. Anaerobic conditions and accumulation of carbon dioxide also favour the infection by the pathogens in soil. Managing ornamental diseases begins with the selection of resistant ornamental plants, maintaining adequate nutrition and irrigation, adopting appropriate cultural practices and providing the right environment for plants. To avoid a never-ending disease prone condition, it is critical to adopt a disease management program before getting to the point where fungicide/ bacteriocides applications are necessary.

IL 03: Management of soil borne nematode diseases using biocontrol agents

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Increasing population and decreasing land resource availability especially in India is likely to pose a major threat for food and environment security in coming years. At the same time, constraints posed by pest and pathogens on agricultural crop production becoming a major and chronic threat to crop production and ecosystem stability. In view of maintaining agricultural crop production sustainability, farmers generally depend on number of chemical fertilizers and pesticides. The use of chemical fertilizers and pesticides increased tremendously which is directly associated with environmental pollution and health hazards. Regarding the adverse impacts on environmental, soil and human health as well as increasing consumer demand for pesticide-free food materials has led to a search for substitutes for these products. The use of biocontrol agents *viz.* PGPRs and fungal bioagents can therefore be considered as an alternative or a supplemental way of reducing the use of chemical pesticides in Indian agriculture system. The bioagents interaction helps in reducing the dependency on chemicals nematicides in agricultural crops thereby stimulating plant growth and managing plant parasitic nematodes. The bioagents are important determinants of plant health and soil fertility because of their participation in several key processes such as those involved in the microbial management of plant pest / pathogens and seedling establishment. Some of the microbes like PGPRs can also affect plant growth both by indirect or direct mechanisms *viz.* competition for an ecological niche or a substrate, production of inhibitory allelochemicals, induction of systemic resistance (ISR), siderophore production, synthesis of various enzymes and growth hormones etc. Soil is an unpredictable environment and sometimes is very difficult to obtain consistent results with biological agents. Different soil types, pH and abiotic factors have a large impact in the effectiveness of rhizospheric bioagents.

IL 04: Characterizations of *Pseudomonas fluorescens*

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Seven *Pseudomonas* isolates obtained from rhizosphere of different crops were designed as PF-1 to PF-7 which showed the characteristics of *Pseudomonas*. All the isolates were gram negative, rod shaped and produced yellow and greenish yellow pigment. Biochemical characterizations were studied *viz*., KOH test, catalase test, starch hydrolysis, gelatin liquefaction, H_2S production, acid and gas production, some of the isolates show both positive and negative to starch hydrolysis, H2S production, IAA production and phosphate solubilization. The bacterium failed to produce hydrogen cyanide (HCN). Physiological studies revealed that all isolates show maximum growth at 25 and 30°C temperature with OD value $\geq$ 0.60. All the isolates show maximum growth at pH 7 and 8 with OD value $\geq$0.60. Antagonistic activity of *Pseudomonas fluorescens* isolates were studied against *Xanthomonas axonopodis* pv. *citri*. There were significant differences on inhibition zone. Isolate PF-7 recorded maximum zone of inhibition (29.1 mm) followed by PF-4 (28.7 mm), whereas no inhibition shows by isolate PF-6.

Key words: *Pseudomonads fluorescens*, Isolation, characterizations, *Xanthomonas axonopodis* pv.*citri*

IL 05: Success story of Biomix (a microbial consortium) in improving plant health of turmeric

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During 2010, the consortial product a mixture of bioagents was prepared for management of different pests and diseases in turmeric by the Department of Plant Pathology, V.N.M.K.V., Parbhani. It is a mixture 12 of different biofungicides like *Trichoderma* spp., *Pseudomonas* sp., biopesticides like *Metarhizium, Beauvaria* and PGPRs like *Azospirillium*. This product was proved best in solving the disease and pest problems like rhizome rot, leaf spot and rhizome fly, white grub in turmeric, respectively.

The survey on use of Biomix during 2017-18 was carried out in the Nanded, Parbhani and Hingoli districts of Marathwada region of Maharashtra. The survey results on farmer's field were promising. The product managed the foliar diseases like leaf spot, rhizome rot and pests like rhizome fly and white grub. The yield and quality of product was improved. The size and number of fingers on rhizome was increased resulting in increase of the yield. Average yield of processed turmeric was 70-100 q per hectare as compared non used 60-80 q. This product was also used by farmers in other crops like tomato, brinjal, papaya, water melon, orange and lime. The result of the product was excellent. It protected plants from diseases and pests.

Key words: Turmeric, Biomix, Survey, yield, rhizome rot

IL 06: Application of Bio-control agent for management of pathogenic post-harvest fungi isolated from food grains

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Food grains which are cereals, pulses and oilseeds are staple food for human beings and animals. Majority of food grains are carrying the varieties of storage phyto-pathogens which are responsible to spoil the food grains by their pathogenic activity as deterioration and toxification which becomes mycotoxicosis to the consumers. These important to consider to choose the topic for investigation and management of pathogenic post-harvest fungi from storage oilseeds and pulses. The attempt made for management by using the bio-control agent such as species of *Trichoderma* and bioactive compounds from different botanicals. The selected botanicals to be used for preparation of extracts by serving different chemical solvent and their different concentration utilized for management of storage fungi. The isolated fungi such as species of *Fusariam, Aspergillus, Curvularia, Alternaria, Cladosporium* and *Drechslera* from oil seeds and pulses. Among these species of *Fusarium* and *Alternaria* are mainly responsible to cause harmful effects on health of food grain and resulting into deterioration and poisoning. Management of post-harvest fungi by the bio-control agent is easy to available, economic, safe, biodegradable and effective for the maximum inhibition of detected pathogens. Pathogenic mycoflora of oilseeds and pulses were detected. The result regarding the bio-deterioration and toxification of food grains were remarkable to decreasing the quantum of the protein, fat and carbohydrates and other bio-chemical compounds. The toxification as production of the toxins such as Zeralelone, Moniliformin, Nivalenol (DAS) diacetoxyscripenol, (DON) deoxynivalenol which were detected from isolated post-harvest pathogens such as *Fusarium avanaceum, F. clamydosporum, F. graminarum* and *F. moniliforme.*

Oral Presentations

OP 01: *Catenaria anguillulae* Sorokin: Media for its different types of studies

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Catenaria anguillulae is a widely distributed facultative endoparasite of nematodes owns almost all the attributes of an effective biological control agent. Culture or mass culture media are prerequisite to carry out various studies, viz., morphological characteristics, growth in relation to additives, temperature, pH; residue free growth in broth for molecular studies, maintenance of the cultures, growth rate and mass culture of the fungus. The suitability of media for the different purposes was determined based on the colony characteristics and quality and quantity of growth *C. anguillulae*. The various media were identified to meet the said purposes. The OS1, YES, BES, OS6, O6 and LOC media exhibited transparent to compact colony were found suitable for morphological studies showing good development of sporangia larger in size and with thick wall. However, the colony of the fungus on LOC and O6 media were transparent and found appropriate for examination of the different structures of the fungus such as hyphae, isthmuses, rhizoids, attachment of sporangia and release of zoospores in culture plates. In order to carry out molecular studies particularly extraction of DNA for molecular characterisation, the broth of proteinaceous media such as YES, PYG, UYBS, BES and BE can be used as they produce clear transparent biomass of the fungus without residues. The fat containing media namely OS1, M3, O7 and M2 were found suitable for the maintenance of *C. anguillulae* as the fungus was found able to yield thick compact growth and lesser diameters that can reduce number of sub-culturing. The transparent colony with fast growth of the fungus was encountered on O11, O3, LOC and BE media to carry out cultural studies within a short span of time such as requirement of temperature, pH, and salt and effect of additives such as agrochemicals, oilcakes and fertilizers used in agriculture. The brothOS1 and M2 yielded thick compact mat and found suitable for their use to mass culture *C. anguillulae* in liquid state.

OP 02: Management of soil borne diseases in vegetables by *Trichoderma viride* in Bundelkhand region of Madhya Pradesh

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Soil borne pathogenic fungi attack most of the vegetable crops resulting in heavy losses. Presently, the most widely used control measures for suppressing the pathogens is the use of fungicides which not only cause environmental pollution but also lead to the development of resistant strains. Biological control of plant pathogens is an attractive proposition to decrease heavy dependence of modern agriculture on costly chemical fungicides. The genus *Trichoderma* by virtue of its broad spectrum action against a number of plant diseases caused by fungi, bacteria and even nematodes has occupied the top position among the bio-protectants developed for plant disease management. *Trichoderma* species became popular biological agents to protect crops against plant pathogens all over the world.

On farm trails were conducted at 85 farmers field in chilli, tomato and ginger crops during 2010-16 in Chhatapur and Sagar districts. Each trail was conducted in 0.2 ha area and same area adjacent to the demonstration plot was kept as farmer practice. 10 gm per Kg *Trichoderma* used for seed treatment. For nursery treatment, 50 gm of *Trichoderma* powder applied in nursery bed of 01 m^2. For seedlings, mixed 10g of *Trichoderma* powder along with 100 g of well rotten FYM per liter of water and dip for 10 minutes before planting. For soil treatment, 2.5 Kg of *Trichoderma* powder mixed with 100 kg of farmyard manure and cover it for 7 -10 days with polythene. Sprinkle the heap with water intermittently. Turn the mixture in every 3-4 days interval and then broadcast in the field of one hectare.

The germination of Ginger was found 91 per cent in *Trichoderma viride* treated plots in comparison to control (72%). The rhizome rot incidence was recorded as 6.4% in treated plots whereas 28.6% was recorded in control plot. The yield of Ginger was found 126 q/ha in *Trichoderma viride* treated plots in comparison to control (61 q/ha). Soil application with *Trichoderma viride* reduced the damping off by 72 per cent in the nursery of tomato and chilli. The incidence of wilt disease in chilli was 10.9 per cent and 13.8 per cent in tomato in untreated fields whereas it was 2.9 and 3.8 percent in seedling treatment + soil application of *Trichoderma viride* 2.5 kg/ha with FYM treated fields. Yield of chilli and tomato was found 34.2 and 28.6 per cent more in treated fields as compared to farmers practice which ultimately increased the net returns and B:C ratio.

OP 03: *In vitro* bioefficacy of different bio-agents and essential oils against *Alternaria alternata* causing fruit rot of pomegranate

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Maharashtra State experienced a very rapid growth in pomegranate area during last 2 decades from 4.6 thousand ha to 90.0 thousand ha and accounts for 68.70 per cent of the total cultivated area under pomegranate in the country. Of the fungal fruit rot diseases caused by *Alternaria alternata* (Fr.) Keissler, *Colletotrichum gloeosporoides* (Penz.) Penz and Sacc., *Aspergillus niger* and *Rhizopus stolonifer* are the most important and destructive disease causing accountable qualitative and quantitative losses.Although, satisfactory control of the major fungal fruit rot disease of pomegranate, with various chemicals has been documented in the literature; however, rapid and extensive use of agrochemicals to control fruit rot diseases may pose several problems like disturbance in the ecological balance, toxicity to non target organisms, development of resistance among pathogen populations, environmental pollution and increased health risks. Therefore, several alternative methods *viz.,* use of biocontrol agents and essential oils are one of the best strategies to manage plant diseases and to sustain the agriculture. Considering importance of disease bioefficacy of different bioagents and essential oil was carried out. All of the nine antagonists tested, exhibited significant mycelial growth inhibition of *A. alternata.* Among bioagents, *T. harzianum* was found most effective with least mycelial growth (14.66 mm) and numerically highest mycelial inhibition (82.11%), followed by *T. virens* (16.66 mm and 80.07%), *T. hamatum* (18.66 mm and 77.96%), All of the ten essential oils tested were found fungistatic against *A. alternata.* Among essential ois, cinnamon oil was found most effective with least mycelial growth (19.83 mm) and numerically highest mycelial inhibition (77.30%), followed by Mustard oil (43.33 mm and 51.23%), Nutmeg oil (43.63 mm and 51.01%),

Key words: Essential oils, Bioagents, fruit rot, *Alternaria alternate.*

OP 04: Management of stem rot of mustard with eco friendly approaches

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Now a day, a potential threat of mustard “Stem rot” incited by *Sclerotinia sclerotiorum* set as key in northern region of Madhya Pradesh. The present investigation was done to manage stem rot of mustard with ecofriendly approaches during 2014-15 and 2015-16 at experimental field, Department of Plant Pathology, RVSKVV, Gwalior (M.P.). The experiment laid out in randomized block design with replicated thrice. In the experiment, series of botanicals, biocontrol agents, Amritjal and fungicides were tested against *Sclerotinia sclerotiorum* thereafter, standardized the effective treatments on different concentrations. The effective concentration of each treatment was evaluated in field condition against the stem rot. The data revealed that the series of botanicals, *Allium sativum*, *Curcuma longa, Eucalyptus* spp., *Zingiber officinalis* and *Azadirechta indica* were found effective, while, *Trichoderma harzianum* in biocontrol agents, Amritjal in mixed product, carbendazim, thiophnatemethyl and propiconazole in fungicides were found significantly superior from other treatments. Standardized treatments, *Allium sativum*, *Curcuma longa, Eucalyptus* spp., *Zingiber officinalis* and

Azadirechta indica @ 20 per cent, while, Amritjal in mixed product @ 15 percent, carbendazim, thiophnate-methyl and propiconazole @ 0.1 per cent were found significantly inhibited the growth and development of *S. sclerotiorum*. In the field evaluation among all the treatments, none of the treatment gave complete freedom from the disease, however, three sprays treatments starting before symptoms appearance resulted in effective management of disease. Treatment, carbendazim, thiophnatemethyl propiconazole were found statistically significant superior and at par with each other followed by *Allium sativum, Eucalyptus amydalin,* Amritjal and *Trichoderma harzianum.* Stem rot disease can project by eco-friendly chemicals management approaches that may be lead increases the production and productivity of the mustard crop

Keyword: Management, Stem rot, *Sclerotinia sclerotiorum*, Ecofriendly, Fungicide

OP 05: Evaluation of different antibiotics, bioagents and botanicals against *Xanthomonas axonopodis* pv. *citri*

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Four antibiotics (@100 ppm, 250 ppm and 500 ppm conc), five botanicals (@ 5%, 10% and 15% conc.) and four bioagents *viz*., *Pseudomonas fluorescens*, *Bacillus subtilis*, *Trichoderma harzianum* and *Trichoderma viride* were evaluated by *in vitro* against *Xanthomonas axonopodis* pv. *citri* (Hasse). Among the different antibiotics and antibacterial chemicals, streptomycin sulphate @ 500 ppm, among botanicals ginger (*Z. officinale*) @ 15% and among the bioagents *Trichoderma harzianum* showed maximum inhibition zone as 24.3mm, 12.3mm and 23.6mm respectively. The fungicide vitavax, turmeric (boatanical) and *Bacillus subtilis* (bioagent) were found less effective against the *Xanthomonas axonopodis* pv. *citri* inoculum.

OP 06: *Bio-efficacy of Beauveria bassiana* and *Metarhizium anisopliae* against pyrilla (*Pyrilla perpusilla*) in sugarcane under field condition

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Beauveria bassiana and *Metarhizium anisopliae* are most effective fungi under laboratory, green house and field condition against many insect pests of economically important crops in world including India. *Beauveria bassiana* have been found naturally as entophytes in many plants. While, *Metarhizium anisopliae* have been found naturally as soil inhabitant. When, these fungi are sprayed onto plants an alternative intervals resulting number of spores of these fungi build-up more within the crop canopy. Thereby more chance to provide protection against infestation Pyrilla in sugarcane. Application of *B. bassiana* has been successful in maize, cacao, date palm, coffee, banana, radiata pine, faba beans, cotton, the common bean, and tomato for the control of their pests. Similarly *Metarhizium anisopliae* was reported for the control of insect pest in tomato, faba bean, oilseed rape, and haricot bean. Therefore, keeping in view of above facts an experiment was conducted on efficacy *Beauveria bassiana* and *Metarhizium anisopliae* isolates against *Pyrilla perpusilla* in sugarcane. Experiment was laid with seventeen treatments in which two entomopathogenic fungi *viz*., *Beauveria bassiana* and *Metarhizium anisopliae, two* isolates of *B. bassiana* (Bilaspur and Jagdalpur) and two isolates of *M. anisopliae* (Bilaspur and Kawardha) *and* three concentration *viz.,* 5, 10 and 15 per cent of all

entomopathogens. All treatments were applied against *Pyrilla* on Co-86032 variety of sugarcane. Two sprays of formulation of *B. bassiana* and *M. anisopliae* were applied at 15 days intervals. One set was kept as unsprayed (Untreated) plots. Results indicated that the most effective treatment was found *Metarhizium anisopliae Kawardha isolate @ 15% which showed* 17.20 and 18.17, 31.02 and 34.93, 39.04 and 43.28, 41.34 and 48.52 per cent parasitized adults and nymphs at 15 days after first spray, 15, 30, 45 days after second spray, respectively. Second effective treatment was found *Metarhizium anisopliae* Bilaspur isolate @ 15%. Both the isolates of *Metarhizium anisopliae* Kawardha were found significantly superior over both the isolates to Beauveria bassiana isolates against adult and nymph of Pyrilla population in sugarcane.

Posters

P 01: Inclusion of useful soil microorganisms under ecofriendly organic agriculture

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The present plight of Indian agriculture is degrading soil health condition at large due to indiscriminate use of insecticides, herbicides and chemical fertilizers. The soil is a living body full of soil microbes like bacteria and fungi and many more. These microorganisms are very much essential for decomposing organic matter and recycling old plant material for organic crop cultivation. Some soil bacteria and fungi form relationships with plant roots that provide important nutrients like nitrogen or phosphorus. Although soil organisms comprise <1% of the total mass of a soil, they have their vital functions as break down organic matter, recycling of plant and soil nutrients, soil microbes create humus, soil microbes create soil structure, soil microbes fix nitrogen, soil organisms promote plant growth and soil microbes control pests and diseases like soil bacterium *Bacillus thuringiensis* (Bt) to control caterpillar pests of crops. Soil microorganisms can be classified as bacteria, actinomycetes, fungi, algae and protozoa. Each of these groups has characteristics that define them and their functions in soil. Up to 10 billion bacterial cells inhabit each gram of soil in and around plant roots, a region known as the rhizosphere. Without inclusion of beneficial soil microbes the dream of green agriculture or natural agriculture or organic agriculture cannot be completed for healthy and sustainable crop production.

Key words: Organic agriculture, Sustainable crop production, Soil health and Soil microorganisms

P 02: Evaluation of efficacy and growth promotion activity of different strains of *Trichoderma* spp. and *Pseudomonas* spp. in arhar and soybean intercrops in kharif season

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Two strains of *Trichoderma harzianum* and *Trichoderma viride (T6 and T18)* and single strain of *Pseudomonas fluorescens* (P6) evaluated for management of soybean and Arhar diseases *i.e.*, *Phytophthora* blight and Root rot and web blight etc. and comparison among the growth promotion activity by taking observation in different growth parameters *i.e.* shoot length, root length, plant height no. of nodules etc of different strains by using different formulations (1%, 5%, 10%, 15% & 20%) as seed treatment and spray in which formulation 10% to 15% is found to be best formulation for disease control potential and growth promotion activities and among strains *Trichoderma harzianum* is found to be superior strains than other strains.

P 03: Evaluation of efficacy and growth promotion activity of different strains of *Trichoderma spp.* and *Pseudomonas* spp. in chickpea during rabi season

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Chickpea experiment was conducted during Rabi season in which the performance of *Trichoderma harzianum* (T6) was found to be better than *Trichoderma viride* (T18) and *Pseudomonas* strains (P6) in growth parameters i.e., root length and shoot length, plant height, number of branches per plant, number of pods per plant, number of nodules per plants and yields as well as in disease control potential for root rot and wilt. By using different strains with formulations (1%, 5%, 10%, 15% & 20%) as seed treatment and followed by spray in which formulation 10% to 15% was found to be best formulation for disease control potential and growth promotion activities and among strains *Trichoderma harzianum* was found to be superior strains than other strains.

P 04: Studies on interaction of *Meloidogyne incognita* and *Fusarium oxysporum* in blackgram and manage the disease complex using bio control agents

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The experiment on interaction of *Meloidogyne incognita* and *Fusarium oxysporum* in blackgram and manage the disease complex using bio control agents was conducted under pot conditions at the glass house of Department of Plant Pathology, J.N.K.V.V. Jabalpur (M.P.) during kharif season of 2014-15. The interaction of nematode and fungus, significant reduced the plant growth parameters in blackgram. Pathogen interaction the plant height i.e. (13.40cm), length of root (11.52cm), fresh shoot weight (0.60g), root weight (0.58g), and the dry shoot reduced up to (0.29g). The use of bio control agents reduced the infection of pathogen which resultant the increase in plant height (19.02cm). In case of *Paecilomyces lilacinus* followed by *Pochonia chlamydosporia* (17.70cm). The root length was reduced (18.38 cm), with *P. lilacinus* and (11.24 cm), *Pochonia chlamydosporia*. The fresh weight of shoot (0.89g) recorded with *P. lilacinus* which remained almost at par with *P. chlamydosporia* (0.87g). The dry weight of shoot was also significantly increased (0.41g) in *P. lilacinus.* Against the minimum (0.26g) in control increased dry root weight of black gram. Maximum (o.39g) dry root weight was recorded with *P. lilacinus* followed by *P. chlamydosporia* (0.36g), Minimum number (8.20) of galls were recorded in *P. lilacinus* followed by *P. chlamydosporia* (9.80), Maximum (1890.20) nematode recovery was noted in inoculated control.

P 05: Effect of bio-agents against post-harvest mango disease causing pathogens *in vitro*

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Mango (*Mangifera indica* L.) is an important fruit crop of India and other sub-tropical and tropical countries of the world. Mango fruit is one of the most popular, nutritionally rich fruits with unique ?avour, fragrance, taste, and health promoting qualities, making it number one among new functional foods, often labelled as “super fruits”. In post-harvest condition, several diseases are found on the mango fruit, which reduces marketability and shelf life after harvest of the fruits. Widely used fungicides have led to increased activity in the development of biological control against plant pathogens. Hence, the present investigation on the biological control of mango diseases was carried out in *in vitro* condition, the efficacy of bio-control agent on the post-harvest disease of anthracnose, stem end rot of mango by dual culture technique. All the tested bio-control agents were found significantly superior in inhibiting the mycelial growth of the pathogen over control. Significantly the least radial growth of *C. gloeosporioides* (5.25 mm) was observed with *T. harzianum* whereas *T. viride* gave least radial growth of *B. theobromae* (9.50 mm) over control.

P 06: Evaluation of *Trichoderma viride* against *Fusarium* wilt of chickpea caused by *Fusarium oxysporum* f. sp. *ciceris* under *in vitro* condition

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Chickpea is a well-known rainfed crop of high value. Wilt caused by *Fusarium oxysporum* f. sp. *ciceri* (Foc) is the major seed, soil borne disease which results in excessive damage to the crop. The present study was aimed to determine the potentiality of four local isolates of *Trichoderma viride* against four isolates of *Fusarium oxysporum* f.sp. *ciceri* causing chickpea wilt. Under *in vitro* conditions, all the tested antagonist species inhibited the radial growth of the pathogen. The isolates of *T. viride* showed significant antagonistic effect against *F. oxysporum* f. sp *ciceri*. Results showed that Tri-1 strongly inhibited the growth of Foc-4 (72.18%) and its inhibition was least in case of Foc-3 (52.81%). In case of Tri-2, highest inhibition was recorded for Foc-2 (66.87%) and least for Foc-3 (48.43%). Two isolates Tri-3 and Tri-4 showed great inhibition against isolates Foc-4 (63.75 and 6.68% respectively). Tri-3 exhibited least inhibition for pathogen isolate Foc-2 (52.18%) while Tri-4 showed least inhibition against Foc-3 (52.18%) The mean inhibition pattern of all the *T. viride* isolates showed that Tri-1 and Tri-4 exhibited alike pattern (62.11 and 62.18% respectively). While isolates Tri-2 and Tri-3 also inhibited the pathogen in similar manner (56.9 and 56.56% respectively). Results of the study show that bio-agent significantly reduced the wilt incidence of chickpea.

P 07: Efficacy of *Trichoderma* strains as seed treatment for plant growth promoting activities in groundnut

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The experiment was conducted in vivo at BTC, College of Agriculture and Research Station, Bilaspur to study the plant growth promoting activities of strains of *Trichoderma harzianum* and *Trichoderma viride* used as seed treatment@ 10 g/kg seed in groundnut. Various observations of growth parameters and yield components i.e. plant height (cm), no. of branches, no. of pods / plant, unfilled pods/plant, filled pods/plant and pod yield/ plant(g) were recorded. All strains of *Trichoderma harzianum* and *Trichoderma viride* were found significantly effective in promoting plant growth and enhancing yield components over control. Data indicate that Trichoderma strain number T2 (34cm),T4 (32.8 cm) and T3 (32 cm) were significantly at par among themselves and more effective in increasing plant height over *Trichoderma harzianum* strain number T1 (31.2 cm), T5 (31 cm), *Trichoderma viride* strain number T18 (30.6 cm) and *Trichoderma harzianum* strain number T8

(30.4 cm) which are statistically at par among themselves. Whereas, *Trichoderma harzianum* strain number T 3 (5.6cm), T5 (5.6cm), T8 (5.6cm), T1 and T2 were significantly more effective in increasing number of branches/ plant over other strains and control. Numbers of pods / plant were significantly higher in treated plots over control(8.4) with maximum number of pods from T18 (10.8),T2 (9.6),T1 (9.6) and T3 (9.0). However, numbers of pods / plant recorded from T4 (6.4) were significantly less over other strains and at par with control(8.4). Similarly, unfilled pods/plant were also less inT4 (1.4) and at par with T5 (3.0), T6 (3.2) andT7 (2.1). Whereas significantly higher number of unfilled pods were recorded from control (5.8). All strains were found significantly effective in increasing filled pods/ plant over control (2.6). However, significantly higher number of filled pods were recorded from *Trichoderma viride* T18(6.6), T7(6.4) and T2 (6.2) over other strains. Pod yield (g) / plant recorded from plots treated with different isolates shows significantly higher pod yield (g) from *Trichoderma harzianum* strain number T2 (12.6g), T1 (12.4g), T3 (12g), *Trichoderma viride* T18 (11.8g), T6 (10.8gm),T4 (10.8gm) and T28 (10.6gm) over control (6.6gm). Similar findings reported by Saralamma and Reddy (2003) confirms above findings regarding plant growth promoting activities of different *Trichoderma* strains isolated from different locations.

P 08: Evaluation of different formulations of *Trichoderma* against wilt disease and yield attributing traits of linseed

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An experiment was conducted to evaluate the effect of *Trichoderma* at different formulation i.e. CG Tricom, Leachates, CG TrichoCap on linseed crop at the Research Field, Indira Gandhi Agriculture University, Raipur in 2017. The experiment consisted of nine treatments namely: T1: Seed Treatment by CG Tricom, T2: Soil Application of CG Tricom, T3: Leachates Seed Treatment (Dipping for 25 min.), T4: Leachates Spray (1 time), T5: Leachates Spray (2 times), T6: Leachates Spray (3 times), T7: CG TrichoCap seed treatment, T7: Inorganic seed treatment (Bavistin) and T8: Control. The results revealed that all the treatment reduce wilt disease significantly over control. Among these treatment, maximum wilt reduction percent (12.70%) was recorded with T1. Treatment T6 confer the maximum yield/plot (0.57 kg) along with the maximum number of seeds/10 pods(73.3) and 1000 seed weight of linseed (6.43g).

P 09: Evaluation of *Trichoderma viride* against *Myrothecium roridum* isolates *causing leaf spot of* soybean under *in vitro* condition

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Myrothecium leaf spot of soybean is caused by *Myrothecium roridum.* Myrothecium leaf spot of soybean is occurring in almost all the major soybean growing areas of India causing about 30 per cent yield loss. Initial symptoms of the disease appear as small round or oval, brown spots with dark brown margin on leaves in the infected plant. For eco-friendly and sustainable management of the disease, study was conducted to know the efficacy of biocontrol agent *Trichoderma viride* against twenty isolates of *M. roridum*. *Trichoderma viride* were used to test antagonistic performance in dual culture with a test pathogen *Myrothecium roridum.* *Trichoderma viride* was significantly superior in reducing the radial growth of all isolates of *M. roridum*.

Maximum radial growth inhibition (72.70%) was observed in the isolate Mr10 followed by Mr14(70.21%), Mr7(69.87%), Mr13(67.23%), and Mr11(65.95%) by the *T. viride.* The minimum growth inhibition (46.10%) was observed in the isolate Mr15 followed by Mr1 (46.46%), Mr2 (47.41%), Mr17 (49.65%) and Mr12 (53.82%) by *T. viride. Trichoderma viride* was found most effective in inhibiting the mycelial growth of *Myrothecium roridum* isolates Mr10, Mr14, Mr7, Mr13, Mr9, Mr3,Mr9 and Mr20. Results of the study show that bio-agents significantly reduced the leaf spot incidence of soybean.

P 10 : Evaluation of non-rhizospheric endophytic bacteria for the management of wilt, collar rot and dry root rot of chickpea

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The experiment was conducted with four popular varieties of chickpea *viz.,* JG14, JG16, JG62 and JG315. The experiment was conducted at All India Co-ordinated Research Project (AICRP) Lab on Chickpea, Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur during 2017-18. A total of 12 endophytic bacteria were isolated from leaf and stem of chickpea plant. Among these, three endophytic bacteria were selected based on results of dual culture experiment. Hence, a total of nine treatments combinations of three endophytic bacteria including treated and untreated controls were designed to study their effect on disease incidence and severity as well as other plant health characters of chickpea in net house condition. The experiment was laid out in a complete randomized design with three replication. The data recorded on germination percent, pre- and post-emergence mortality, total mortality, root and shoot length, vigor index and disease severity index. The percent growth inhibition was recorded from 21.33 to 55.33 % across the pathogens indicated that these three EBs can significantly reduce the disease incidence and can be used as bio-agent against these pathogens. The endophyte, EBL-4 (37.67%) was recorded highest percent inhibition against *Fusarium oxysporum* f. sp. *ciceris* followed by EBL-2 (30.33%) and EBL-3 (25.00%) on PDA whereas there was no inhibition recorded in control. Similarly, EBL-4 (38.67%) was recorded highest percent inhibition against *Sclerotium rolfsii* followed by EBL-2 (36.00%) and EBL-3 (34.33 %) on PDA as compared to control. EBL-4 (45.67 %) was recorded highest percent inhibition against *Rhizoctonia bataticola* followed by EBL-2 (32.00 %) and EBL-3 (21.33 %) on PDA as compared to control. Nearly 8-10% higher germination and 25 to 30 % higher vigor index was recorded in different treatments compared to treated control across the pathogens indicated that use of these EBs for management of these disease will be fruitful to indirectly increase growth parameters. The minimum total mortality was recorded in T_8 for wilt (20.84%), collar rot (23.33) and dry root rot (16.74%) indicated that the combination for three EBs was superior in reducing the incidence of these three diseases. It was also recorded superior in increasing plant growth parameters such as root and shoot length as well as fresh and dry weight of plants. The disease severity index of different treatments under disease pressure revealed that the lowest DSI was recorded in T_8 for fusarium wilt (6.83), collar rot (9.34) and dry root rot (6.17) which were at par with untreated control. Hence, it is concluded that a combination of three endophytic bacteria are effective against these three diseases of chickpea and can be recommended as bio-agent for management of these diseases after further validations.

P 11: Natural occurrence of entomopathogenic fungi from Chhattisgarh

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The most prevalent pathogens which attack insects in different agro-ecosystem are the entomopathogenic fungi *i.e. Beauveria*, *Metarhizium*, *Paecilomyces, Verticillium*, *Nomuraea, Hirsutella* and pathogenic to various range of insects species *i.e. Nilaparvata lugens*, *Spodoptera litura*, *Bemisia tabaci*, *Scirpophaga incertulas, Lipaphis erysimi* etc. An extensive survey was conducted during Kharif season of 2017 on different crops grown in different regions of Chhattisgarh and collected naturally infected insect cadavers. The purpose of this work was to isolate different entomopathogenic fungi, identify them and study the taxonomy & biodiversity of local isolates. Among different crops surveyed, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) larvae infesting soybean & groundnut were predominantly infected by entomopathogenic fungi *B. bassiana* (Balsamo) Vuillemin (Deuteromycotina: Hyphomycetes) & Nomuraea rileyi (Farlow) Samson whereas, leaf hopper (*Pyrilla perpusilla*) infesting sugarcane were infected by *Metarhizium anisopliae* (Metschnikoff). The incidence of entomopathogenic fungi *B. bassiana* & *N.rileyi* was recorded maximum during last week of August to first week of October whereas, *M. anisopliae* was active from mid of September to January. Soil samples were also collected during survey for isolation of entomopathogenic fungi using Galleria bait method. Sixteen local isolates of *B. bassiana* and two isolates of *N. rileyi* and *M. anisopliae* each were isolated from soil samples collected from different parts of Chhattisgarh.

P 12: Screening of native *Trichoderma* spp. and rhizospheric phosphate solubilizing bacteria (PSB) against *Rhizoctonia solani*ca using rice sheath blight disease

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Sheath blight of rice caused by *Rhizoctonia solani* is one of the most important rice diseases worldwide including India. It is a soil borne phytopathogen and soil borne pathogens imposes a major threat to rice production as well as ecosystem stability, owing to their devastating effects on rice plant health and yield, soil borne diseases needs to be studied extensively. So far, the use of chemical pesticides has remained the method of choice to control them due to their proficient and consistent performance along with the ease of application. However, in the light of developing sustainable agricultural practices and increasing public awareness about the ill-effects of agrochemicals, research needs to be directed towards the development of alternative and complementary pathogen control methodologies as ecofriendly management. Exploring the inherent inhibitory potential as well as their growth promoting ability possessed by native rhizospheric microbes against the phytopathogens may prove to be one of the alternative and environment-friendly substitute of chemical pesticides. Investigation on the occurrence of native *Trichoderma* spp. and phosphate solubilizing bacteria (PSB) from rhizospheric soil of rice from different regions of the valley districts of Manipur were carried out during the year 2015-2016. Fifteen soil samples each from the four districts were collected randomly to isolate native *Trichoderma* spp. and PSB by using agar plate method. Isolates of native *Trichoderma* spp. were screened for antagonistic activity using dual culture method with *Rhizoctonia solani* and phosphate solubilizing

microorganisms were screened by evaluating phosphate solubilization index on National Botanical Research Institute's phosphate growth medium (NBRIP) for its ability to release the available phosphates for plant uptake. Six, three, two and four respective isolates of *Trichoderma* spp. from different regions of Thoubal, Imphal east, Imphal west and Bishempur district were screened. Thirteen and two respective isolates of PSB from Bishempur district, Imphal east and Thoubal district were isolated. All the *Trichoderma* isolates tested showed considerable level of antagonistic activity against *R. solani* causal organism of rice sheath blight.

Key words: Native *Trichoderma*; Phosphate solubilizing bacteria (PSB), *Rhizoctonia solani, NBRIP*

P 13: Seed associated mycoflora of tomato and its management through biopesticides

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Tomato (*Solanum lycopersicum* L. = *Lycopersicon esculentum* Mill) is one of the most popular and widely grown vegetable crops, in India. It is grown for its edible fruits, which are consumed either fresh or it can be processed to several products like puree, paste, soup, juices, ketchup, whole canned fruits. Tomato is a valuable source of vitamin A and C as well as several essential minerals including calcium, iron, manganese, and particularly potassium. It also contains lycopene which is a carotenoid that gives red coloring to tomatoes. In Madhya Pradesh, the total tomato production area is 73.70 thousand ha with production of 2285.90 tones and with productivity of 31.0 tones/ha. Many factors operate in successful cultivation as well as marketing of quality tomato, of which diseases play an important role. Tomato crop is prone to various types of diseases such as seedborne, soilborne as well as airborne. Number of pathogens have been reported to be seedborne in nature, that affect the plant stand thereby reduce the yield. During the investigation, at seed level *Fusarium oxysporum*, *Alternaria alternata*, *Aspergillus niger* and *Aspergillus flavus* were found associated with tomato seeds from farmers and commercial nurseries. In all 12 seed sample from farmers of 6 villages and 18 seed sample from commercial nurseries were analyzed by standard blotter method. Association of *Fusarium oxysporum* was observed in the range of 1.0-19.0%, *Alternaria alternata* (2.0-12.0%), *Aspergillus niger* (6.0-19.0%) and *Aspergillus flavus* (6.0-14.8%). Seed germination ranged from (40-67%). Influence of seed treatment with 3 bio-pesticide and 6 chemical fungicides was determined on the association of mycoflora using a pre-tested seed sample with maximum natural infection (19.0%) of *Fusarium oxysporum*, *Alternaria alternata* (12.0%). Efficacy of Carboxin + Thirum (0.2%), Carbendazim + Mancozeb (0.25%) and Copper oxychloride (0.25%) was recorded among the chemical fungicide whereas *Trichoderma viride* and *Trichoderma harzianum* exhibited about 50.0 % efficacy. Seed treatment with chemical fungicides and bio-pesticides enhanced tomato seed germination.

P 14: Effect of decomposed extracts of kitchen waste on plant growth promotion of cowpea and its phytoxicity

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In the present study, the effect of decomposed extracts derived from kitchen waste (KW) decomposed by microbial decomposers *viz*, *Pseudomonas sp.*, *Trichoderma viride* 1, 2, 3, *T. harzianum* and TV (*Trichoderma viride*) on plant growth parameters (plant height, leaf area, root length, fresh weight and dry weight) of cowpea and its phytotoxicity effect was discussed. The decomposed extracts significantly increased the growth of cowpea. The maximum plant height was showed in T3 (28.28cm) followed by T6 (27.81cm), T4 (27.71cm), leaf area was showed in T4 (19.13 cm^2) followed by T5 (18.40 cm^2), T6 (17.77 cm^2), root length was showed in T2 (16.57cm) followed by T4 (14.82cm), T6 (14.48cm), fresh weight of cowpea was showed in T6 (3.94g) followed by T3 (3.84g), T2 (3.70g), maximum and equal dry weight of cowpea was recorded by T3 (0.64g) and T6 (0.64g). The minimum plant height (19.56cm), leaf area (9.43 cm^2), root length (9.45cm), fresh weight (1.91g) and dry weight of cowpea were recorded in control. No plant mortality was recorded in all treatments. The decomposed extracts showed non phytotoxic to cowpea.

P 15: Antagonistic efficiency of *Pseudomonas* strain against soilborne diseases of chickpea crop under *in vitro* and *in vivo*

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Pseudomonas spp. are the most extensively studied biocontrol agents for management of soilborne and seed borne pathogens as they play an important role in managing the natural population of fungal pathogens. Chickpea crop suffers from various fungal diseases but in the present study deals with the dry rot caused by *Rhizoctonia bataticola* and stem rot caused by *Sclerotinia sclerotiorum*. In the present study, biocontrol potential of four strains of *Pseudomonas viz*. $BHUPf_4$, $BHUP_5$, $BHUP_6$, BHUPsb were studied both *in vitro* and *in vivo* condition. It was found that all the strains of *Pseudomonas* exhibited antagonistic effect leading to reduced radial growth of the test pathogens namely *Rhizoctonia bataticola* ranged from 16 to 47 mm and *Sclerotinia sclerotiorum* ranged from 23 to 45 mm. In the field experiment study seed treatment of succeptible variety Radhey with strains of *Pseudomonas fluorescence* reduced the disease incidence of dry root rot and stem rot significantly in all treatments in comparison to uninoculated control were 33 to 44% against dry root rot (*Rhizoctonia bataticola)* and 16 to 32% against stem rot (*Sclerotinia sclerotiorum)* diseases. However, *Pseudomonas* strains $BHUPf_4$ showed more effective against both the fungal diseases and followed by *strains* $BHUP_5$, $BHUP_6$ and BHUPsb.

P 16: Efficacy of *Trichoderma harzianum* and *Rhizobium* sp. against complex wilt of chickpea at natural sick field

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The experiment was conducted at KVK, Janjgir Champa (Chhattisgarh) field. The study was performed under natural sick field irrigated condition in paddy-chickpea-paddy cropping system. Studies focused on the efficacy of bio-control agents at natural sick field *viz.* collar rot, fusarium wilt and root rot condition through evaluation and demonstration leads to maximum productivity of chickpea. The disease incidence was observed in range from 7.44 to 34.92 per cent. The most effective and least mortality (7.44 %) was observed in T_5 treatment {combination of seed treated 10gm/kg (CFU 10^{10}/g) with *Trichoderma harzianum* + *Rhizobium* sp. 10gm/kg (CFU 10^{10}/g) along with soil application of *T. harzianum* 10 kg/hac. (10% WP) enriched FYM + drenching of *T. harzianum* (1%)}, whereas 34.92 per cent found in T_6(control). The yields were also recorded in range from 4.13 to 9.31 q/ha. Maximum yield was obtained (9.31 q/ha) in T_5 treatment (seed treatment of *T. harzianum* + *Rhizobium* along with soil application of *T. harzianum* enriched FYM + drenching of *T. harzianum*) followed by 8.53q/hac. in T_4 (Seed Treatment by *T. harzianum*+ *Rhizobium* along with soil application of *T.*

harzianum). Integrated Disease Management (IDM) approach was carried out to combat chickpea wilt with a combination of bio agents and organic amendments.

Key words: Disease, wilt, incidence, mortality, bioagent.

P 17: Biological control of plant diseases

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Food, feed, and fibre are the basic need of population and the control of plant diseases is essential to maintain the quality and abundance of these produce. We have different approaches to prevent, mitigate or control plant diseases like good agronomic and horticultural practices however, chemical fertilizers and pesticides are often used by growers. Although such chemicals have significantly controlled the diseases and contributed to the spectacular improvements in crop production, productivity and quality over the past 100 years. However, people's attitudes towards the use of pesticides in agriculture has been changed considerably due to the environmental pollution caused by excessive use and misuse of agrochemicals. Consequently, some pest management researches have carried out to develop alternative inputs to synthetic agrochemicals for controlling pests and diseases like biological controls. In a simple way we can define the biological control of plant diseases as the use of one organism to influence the activities of a plant pathogen. Bio-control organisms can be fungi, bacteria, or nematodes. The interaction among organisms and pathogens can be of various types i.e. mutualism, commensalism, neutralism, antagonism, parasitism etc. depending on the environmental context within which they occur. Bio-control organisms may compete with the pathogen for space and nutrients or they can control pathogens by parasitism or predation, by inducing the plant's natural defence system, and/or by the production of antimicrobial substances (antibiotics like streptomycin). Often more than one mechanism function together to make an organism effective.

Bio control organism's establishment is difficult on foliar surfaces but most positive research results come against soil borne problems such as root, fruit, crown and seed rots. For example the plant growth promoting rhizobacteria can significantly reduce the incidence of root rot (*Pythium*, *Rhizoctonia*) and *Rhizoctonia* in broccoli as well as less post emergence disease in spinach due to soil-borne fungi. Root and seed rot severity in peas and soil born fungi like *Pythium* and *Fusarium* can be reduced by Actinovate (*Streptomyces lydicus*). Likewise, Black Scurf (*Rhizoctonia solani*) and common scab (*Streptomyces scabies*), both in potato tubers can be significantly reduced by compete plus (Six species of *Bacillus, Streptomyces griseoviridis*, *Trichoderma harzianum* plus organic nutrients). Muscador (*Muscador albus*) is a novel biocontrol organism that acts as a biofumigant by producing gaseous compounds. It has shown good efficacy against storage insect pests of apples and potatoes. Application of *Muscador* to radish resulted in significantly less root and hypocotyl rot and less Phytophthora fruit rot on pepper. Combining *Muscador* treatment with a resistant pepper cultivar significantly reduced Phytophthora disease severity. Environmental conditions, application techniques and the timing of application are the major controlling factors for their efficacy. As preventive measures these organisms are more likely to be effective. Combining these products with a naturally resistant or tolerant cultivars is a promising avenue for their use.

P 18: *Trichoderma* for resilient agriculture

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Microbial diversity is an important component of the overall global biological diversity. Recent technological advances in exploring microbial diversity have revealed that a large proportion of microorganisms are still undiscovered, and their ecological roles are largely unknown. Careful selection of microbes and intelligent design of test assays are the key steps in developing new technologies for effective utilization of microorganisms for sustainable agriculture, environmental protection, and human and animal health. Several microbial applications are widely known in solving major agricultural (*i.e.*, crop productivity, plant health protection, and soil health maintenance) and environmental issues like bioremediation of soil and water from organic and inorganic pollutants). Several reports highlighted the need for better agricultural practices and use of eco-friendly methods for sustainable crop production under such situations. In this context, *Trichoderma* species could be a model fungus to sustain crop productivity. Currently, these are widely used as inoculants for biocontrol, biofertilization and phytostimulation. They are reported to improve photosynthetic efficiency, enhance nutrient uptake and increase nitrogen use efficiency in crops. Moreover, they can be used to produce bio-energy, facilitate plants for adaptation and mitigate adverse effect of climate change. The discovery of several traits and genes that are involved in the beneficial effects of *Trichoderma spp*. has resulted in better understanding of the performance of bioinoculants in the field and will lead to more efficient use of these strains and possibly to their improvement by genetic modification. The present mini-review is an effort to elucidate the molecular basis of plant growth promotion and defence activation by *Trichoderma spp*. to garner broad perspectives regarding their functioning and applicability for climate resilient agriculture.

Key words: *Trichoderma* spp*.,* biocontrol, biofertilization, and phytostimulation.

P 19: Biological control of plant diseases

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Plant diseases need to be controlled to maintain the quality and abundance of food, feed, and fiber produced by growers around the world. Different approaches may be used to prevent, mitigate or control plant diseases. Beyond good agronomic and horticultural practices, growers often rely heavily on chemical fertilizers and pesticides. Such inputs to agriculture have contributed significantly to the spectacular improvements in crop productivity and quality over the past 100 years. However, the environmental pollution caused by excessive use and misuse of agrochemicals, as well as fear-mongering by some opponents of pesticides, has led to considerable changes in people's attitudes towards the use of pesticides in agriculture. Today, there are strict regulations on chemical pesticide use, and there is political pressure to remove the most hazardous chemicals from the market. Additionally, the spread of plant diseases in natural ecosystems may preclude successful application of chemicals, because of the scale to which such applications might have to be applied. Consequently, some pest management researchers have focused their efforts on developing alternative inputs to synthetic chemicals for controlling pests and diseases. Among these alternatives are those referred to as biological control. A variety of biological controls are available for use, but further development and effective adoption will require a greater understanding of the complex interactions among plants, people, and the

environment. The bio control agents are based either on plant parts / plant products, microorganisms such as bacteria, viruses and fungi, fungal and bacterial enzymes, enzyme inhibitors, antibiotics that play an important role in control of plant-pathogenic fungi and insects.

Keywords: Biological control, plant diseases, microorganisms, enzymes, antibiotics.

P 20: Prospects of organic manures and bio-control agents in medicinal and aromatic plants

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Medicinal and aromatic plants, in India, are numerically very large and provide the basic raw material for the indigenous pharmaceuticals, perfumery and cosmetic industries. Indiscriminate use of chemical fertilizers and pesticides lead to chemical residue in these plants. Organic farming, keeps the soil alive and in good health, and also an alternative to the present system of chemical based farming. Various organic manures *i.e*., FYM, vermicompost, poultry manure, bio-inoculants (*Azotobacter, Azospirillium,* VAM*, Trichoderma, Aspergillus,* PSB*)* play a promising role to approach this rising demand. Various analysis suggest that these *provide* less reliance on purchased inputs of nutrients leading to lower cost of production, increased soil productivity through improved soil quality, for landless people provides additional source of income generation. Biological control has become necessary due to its environmental advantages. *Trichoderma harzianum* has antagonistic effect against the causal agent of leaf rust. A collection of *Streptomyces* can be used as bio-control agent for various fungal species e.g., *Alternaria brassicicola, A. porri*, *Colletotrichum gloeosporioides, Penicillium digitatum* and *Sclerotium rolfsii*. Inoculation with *T. viride* and *Glomus mosseae* found to be the best in controlling the root rot or wilt of *Coleus forskohlii*, a serious soil-borne disease caused by *Fusarium chlamydosporum*. Petroleum ether extracts of leaves of *Andrographis panniulata* are effective against larval mortality and egg hatching of *Meloidogyne incognita* followed by *Mellia azedarach*. Extract of *Curcuma longa* ,*Allium sativum* and *Ocimum sanctum* effectively inhibit the *Aspergillus flavus* growth. Organic farming, in association with bio-control agents for the production of medicinal and aromatic plants, have a great future prospect in coming era of *Ayurveda* as products made from the extract of these plants will be eco-friendly and won't be hazardous to human health.

P 21: *Trichoderma* and *Pseudomonas* : The most effective bio-control agents against dry root rot (*Rhizoctonia bataticola* Taub (Butler)) of chickpea (*Cicer arietinum*)

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Chickpea dry root caused by *Rhizoctonia bataticola* is the most destructive disease and causes severe losses in yield. The studies aimed to screen and evaluate the bio-efficacy of *Trichoderma* and *Pseudomonas* with antagonistic activities against *R. bataticola* under *in vitro* and *in vivo* condition. Isolates of *Trichoderma* spp. (15 isolates) and fluorescent *Pseudomonas* (22 isolates) were isolated from dry root rot infested areas. For isolation of *Trichoderma* and *Pseudomonas* soil was derived from chickpea rhizosplane.

Fifteen isolates of *Trichoderma* were evaluated for their efficacy against nine isolates of *R. bataticola.* Isolate T40 was found significantly superior among all the isolates of *Trichoderma* in reducing the mycelial growth of *R. bataticola* by 67.65% over control, followed by T36 (64.81%), T14 (64.07%) and T29 (63.21%) which were at par with each other. The average mortality of chickpea in sick pots after 30 days of challenge inoculation was minimum in T40 (Bemetara) and T 23 (Bilaspur) that is 20.83 per cent. Diseases grade observed was 4.3 out of 9 in both the isolates whereas, maximum in T23 (Bilaspur) isolate that is 8.3.

Fluorescent *Pseudomonas* were screened for confirmation with following biochemical test gelatin hydrolysis test, nitrate test, starch hydrolysis test, lypolytic test, casein hydrolysis test, growth test at 4°C and 42° C, hydrogen sulphide gas production, triple sugar iron test and antibiotic sensitivity test. Fluorescent *Pseudomonas* inhibited the mycelial growth by the antagonistic activity across all isolates of *R. bataticola*. The maximum growth inhibition was recorded by P33 (Lohara) isolate (63.21%) followed by P40 (Bemetara) isolate (62.35%) and P36 (Dhamdha) isolate (61.91%). The average mortality of chickpea in sick pots after 30 days of challenge inoculation with RB4 (Kawardha) was recorded minimum in P3 (Rajnandgoan), P8 (Raigarh) and P40 (Bemetara), which were significantly superior over control, with 12.5 per cent mortality and disease grading on the basis of extent of root damage were 3.66, 5.66 and 5.66 respectively. Selected native isolates of *Trichoderma* spp. and fluorescent *Pseudomonas* manifested the promising potential as biocontrol agents and alternative for dry root rot management.

P 22: Evaluation of *Trichoderma spp.* against *Corynespora cassiicola* isolates *causing* target leaf spot disease *of* soybean under *in-vitro* condition

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Target leaf spot disease of soybean is caused by *Corynespora cassiicola.* The disease affects leaves, stems, pods and seeds. Leaf lesions are rounded to irregular and reddish brown they vary from speck to big mature spot. Lesions are frequently surrounded by a dull green or yellowish green halo. For eco-friendly and sustainable management of the disease, the efficacy of biocontrol agents *Trichoderma harzianum* and *Trichoderma viride* against the isolates of *Corynespora cassiicola* was studied. *Trichoderma harzianum* and *Trichoderma viride* were used to test antagonistic performance in dual culture with a test pathogen *Corynespora cassiicola*. The study was carried out under In vitro conditions. Results revealed that both *T. harzianum* and *T. viride* have significantly inhibited the growth of isolates of *C. cassiicola.* Among the eleven isolates of *C. cassiicola* highest percent inhibition of mycelial growth of 51.22% was found in CC-04 isolate followed by CC-08 (46.00%) and CC-01 (45.83%). While CC-09 was most resistant and revealed lowest percentage inhibition of mycelia growth as 20.00 percent in combination with *T. harzianum.* But *T. viride* CC-01 was found to be most susceptible and revealed highest percent inhibition of mycelia growth of (52.08) percent, followed by CC-08 (50.00%) and CC-04 (46.34%). While CC-09 was most resistant and revealed lowest percentage inhibition of mycelial growth as 23.33% in combination with *T. viride.*

P 23: Evaluation and application of potential biocontrol agents against collar rot of chickpea (*Cicer arietinum* L.)

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In this study, the biocontrol agents, *Trichoderma* spp. (17 isolate), fluorescent *Pseudomonas* (24 isolates) and *Bacillus* spp. (9 isolates) were isolated from collar rot infected chickpea area in Chhattisgarh and screened against *S. rolfsii* under *in vitro* dual culture and *in vivo* pot experiment. Talc based formulations were prepared from respective potential isolate of biocontrol agent *Trichoderma* spp.(*Tricho*-12), fluorescent *Pseudomonas* (*Pf*-17) and *Bacillus* spp. (*Bs*-6) and used for seed treatment and soil application against collar rot disease in chickpea. Seed treatment was done with different doses (5g, 10g, 15g, 20g, 25g and 30g per kg seed) of biocontrol agent to find out effective dose for control of chickpea collar rot and it was concluded that when increase in dose more than the recommended can efficiently control disease and also increase plant growth. Seed treatment with biocontrol agent alone was effective in controlling collar rot of chickpea as compared to control but combined seed treatment and soil application significantly increased the plant vigour index and reduced the incidence of collar rot under greenhouse conditions.

P 24: Development of capsule formulation of *Trichoderma* spp.

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The success of the biological control agent *Trichoderma* spp. in respect to the plant growth promotion, disease managements and to the environment, depends not only on its highly effective propagules and biocontrol mechanisms but also its formulation and delivery systems. The development of biological control systems in formulation of *Trichoderma* is essential to promote sustainable plant disease management. Capsule formulation of *Trichoderma* spp. are focused on prolong shelf life and enhance application efficiency. To develop *Trichoderma* capsule, broth of *Trichoderma* was grown in plastic containers and thereafter it was collected and dried in oven for 48 hrs at 35ºC. Dried form of *Trichoderma* was crushed to make powder form and filled in empty capsules. Each capsules contain 0.15g powder form of *Trichoderma*. These capsules will be kept in polythene bags and stored at room temperature for further applications. Capsules are suitable for seed treatments and further mass multiplication of *Trichoderma* spp.

P 25: Disease controlling potential of *Pseudomonas fluorescens* for management of collar rot of chickpea

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Pseudomonas fluorescens used as seed treatment for management of collar rot of chickpea caused by *Sclerotium rolfsii* was found effective over control. However, efficacy of one strain *Pseudomonas fluorescens* was different in different types of soil. Minimum mortality (19.33%) was recorded from soil type- 3 (Mungeli-Sandy clay loam) followed by (20.33 mortality %) type- 4 (Kawardha- Clay loam); whereas, maximum number of mortality % was recorded from type -1 (23.66%). It may be concluded from above findings that *Pseudomonas fluorescens* multiplied efficiently in medium textured soil compared to heavy textured and light textured soils.

Key words, *Pseudomonas fluorescens*, *Sclerotium rolfsii.*

P 26: Isolation and evaluation of potential *Trichoderma* species for decomposition of paddy straw

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Composting is one of the potential ways to reduce organic wastes like paddy straw and other agricultural wastes by converting them to bio-fertilizer. The conventional style of composting through natural degradation is slow and is not applicable to some lignocellulosic materials. Cellulose degrading microorganisms hasten the biodegradation of crop residues such as straw, leaves, trash etc. *Trichoderma* from other sources is one of the most commonly used compost activator. Study was conducted to evaluate the *Trichoderma* isolates collected from compost pits and crop rhizospheric zones of different crops. These isolates were evaluated for their ability to degrade paddy straw under *in vitro* conditions. Fifteen isolates were selected to test their ability to decompose paddy straw. Among these 15 isolates only seven isolates viz. Ts1, Ts2, Ts3, Ts4, Ts5, Ts6 and Ts7 showed higher percent of paddy straw decomposition. Among all the isolates, the isolate Ts7 had shown greater efficacy in paddy straw decomposition followed by Ts3The paddy straw compost prepared by these seven isolates was tested for its ability to promote plant growth of wheat. In all these seven isolates, *Trichoderma viride* liquid metabolites showed greater effect on paddy straw decomposition. The compost produced by the isolate Ts7 showed increased root and shoot growth with high dry weight. . These isolates were further tested for their cellulase producing activity where Ts7 showed higher enzyme production of 2.45mg/ml.

Key words: Paddy straw, Decomposition, *Trichoderma,* cellulase

P 27: Mass production of *Trichoderma* spp. by using waste wheat spent water of mushroom spawn production

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Large scale production, along with shelf life and establishment of bioagents in targeted niche, determine the success of biological control. Therefore cost effective large scale production, shelf life of formulation, establishment of bioagent in to targeted niche and consistency in disease control are the primary concern with augmentative biological control. *In vitro* experiment was carried out to see the effect of wheat spent water on mass production of *Trichoderma* species. Wheat spent water is the waste water thrown out of boiling wheat grains used for mushroom spawn production. *Trichoderma* was mass multiplied in this wheat spent water. In this method, unbroken wheats are boiled in water, after that filtered by muslin cloth. Boiled wheat are used for mushroom spawn production and extract (spent water) volume was made upto 1 liter by adding fresh water and 20gm dextrose. Thereafter it was allowed to sterilize in autoclave. After cooling it was used in *Trichoderma* mass production.

P 28: Broken rice based organic method for mass multiplication of *Trichoderma* at farmers level

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Mass production of *Trichoderma* spp. has become a focus of research in the search for alternatives to polluting chemical pesticides and fertilizers. Techniques for large-scale production of this fungus are still in infancy. Consequently any media used for mass production of *Trichoderma* spp. must be economical and able to support maximum growth and sporulation. A variety of media have been used by various researchers for production of *Trichoderma* spp. The most common method for growing *Trichoderma* is on solid media which is too expensive and impractical at farmers level for mass production. Biocontrol Laboratory, Indira Gandhi Agricultural University, Raipur developed inexpensive and more commonly available alternative to *Trichoderma* mass production using broken rice (III-Grade) at farmers level without using expensive laboratory equipments and media. In this method broken rice was put on boiling water for 1-2 minute then taken out in half boiled condition and spread on spirit sterilized paper. *Trichoderma* powder (0.30 gm) formulation was mixed with half boiled broken rice (2 CG Trichocap/ kg). This mixture was allowed to put in sprit sterilized plastic box upto 1cm height. Depth should not be more than 1cm to avoid rotting of substrate. After 7-8 days culture was ready to be use.

P 29: Evaluation of antifungal activities of certain plant extracts against *Fusarium udum* Butler causing wilt in pigeonpea

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Diseases are major biological constraints to production of pigeonpea. Of these wilt caused by *Fusarium udum* is widespread and causes heavy damage. The wilt incidence was 69-99% and 31-63 percent in susceptible and moderately susceptible cultivars, respectively. As the management of this soil borne disease through conventional technology such as growing resistant varieties, fungicidal seed treatment, single treatment of fungicide or bio-agent cannot provide a remedy for disease management. Non judicious use of synthetic fungicides since last four decades led to several problems to human and animal health besides environmental problems. This scenario, therefore, calls for alternative approaches which are economically feasible and ecofriendly to increase yield of pigeonpea. In view of the hazardous effect of synthetic fungicides, that too for the soil borne ones the present investigation has been carried out for evaluating the phytotoxic activity of locally available plants *viz.*, *Citrus limon, Azadirachta indica, Allium cepa, Allium sativum, Polyalthia longifolia, Ricinus communis* and *Parthenium hysterophorus* at 5, 10 and 15% concentration against *F. udum* by following the poisoned food technique under in vitro condition. None of the plant extracts could completely inhibit the growth of *F. udum in vitro* after 168 hrs of incubation but garlic clove extract was highly effective in inhibiting the growth of *F. udum* as it produced 51.6, 58.2 and 62.8 percent growth inhibition of *F. udum* at 5, 10 and 15 percent concentration followed by neem leaf extract (34.40%). Least inhibition was recorded in castor leaf, citrus leaf and onion bulb extracts which were not very promising as they produced only 17.3, 13.5 and 12.2 percent inhibition at 15 percent concentration.

P 30: Effectiveness of *Andrographis panniculata* against major phytopathogens

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Pathogen management using conventional techniques that involves chemicals has many negative effects on the surrounding ecosystem. The risk of user's contamination, environmental pollution and residual effects imparted by use of chemicals urges us to search for ecofriendly alternative for controlling plant pathogens. Medicinal plants usage is a captivating approach in the field of plant disease control, particular plant extracts having profound measure of antimicrobial properties and contain a continuum of secondary metabolites. Keeping above facts in view, In the present study the bioefficacy of kalmegh (*A. paniculata*) was evaluated against major crop pathogens *S. rolfsii*, *R. solani* and *F. udum*. The experiments were laid out in a completely randomized design with six replications. In case of pathogens, the ethanolic leaf extract of *A. paniculata* at 1%, 2%,3%, 4% concentrations respectively were assessed against three pathogens. Results revealed the average inhibition of 44.42%, 33.36% and 36.07% against *S. rolfsii, R. solani* and *F. udum* at 4 % concentration. So, 4%concentration was the most effective one. Treatments were also significantly ($P<0.05$) different from the control in all the parameters examined. These results confirm *A. Paniculata* property to act as and be a cynosure in future pest management programmes. Therefore, it can serve as a source of competent and potent bioactive compound that function against pests/pathogens.

P 31: An overview of the industrial applications of *Bacillus* species

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Bacillus species include gram-positive bacteria which are rod-shaped and often move. These bacteria can produce products such as ethanol, H2, acetone, acetic, formic, lactic, and succinic acids by fermentation of glucose. *Bacillus subtilis* YM 10-20 can produce compounds which resist against fungi. *Bacillus* bacteria are widely used to produce important industrial enzymes, food products, pesticides, and insecticides. *Bacilli* secrete extracellular enzymes such as alpha-amylase and protease, which make half of the total commercially produced enzymes. Certain strains of *Bacillus* are generally safe (GRAS) and are used in industry and agriculture. *Bacillus thuringiensis* contains etorins that is effective in protecting the berry leaves against *Colletotrichum dematium*. Some *Bacillus* species produce very strong natural biosurfactant compounds such as surfactants from *B. subtilis* and *lichenysin* from *B. licheniformis* which are used to improve the oil refinement. Lantibiotics (a class of polycyclic peptide antibiotics which are produced by a large number of Gram-positive bacteria such as *Streptococcus* and *Streptomyces* to attack other Gram-positive bacteria) produce peptide antibiotics containing lanthionine (non-proteinogenic amino acid) like mersacidin which is produced by *Bacillus spp.*

Keywords: *Bacillus*, gram-positive bacteria, enzymes, strain, antibiotics.

P 32: Pest and disease management in organic ecosystem

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Immense commercialization of agriculture has had a very negative effect on the environment. The use of pesticides has led to enormous levels of chemical build up in our environment, in soil, water, air, in animals and even in our own bodies. Fertilisers have a short-term effect on productivity but a longer-term negative effect on the environment where they remain for years after leaching and running off, contaminating ground water and water bodies. The use of hybrid seeds and the practice of monoculture has led to a severe threat to local and indigenous varieties, whose germplasm can be lost for ever. All this for "productivity". In the name of growing more to feed the earth, it has taken the wrong road of unsustainability. The effects show - farmers committing suicide in growing numbers with every passing year; the horrendous effects of pesticide sprays, pesticide contaminated bottled water and aerated beverages are only some instances. The bigger picture that rarely makes news however is that millions of people are still underfed, and where they do get enough to eat, the food they eat has the capability to eventually kill them. Another negative effect of this trend has been on the fortunes of the farming communities worldwide. Despite this so-called increased productivity, farmers in practically every country around the world have seen a downturn in their fortunes. This is where organic farming comes in. Organic farming has the capability to take care of each of these problems. Besides the obvious immediate and positive effects organic or natural farming has on the environment and quality of food, it also greatly helps a farmer to become self-sufficient in his requirements for agro-inputs and reduce his costs. Modern farming affects our world, by the way of land exhaustion, nitrate run off, soil erosion, soil compaction, loss of cultivated biodiversity, habitat destruction, contaminated food and destruction of traditional knowledge systems and traditions. Thus to overcome the ill effects of modern agriculture, can be delineated by adopting organic farming.

Keywords: Organic farming, agriculture, environment, traditional knowledge, pesticide.

Technical Session-III :

Plant Protection Equipments,
their Maintenance and
use in Successful Disease Management

Lead Lectures

LL 01 : Pesticides usage in agriculture : Benefits, risks and safety

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Agricultural production as such and productivity of various crops has consistently suffering from the plethora of the threats instigated by various pests (insects, pathogens, weeds etc.) leading to huge economic losses. Currently, ever escalating global population and changing climate are continuing challenges to worldwide crop production as well as crop protection. Good Agricultural Practices (GAP), Modern Technologies, Plant Protection/ Integrated Pest-Disease Management (IPDM) and many more are being amalgamated for an intensified agricultural production in a sustainable manner. Of these, the plant protection is of utmost importance for which an array of pesticides (insecticides, fungicides, weedicides etc.) have invariably and extensively used to combat various pests and consequently to reduce crop losses. But, in addition to there beneficial effects of suppressing many pests, most of the pesticides used have been implicated to exert long-lasting harmful effects on living beings, non-target organisms, environment/ eco-system etc. Moreover, pesticides are measurably accounted for self-poisoning in developing world. More than three million cases of pesticide poisoning and about 2,20,000 fatal death occurs worldwide, every year.

Various pesticides, when used wisely are safe and effective against the target organisms, reduce agricultural losses, improve quality of the produce and thereby farmers get reasonable price to their produce. But, irrational and indiscriminate use of pesticides certainly leads to human/ animal health hazards, toxic residues in food commodities, contamination of soil, surface and ground water. Environmental concern loss of beneficial micro- and macro-biota, air pollution, resurgence of pests, development of resistance against chemicals etc. The most potent hazardous pesticides popularly used for plant protection belongs to the chemical groups such as organophosphates, organochlorines, synthetic pyrethroides, heterocyclic nitrogenous compounds, benzimidazoles, trizoles, hydrocarbons etc. Exposure to pesticides for a longer period result in various diseases / disorders such as neurological, psychological and immune system dysfunctions, hormonal imbalances, cancers, blood disorders, kidney and liver damage etc.

Various risks arise due to irrational use of pesticides could be alleviated by integrating various conventional plant protection measures such as natural pesticides biocontrol agents, genetic engineering, cultural practices etc. Also safety measures to overcome the risks / harms of pesticides used, which needs to be explore and exploit on community scale.

Key Words : Pesticides, Hazards, Plant Protection, Environment, Toxicity

LL 02: High volume, low volume and ultra low volume spraying techniques

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The technique of application of pesticide and equipment used for applying pesticide are vital and play an important role in pest management. The main purpose of pesticide application technique is to cover the target with maximum efficiency and minimum efforts to keep the pest under control as well as minimum contamination of non-target including environment. A large number of pesticides are being used to combat the pest population to keep the population below economic injury level. The success of pest control operations by pesticide application greatly depends on quality of pesticide, timing of application and quality of pesticide and the coverage. Among these, the quality of application and coverage depend up on the application technique requires with proper volume of spray mix to cover the area for target pest. In general the technique of spraying includes high volume spraying, low volume spraying and ultra low volume spraying requiring respectively 300-500 L/ha, 50-150 L/ha and less than 5 L/ha by using different application equipments/machine. Thus, selection of different spraying techniques play a crucial role in the management of target pest of any kind.

Invited Lectures

IL 01: Role of traditional /modern storage structures in minimizing storage pest problems of food grains

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The major factor of losses in storage is due to insect infestation. Post harvest losses in India are estimated to be around 10% of which the losses during storage alone are to be about 6.58%. Post harvest losses occur both in quality and quantity.

The traditional structures used by the farmers are a potent source of insect infestation. These traditional structures used in India are Malika/Nand for storing small quantity of grains. Kothiar, Kuthla and Bharda or Bharoli are mud bins, Bukhari, Pura and Murai bins are made entirely of straw. Later on bags, metals bins are being used. At village level, grains are stored for a period between three months to two years depending upon the requirement.

In storage, losses are caused by abiotic (grain temperature, moisture control and RH of the atmosphere) and biotic factors (insect, mites, fungi, rodents and birds). With the advent of improved agriculture technology, the producer can afford to store the seed/ grains for longer period with minimum loss. An ideal storage facility should provide maximum possible protection from ground moisture, rain, insect pest moulds, rodents & birds etc. It should provide the necessary facility for inspection, disinfection, loading, unloading, cleaning, reconditioning and it should be economical and suitable for particular situation. Improved rural level storage structures used for storage are bitumen/coal tar drum, Hapur bin/ Kothin, Udaipur bin, PKV bin, Pusa bin ,Pusa Cubicle, Pusa Kothar, Metal bins, Baked clay bin. For huge bulk storage brick build godowns, silos and cap (cover and plinth) are used.

IL 02: Selection of pesticides with label claim, pre harvest intervals and reduction of residues in vegetable crops.

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A pesticide is a substance or mixture of substances intended for preventing, destroying, repelling, or lessening the damage of any pest. About 35-45 % crop production is lost due to insects, weeds and diseases, while 35% crop produces are lost during storage. Pre harvest interval (PHI) also termed as with holding period or waiting period is the wait time between a pesticide application and when a crop can be harvested. During the PHI, the pesticide may be broken down in the plant, or on its surface. Sun, rain, and warm temperatures may affect how quickly this happens. The Food Safety and

Standards Authority of India (FSSAI) is established under the Food Safety and Standards Act, 2006, Ministry of Health and Family Welfare. The Ministry of Health and Family Welfare regulates Maximum Residue Limit (MRL) of pesticide and agrochemical in food product through the Food Safety and Standards Authority of India (FSSAI), 2006. Pesticide labels contain detailed information on how to use the product correctly and legally. Labels also contain information on potential hazards associated with the product and instructions one should follow in the event of a poisoning or spill.

Minimizing Pesticide Residues in Food

- Always read the label carefully before you buy a product.
- Use the appropriate amount of pesticide.
- Storing and disposing of leftover pesticides can lead to unnecessary risks.
- Treat only the specific areas needing treatment.
- Choose Integrated Pest Management (IPM) options that allow to control pests with the least possible hazard.

IL 03: Role of modern storage structures in minimizing storage pest problems of food grains

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Storage of food grains is an integral part of Indian Agriculture in general and for food security in particular. Its storage is essential to ensure the national food security, prevent deterioration, to avoid social unrest, to provide seed for the next season in the country. India produces nearly 270 million tonnes of food grains annually of which about 60-70% is stored at farm level by the farmers to meet their own requirement and also to take the advantage of seasonal price variations. In India, the storage of grains at farm level is mostly done in traditional methods using different types of storage structures made or constructed using locally available materials. On the other hand educated and improved farmers use modern storage structures of different sizes and capacities. Improper storage results in high loss of gains qualitative and quantitative both. Grain losses in the storage account nearly 10% of the overall production. The preliminary storage losses are due to inadequate storage capacity, insect pest infestation, birds and rodents. A loss of grains during storage depends on many factors which include type of storage facilities, grains property and its condition before storage, period of storage, physical or the environmental factors such as temperature, humidity, moisture content of the grain etc. Additionally the role of insects, pests, rodents and micro-organisms cannot be ignored for safe storage or the losses during storage. Modern grain storage structures or the facilities have been proved to be beneficial not only from point of view of easy handling, longevity and reduction in quality loss but are also helpful in maintaining the quality of grains. In modern storage structures, it is easy to apply the management protocols and maintain the regulations of storage for any grains closely. Further, due to health consciousness, it has become mandatory for the industries to disclose the history of raw materials of the product which essentially include the storage history. The term loss refers to both the qualitative and quantitative and hence, the modern facilities are helpful in minimizing the losses significantly compared to the old traditional farm level storage structures.

IL 04: Pesticide formulations, safe and judicious use of pesticides

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In agricultural ecosystems, insect pests, mites, plant pathogens and weeds pose a major challenge to crop productivity and global food security. Without crop protection measures, the crop damage inflicted would be more severe by almost 40% than that at present. Pesticides have proved to be an efficient and reliable way of minimizing pest pressure all over the world to save crops in the field and in the storage. However, the desired effect of a pesticide can be obtained only if it is applied by an appropriate method in appropriate time. The method of application depends on nature of pesticide, formulation, pests to be managed, site of application, availability of water *etc*.

A pesticide formulation is a mixture of active and other ingredients. An active ingredient is a substance that prevents, kills or repels a pest or acts as a plant regulator, desiccant, defoliant, synergist or nitrogen stabilizer. Pesticides come in many different formulations due to variations in the active ingredient's solubility, ability to control the pest, ease of handling and transport.

Evidence suggests that not only are chemical pesticides used in increasing quantities but they are sometimes used and handled in an irresponsible way. This has led to problems regarding the safe use of pesticides and contamination of the environment. The problem of misuse of pesticides is a world-wide problem. This problem has arisen because of insufficient information and training. The manufacturers and distributors of pesticides and the user all carry a responsibility for safe handling and the use of pesticides. The problems of pesticides safety can be studied under three categories *viz.,* education, enforcement and engineering. The need of the hour is co-ordination of the efforts by all agencies concerned with the safe effective use of pesticides.

IL 05: Precision application of sprayers and dusters

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Chemicals are widely used for controlling disease, insects and weeds in the crops. They are able to save a crop from pest attack only when applied in time. They need to be applied on plants and soil in the form of spray, dust or mist. The chemicals are costly. Therefore, equipment for uniform and effective application is essential. Dusters and sprayers are generally used for applying chemicals. Dusting, the simpler method of applying chemical, is best suited to portable machinery and it usually requires simple equipment. But it is less efficient than spraying, because of the low retention of the dust. High volume spraying is usually effective and reliable but is expensive. Self-propelled high clearance sprayer is most suitable for spraying on tall crop like cotton. This machine can be operated at a forward speed up to 5 km/h in field and up to 25 km/h on road. The effective field capacity varies from 1.6 to 2.0 ha/h and the cost of operation is Rs. 485/h. Tractor operated aero blast sprayer consists of a tank of 400 litres capacity, pump, fan, control valve, filling unit, spout adjustable handle and spraying nozzles. This sprayer is mounted on the tractor 3-point linkage and operated by tractor PTO. The machine can cover about 1.7 ha/h at a speed of 1.5 km/h. Application rate of sprayer can be varied from 100 to 400 l/ha depending upon different valve settings. The unit price of aeroblast sprayer is Rs 1.00 lakh.

The cost of operation of this machine is Rs. 500/ha as against Rs. 700/ha by conventional method. Multi orchard sprayer is suitable for spraying chemicals in orchards like grapes, citrus, pomegranate etc. The orientation of booms can be adjusted depending upon the plant size and their row spacing. Spray booms of manually operated sprayers are mounted behind the operator. The boom covers half of the tree canopy on either side of the sprayer. Multi orchard sprayer can cover 0.40-0.70 ha/h at forward speed of 1.20-1.50 km/h. New technology of plant protection equipment such as variable rate applicator equipment is used in modern era. These variable rate applicators are used ultrasonic sensors to apply the variable application of chemicals. Variable rate applicators can be used on the crop having variable size of fruits i.e. vines. The changes in the shape and size of vines during the growing season require a continuous adjustment of the applied dose to optimize spray application efficiency. Target detection with ultrasonic sensors can be used to adapt the applied dose following the principles of the variable rate technology. On average 58% less liquid was applied compared to the constant rate application.

Key words: Field capacity, Sprayer, Variable rate applicator.

Poster Presentations

P 01: Evaluation of bio-rational insecticides against okra shoot and fruit borer (*Earias* spp.)

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Investigation on evaluation of bio-rational insecticides against okra shoot and fruit borer (*Earias* spp.) was carried out in okra (var. Super Green) at Horticultural field, BTC College of Agriculture and Research Station, Bilaspur during *summer* 2018. The experiment was comprised of nine treatments and three replications. The bio-rational insecticides being neem leaves 5%, marigold leaves 5%, bael leaves 5%, carrot grass leaves 5%, *Beauveria bassiana*5v/w @ 4gm/l (CFU's=10^8/gm), *Baccillus thuringiensis* 1.15w/w @2gm/l (CFU's=10^{12}/gm), spinosad 45SC @0.25ml/l along with untreated treatment. The experimental findings revealed that the spinosad 45SC was found to be the most effective against okra shoot and fruit borer as it has recorded overall less fruit infestation percentage and also gave a better increase in healthy yield over control. The second best bio-rational treatment was *Bacillus thuringiensis* 1.15w/w followed by neem leaves extract (5%) while the least effective treatment was found to be of castor leaves extract (5%). These insecticides were also found to be effective against sucking pests like white fly which is the carrier of yellow vein mosaic of okra. Thus, above insecticides may take care of both insects as well as viral diseases.

P 02 : Hand sprayer is useful for spraying wettable fungicides and insecticides in small area

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The hand sprayer is a small capacity Pneumatic sprayer. It consists of chromium plated brass tan having a capacity of 0.5 to 3 litres (one litre is more common) which is pressurized by a plunger pump. The air pump remains inside the tank. The sprayer has a short delivery tube to which a cone nozzle is attached. In some models, the nozzle is attached at the top of the tank with flow spring actuated liver, which regulates the flow of the sprayer liquid. For spraying, the tank is usually filled to three-fourths capacity and pressurized by air pump. The compressed air causes the agitation of the spray liquid forces it out, on operation of trigger or shut off type

valve usually the chemicals with suspension characteristics cannot be effectively sprayed with this type of sprayer. For spraying wettable powders, the sprayer is shaken frequently to prevent setting of the chemical. For operation, the spray nozzle is directed to target after charging. It is fitted with mist spray nozzle with gooseneck bend. The pump assembly is made of brass and operated by one person. It is ideal for small nurseries, rose plants, kitchen garden and spraying insecticides and fungicides. Its plus point is that due to prior development of air pressure, pumping process during spraying is minimized. These sprayers come in many shapes and models.

P 03: Plant protection equipments, their maintenance and use in successful disease management

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Pesticide application plays an important role in pest management. Proper technique of application of pesticide and the equipment used for applying pesticide are vital to the success of pest control operations. The application of pesticide is not merely the operation of sprayer or duster. It has to be coupled with a thorough knowledge of the pest problem. The use of pesticides involves knowledge not only of application equipment, but of pest management as well. The main purpose of pesticide application technique is to cover the target with maximum efficiency and minimum efforts to keep the pest under control as well as minimum contamination of non-targets. All pesticides are poisonous substances and they can cause harm to all living things. Therefore their use must be very judicious. The application techniques ideally should be target oriented so that safety to the non-targets and the environment is ensured. Therefore, proper selection of application equipment, knowledge of pest behavior and skillful dispersal methods are vital. The complete knowledge of pest problem is important to define the target i.e., location of the pest (on foliage, under the leaves, at root zone etc). The most susceptible stage of the pest for control measures will help to decide the time of application. The requirement of coverage and spray droplet size depends upon the mobility and size of the pest. The mode of action of pesticide, its relative toxicity and other physicochemical properties, help to decide the handling precautions, agitation requirement etc. Further the complete knowledge of the equipment is necessary to develop desired skill of operation, to select and to estimate the number and type of equipments needed to treat the crop in minimum time and to optimize use of the equipment.

Keywords: Pesticide, equipment, application, knowledge.

Technical Session-IV :

Chemical Pesticides in Effective Management of Plant Diseases

Lead Lectures

LL 01: Integrated Pest Management (IPM): Need for prioritized component-wise estimates

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Silent Spring and the public's response to it was responsible for the United States' ban on DDT in 1972 and its policy on Integrated Pest Management (IPM). Indonesia also has set an example while other nations have since followed suit. Since that time, the ecological movement has accelerated and burgeoned across the world. It is only because of the public's increased awareness of and increased protestation against environmental destruction that initial safeguards have been instituted and the beginnings of progress on some environmental fronts have been made. But it all happened in the western world and may be a part of it aroused the Government of India and the Indian Council of Agricultural Research (ICAR) also to have Integrated Pest Management (IPM) as part of the National Agriculture Policy. Thus, came up the ICAR: National Research Centre for Integrated Pest Management (NCIPM) in 1988, which also understood the herculean task of spreading the message of IPM across pan Nation India rather tough due to poor awareness about the subject among people in line departments as also among the farmers. The available data on chemical pesticide residue in different crops, pockets of the country is also not too encouraging. Integrated Pest Management (IPM) provides a long-term solution to these problems by employing as many pest management techniques as possible for using chemical pesticides rationally. IPM is not new – mechanical, cultural and biological tactics were used by farmers for hundreds of years before chemical pesticides became available. In addition, there are IPM techniques that have been developed more recently and are effective in suppressing pests without adversely affecting the environment.

Despite availability of so many options for managing pests of crops in India, IPM for a better crop health is not seeing success in the farmers' fields and adoption of IPM is low owing to a number of socio-economic and other constraints. With changing cropping system, land-use pattern, climate, farming is gradually becoming a less remunerative option in India, whereby growers keep calculating input costs irrespective of benefit. Apart from lack of awareness among them, it was also understood that a long prescription for IPM was not suiting the financial provision of the farmers for the purpose. This was due to the fact that each of the components of the IPM package or the prescription thereof involved some cost, which totalled to a huge figure that varied with location, etc., which was not financially viable. Thus, devising a methodology to decide the components priority-wise in terms of reducing losses vis-à-vis financial benefit is the need of the hour. Very little information is available on IPM with reference to input-based economics. Thus, there is need for efforts to obtain precise estimates for economics of different interventions as a part of prioritized component-wise IPM for easier adoption of crop health management strategies. Under the circumstance, it becomes imperative to not only clarify the input cost, the benefit thereof individually and as integrated treatment for managing the pest problem, environmental welfares in reducing use of chemical pesticides as also ensure that the complete package of practice for crop production leads to a remunerative return.

LL 02: Extension nematological techniques for farming community

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Phytonematodes, the hidden enemies of crops, continuously browse crop roots and cause enormous damage both quantitatively and qualitatively. According to the Agrochemicals International, 2007, monetary loss of Rs. 1,40,000 crore has been reported due to insects-pest, diseases, nematodes, weeds, rodents, etc. which raised to Rs. 2.25 lac crore annually in 2015. Nematode loss is around 12- 13 % of the total loss. QRT for All India Coordinated Research Project on Plant Parasitic Nematodes with Integrated Approach for Their Control, New Delhi has estimated the total national annual loss of Rs. 21,068.73 million through experimental data for 24 crops covered under the project during 2007.

1. Pressmud @ 15 t/ha broadcast applied a week prior to seeding is recommended for effective management of root-knot disease in kharif okra (ICBR 1 : 31).
2. Carbofuran @ 1 kg/ha coupled with neem oil @ 5 l/ha (2000 1it water/ha with 0.1 % detergent powder) applied a day earlier was effective and economic in management of *M. javanica* pt2 and higher groundnut yield (ICBR1 :3.47).
3. Incorporation of either Naffatia/ besharmi or Aak or Congress grass each @ 3 kg/m^2 in soil before flowering 15 days prior to seeding is recommended for management of RKN in tomato nursery (ICBR 1:2.9, 1:2.3 &1:2.1).
4. Soil solarization through tarping with 25µ LLDPE clear film for 15 days during May controlled RKN and weeds in tomato nursery by increasing transplantable seedlings by 61 % and decreased RKN and weeds by 66 % and 92 %, respectively (ICBR 1 :5.65).
5. Poultry manure @ 2.0 t/ha applied 15 days prior to tomato seeding was effective in management of RKN and produced more tomato transplants (ICBR 1:4.54).
6. Paring and hot water treatment of banana suckers at 50°C for 20 minutes combined with application of neem cake @ 1 kg/plant carbofuran @ 16.6 g/plant in pit before plantingwas effective against RKN and burrowing nematodes.
7. In crop rotation, significant increase in yield of kharif okra by 28.4 % was obtained due to previous crops of cauliflower in rabi and clusterbean in summer. Rabi crops like onion and garlic had more reduction of soil nema population by 92.0 and 86.9 % respectively over brinjal crop in field. In summer, crop rotation of okra-potato-clusterbean had maximum reduction of 64.6 % nema population.
8. Combined treatment of NSKP @ 10 % (w/w) +*T. viride* @ 10 g/kg seeds was found to reduce *H. cajani* in pigeon pea by 58 % and increased yield by 32 %.
9. Application of neem cake @ 100 kg/ha + *T. viride* @ 2.5 kg/ha was found to reduce *H. cajani* by 62 % and increased pigeon pea yield by 34 %.
10. Growing castor as inter/relay crop (2 : 1) along with soil application ofcarbofuran @ 1 kg/ha reduced *M. arenaria* to get higher groundnut yield (ICBR1:2.35).
11. Combined application of neem cake @ 1000 kg/ha and soil drenching with mancozeb 75 WP @ 0.25 % was effective for management of *M. incognita –Macrophomina* complex in jute.
12. Seed dressing with carbosulfan 25 DS @ 3 % (w/w) is recommended for control of RKN in bittergourd, bottlegourd, watermelon, mung and pigeon pea with ICBR 1:17.24,1:18.43,1:11.52, 1 :1.49 and 1:3.20, respectively.
13. Paddy seed soaking in carbosulfan @ 25 EC @ 0.1 % solution for 6 hrs. and foliar spray of carbosulfan25 EC @ 0.02 % at 40 DAP was effective in management of *A besseyi* (ICBR1: 4.7).
14. Application of Carbofuran@1Kg + 5 kg Pl/ha under crop row a day before potato seeding checked 94% RKN infection on potato tubers and enhanced 45% production of healthy tubers.
15. Pl multiplied on neem cake (7 X 10^8cfu/g) applied @ 10 kg/ha reduced PCN population and increased potato tuber yield by 88.2 and 76.2 %.
16. Combined ST of *Pf* @ 5g + *Tv* @5g/kg seeds reduced *M. incognita* and increased 20.29% mung yield (ICBR1:7.9), reduced *R. reniformis* infection and increased17.2% cowpea yield and reduced *H. cajani* infection and increased 32.55% pigeon pea yield (ICBR 1:4.18).

17. Seed treatment with Pl @ 20g/kg seeds reduced 74.87% *R. reniformis* root population and increased 67.80% cotton yield (ICBR 1:68.74).
18. Soil fumigation with Metham-Sodium @ 30 ml/m^2 reduced RKN by 95.45 % and increased tomato yield by 100.91 % (ICBR 1:3.38) at Palampur , 54.6 % reduction in RKN with 32.84 % increase in capsicum yield (ICBR 1:2.58) at Rahuri and checked RKN by 68.16 % and increased 361.65% carnation flower production at Bangalore.
19. Soil fumigation with Dazomet and Metham Sodium each @ 40 g or ml/ m^2 significantly reduced RKN by 78.3 % and 74.7 % with 110.9 % (ICBR 1:4.38) and 144.2 % (ICBR: 1:5.69) increase in tomato yield & reduced RKN by 74.0 % and 74.2% with 63.7 % (ICBR 1:3.76) and 65.1 % (ICBR: 1:3.84) increase in cucumber yield, respectively.

These and others that are included in POP need to be demonstrated on a large scale in nematode prone areas on farmers' fields. Field/farmers' days should be organized to educate farmers for adoption. More participation of scientists in kisanmela, exhibitions, field visits/day, DD programs, KVKs, etc., is advocated as existing and new nematodes problems are emerging a great threat in agricultural and horticultural crops.

LL 03 : Integrated pest management of sucking pests vector of plant diseases

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Plant diseases are generally caused by microscopic organisms i.e. fungi, bacteria, nematodes, protozoa, and parasitic green algae, submicroscopic organisms like viruses and viroids. It also caused by abiotic, environmental factors *viz.* nutrient deficiencies, extremes in temperature and soil moisture, etc. Besides other causes of diseases, many of them are transmitted by insects either accidentally carrying bacteria and fungi on their bodies and legs (several fungi and bacteria) or by a specific insect vector on which the pathogenic organism depends on for transmission from one plant to another, and on which some pathogens depend on for survival. Insects transmit pathogens among plants belongs to orders Hemiptera, Thysanoptera, Diptera, Coleoptera and Hymenoptera they transmit pathogens in three main ways.

- Some insects transmit bacterial and fungal spores passively by feeding in or walking through an infected plant area that has on its surface plant pathogenic bacteria or fungal spores as a result of the infection. The bacteria and spores are often sticky, cling to the insect as it moves about, and are carried by it to other plants or parts of the same plant where they may start a new infection.
- Some insects transmit certain bacteria, fungi, and viruses by feeding on infected plant tissues and carrying the pathogen on their mouth parts as they visit and feed on other plants or plant parts.
- Some insects (sucking pests) transmit specific viruses, phytoplasmas, protozoa, nematodes, and xylem- and phloem-inhabiting bacteria by ingesting (sucking) the pathogen with the plant sap they eat. Subsequently, the pathogen circulates through the body of the insect until, with or without further multiplication in the insect body, the pathogen reaches the salivary glands and the mouthparts of the insect through which it is injected into the next plant on which the insect feeds.

There have been two systems of terminology established to describe the association and transmission of plant diseases by insect vectors which feed in a piercing-sucking manner. One is based on how long the virus persists in the insect vector, and the second is based on the route of virus movement through the insect vector. They can be combined as follows: 1) the non-persistently transmitted, stylet-borne viruses; 2) the semi-persistently transmitted, foregut-borne viruses; 3) the persistently transmitted, circulative viruses; and 4) the persistently transmitted, propagative viruses. Using this terminology, virus 'transmission' is referred to as 'non-persistent,' 'semi-persistent,' or 'persistent' Non-persistent plant viruses are retained in the insect stylet. Semi-persistent viruses are internalized in the insect by binding to chitin lining the gut, but do not appear to enter tissues. Persistent viruses are taken up into and retained by insect tissues and are characterized by invading the salivary glands. Persistent viruses can be further divided into circulative, non-propagative, and circulative, propagative. Circulative viruses must escape the insect gut and spread to neighboring organs to reach the salivary glands for transmission.

Sucking insect pests are transmitting various diseases in plants are listed in table 1. Mostly these insects are soft bodied and fast multiplying in nature and hard to control and develop resistance for insecticides. Integrated approach for the management of these pests are the only way to save the crop from the damage caused by them. Efficient for the management of these pests are discussed in present paper. Integrated Pest Management or IPM, is a method used to control pests in an environmentally responsible manner. By reducing our dependence on pesticides, IPM protects the environment and our health. It also saves money. IPM can be applied wherever pests are found: IPM combines different techniques to prevent pest damage without harming the environment.

Rabindra and Ramanujam (2007) reported that the sucking pests cause serious damage to several agricultural, horticultural and plantation crops either by direct feeding or by transmitting plant viral diseases. Since sucking pests like plant and leaf hoppers, aphids, whiteflies, scale insects, thrips and mites to have developed resistance to insecticides, biological control using microbial pathogens, particularly fungal pathogens like *Beauveria bassiana, Metarhizium anisopliae*, and *Verticillium lecanii*, has been explored for a number of pests. Several commercial formulations based on entomopathogenic fungi were developed for the control of sucking pests in different countries. Mycotrol and Botanigard based on *B. bassiana*, Mycotal based on *V. lecanii* and PFR-97 and Pae-Sin based on Paecilomyces fumosoroseus were developed for the control of whiteflies, aphids and thrips.

Jin *et al.* (2008) studied the effect of fungal isolates for microbial control of brown planthopper (BPH) *Nilaparvata lugens* (Stal), to which little attention has been paid in the past two decades. Thirty-five isolates of *Metarhizium anisopliae* (Metschnikoff) Sorokin and *M. flavoviride* Gams & Rozsypal from different host insects worldwide were bioassayed for their lethal effects against third-instar BPH nymphs. Mortality attributable to mycosis ranged from 6.5 to 64.2% and differed significantly among the tested isolates with no apparent relationship to their host origin. Only two BPH-derived *M. anisopliae* isolates from the Philippines (ARSEF456) and Indonesia (ARSEF576) killed >50% of the nymphs. Both isolates were further bioassayed for time-concentration-mortality responses of the nymphs to the sprays of 19- 29, 118-164 and 978-1088 conidia mm-2 in repeated bioassays. The resultant data fitted a time-concentration-mortality model very well. Their LC50 values were estimated as 731 and 1124 conidia mm-2 on day 7 and fell to 284 and 306 conidia mm-2, respectively, on day 10. The two *M. anisopliae* isolates are potential biocontrol agents of BPH for further research. This is the first report of the lethal effects of global *Metarhizium* isolates on the rice pest.

Li *et al.* (2010) tested the effectiveness of four biological and two man-made pesticides, and mixtures of these compounds, in controlling sympatric populations of *Nilaparvata lugens* (Stal) and *Sogatella furcifera* (Horvath), in rice fields. The results show that, of four biological pesticides tested, matrine (0.36% AS 1 500 ml/ha.), veratridine (0.5% WP 3 000 g/ha.), abamectin (1.8% EC 900 ml/ha.) and *Beauveria bassiana* (4.0 × 1010 spores/g WP 1 800 g/ha.), abamectin was the most effective with control efficiencies 7 and 14 days after spraying of 73.3% and 82.3% respectively. These results were significantly higher than those achieved by the man-made pesticides, chlorpyrifos (48% EC at 1 500 ml/ha.) and buprofezin (25% WP at 750 g/ha.).

Smitha *et al.* (2010) observed the occurrence of an entomopathogenic fungus, *Hirsutella sp*. (Fungi: *Imperfectii*) on root mealy bugs, *Geococcus coffeae* and *Geococcus citrinus* infesting banana variety, Nendran. The fungus was isolated in laboratory and pathogenicity confirmed through Koch's postulates. Different solid media tested for the growth revealed that SMA + Y media was the most suitable for laboratory multiplication. Large scale multiplication in the half-cooked sorghum grains produced significantly higher number (9.38 × 106 spores g-1) of spores followed by rice grain (9.13 × 106 spores g-1) at 45 days after inoculation. Some practices are taken into consideration for managing the sucking pests. High levels of nitrogen promote succulent, nutritious new growth, which is preferred by aphids and can help boost aphid reproduction. Over fertilizing a plant can enhance aphid population growth and make the problem worse. Using smaller amounts of fertilizer throughout the growing season can help to reduce potential aphid outbreaks.

Lady beetles and their larvae feed on many different types of aphids, Another natural enemy, that can be effectively used, is green lacewing larvae (*Chrysoperia rufilabris*). These larvae are extremely aggressive and will eat numerous aphids a day. Another natural enemy are parasitic wasps (*Aphidius* species) that sting aphids and impregnate them with an egg. The egg then grows inside the aphid, killing and mummifying it, A biological control that can be applied similar to a traditional is insecticide is any product containing *Beauvaria bassiana*. This entomopathogenic fungus is usually applied as a foliar spray and is parasitic to many soft body insects.

Silver-colored reflective mulches have been successfully used to reduce transmission of aphid-borne viruses in summer squash, melon, and other susceptible vegetables. These mulches repel invading aphid populations, reducing their numbers on seedlings and small plants. Another benefit is that yields of vegetables grown on reflective mulches are usually increased by the greater amount of solar energy reflecting onto leaves. *N. cucumeris* primarily feeds on the young thrips larvae but may survive on pollen and spider mites in the absence of thrips. *Amblyseius swirskii* is a predatory mite that feeds upon both thrips and whiteflies. It may also feed upon broad mites, two-spotted spider mites and pollen in the absence of thrips and whiteflies. Different species of predatory bugs (*Orius spp*.) are generalist predatory that feed upon thrips, spider mites and pollen. They are most effective on long term greenhouse vegetable crops such as peppers due to the presence of pollen.

Whiteflies have many natural enemies, general predators include lacewings, bigeyed bugs, and minute pirate bugs. Several small lady beetles including *Clitostethus arculatus* (on ash whitefly) and scale predators, such as *Scymnus* or *Chitocorus* species, and the Asian multicolored lady beetle, *Harmonia axyridis*, feed on whiteflies. Whiteflies have a number of naturally occurring parasites that can be very important in controlling some species. *Encarsia* spp. Avoiding the use of insecticides that kill natural enemies is a very important aspect of whitefly management. In vegetable gardens, yellow sticky traps can be posted around the garden to trap adults. Such traps won't eliminate damaging populations but may reduce them somewhat as a component of an integrated management program relying on multiple tactics. Besides these practices adoption of clean cultivation, use of tolerant varieties, inter cropping, agronomical practices including date of sowing and nutrient management, use of trap crops, use of safer pesticides are the important in management of sucking pests, to protect natural enemies of pest, environment and to avoid buildup of resistance for pesticides in sucking pests.

Invited Lectures

IL 01: Spot blotch an emerging threat to wheat and progress

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Spot blotch of wheat caused by *Bipolaris sorokiniana*, one of the major biotic threats of wheat in the warm humid tropics encompassing India, Bangladesh, Nepal and South America. The disease has spread to 10 million hectare of wheat in south Asia, and responsible for the average annual loss of 7-8 million tons. This disease has become matter of global concern due to climate change. The outbreak of spot blotch is noticed during grain filling which is most crucial period for grain yield and quality. Although, breeding efforts brought many improved wheat genotypes performed better to spot blotch. However, desired levels of resistance are yet to be achieved that could sustain during intermittent rains and warm temperature of January and February. High yielding and spot blotch resistant genotypes may used directly under integrated disease management program. Resistance based on the restricted growth and reproduction of pathogen in most of the environments is often durable. This kind of resistance is based on fewer lesion number, small lesion size, and late and less spore production from individual lesion (Museid *et al*. 2013; Comfort *et al*. 2016). These resistance components are additive and also interact with reproductive components of plant and increased its fitness. Bringing resistance and fitness components together in a cultivar is important breeding aspect. This is now possible using biotechnological tools covering whole genome and identifying various markers associated with the phenotypic components of resistance and yield.

Monitoring shift in pathogen population for higher aggressiveness will provide insight about the behavior of individual resistance components. The genomic resources of pathogen will further help to understand the fitness of the pathogen. Recently the pathogenic effect or ToxA has been identified from the Indian strains of *Bipolaris sorokiniana*. The assessment of pathogen population for this effector is very useful for the screening of the resistance genotype. The molecular tools including barcoding of gene and molecular markers could be utilized to identify new strains and races. Migration of more aggressive strains through seed can be restricted by seed treatment. The disease forecasting can be integrated for timely application of chemical fungicide and preventive measures.

IL 02: Recent advances in the management of sugarcane diseases

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Diseases are major limiting factor for crop productivity. More than 150 diseases on sugarcane have been recorded worldwide, of which 50 diseases have been recorded in India. Among them red rot, smut, wilt, Grassy shoot, ratoon stunting, sett rot and mosaic are the major diseases which seriously affecting sugarcane production in India. Recently reported yellow leaf syndrome and streak mosaic in sugarcane occurs under specific situation in different states. Some of the major diseases affect the cane production and leads to varietal degeneration in long run. Timely detection of diseases may help on the management of diseases to ensure higher cane production and sugar recovery. Sugarcane diseases are transmitted through infected sets or through surviving inoculums in soil or crop debris. Hence selection and propagation of healthy seeds are important factor for minimizing the diseases. Hence, varieties viz. Co 8021, Co 85019, Co 86010 and Co 86032, Co86249 and Co 93009, Co 99004 and Co 99006 are tolerant/resistant to red rot. In addition possible elimination of viral and bacterial pathogens from seed cane by specific treatments is also required. Suitable agronomical methods found suitable to break the disease cycle of soil borne pathogens. In addition to this, strict regulation of seed movement through legislation will help in preventing the spread of diseases. However, chemical controls are possible for few diseases, particularly caused by fungal pathogens. As a prophylactic measure the sets are to be dipped in fungicide solution to protect the cut ends from soil borne pathogens. It is advised to dip the cane sets in Carbendazim (0.1%) or Tebuconazol (0.1%) solution for 10-15 minutes prior to planting for management of sett and soil borne diseases. Similarly sets from smut affected field should be treated in hot water at 50 ^{o}C for one hours or 52 ^{o}C for 30 minute along with systemic fungicides. However, recent studies revealed that sett treatment with Thiophanet methyl fungicides and biocontrol agent Pseudomonas reduces the soil borne infection of red rot.

IL 03: Management of wheat disease using chemicals

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Wheat is a major rabi cereal crop of India and a record production of 98.61 million tons was achieved from 30.50 million ha with an average productivity of 32.32 q/ha during 2017-18 crop season. The wheat cultivation has gone changes in terms of cropping system, climatic conditions, tillage practices, and larger area under single variety, private sector varieties and other crop management practices during last one decade. As a result, the diseases the magnitude of disease spread and extent of losses increased and a new thinking and approach is required for their proper management in order to achieve the maximum yield and quality. Rice-Wheat cropping system is still very popular in entire Indo-Gangetic Plains. Use of sprinkler irrigation is increasing in drier areas. Wheat is now grown under warm and humid climate in north-eastern India also which is quite favourable for leaf rust, spot blotch and head scab. Regular evolution of new pathotypes of rusts renders mega varieties susceptible to rusts. Wheat suffers from diseases like, leaf rust (*Puccinia triticina)* and spot blotch (*Bipolaris sorokiniana*) in all the six agroecological zones in India whereas stripe rust (*P. striiformis)* is a disease of cool weather in northern hills and north-western plains zone. Stem rust (*P. graminis*) and foot rot (*Sclerotium rofsii*) occurs in central and peninsular zones. Karnal bunt *(Tilletia indica)*, loose smut (*Ustilago tritici)*, flag smut *(Urocystis agropyri)*, head scab *(Fusarium graminearum*) and powdery mildew (*Erysiphe graminis* f. sp. *tritici)* occur in north India. Although host resistance is greatly used in wheat to manage diseases but having resistance to all diseases in a cultivar is not possible. Therefore, survey and surveillance of diseases is done regularly and advisories are issued to farmers for pre sowing seed treatment and spray of the crop with fungicides. For management of seed borne inocula of loose smut, flag smut and spot blotch, seed treatment of carboxin 75 WP or carbendazim 50 WP @ 2.5 g/kg seed or tebuconazole 2DS @ 1.5 g/kg seed or a combination of a reduced dosage of carboxin (75 WP @ 1.25 g/kg seed) and a bioagent fungus *Trichoderma viride* (@ 4 g/kg seed) is recommended. The rusts, powdery mildew and spot blotch are managed using foliar sprays of propiconazole or tebuconazole @ 0.1% at initiation of disease whereas; Karnal bunt is managed by foliar sprays of propiconazole @ 0.1% at boot leaf stage. New molecules are being tested against diseases of wheat. The use of fungicides in wheat is only recommended when a variety turns susceptible and weather is favourable to disease and in India use of chemical control is bare minimum by using epidemiological approach.

IL 04: Natural reservoirs and spread sources of phytoplasmas: An update

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Phytoplasma are minute bacteria which are characterized by lack of a cell wall, a pleiomorphic or filamentous shape of 200-800 µm and inhabit phloem sieve elements in infected plants. The genome size of phytoplasmas is very small ranges between 530 kb and 1350 kb. Phytoplasma caused more than 400 plant diseases which include fruits , vegetables, spices , cereals, trees, ornamentals, forage crops and legumes and the damage they cause to crops has a noticeable impact on agriculture economics. They are poorly understood group of organisms, because they cannot be cultured *in vitro*. They are unevenly distributed and present in low titre in the phloem tissues of infected hosts and insects. These non-cultivable plant pathogens belong to the class of Mollicutes. Comparison of 16S rDNA sequences showed that the phytoplasmas to be phylogenetically close to the acholeplasma/ anaeroplasma group of the Mollicutes.

Phytoplasmas are spread via vegetative propagation such as the grafting, cutting, tubers, bulbs and rhizomes, dodder, micropropagation or other ways to propagate plant germplasm avoiding sexual reproduction. The possibility of seed transmission has also been investigated following *in situ* detection of phytoplasma DNA in embryos from coconut palms with lethal yellowing disease. Evidences of seed transmission of phytoplasma are also confirmed on *in vitro* growing commercial seedlings of alfalfa, lime, totamo, corn and winter oil seed rape.

Sap-sucking insect vectors belonging to the family Cicadellidea (leaf hoppers) and Fulgoridea (plant hoppers) and psyllids are responsible for their spread in a persistent manner. They feed on the infected phloem tissues and acquire the phytoplasmas and transmit them from one plant to another. Some phytoplasmas have low insect vector specificity, being transmitted by multiple vectors (aster yellows phytoplasma is transmitted by at least 24 leafhopper species) but others are highly vector specific, being transmitted by only one or a few vectors . Phytoplasmas are found in most major organs of infected insects. Uptake of phytoplasmas from plant sieve elements occurs through the stylet and involves passage through the intestine and entry into the circulatory system of the haemolymph. To infect the next plant, phytoplasmas must colonize the salivary glands of the insect vector and multiply within the saliva to such a level that feeding introduces an infective dose to healthy plants .The colonization of the insect can take 3 weeks before the titre of phytoplasmas reaches an infectious level. Once infected, the insects remain infectious for the rest of their life, including overwintering, but they do not usually transmit phytoplasmas transovarially . However, exceptions have been reported – phytoplasmas have been found in eggs, nymphs and adults after the first and second generation insects were reared on phytoplasma-free plants.

An important parameter for the epidemiology of phytoplasma diseases is the wide host range of some phytoplasmas. Overlapping plant hosts and vectors also give ample opportunities for phytoplasmas to interact and exchange genetic information. Phytoplasmas have been detected in most organs of infected plants, where they colonize the sieve tubes of the phloem. Several weeds are reservoirs of important phytoplasma and play an important role in spreading phytoplasma and serve as natural alternative hosts for the spread of phytoplasma pathogen to other economically important plants and thereby chances of causing severe losses.

IL 05: Fourth generation fungicides for disease management

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Since the beginning of agriculture, generations of farmers have been evolving century, our growing practices for combating the various plagues suffered by our crops. Following our discovery of the causes of plant diseases in the early nineteenth understanding of the interactions of pathogen and host has enabled us to develop a wide array of measures for the control of specific plant diseases. In the modern, intensified agriculture, the efficient management of plant diseases is essential. At present the most reliable means of doing this is by the use of fungicides. Fungicides are the toxic substances which either kill or check the growth of the fungi. During the last two decades, fungicide research has produced a diverse range of fungicidal products with novel modes of action which had a significant impact on plant disease control. The need for new and innovative fungicides is driven, among other factors, by resistance management, regulatory hurdles, and increasing customer expectations. Compounds having a novel mode of action are of course of special interest, since they play a key role in resistance management strategies, but equally important are new fungicides with enhanced characteristics such as systemicity, curativity, and longevity of disease control. The technical feature of new generation fungicides are target specific action and safer to non target sites. Over the past few years, however, several truly novel compounds have been launched commercially and have reached an advanced stage of development, which include phenylpyrroles, anilinopyrimidines, strobilurin analogues etc with effects on respiration, cell membrane components, protein synthesis, signal transduction and cell mitosis. Many of the important plant diseases, which were not controlled satisfactorily by the previous traditional fungicides, can now be well managed by the new compounds which are mostly systemic in nature. In view the risk of resistance development with most of the systemic, site specific compounds, there is a need to develop more classes of fungicide with novel target sites.

The use of fungicides has assumed importance over the years in the control of more damaging plant pathogens against which host resistance is not easily available or is unstable, particularly for polycyclic pathogens. The new compounds which have originated from different approaches such as traditional random screening and from natural products are expected to provide better disease control options and are ecologically safe show good efficacy at much lower doses. These require lesser treatments per season compared to earlier compounds. Since they possess novel modes of action, there are fewer chances of resistance development or cross resistance to previous fungicides. These are also easily degradable and pose less threat to the environment. There is significant improvement in their formulations and are safer to the crops. In some cases, the benefit gained through fungicide use is more critical to the extent that certain crops, such as apple, grapes, banana, potato, tomato etc cannot be cultivated in the absence of disease control that remains heavily dependent on the use of fungicides. Intensive use of chemical control measures has in turn led to its own challenges, including resistance to fungicides. The sustainable use of fungicides to prolong their effectiveness and usefulness to growers is key, and the implementation of resistance management strategies are essential part of this. Only if the long-term effectiveness of fungicides can be ensured will industry invest the money and resources required for their discovery and development, especially considering the high standards of today's registration requirements. The Fungicide Resistance Action Committee and its network play a vital role in the design and support of these strategies.

Oral Presentations

OP 01: Survey, etiology, screening of local germplasm, management of Taphrina leaf blotch (*Taphrina maculans* Butler) of turmeric by new generation fungicides and validation under farmers fields

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Turmeric (*Curcuma longa* L.) the ancient and traditional spices of India known as 'Indian Saffron' is an important commercial spice crop grown in India. It is also known as the 'Golden Spice of life" and is one of the most essential spices used as an important ingredient in culinary all over the world. India is the largest producer, consumer, and exporter in the world. Turmeric is used in many ways *i.e.* condiments, cosmetics, medicine and textile industry for coloring agents. Taphrina leaf blotch is major disease of turmeric growing areas wherever grown and limiting production of turmeric crop. The survey has made five different blocks and ten villages from August to December for different places in Raigarh to identify disease causing organism in the region during 2015-16.The available germplasm under AICRP on Spices were screened out for search material for disease resistance, for four fungitoxicants comprising different groups were taken for the management in different combinations of seven treatment including check to manage the Taphrina leaf blotch as viz. Rhizome treatment with Fusilazole (0.1%)+ Spray on 45 , 75 and 105 DAP (T_1), Rhizome treatment with Tebuconazole (0.1%)+ Spray on 45 , 75 and 105 DAP (T_2), Rhizome treatment with Azoxystrobin (0.1%)+ Spray on 45 , 75 and 105 DAP (T_3), Foliar spray with Fusilazole (0.1%) on 45, 75 and 105 DAP (T_4), Foliar spray with

Tebuconazole (0.1%) on 45 , 75 and 105 DAP (T_5), Foliar spray with Azoxystrobin (0.1%) on 45 , 75 and 105 DAP (T_6), Rhizome treatment with Carbendazim + Mancozeb (0.1%) + Foliar spray – Carbendazim + Mancozeb (0.1%)on 45 and 90 days(best result of previous experiments) (T_7), unsprayed Check(T_8). The disease is characterized by the appearance of several spots on both the surfaces of leaves and being generally 'more numerous on upper surface. The leaf spots first appear as pale yellowish discolouration which become dirty yellow and then deepen to the colour of old gold and some times to bay shade. The individual spots are small, 1-2 mm in diameter and coalesce freely. In severe cases of attack, hundreds of spots appear on both the sides of leaves. The spots are discrete brownish black and mostly confined to lower leaves. The severely infected plant exhibited a burnt appearance. The survey has found minimum disease intensity 5.56 percent in Telipali Village of Pussore developmental block in month of August and Ratanpur Village of Dharamjaigarh developmental block in 40.67 percent in month of December. In local germplasm pool, no entries has highly resistant and resistant categories and none of the entries were highly susceptible categories. The forty five entries were in moderately resistant categories and will utilize for breeding and development of the varieties in the fungicidal management trail conducted during the year 2013-14 to 2015-16 Minimum Disease intensity 13.12 percent and maximum yield 14.08 t/ ha was found when rhizome treated with Rhizome treatment with Carbendazim + Mancozeb (1:1) (0.1%) + Foliar spray – Carbendazim + Mancozeb (0.1%)on 45 and 90 days followed by Azoxystrobin spray (0.1%) after 45 and 75 and 105 DAS after Planting followed by minimum disease intensity 15.48 percent and yield 13.14 t/ha. Both of the treatments are statistically at par. The front line demonstration has been conducted for the management of foliage disease at Telipali Village of Pussore Block and Gerwani Village of Raigarh Block Successfully in the year 217-18 to demonstrate the technology. The farmers see the result of the FLD and convince for future management of foliage disease by the fungicides including in FLD.

OP 02: *In vitro* evaluation of systemic and nonsystemic fungicides against *Colletotrichum gloeosporioides* and *Alternaria alternata* causing fruit rot of pomegranate

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Pomegranate (*Punica granatum* L.) diseases often caused by a range of fungi and bacteria, pose direct significant financial, nutritional and postharvest loses along the value chain. The major fungal genera, that causes fungal fruit rots in pomegranate are *Alternaria, Colletotrichum* and *Aspergillus* causing 40-50%, 40-60% and 30-45% yield losses reported by Ezra *et al*. (2010) and Godara *et al*. (2013), respectively. Major fungal fruit rot infection of pomegranate is widespread particularly in rainy season/high moisture conditions. Therefore evaluation of fungicides to manage the fungal pathogens is most essential within the reasonable limit of fungicidal residues permitted by the importing countries, so as to incorporate the effective ones in the management package. Hence, *in vitro* studies on bio efficacy of fungicides against fungal fruit rots in pomegranate was carries out All of the seven systemic, three non-systemic and four combi fungicides tested were found effective in respect of mycelial growth inhibition of major fungal fruit rot of pomegranate. Among systemic fungicides, Propiconazole 25 EC at 1000 ppm concentration against *A. alternata* mycelial growth inhibition was cent per cent (100%). These were followed by Hexaconazole 5 EC (90.04%) and systemic fungicides against *C. gloeosporioides* mycelial growth inhibition was 87.23% with Carbendazim 50WP. These were followed by Difenconazole 25 EC (85.74%), followed by Benomyl 50WP (85.66%) at 1000 ppm concentration, However, three non-systemic and four combi fungicides at 2000 ppm concentration against *A. alternata* mycelial growth inhibition was numerically highest and 96.55% with Carboxin+ Thiram 75 WP. This was followed by Carbendazim+ Mancozeb 75 WP (87.63%), Metalaxyl+ Mancozeb 72 WP (75.62%), Mancozeb 75 WP (74.81%) and three non-systemic and four combi fungicides at 2000 ppm concentration against *C. gloeosporioides* mycelial growth inhibition was numerically highest (95.62%) with Carboxin+ Thiram 75 WP. This was followed by Carbendazim+ Mancozeb 75 WP (94.00%).

Key words: Systemic fungicides, nonsystemic fungicides, fruit rot, *Colletotrichum gloeosporioides, Alternaria alternata*,

OP 03: Integrated pest management of chickpea by adaption analysis in eastern plateau and hills region of Chhattisgarh and plain zone of Balaghat district of Madhya Pradesh

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Three years of adoption practices was studied in the National Initiative on Climate Resilient in Agriculture adapted village Koste block Kirnapur District Balaghat, Madhya Pradesh for the Integrated pest management technologies of chickpea during 2011-12, 2012-13 and 2013-14 among 200 respondents of adapted village. It was observed that under the management by cultural practices 73.67 per cent seed treatment, 62.68 per cent timely sowing, 33.68 per cent crop rotation, 31.75 per cent by the selection of biotic and abiotic tolerant variety, 16.42 per cent inter cropping system with Coriander and only 12.98 per cent single ploughing were practiced by the respondents. In mechanical management practices for weed flora management 9.44 per cent, 8.5 per cent were adopting by hand picking of insects and rouging of wilted diseased plants and 8.11 percentage by setting of bird perches respectively. Only 20.67 per cent respondents were using *Trichoderma spp*. for management of soil borne plant pathogens, where as 18.64 per cent respondents were adopting chemical management practices for disease and insect management. The majority of farmers was facing unavailability of seed and was unaware of quality seeds, bio- pesticides bio fungicides, accurate time of pesticide application, lack of knowledge about identification of beneficial and harmful insects during pod formation stage. Higher market price of chemical pesticide was also plays an important constraint in adoption of IPM technologies for Chickpea. Low categories of farmer were more to adopt the IPM practices than medium and high level of respondents

OP 04: Evaluation of fungicide Trifloxystrobin 3.5% + Propineb 61.3% WG in different dosage for the management of blast disease (*Pyricularia grisea*) of rice in Bastar region of Chhattisgarh

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Blast disease of rice is caused by *Pyricularia grisea* is a major problem in production of rice in Bastar region of Chhattisgarh. The field experiment were conducted during kharif-2016 and 2017 crop season under rainfed conditions at SG College of Agriculture and Research Station farm Jagdalpur, Bastar. Growing blast disease susceptible rice (Oryza sativa) variety- Swarna to use fungicides for prevent significant reductions of blast disease of rice. Studies were conducted to evaluation of Trifloxystrobin 3.5% + Propineb 61.3% WG in different dosage (1500g/ha; 1750 g/ha; 2000 g/ha; 4000g/ha) for the management of blast disease of rice. Trifloxystrobin 3.5% + Propineb 61.3% WG. The respective fungicides treatments applied three times. The sprays of fungicides were done at 15 day's interval after occurring the initial disease symptoms and data were recorded after 1st spray and before 2nd spray. Leaf blast severity of the disease was recorded using the standard visual 0 to 9 ratings scoring. The per cent neck blast incidence was assessed by counting infected panicles and healthy panicles in each hill. Resulting the combinations of chemicals Trifloxystrobin 3.5% + Propineb 61.3% WG was found effective as tested formulations/concentration as 4000, 2000, 1750 and 1500 g/ha. The higher concentrations of Trifloxystrobin 3.5% + Propineb 61.3% WG was found more effective for the control of leaf blast and neck blast disease of rice, at these doses minimum percent incidence and minimum Percent Disease Index were recorded as comparison to remaining fungicidal treatments and control. In the case of Trifloxystrobin 3.5% + Propineb 61.3% WG the grain yield was also found higher as compare to other tested alone fungicides, combinations and control.

Key words: Rice Blast, *Pyricularia grisea,* fungicidal management

OP 05: Which side? Pesticide or No Pesticide

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Plant Protection is one of the key issues in the overall gamut of Indian agriculture. Crop yield losses in India due to pest and diseases range 18-30 percent, which in monetary term is 0.9 to 1.4 lakh crore. This huge crop loss could be attributed to the low pesticide consumption in India The consumption of chemical pesticides has been found to be reducing in tonnage terms, although crop coverage has increased substantially, due to advent of green chemistry molecules. Even though a lot are being said and done against the frivolous use of pesticides, they are the best choice that farmers make in a given situation. The reasons being- immediate action, obvious results, easy use, wider availability and choice and most of all cost effective compared to any other method. Their dominance in Indian agriculture has never been challenged. India's per capita pesticide consumption of 600 gm is far below most of the Asian countries like China and Japan, where it is 14 kg and 12 kg respectively. Even among the states, the consumption is highly skewed. Andhra Pradesh, Haryana, Karnataka, Maharashtra, Punjab and Uttar Pradesh (UP) having fertile lands are major pesticides consuming states, while states like Kerala, Orissa and Bihar are least pesticide consuming states mainly due to low purchasing power of farmers having fragmented land holdings.

Biopesticides have touted as a viable alternative to the chemical means; many doubt the efficacy of bioentities in managing disease and pests problems. Many believe in this era of shrinking productivity and cultivable land area, this approach can hardly take us anywhere. We need to bear in mind that a country like India which is still struggling for enhancing at a fast rate its agricultural production, biopesticides donot offer a plausible alternative to synthetic chemical pesticides. At the most we see a scope for biopesticides as supplement crop protectants and that too for very limited crops and area.

IPM is a pro environmental approach and advocates the use of pesticides as only a last resort. Though a lot of policies and amounts are earmarked for this way of crop management, very little actually happens at the farmers' level. Majority of the farming community are still comfortable with using pesticides as the only resort. But resorting to a one point strategy like this may not be sustainable

In fact, the pesticides in India are not used scientifically or judiciously. There is general unawareness regarding the use of pesticides. This has resultant environmental pollution, pesticide resistance and resultant loss of harvest and stored produce and pesticide residue. The pesticide industry is also troubled by instances of spurious chemicals by 'fly-by-night' operators, which is further tarnishing their reputation. There is still no effective mechanism to check the flow of such dubious substances. Plant protection scientists need to come forward with some innovative idea and execute the same in cooperative with the Governmental and the industry to formulate programs jointly to educate farmers. We need a long term plan that will not only raise our food production but also assure there is enough scope for it in the future. Protecting our crops effectively is equal to protecting our farmers, the Indian economy and the country.

OP 06: Potato late blight: Successful management through integrated approach

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Management of potato late blight in region is heavily based on fungicides. However, reduction in fungicide usage is need of the day in both conventional and organic potato cultivation. Thus, the study was conducted to develop an area specific integrated disease management (IDM) module against the disease by combining the bio-control agents and need based fungicidal application. Of the three IDM modules tested in the field conditions for two consecutive growing seasons, rabi 2014-15 and rabi 2015-16 (the experiments were conducted as a part of On Farm Testing - OFT) by ICAR-KVK, Kolar, Karnataka, the module T3 consisting of soil application of bio-agents (1 kg each talc formulation of *Trichoderma harzianum* and P*seudomonas fluorescens* enriched in 100 kg well decomposed FYM) 15 days before planting, tuber treatment with Mancozeb @ 0.25%, prophylactic spray with Mancozeb @ 0.2% twice at weekly interval before onset of the disease followed by curative sprays with Cymoxanil + Mancozeb @ 0.3%, Dimethomorph @ 1.0% + Mancozeb @ 0.2%, and Fenamidone + Mancozeb @ 0.3% at weekly interval at onset of the disease was found most effective and recorded least disease severity and higher yield compared to other modules. Further, the effectiveness of this module was tested on a large scale in the farmer's fields for three consecutive growing seasons, rabi 2015-16 (Seegenahalli village), rabi 2016-17 (Ginnerahalli village) and rabi 2017-18 (Seethahalli village) through frontline demonstrations (FLD). The results revealed that, module T3 recorded 55.30% mean reduction in late blight incidence compared to check. Additionally, the module was also witnessed the mean average yield of 22.66 t/ha and BCR of 1.92 compared to 18.84 t/ha yield and 1.61 BCR in check. The impact analysis of this study revealed that, the technology is highly effective in curbing the late blight menace in the region and has occupied a 100 ha of potato area spread across the district. Hence, this module was found most effective in management of late blight disease under field conditions and marked as example of successful management of potato late blight in the farmer's field.

Keywords: Potato, Late blight, IDM, Phytophthora infestans and Bio-control agents.

OP 07 : Effective management of sesame and niger diseases

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Sesame (*Sesamum indicum* L.) is one of the oldest oil seed crop and is under cultivation from ancient times. India contributes the highest sesame acreage of above 17.73 lakh hectare and production 8 lakh tones and productivity of 445 kg/hectare. The low productivity is attributed to poor crop management and exposure of the crop to a number of biotic and a biotic stresses Sesame phyllody is the most destructive disease in India. Among the fungal diseases, *Alternaria* leaf blights, *Phytophthora* leaf spot, *Cercospora* leaf spot *Macrophomina* root /stem rot, Powdery Mildew, Bacterial leaf spot and Bacterial blight are important diseases of sesame. The incidence of important diseases varies from state to state based on agro climatic situations. Seed treatment with Thiram (0.2%) + Carbendazim 50WP (0.1%) and foliar spray should be done with Wettable sulphur (0.2%) was most effective to minimize the incidence of powdery mildew. For bacterial diseases Streptocycline (250-300ppm) may be used for seed treatment. Seed treatment with Thiram (0.2%) + Carbendazim 50WP (0.1%) and two foliar sprays of (Mancozeb 2%+ Carbindazim1%) was effective in reducing the *Alternaria* and *Cercospora* disease and highest yield. Seed treatment with Imidacloprid (@ 5 ml/kg seed) followed by foliar spray of Thiomethaxam @ 0.2 g/l was found effective in reducing the vector population and phyllody incidence. Seed treatment with *Trichoderma viride* (5g/kg seed and soil application of *T. viride* @ 2.5 kg/ha was found effective and economical for the management of *Macrophomina* root /stem rot of sesame.

Niger (*Guizotia abyssinica*) is a oilseed crop which plays significant role in the food and nutritional security of the poor tribal. It is cultivated to limited extent in Ethopia, South Africa, East Africa, West Indies and Zimbabve. India ranks first in area, production and export of niger in the world. In India it is mainly cultivated in tribal pockets of M.P., Orissa, Maharashtra, Gujarat, Bihar, Karnataka and Andhra Pradesh. Niger is although considered as a minor oilseed, is very important in term of quality and taste of its oil and export potential. Niger is a crop of dry area grown mostly by tribal in interior places due to which desired attention has not been given on the biotic and abiotic stresses. Now the crop is gaining importance and studies are being made on disease aspects. The important diseases of niger are Ozonium wilt (*Ozonium texanum* var. *parasiticum* Thirum.), Collar rot (*Sclerotium rolfsii* Sacc.), Macrophomina root and stem rot [*Macrophomina phaseolina* (Maubl.) Ashby], Damping off/root rot (*Rhizoctonia solani*), Cercospora leaf spot (*Cercospora guizoticola*), Alternaria blight (*Alternaria sp.),* Curvularia leaf spot (*Curvularia lunata*), Powdery mildew (*Sphaerotheca* sp.), Rust (*Puccinia guizotiae*), Bacterial leaf spot (*Xanthomonas campestris* pv. *guizotiae*), Seed rot/ Seed borne microorganisms and Cuscuta (*Cuscuta hyalina*). Seed treatment with Thiram (0.2%) + Carbendazim 50WP (0.1%) and two foliar sprays of (Mancozeb 0.2%+ Carbendazim 0.1%) was effective in reducing the *Alternaria* and *Cercospora* disease and higher yield.

The use of eco-friendly pest control method has got tremendous scope since the diseases are controlled without putting any threat to the quality of produce and surrounding ecosystem. Major diseases, their characteristic symptoms and control measures recommended for their eco-friendly management.

Poster Presentations

P 01: Integrated pest management of brinjal crop in Chhattisgarh

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In India, brinjal is extensively grown under diverse agro-climatic conditions throughout the year. Brinjal (*Solanum melongena*), also known as eggplant or aubergine belongs to the family Solanaceae. It is one of the common and popular vegetables grown throughout the world including India. Brinjal is an important vegetable crop due to its nutritional, medicinal as well as commercial value. It is available everywhere at reasonable price hence is known as 'poor man's vegetable. For the management of insect pests and diseases of brinjal, farmers are using conventional as well as novel pesticides including carbendazim, cypermethrin 25 EC, spinosad 2.5 percent SC and indoxacarb 15.8 SC. The large scale use of pesticides has caused many environmental problems like pesticide poisoning, insecticide resistance, resurgence of insect pests, effect of non-target organisms and pesticide residue which led to the scientist on alternative methods of pest control in brinjal. The objectives of the study were to minimize the use of chemical pesticides and establish the use of eco-friendly management practices for pests/diseases of brinjal using all the strategy available to the grower (cultural, biological, host-plant resistance, and chemical) that provides acceptable yield and quality at the least cost.

Key words: *Solanum melongena,* Integrated pest management

P 02: Comparative studies on the individual integrated disease management component against *Phytopthora* and wilt disease of pigeon pea and their impact on economic gain

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Pigeon pea (*Cajanus cajan* (L.) Millspaugh) is a most important food legume and grain crop. Madhya Pradesh is one of the pigeon pea growing state in which it is grown in 0.53 million hectares area with 625 kg /ha productivity. In Katni district, it is cultivated on an area of about 27 thousand ha with the production of 18.75 thousand tons and productivity 892 kg / ha. The experiment was conducted during kharif 2015-16 and 2016-17 under cluster front line demonstration in the block Rithi, Katni and Dhimarkhera on the effect of Integrated Disease Management practices against Phytophthora and wilt disease with 75 farmers in 30 ha area. Out of 75 respondent,72.25 percent used seed treatment, 58.26 per cent timely sowing, 27 per cent crop rotation, 28.46 per cent deep summer ploughing were practicing under cultural practices. In mechanical management practices, 20.66 percent were adopting roughing of diseased plants and removal of weeds .Nearly 48.66 percent respondents were applied *Trichoderma viride* for soil and seed treatment. Nearly 86.50 percent were used ridomil MZ72 and Mancozeb fungicides against both diseases. In another experiment, different IDM component individually and in different combination were used and found that combined application of all the IDM component gave better response in reducing the incidence of disease, enhance the quantitative attributes of pigeon pea (21.67Q/ha) incremental B:C ratio than other treat mental plots. Combined effect of biological +chemical and cultural+ chemical was found at par.

P 03: Management of Alternaria blight of cauliflower incited by *Alternaria brassicae* through integrated disease management practices

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Daily per capita consumption of vegetable in the country is 145g which is much less than requirement of 285g for a balance diet. Among the vegetable crops, cauliflower (*Brassica oleratia* var. *botrytis*) is an important vegetable in the group of crucifers contain several important elements including vitamin and minerals which is necessary for daily diet. Quality and quantity adversely affected by the attack of several biotic and a biotic factors. Among the biotic factors, fungi play important factors in reducing the crop yield. Several species of *Alternaria* attacked cruciferous crops such as cauliflower, cabbage, mustard and radish. *Alternaria brassicae* attack all the above crops except radish which is incited by *A. raphani.* The experiment for the management of alternaria blight through IDM practices conducted during 2015-16 and 2016-17 with eight treatments including chemical fungicides and bio- agents. The mean analysis of two year data showed that

minimum disease intensity (3.86 and higher yield (237q/ha) obtained in those treatment sprayed with ridomil MZ72 and mancozeb at 10 days interval followed by mancozeb and chlorothalonil. Minimum response in reducing the disease intensity was found in both *Trichoderma* and *Pseudomonas fluorescens*. It might be observed that intensity of disease increased (15.66 %) with decrease in the yield which was minimum (79.53q/ha) in control plot.

Key words: Cauliflower, Integrated Disease Management Practices, Yield.

P 04: Effect of systemic fungicides on nodulation traits and plant growth parameters of soybean induced by *Bradyrhizobium japonicum*

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Soybean (*Glycine max* (L.) Merrill) is one of the most remunerative grain legumes popularly grown in the world. In soybean, an array of fungicides are being applied as pre-sowing seed treatment and post-emergence foliar sprays to manage various diseases. These fungicides applied to soybean crop may influence symbiotic activities of *Bradyrhizobium japonicum* and other *Rhizobium* spp., and thereby exerting either synergistic or antagonistic and / or both kinds of effects on nodulation traits as well as crop growth parameters in soybean. Therefore, present study was undertaken at the Department of Plant Pathology, College of Agriculture, Latur, VNMKV, Parbhani (MS) during *Kharif,* 2017, to ascertain the effects of various systemic fungicides on nodulation traits and plant growth parameters in soybean. A total of seven systemic fungicides were evaluated at their recommended field dosages, as pre-sowing seed treatment, in polybag / pot culture and the experiment was planned in CRD and all the treatments replicated thrice.

The results revealed that all of the seven systemic fungicides tested significantly enhanced the soybean plant growth parameters *viz*., seed germination, root and shoot length and seedling vigour index and nodulation traits *viz.,* number of nodules / plant and nodules dry wt./plant (g), over untreated control. However, highly compatible and most effective fungicides found were carbendazim 50 % WP, propiconazole 25% EC, pyraclostrobin 20%WG (each @ 1.0 g /kg seed) and thiophanate methyl 75% WP (@ 1.5g /kg seed). Rest of the systemic fungicides tested were also found effective in enhancing root nodulation traits as well as plant growth parameters.

Keywords: Soybean, *B. japonicum,* Systemic fungicides, Nodulation, Plant growth.

P 05: *In vitro* efficacy of various fungicides against *Macrophomina phaseolina*, *causing charcoal rot of sesame*

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Sesame (*Sesamum indicum L.*), adorned as “Queen of oilseeds” is one of the most oldest and ancient indigenous edible oilseeds crop grown in India. Among various biotic agents responsible for low production and productivity of sesame, charcoal rot caused by *Macrophomina phaseolina* (Tassi.) Goid., is one of the most devastating fungal disease, affecting all crop growth stages. Therefore, present *in vitro* study was conducted,

during *Kharif*, 2017, at the Department of Plant Pathology, College of Agriculture, Latur. A total of seven each systemic (each @ 500, 750, 1000 ppm), non-systemic /contact (each @ 2000,2500 ,3000 ppm) and combi-fungicides (each @ 1500,2000 ,2500 ppm) were evaluated *in vitro* by applying Poisoned food technique. Three separate experiments were planned in CRD and all the treatments replicated thrice.

Results revealed that all of the seven each systemic, non-systemic, non-systemic/ contact and combi-fungicides tested significantly inhibited mycelial growth of *M. phaseolina*, over untreated control. Among seven systemic fungicides, average mycelial growth inhibition was highest with Carbendazim (93.12%), followed by Tebuconazole (87.73 %), Hexanconazole (87.46 %), Propiconazole (78.61%), Difenconazole (77.86 %) and Thiophanate methyl (71.48 %). Of the seven non-systemic fungicides, average mycelial growth inhibition was cent per cent with Mancozeb and Propineb (each 100.00%), followed by Captan 50% WP (74.63 %), Chlorothalonil (63.83 %), Zineb (58.25%) and Copper oxychloride (56.44 %). Among seven combi-fungicides, average mycelial growth inhibition was cent per cent (100%) with Carboxin 37.5 + Thiram 37.5 WP, Carbendazim 25% + Mancozeb 50% WS. Carbendazim 12% +Mancozeb 63% WP and Metalaxyl 8% + Mancozeb 64% WP, followed by Metalaxyl 4% + Mancozeb 64% WP (92.69 %), Hexanconazole 4% + Zineb 64% WP (77.31 %) and Trifloxystrobin 25% + Tebuconazole 50% WG (70.98 %).

Keywords: Sesame, *M. phaseolina* , Charcoal rot, Fungicides, Inhibition

P 06: Effect of various fungicides on bottle gourd (*Lagenaria siceraria*) against downy mildew under field conditions

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The bottle gourd (*Lagenaria siceraria* Standl.), is a tropical vegetable of Afro-Asian origin and is cultivated in India throughout the year for its young and tender fruits eaten as popular domestic vegetable called 'Lauki'or 'Dudhi'. It is traditionally used as a cardio-tonic, aphrodisiac and general tonic, liver tonic, anti-inflammatory, expectorant and diuretic agent. The fruit of bottle gourd is also reported to have good source of Vitamin-B complex and choline along with fair source of vitamin-C and β-carotene. Downy mildew in bottle gourd is a serious disease caused by *Pseudoperonospora cubensis*. The occurrence of downy mildew was first observed from second fortnight of December 2017 and gradually increased during the cropping period. The seeds treated with chemical *i.e*. carbendazim 12% + mancozeb 63% (3g/kg seed) considerably increased the germination percentage (93.33%), root length (9.14cm), shoots length (13.11 cm), fresh weight (5.67 g), dry weight (0.66 g) and vigour index (2183.65). The minimum days to first flowering (40 DAS), 50 per cent flowering (45 DAS) and first fruiting (43 DAS) was recorded in Seed treatment with Carbendazim 12%+ mancozeb 63% @3 g/kg; Drenching with Captan 70% + Hexaconazole 5%WP @ 0.1 %; First and Fifth (Imidacloprid 17.8 SL @7.5ml/15 L + Neem oil 0.2%); Second and fourth spray of Captan 70% + Hexaconazole 5%WP @ 0.1 % and Third and Sixth spray of Fosetyl-Al 0.1%. However, maximum days to first flowering (40 DAS), 50 per cent flowering (45 DAS) and first fruiting (43 DAS) was recorded in control. Seed treatment with seed pro @ 2.5g/kg + drenching with seed pro @ 5% at first true leaf stage + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + spray of tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% recorded less downy mildew disease compared to the control. Seed treatment with chemicals also promoted good germination, root/shoot length and biomass (fresh/dry weight) followed by treatment with bio control agents when compared with untreated control.

Key words: Bottle gourd, disease, downy mildew

P 07: Yield gap analysis of field pea through improved FLD in Panna district of Madhya Pradesh

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Front line demonstration on field pea was conducted by Krishi Vigyan Kendra, Panna district during the period from 2013-14 and 2014-15 in seven villages of two blocks with 87 numbers of farmers. FLD on Prakash variety of the Field pea with full package of practice was conducted in a 28 ha. In 2013-14 and 2014-15 with recommended improved practices including use of pesticides to check diseases / insect-pests. A control plot was also kept where farmers practices was carried out.

In comparison to the year 2013-14, yield during the year 2014-15 was higher both in the demonstration plot (1928 kg/ha) and farmers plot (1530kg/ha). The mean yield in the demonstration plots were higher than the farmers plot by 24 and 26 percent during 2013-14 and 2014-15, respectively. The mean yield of the demonstration was 1871 kg/ha against the potential yield of 2200kg/ha of Prakash variety of the Field pea. The yield gap of 329 kg/ha indicates that there exits a technology gap which may include the severity of powdery mildew. Interestingly, the extension yield gap ranging between 350-398 kg/ha during the period of study was higher than that of technological yield gap.

The technology index shows the feasibility of the evolved technology at the farmers fields. The technology index varied from 12.36 to 17.5 percent. Cultivation of field pea under improved technologies gave average higher net return of Rs. 35,868/ha which comprised of use of fungicides as compared to Rs 27,230/ha under local farmers practices in which the plant suffered from powdery mildew disease. The benefit cost ratio of field pea under improved technologies was higher (2.61) than that under farmers practices (2.41).

Key word : Yield Gap, Technology Gap Technology Index and B.C. Ratio.

P 08: Assessment of some fungicides against rice blast through OFT in Kabirdham district of Chhattisgarh

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Rice (*Oryza sataiva*) is one of the chief and staple food grains in India that's affected by large number of diseases, like fungal, bacterial , viral and nematode etc. Among the fungal diseases blast caused by *Magnapor the grisea* is economically important disease in Chhattisgarh that can cause 15-16 % yield loss. Considering the importance of crop, the field experiment was conducted in Kabirdham district during Kharif season 2014-15 and 2015-16 at different location of farmer's field. The efficacy of three systemic fungicides Tricyclazole and Carbendazim were tested by application of different method at all stages of plant growth at recommended dose. The observation was recorded at all stage of plant growth on various parameters viz. disease incidence, severity and yield with cost benefit ratio in two consecutive years. Tricyclazole was found economically more effective for blast with low disease incidence, severity, cost and high benefit ratio as compared to Carbendazim.

Key words: Rice, blast, fungicide, Assessment, Chhattisgarh

P 09: Assessment of Propiconazole and Carbenazim in rice through OFT against false smut disease in Kabirdham district of Chhattisgarh

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Rice is a major crop in Chhattisgarh which occupies an area of 3.6 million hectares and the productivity ranges between 1.2 to 1.6 tonnes/ha. Rice production in CG is gradually increasing in 2014 and 2015 with production of approx 75 and 77 lakh tons and productivity of 1600 and 1700kg /ha. due to availability of high yielding variety, better soil and agro-climatic zone. The rice crop in CG can give much more production but the main problem in high yielding variety is susceptibility against disease and pest. In Chhattisgarh, rice false smut (*Ustilaginoidea virens*) is one the most important problem in all rice growing area which directly affect the yield during infection. Keeping in the view of above, the present study was carried out to assess the efficacy of Propiconazole and Carbendazim in Kabirdham district of Chhattisgarh during Kharif season 2014-15 and 2015-16 at different location of farmer's. The observation on no. of infected Panicle/m^2, disease Incidence (%), no. of smut balls/ infected panicle and yield data, cost: benefit ratio was recorded. Propiconazole gave good result in all respective parameters with low cost high benefit ratio compared to Carbendazim.

Key words: Rice, false smut, fungicide, assessment, Chhattisgarh

P 10: *In vitro* evaluation of fungicides, botanicals and bioagents against *Erysiphe cichoracearum* an incitant of cucumber powdery mildew

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Cucumber is the oldest vegetable cultivated throughout the world and around 50-55% losses have reported due to powdery mildew and downy mildew. In the present study, various systemic, combi fungicides, bioagents and botanicals were evaluated in lab condition by following factorial design. Results reveals that among the systemic fungicides tasted amistar showed highest inhibition (94.51 per cent at 0.15 per cent concentration) and in combi fungicides native (87.78 % at 0.15 per cent). In vitro efficacy of fungicides revealed that maximum inhibition of conidial germination was observed with azoxystrobin and it was found significantly superior over all the other fungicides tested with maximum conidial germination inhibition (94.51 %) followed by tebuconazole (90.54 %). Minimum inhibition of conidial germination was recorded in myclobutanil (78.83 %) at 0.15 per cent concentration. In vitro efficacy of combi fungicides revealed that tebuconazole 50 % + trifloxystrobin 25 % (Nativo) found to be significantly superior over other treatments and showed maximum inhibition (87.78 %) at 0.15 per cent followed by captan + hexaconazole (Taquat) which recorded 74.65 per cent inhibition at 0.15 per cent. Minimum conidial germination inhibition was observed with carbendazim + mancozeb (Saaf) (56.02 %) at 0.05 per cent.

P 11: *In vitro* evaluation of fungicides against blast disease of pearl millet caused by *Pyricularia grisea*

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Pearl millet belongs to family Poaceae is a staple cereal grown mainly in the arid and semi-arid tropical regions of world. Among the non systemic fungicides evaluated mancozeb 75WP gave maximum inhibition (93.30%) of the mycelial growth of the pathogen and was significantly superior over the combi-product; tricyclozole18 + mancozeb 62 (87.38%) and chlorothalonil 75WP (83.81%) across different concentrations. However, it was noticed that, mancozeb was on par with another combi-product; captan 70 + hexaconazole 5 (93.17%) as well as copper oxychloride (89.41%). Among systemic fungicides evaluated against *P. grisea*, tricyclazole 75WP gave maximum inhibition of the mycelial growth (87.78%) of the pathogen followed by difenconazole 25EC (86.91%), hexaconazole SE (85.33%) and propiconazole 25EC (75.92%) and were found to be on par with each other as well as significantly superior over carbendazim 50WP (54.23%) which was found to be the least efficient in inhibiting mycelial growth of the pathogen.

P 12: Assessment of Thiamethoxam for the management of yellow mosaic virus disease in soybean crop

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Soybean is the major oilseed crop of Madhya Pradesh that boosted the economy of the state. It is legume but widely grown for oil purpose. It has great potential as a *Kharif* oilseed and has emerged as an important commercial oilseed. Yellow mosaic virus of soybean transmitted by white fly (*Bemisia tabaci*) is the most destructive pest of soybean worldwide causing significant yield losses ranging up to even 100%. The cultivation of resistant variety and use of Insecticides have been advocated by several workers for yellow mosaic virus management. Hence, it is need of the day that we concentrate in developing resistant varieties against yellow mosaic virus with matching production technologies and in development of strategies or transfer of appropriate technologies. Even though, a wide gap existed in the potential yield and farmers yield on soybean crop in Madhya Pradesh. In view of this, the scientist of Krishi Vigyan Kendra, Raisen conducted the front line demonstrations (FLD) on soybean crop to know the technology gaps between FLD's and farmer's field, extent of technology adoption. The areas under soybean were reducing in Madhya Pradesh due to non-availability of seeds of resistant variety, poor management and biotic and abiotic stress. The main aims of organizing these FLDs in farmer's field to bridge wide gap between demonstration field yield and farmer field yield and popularizing the cultivation of soybean in large area of Raisen district of Madhya Pradesh. The present study was carried out during *Kharif* season of 2017 in ten villages of Raisen district. In all 25 demonstrations on soybean crop were carried out in area of 10 ha with the active participation of farmers with the objective to demonstrate the latest technology of soybean production with suitable variety'JS-2029' and management for yellow mosaic management with Thiomethoxam 25 WG. The results revealed that FLD recorded higher yield as compared to farmers practice over the years of study. The improved technology recorded average yield of 10.85q/ha which was higher than that obtained with farmers practice of 8.65 q/ha. The improved technology gave higher gross return of 27125Rs./ha, net return of 14125Rs./ha with benefit cost ratio 2.08 as compared to farmers practice (21625Rs./ha, 9125Rs./ha and benefit cost ratio 1.73, respectively).

P 13: IDM module for the management of leaf curl disease in chilli of Raisen district of Madhya Pradesh

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Chilli, *Capsicum annuum* L. is one of the most important commercial crops of India. It is grown almost throughout the country. India is a major producer, consumer and exporter of chilli in the world. Chilli is a major vegetable crop grown in Raisen district of Madhya Pradesh. One of the major constraints of low productivity of this vegetable may be due to partial adoption of recommended package of practices by the chilli growers. The present study was undertaken to address the yield gap through FLDs on Chilli crop. Krishi Vigyan Kendra, Raisen district of Madhya Pradesh conducted 10 demonstrations on chilli since 2015-16 and 2016-17 in different locations of the districts. Prevailing farmers' practices were treated as control for comparison with recommended practices. In the two years data it was observed that labour required for weeding and frequency of irrigations. KVK Raisen assessed the integrated disease management module (Resistant variety + seed treatment with Thiomethoxam 70 WS @ 3 gm/ kg + 2-3 spray of systemic insecticides Acetamiprid 20 SP @ 125 g/ha +Sulphur 80 % WP @ 500 g/ha before flowering) for the management of leaf curl disease in chilli during *Kharif* season. Reduction of leaf curl disease incidence in demonstrated technology over farmers practice resulted in enhancement of the average productivity. Due to this, an average yield of 160.50 q/ha was obtained in demonstrated plot over control (127.50 q/ha) with an additional yield of 33.00 q/ha and the increasing the average chilli productivity by 25.8 per cent. Besides this, the demonstrated plots gave higher gross return (Rs.192000/ha), net return (Rs.151100/ha) with higher benefit cost ratio (4.64) as compared to farmer's practice gave higher gross return (Rs.153000/ha), net return (Rs.115500/ha) with higher benefit cost ratio (4.08).

P 14: Study of the species *Lasiodiplodia theobromae and in vivo* evaluation of different fungicides against die back disease of mango var. Alphonso

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Die back is one of the serious diseases of mango var. Alphonso in Konkan Region of Maharashtra. This disease may be noticed at any time of the year. The infection of the disease occurred in the month of June and most conspicuous during October-November. The disease is characterized by drying of twigs and branches followed by complete defoliation, which gives the tree an appearance of scorching by fire. Initially, it is evident by discoloration and darkening of the bark. The dark area advances and extends outward along the long axis of branch. Many times infected branches exhibit longitudinal cracks with exudation of brown thick gummy substance. Leaves on affected branches turns brown and its margins roll upwards. At this stage, the twig or

branch undergo shrivelling and drying resulting in defoliation. This may be accompanied by exudation of yellowish brown gum. Die back of mango var. Alphonso is now a day's becoming major hurdle in successful cultivation of these fruit crop in Konkan region. Mycelium of *L. theobromae* was initially hyaline, thick, filamentous and profusely branched later turning brown to dark brown in colour and the breadth of mycelia ranges between 5.88-3.28 µm. *T*he average size of immature spore of *L. theobromae* ranges between22.23-16.32 X 13.68-8.47 µm and mature spore with a range of 21.21-18.17 X 13.94-11.40 µm and the average size of pycnidia ranges between 696.56-147.67 X 449.51-94.63 µm.

Observation on disease intensity was recorded during the year 2012 and 2013 at Farmer's field, Poladpur. There were five fungicides evaluated, of which thiophanate methyl (0.2%), Bordeaux mixture (1%), hexaconazole (0.1%), propiconazole (0.1%) and hexaconazole + zineb (0.2%) gave the best inhibition of *B. theobromae in vitro.* These were used in the field trials. There were four plants per fungicide treatment. The plants were thoroughly sprayed two times at two months interval. The first spray was conducted in the month of June and second in September. Observations on disease severity were recorded one month after the spraying. The cent percent disease reduction over control was recorded by Bordeaux mixture. All the fungicidal treatments were found significantly superior to control treatment. Bordeaux mixture (1.0%) was found superior to the rest of fungicides. It was followed by propiconazole (0.1%), hexaconazole+zineb (0.2%) and hexaconazole (0.1%) which were found significantly superior over control. Maximum disease reduction over control was recorded in the treatment Bordeaux mixture *i.e.* 100% followed by propiconazole (95.38%), hexaconazole+zineb (95.22%), and hexaconazole (90.76%) respectively.

P 15: On-farm evaluation of new molecule insecticide for sucking pest management in black gram

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Field experiments were conducted on farmer's field by Krishi Vigyan Kendra, Raigarh (C.G.) during kharif 2016 and 2017 to evaluate the efficacy of new molecule insecticidal treatment against aphid, *Aphis craccivora* Koch, leafhopper, *Empoasca kerri* Pruthi and Flower Thrips *Caliothrips indicus* on black gram. The results showed that both year seed treatment with Thiamethoxam 25 WG @ 3 g/ kg of seed + spray with Thiamethoxam 25 WG @ 0.4 g/l of water recorded the lowest population of aphids (7.52, 6.03 no. /3 leaves/plant), leafhoppers (2.41, 2.20 no.3 leaves/plant) and flower thrips (1.53, 1.78 no./plant) with highest yield (8.23, 8.95q/ha) and % increasing in yield 28.19, 32.00 respectively over the year as compared to (72.23,55.10 and 8.31, 9.10 no. of aphid and leafhopper/3 leaves/plant and 7.10, 6.60 flower thrips/plant with lowest yield 6.42, 6.78 q/ha) untreated control. Over the year the cost benefit ratio was maximum (1:2.99, 1:3.60) in treated trial. Thus, seed treatment with Thiamethoxam 25 WG @ 3 g/kg of seed + spray with Thiamethoxam 25 WG @ 0.4 g/ l was effective new molecule insecticide against sucking pests management in black gram ecosystem minimising the incidence of bud necrosis and other viral diseases of blackgram.

P 16: Integrated disease management of leaf blast of rice caused by (*Pyricularia grisea)* in Madhya Pradesh

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Rice (*Oryza sativa L*.) is one of the most important kharif crop grown in 44 mha in various diverse ecosystem in India. Among the biotic stresses the occurrence of leaf blast may cause considerable yield losses and became a major threat for rice cultivation. Practical issues related to the identification of a disease based on symptoms and presence of pathogens are shown, as they have utmost importance for successful management. The main concept for Integrated Disease Management are discussed together with the technologies advocating the combination of a variety and chemical control measures, including the conservation of existing natural defense system like crop rotation, intercropping, and cultivation of diseases-resistant varieties.

The experiment on integrated disease management on leaf blast was conducted at Agriculture Research Station Rewa during Kharif 2016-17 with three cultivars viz., PS-4 (susceptible variety), Sahbhagi (moderately resistant variety and JRH-5 (hybrid) under Randomized Block Design with three replications under irrigated ecosystem. With respect to cultivars, JRH-5 shown immune reaction to leaf blast even without disease management practices, as compared to Sahbhagi (DS-4.57%; DI-8.47%) and PS-4 (DS-20.53%; DI-33.07%).

Application of integrated disease management practices like timely sowing, application of weedicides, fertilizer and pesticides reduced the leaf blast disease severity/incidence in susceptible tested varieties Sahbhagi and PS-4. It was found that application of Tricyclazole@ 0.6g/l gave outstanding performance in decreasing the disease severity and in increasing the grain yield significantly. The highest grain yield of 6667 kg/ha was recorded in JRH-5, as compared to Sahbhagi (3937 kg/ha) and PS-4 (3793 kg/ha).

P 17: Assessment of ITK based integrated pest management against major diseases and insect pests of rice (Swarna)

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India has the largest area under rice cultivation in the world (431.94 lakh hectares) and ranks second in production (110.15 million tonnes in 2016-17). Chhattisgarh state is known as Rice bowl of India. In Rajnandgaon district of Chhattisgarh state rice crop is cultivated in 243.742 thousand ha and its productivity is 2410 kg/ha and 67% area is covered by rice crop among net area of kharif crops. Rice is grown under different agro ecological conditions *viz*., water logged, deep water, hills, high humidity, high temperatures, salinity, alkalinity and flood prone areas. The rice crop is prone to stress throughout the crop growth period due to onslaught from different pests such as insects, nematodes, diseases, weeds and rats. Among the biotic factors, disease is the most important factor which results in crop losses of $ 5 billion every year (Asghar *et al.,*2007). Rice blast caused by *Pyricularia oryzae* Cavara and sheath blight caused by *Rhizoctonia solani* Kuhn are most destructive and widespread diseases of rice crops where rice stem borer *Scripophaga incertulus* and plant hopper *Nilaparvata lugens* are the major destructive insects which cause high yield losses in Rice crops. Indigenous Technology Knowledge based Integrated Pest Management against major diseases and insects has taken under On farm Trial in Swarna variety of Rice by Krishi Vigyan Kendra, Rajnandgaon in Kharif 2016-17 and Kharif 2017-18. T_1 Seed treatment by Thiram is Farmer practices, T_2 is seed treatment by Tricyclazole @ 2 g/kg + Foliar spray of Trifloxystrobin 25% + Tebuconazole 50%@ 80 gm/acre at tillering and panicle initiation stage and T_3 is seed treatment by Beejamrut (1 kg. cowdung of local cow,1 litre of cow urine, 50 gm quick lime, 10 gm asafetida, melt all these in 20 litres of water at night.)

Foliar spray by Panchgavya- Take 10-15 kg. cowdung of a pure local breed, 5-10 litres of cow urine, 2 kg black jiggery or 4 liters of sugarcane juice, 2 kg powder of any pulse (gram, black gram, horse bean), 1 kg. jeev soil (the soil from the borders of the farm or from the Dam-site) and 200 litres of water. Keep all the above mentioned materials in a barrel for 2 to 7 days under shadow in 7 replications and each farmer have 0.40 ha land for treatment. Main observations were taken on disease incidence, percent severity, percent insect pest infestation and yield parameters. In both years T_2 showed significant results against disease incidence (16%, 14.8%) and disease severity (15%,13.2%) of blast but T_3 gave low dead hearts and white ear heads (0.63 and 0.65) along with high B:C ratio (2.40 and 2.44) in year kharif 2016-17 and 2017-18 respectively whereas cost of cultivation in ITK based technology is very low. Farmers are interested to adopt ITK based technology because it is economical, effective and environment friendly technology.

P 18: Field evaluation and comparative efficacy of different new fungicides against powdery mildew disease of fieldpea (*Pisum sativum* L.)

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Among the various diseases of pea, powdery mildew caused by *Erysiphe pisi* is one of the major diseases causing severe loss with in short period of time. Powdery mildew appears in epidemic form when the plants are in the pod stage. The disease can also hasten crop maturity and affects pea quality. Current powdery mildew control methods include early planting, the use of fungicides and of resistant cultivars. Chemical control is feasible with a choice of protective and systemic fungicides. Chemical control of the disease has been reported to be effective if applied at proper time and different chemicals have been tested for their efficacy against the disease from time to time. The present study was conducted during consecutive *Rabi* season of year 2014-15 and 2015-16 at farmers field of village Amethi in Gariyaband district of Chhattisgarh Plains to test efficacy of some new fungicides in controlling powdery mildew diseases of fieldpea. In general, the incidence of powdery mildew disease in fieldpea was slightly higher during first year of experimentation *(Rabi* 2014-15) when compared to the next year (*Rabi* 2015-16). All the tested fungicides was found effective against powdery mildew disease and also found significant differences over untreated control. The mean per cent powdery mildew disease incidence ranged from 5.19 to 36.60 per cent. Results revealed that tebuconazole + trifloxystrobin (75 WG) recorded highest reduction of powdery mildew disease incidence before 2^{nd} spray, before 3^{rd} spray and after 3^{rd} spray of fungicides and was found significantly superior as compared to other tested fungicides followed by azoxystrobin + difenoconazole (325 SC) and azoxystrobin + benovindiflupyr (55 EC). Highest percent disease incidence was recorded with untreated control plot. As far as yield attributing characteristics of fieldpea was concerned, Tebuconazole + trifloxystrobin (75 WG) recorded highest plant height, length of pods, breadth of pods, number of pods plant^{-1}, number of seeds pod^{-1} and 1000 seed weight of fieldpea followed by azoxystrobin + difenoconazole (325 SC) and azoxystrobin + benovindiflupyr (55 EC). Among different fungicides, Tebuconazole + trifloxystrobin treated plots produced 12.24 q ha^{-1} and 12.56 q ha^{-1} of seed yield in both consecutive year of experimentation, respectively with mean yield of 12.40 q ha^{-1}. However, this treatment was found significantly superior and produced more seed yield than any other treatments. Spraying of other fungicides *i.e,* azoxystrobin + difenoconazole and azoxystrobin + benzovindiflupyr fungicides for powdery mildew control also recorded significant higher seed yield in both crop season with mean seed yield of 11.72 q ha^{-1} and 10.48 q ha^{-1}, respectively as compared to untreated control plots (7.41 q ha^{-1}). Lowest yield and yield attributing characters was found with untreated control.

Keywords : Fieldpea, fungicides, powdery mildew, disease, yield and yield attributes.

P 19: Evaluation of chemical fungicides against *Myrothecium leaf* spot of soybean under field condition

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Myrothecium leaf spot of soybean is caused by *Myrothecium roridum.* Myrothecium leaf spot of soybean is occurring in almost all the major soybean growing areas of India causing about 30 per cent yield loss. Initial symptoms of the disease appear as small round or oval, brown spots with dark brown margin on leaves in the infected plant. In study of the foliar spray of different chemical fungicides against myrothecium leaf spot of soybean under *in vivo* condition during kharif 2015, fungicides *viz.*, Tebuconazole, Hexaconazole, Mancozeb, Pyraclostrobin, Fluxapyroxad and Propiconazole were quite effective in reducing the percent disease index over control. All fungicides were significantly found effective in reducing the percent disease index of myrothecium leaf spot. Foliar application of Propiconazole (10.50%) was significantly superior over all other fungicides followed by Pyraclostrobin (13.50%) and Mancozeb (18.90%). These fungicides were also effective in reducing the percent disease index under field conditions.

P 20: *In vitro* evaluation of different fungicides and botanical against *Colletotrichum capsici* f.sp. *cyamopsicola* of clusterbean

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Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] commonly known as "guar" is an annual Kharif arid legume grown for green fodder, vegetable, green manuring, gum and seed purpose. India is the largest grower and producer of clusterbean in the world. In India, clusterbean is being grown in the area of 4.26 million hectares with production of 2.42 million tonnes of clusterbean. In M.P., clusterbean is cultivated as pure crop in 70622 hectares. About 80% area of the state is in Gird zone, which consist of Bhind, Morena, Gwalior, Shivpuri, Sheopur, Datia and Guna Districts. Clusterbean crop has a great role to play in nitrogen economy for the succeeding crop as it builds up soil fertility by fixing atmospheric nitrogen and by addition of organic matter. It's a good source of carbohydrates, protein, fibre and minerals like calcium, phosphorus and iron as well as contains appreciable amount of vitamin C, and it has become an important industrial crop with a great potential for foreign exchange. The crop suffers due to number of diseases like vascular wilt (*Fusarium moniliformae* and *Fusarium* sp.), charcoal rot (*Macrophomina phaseolina*), powdery mildew (*Leveillula taurica*), Alternaria blight (*Alternaria cyamopsidis*) and anthracnose caused by *Colletotrichum capsici* f.sp. *cyamopsicola.* Out of these, anthracnose is an important disease. The disease is characterized by black spots on leaves, petioles and stem. The disease attack on the above ground parts of the plant including the pods.

In present study, an attempt was made to control the disease using different fungicides and botanicals. Seven fungicides were tested against *C. capsici* f. sp. *cyamopsicola* under *in vitro* condition. Findings revealed that all the fungicides significantly reduced the hyphal growth of *C. capsici* f. sp. *cyamopsicola.* Among all the fungicides, hexaconazole and azoxystrobin were found significantly superior to other treatments. In this treatment, mycelial growth was found minimum (2.3 and 3.0) with maximum percent growth inhibition i.e.

97.23 and 96.38 percent respectively. These treatments were followed by Thiophanate methyl and Tebuconazole resulting 93.38 and 92.05 percent inhibition of radial growth which were at par with each other.

Total seven botanicals viz., *Azadirachta indica*, *Parthenium hysteorphorus*, *Eucalyptus isobus*, *Datura stramonium*, *Allium cepa, Ocimum sanctum* and *Calotropis procera* were evaluated in the form of crude extracts. All the botanicals significantly inhibited the growth of test pathogen after 7 days of incubation. Among the tested botanicals, *Eucalyptus globulus* (73.34%) and *Azadirachta indica* (72.31%) inhibited the growth. The treatments, *Parthenium hysterophorus* (66.11%), *Datura stramonium* (65.90%), *Ocimum sanctum* (52.10%) and *Calotrophis procera* (46.06%) were found significantly superior in reducing the fungal growth.

Keywords: Anthracnose, Botanicals, Clusterbean, Fungicides and Colletotrichum.

P 21: Efficacy of new fungicide on sheath blight severity (lesion length) of rice

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Sheath blight caused by *Rhizoctonia solani* Kühn (teleomorph: *Thanatephorus cucumeris (*A.B. Frank) Donk) is a major constraint (second only to rice blast) to rice production, causing 5-10% yield losses in low land tropical Asia. Nine fungicide (Taqat, Captaf, Contaf Plus, Pulsor, Propiconazole, Ill-Hexacarb, Hexaconazole, Bavistin, and Folicur) were used to evaluate the efficacy against sheath blight disease. The different fungicides (Taqat, Captaf, Contaf Plus, pulsor, Propiconazole, Hexacarb, Hexaconazole, and bavistin, Hexaconazole, Folicur) at recommended concentration were sprayed with the help of hand sprayer. Plant of variety swarna was inoculated first and a day after the inoculated plants were sprayed with fungicides. Growth of runner hyphae originating from inoculum induced lesions at the surface of rice tissue, established penetration structures to produce primary lesion. Growth of runner hyphae originating from this lesion at the surface of rice tissues, establishes penetration structures to produce a new lesion, and typical symptoms of sheath blight which were observed 96 hrs. after inoculation. This refers to the progress of infection along a tiller, from its base to its upper leaves by means of expanding lesions or by means of short-range progress of, and infection by, mycelial structures of the fungus. Quantitative data was generated for the expanding lesion by measuring the total lesion length and width and individual lesion length and width. Sheath blight severity was calculated in reference to lesion length and sheath length. No differences were observed for the lesion width. It was observed that plots sprayed with Thifluzamide (Pulsor S) (31µl/l), Thifluzamide (Pulsor S) (52µl/l), Thifluzamide (Pulsor S) (42µl/l), Thifluzamide (Pulsor S) 62µl/l, and Hexacarb 2400µl/l affected the sheath blight development by reducing the total lesion length (minimum and maximum % sheath area infected ranged from min 2.73 to 6.00 and 13.64 to 12.50 respectively) affecting the vertical spread of the disease. Rest of the other fungicides in different concentrations sprayed on the crop was not effective in reducing the vertical spread of the disease by reducing the lesion length.

Key words: Sheath blight, disease incidence, Fungicide

P 22: Development of spray schedules for management of late blight of potato using new chemicals

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The late blight of potato is caused by *Phytophthora infestans* (Mont.) de Bary. It causes huge yield losses of potato crop across the world including India. The disease can be managed by chemicals, varietal, cultural and biological methods. The varietal resistant is best and cheapest method to manage this disease. The resistant nature of a variety is broken down, generally within a decade after its development. The biological and cultural method is not much effective as chemical method, due to fast spreading nature of the pathogen. The field efficacy of six new chemicals viz, ametoctradin 27%+ dimethomorph 20.27 % SC, mandipropamid 23.4% SC, metalaxyl- M 3.3% +chlorothalonil 33% SC, azoxystrobin 11%+tebuconozol 18.3% WS, captan70% +hexaconazol 5% WP and dimethmorph 50% WP+ mancozeb 75% WP were evaluated to develop spray schedules for management of late blight during 2015-16, 2016-17 and 2017-18. In each treatment, one prophylactic spray of mancozeb 75% WP was incorporated. The results revealed that treatment mancozeb 75% WP (0.2%- before appearance) followed by two more spray with Azoxystrobin 11%+Tebuconozol 18.3% WS (0.1%) at 7-10 days intervals showed less average terminal disease severity (32.10%) with highest disease controlled (64.90%), which was at statistically par with treatment mancozeb75% WP (0.2%-before appearance) followed by two more spray with dimethmorph 50% WP (0.1%) + mancozeb 75% WP (0.2%) at 7-10 days intervals, with average terminal disease severity 33.11% along with disease controlled 63.78% as against control average terminal disease severity (92.56%). The next best spray schedule was mancozeb 75% WP (0.2%- before appearance) followed by two more spray with ametoctradin 27%+ dimethomorph 20.27 % SC (0.2%) at 7-10 days intervals. The highest tuber yield (38.93 t/ha) was observed with mancozeb75% WP (0.2%-before appearance) followed by two more spray with azoxystrobin 11%+tebuconozol 18.3% WS (0.1%) at 7-10 days intervals. It was followed by 38.82 t/ha with mancozeb 75% WP (0.2%- before appearance) followed by two more spray with mancozeb 75% WP (0.2%) + dimethomorph 50% WP (0.1%) at 7-10 days intervals. These spray schedules found effective for management of late blight of potato and further these schedules can be incorporated at farmer practices.

P 23: Development of disease management strategies for zero fungicides residue in table grapes

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Research was attempted for growing grapes by using pesticides whenever unavoidable and keeping time of applications and choice of pesticides such that at harvest residue will be minimum possible. This strategy interspersed using bio-control agents whenever possible to minimise the use of pesticides. Strategically approach to disease management was different during first fifty days of fruit pruning i.e. before fruit set and thereafter. Till fruit set, the fungicides use dominated, while after fruit set more attempts were made to make disease management more bio-intensive. Non–systemic broad spectrum fungicides belonging to dithiocarbamate group, such as Mancozeb were used and due to which use of bio-control agents as spray was not possible. Therefore, attempts were made to exploit ISR activities of microbes.To achieve maximum ISR activities, application of *Trichoderma* was given before and immediately after fruit pruning. For years, management of powdery mildew in grapes is dominated by use of triazole fungicides. But, in recent year resistance to triazole fungicides has been detected in most grape growing areas, against powdery mildew up to 50 ppm. This low level resistance, use of these fungicides has actually increased due to repeated sprays and has resulted in detection of residues at harvest. Therefore, strategically it was decided that triazole fungicides will not be used after fruit set or after 60 days of fruit pruning. To make it possible, it was essential to find suitable safer substitute. The sulfur was an obvious choice, as it is softer on bio-control agents such as *Trichoderma* as compared to triazoles. Sulfur therefore, not only can be used without residues, but can be easily combined with bio-control agents, when weather is suitable for bio-control. In all field level demonstration (FLD) locations, after 60 days of pruning only sulfur and bio-control agents such as *Trichoderma* and *Ampelomyces* when used in alternation could effectively controlled powdery mildew. These observations have supported our strategy to avoid use of triazole fungicides after fruit set. Based on bio-efficacy experiments, chlorine dioxide, nano silver in complex with hydrogen peroxide were selected as safe chemicals for control of powdery mildew.

The complete strategy was implemented as per relevance in four FLD plots on Tas-A-Ganesh cultivar for two consecutive fruiting seasons. In all four FLD plots disease PDI for downy mildew, powdery mildew and anthracnose were observed to be bare minimum. Dissipation of pesticide residue in vineyards may be dependent on many factors. Microbial degradation is one of such important factors. ICAR-NRCG has isolated and selected *Bacillus subtilis*, from vineyard ecosystem for its ability to dissipate most pesticides encountered in residues faster. The formulation of this bacterium named as DR-39 was field tested in vineyards. Two sprays of DR-39 at 2.5 g / L were found effective to increase the rate dissipation of about 10 pesticides. This formulation was also successfully used at all four FLD locations in Nasik, Sangli, and Pune district during 2017-18 season.

Total fungicide residues detected in grapes from different FLD, during 2016-17 and 2017-18 were in the range of 0-4 and 0-3 respectively. All fungicides detected were below MRLs, and their concentrations were very lessin ppb range. The shelf life of the grapes grown in zero residue plots were studied, and on the basis of observations on per cent physiological weight loss (PLW), fallen and rotten berries, better shelf life as compared to farmers practiced plots was shown. The FLDs have successfully demonstrated that it is possible to grow "Zero residue grapes" by implementing strategy proposed.

Key words: Grapes, strategy, zero residue production

P 24: Assessment of ready mixed formulation of fungicides and insecticides on sheath blight and stem borer of paddy

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Paddy is a main livelihood of rural people of Bilaspur district of Chhattisgarh, being grown in both the season *i.e.* Kharif & Rabi as major crop. The production and productivity is challenged due to various biotic stress *i.e.* sheath blight, blast, stem borer, leaf folder, BPH etc cause severe damage and yield loss to the rice crop in different stages of the crop growth and thus the occurrence of pests and diseases together in rice, demand the necessity of chemical which can be effective for insect and diseases both. Looking to above situation, an assessment trail was conducted during Kharif 2015 & 2016 at village Semartal & Nawgaon block Bilha district Bilaspur Chhattisgarh respectively, to assess the combining efficacy of ready mixed formulation of Hexaconazole 5% + Flubendamide 3.5% and also calculate application cost in the simultaneous occurrence of both pest and disease during any stage of crop growth period against sheath blight, Blast, stem borer, leaf folder and brown plant hopper. Among different treatments assessed during Kharif 2015, Hexaconazole 5% + Flubendamide 3.5% WG @2g/lt showed less sheath blight incidence & severity (17.68 & 9.13%), Blast (PDI 6.98%) and less pest incidence leaf folder (1.05%), Stem borer (0.50 DH & 0.78% WE), subdue the incidence of BPH, compared to untreated control. In contrast of Hexaconazole 5% + Flubendamide 3.5% treatment, Propiconazole 25% EC @1ml/l + Cartap hydrochloride 50% sp @2.0g/l also showed less incidence & infestation level when applied alternatively. During Kharif 2016, almost similar trends were observed. All the treatments recorded significantly higher yields, B:C ratio compared to farmer's practice.

P 25: Plant disease management with chemicals

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Diseases can be managed by a variety of methods that are traditionally summarized under integrated pest management (IPM) or perhaps more appropriately in this case, integrated disease management (IDM). IDM involves the use of all tools to counter the activity of disease agents that may instigate disease development. For example, most diseases require moisture to reproduce, spread and infect plants; moisture in the form of excessive irrigation can exacerbate many diseases in the landscape. A vicious cycle is often perpetuated in the landscape and nursery when too much moisture results in disease development, necessitating the need for ever increasing applications of other management tools, especially chemicals. Most plant diseases are caused by fungi and hence, most chemical management involves fungicides. When applying chemicals for managing plant problems it is vitally important that labels be followed. It is also important to consider options other than chemicals; these alternative options may be more effective and efficient for pest/disease management. As noted, the “Elixir Mixtures” may provide very broad spectrum disease/pest management capabilities.

Keywords:- Integrated Diseases management, Disease agent, Elixir Mixture.

P 26: Evaluation of fungicides for management of Fusarium wilt of soybean caused by *Fusarium oxysporum* f.sp. *glycines*

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Soybean (*Glycine max* (L.) Merr.) is extensively grown in all over Madhya Pradesh because of its wide adaptability to agro climatic conditions and better market value of the produce. More than 100 pathogens are known to affect soybean, of which 35 are of economically important. Soybean diseases reduce yield on an average of 10 to 30% in most production area. The environmental conditions over the past few years have been ideal for Fusarium wilt of soybeans caused by a soil borne fungus, *Fusarium oxysporum* f.sp *glycines* in Madhya Pradesh. The disease can affect soybeans at any stage of development. The effectiveness of fungicide application against soil borne diseases has not yet been widely established in the country. An *in-vitro* and *in-vivo* investigation was conducted to screen eight fungicides *viz*., Captan (0..25%), Mancozeb (0.25%), Carbendazim + Mancozeb (0.25%), Thiophanate Methyl (0.1%), Pyraclostrobin (0.02%), Carbendazim (0.1%)

and Blue copper (0.3%)against wilt of soybean caused by *Fusarium oxysporum* f.sp. *glycines*. The broad spectrum combination of Carbendazim + Mancozeb was found best fungicide which completely inhibited the growth of fungus followed by Carbendzim (88.74,) under *in vitro* condition. Two soil drenching of Carbendazim + Mancozeb @ 0.25 per cent at 15 day intervals was also found the best for managing Fusarium wilt of soybean as minimum disease incidence (5.56 percent) and highest yield (12.6 q/ha) was recorded. Carbendazim @ 0.1 percent ranked second best in reducing the disease incidence (7.64 percent and increasing the yield (11.0 q/ha) under *in vivo* condition.

P 27: Integrated management of *Alternaria* blight in linseed crop

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A field experiment was conducted to assess the yield losses due to *Alternaria* blight disease caused by *Alternaria lini* and their management with the integration of *Trichoderma viride*, Fungicides and Plant extract. The experiment was comprised of ten treatment including control *i.e.* T1: ST. with *T. viride*, T2: ST. with Topsin M, T3: ST with *T. viride* + Spray of Neem leaf extract, T4: ST with *T. viride* + Spray of Garlic extract, T5: ST with *T. viride* + Spray of Mancozeb, T6: ST. Topsin M + Spray of Neem leaf extract, T7: ST. Topsin M + Spray of Garlic extract, T8: ST. Topsin M + Spray of Mancozeb, T9: Recommended practice *i.e.* ST. Thiram (3g/kg) + 2 spray of Mancozeb and T10: Control (Untreated). The result revealed from pooled analysis data that the significantly highest average seed yield (1521.30 kg/ha) over control was obtained in treatment T5 followed by T1 and T4. However, minimum mean disease severity (18.71%) was recorded with the treatment T8 followed by T5 (20.87%).

P 28: *In vivo* antifungal properties of silver nano particles against *Rhizoctonia solani,* a common agent of rice sheath blight disease.

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Sheath blight disease in rice has caused major crop losses worldwide. Managing the causal agent of disease *Rhizoctonia solani* Kühn is difficult because of its broad host range and formation of sclerotia which can survive in harsh environmental conditions; therefore developing innovative disease management methods without application of hazardous chemicals has been considered as the main concern to maintain sustainable agriculture. This presented research has revealed the negative impact of silver nanoparticles (SNPs) on *R. solani* and disease progress *in vivo*. The adverse effects of the SNPs on *R. solani* are significantly dependent on the quantity of SNPs, sprayed at different concentrations *in vivo*. The infection and spread of disease before the flag leaf stage revealed 20% grain loss. A trial was conducted to test the efficacy of different combination(s) of silver nanoparticles against sheath blight of rice. We report herein root dipping-dipping of rice seedlings for 24 hours in Borogold solution (1.5gm in 1 lit water) + three spray of Borogold first spray at 30 DAT + second spray at panicle initiation (90 DAT) + third spray at 50% flowering (110 DAT) 2g Borogold / lit of water in each spray 500 lit water/ ha.),treatment found highly effective in reducing the disease severity of sheath blight, 17.77% and 62.94% decrease of the disease over control treatment and also increased the grain yield as compared to other treatments and control.

P 29: Management of *Rhizoctonia* disease in soybean by integrated approach in Betul District of Madhya Pradesh

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Soybean [*Glycine max* (L.) Merril] is one of the important oilseed as well as pulse crops, which are grown mainly in *Kharif* season. Soybean accounts for 30 per cent and 21.3 per cent of total production and area under oilseed in the country. Soybean is a major Kharif crop of Madhya Pradesh. *Rhizoctonia* root and stem rot, caused by the fungus *Rhizoctonia solani*, is an important disease of soybean. The disease causes heavy mortality of soybean in suitable climate. Continuous cultivation of soybean and non adoption of suitable integrated disease management modules cause heavy loss. Though, there is an extensive rise in area of soybean, the average yield is very low and the main constraint for this low yield is the problem of insect pest and diseases

On farm trials were conducted by Krishi Vigyan Kendra, Betul in 30 farmer's fields during *Kharif* season of the year 2015 to 2017 with farmers participatory approach. The disease management technology assessed was T_1- No seed treatment (Farmers practice), T_2- Seed treatment with *Trichoderma viride* @ 10 g/kg seed, T_3- Seed treatment with *Trichoderma viride* @ 10 g/kg seed and foliar spray with Thiophanate methyl @ 500 gm/ha at 40DAS. The increase of soybean yield in T_3 was 38.1 and 22.5 percent over T_1 and T_2 respectively, where disease incidence decreased in T_3 by 81.6 and 70 percent over T_1 and $T_{2,}$ respectively. The increase in net return and B:C ratio under T_3- was Rs. 15936 per ha and 0.61 unit, respectively over farmers' practice.

P 30: Efficacy of advanced fungitoxicants against anthracnose of french bean (*Phaseolus vulgaris* L.) caused by *Colletotrichum lindemuthianum*

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French bean is one of the most important vegetable and pulse crops of India. It is grown in tropical and subtropical regions of the world for its nutritious value. A number of diseases like web blight, cercospora leaf blight, wilt, fruit rot and broad bean disease etc. are from different origins which attack on french bean, above all diseases, anthracnose causes most deleterious effect on french bean crop caused by *Colletotrichum lindemuthianum*. For the management of anthracnose disease, numerous studies have been done and still going on so, the objective of this conducted study was to identify potential fungicides from the well known ones. For the study, eleven fungicides were evaluated under *in vitro* conditions and it was observed that out of eleven different fungitoxicants, carbendazim (0.1%) and azoxystrobin (0.3%) were proved to be most effective fungitoxicants and showed 100 percent inhibition of pathogen fungal colony. The best eight fungitoxicants were used in field experiment to prove their superiority in minimizing the disease intensity and increasing the grain yield. The best control of the disease was obtained by spray of carbendazim (0.1%) followed by azoxystobin (0.3%) with increased yield (0.634 kg/plot and 0.600 kg/plot) and decrease the disease intensity (*4.95*% and 6.21%). Ridomil (0.2%) was found to be least effective fungi toxicant.

P 31: Study of Panama wilt of banana caused by *Fusarium oxysporum* f.sp. *cubense* and it's management

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Banana is considered as one of the most important fruit crop of India. Panama wilt caused by *Fusarium oxysporum* f. sp. *cubense* (Foc) is the most important disease that affects yield and quality of fruits. The incidence of Panama wilt varied from 33.8 %-55 % in different orchards of coastal district of Odisha with Bantal variety. Characteristic yellowing of lower leaves and blades, hanging down of leaves from pseudostem and splitting of basal stem were the common external symptoms. Vascular discoloration of the transversely cut pseudostem and rhizomes were also observed. Whitish spreading type mycelial growth were observed that turned pinkish afterwards. The macro and micro conidia measured 22-36×4-5µm and 4.82-8.28µm×2.5-3µm respectively. Root dip method for artificial inoculation was found to be the best and plants were killed 20 days after inoculation. Richard's medium supported highest radial growth and pH 5.5 supported highest dry mycelial dry growth of pathogen. Carbebdazim + Mancozeb (0.2%), Thiophanate methyl (0.15%), Tebuconazol(0.1%), Carbendazim (0.1%) and Propiconazol (0.1%) completely checked cent per cent radial growth of *Fusarium oxysporum* f. sp. *cubense* (*Foc*). Kochilla leaf extract showed highest radial growth inhibition *of Panama wilt pathogen* at 20 % concentration*. Trichoderma viride* inhibited maximum radial growth of the causal pathogen followed by *Trichoderma harzianum.* Rhizome dipping in carbendazim @ 0.2% for 30 min. followed by Carbendazim 0.2% solution drenching @ 3.5/plant at 2nd , 4th and 6th months after planting (MAP) and Carbendazim injection 2% solution @ 3ml/plant at 3rd, 5th and 7th MAP alone or along with neem cake application @ 250 gm /plant and calcium carbonate application @ 10 gm /plant at the time of planting proved to be the best controlling Panama wilt disease completely and improved the height, girth and healthy leaves.

Key word : Panama wilt of Banana , *Fusarium oxysporum* f.sp*. cubense*

P 32: Chemical management of leaf curl of chilli

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Chilli (*Capsicum annuum* L.) is an economically important and widely cultivated crop of India. Chilli leaf curl virus is one of the major limiting factors in chilli production, which is drastically decreases yield. Chilli leaf curl causes huge crop loss in growing areas that occurs primarily due to attack of thrips, yellow mites and white fly followed by invasion of chilli leaf curl virus. The significant symptoms of chilli leaf curl are curling of leaf margin, reduction in leaf size, vein clearing accompanied by puckering, thickening, swelling of the veins and stunted growth of the plant. The increase or decrease of leaf curl virus disease of chilli was found directly correlated with vector population and vector population was determined by environmental factors. Six treatments were taken up for study *i.e.* profenophos, imidacloprid 17.8 SL, fipronil, spinosad 48 EC, trizophos and acephate75 SP and untreated control. The lowest population of thrips, mites and white fly was recorded with three foliar spray of imidacloprid 17.8 SL(0.2 ml/lit) at 12 days interval recorded least number of whiteflies and leaf curl virus per plant with significant increase of growth and yield.

Keywords; Leaf curl, chilli, Chemical, Management

P 33: Integrated management of charcoal rot (*Macrophomina phaseolina*) of sesame

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Sesame (*Sesame indicum* L.) is one of the most ancient oil seed crops cultivated in tropical and subtropical countries. Irrespective of the agro-climatic conditions, sesame is infected by various pathogenic fungi. Among the fungal diseases, charcoal rot of sesame caused by *Macrophomina phaseolina* (Tasi) Goid is the most devastating, causing up to 55% or more disease incidence in field resulting in heavy yield losses. The pathogens survive as sclerotia in the soil and in host tissue for varying periods. The pathogen attacks plant at all growth stages and causes pre-emergence rotting in seeds, soft rot in emerging seedlings and charcoal rot in mature plants. Due to soil borne nature, practically no effective field control and no resistance variety is available so far. Thus, management of charcoal rot by fungicides is expensive and not eco-friendly. Biological control of plant disease is cost effective and environmentally safe. A field experiment was conducted on sesame during Kharif at PC unit sesame and Niger JNKVV farm field, with three replications and seven treatments include control using susceptible variety VRI-1, to find out the effect of *Trichoderma viride*, *Pseudomonas florescens* alone or both with or without combination on incidence of charcoal rot disease in sesame. On the basis of the observation recorded viz. Percent disease index (PDI), no of capsule/plant, yield/plant and 1000 seed weight, it was concluded that the, seed treatment with *Trichoderma viride* (5g/kg seed*) + Pseudomonas florescens 10g/kg* +soil application of *T. viride* or *pseudomonas florescens* before @2.5 kg/ha each, sowing was found effective and economical for the management this disease.

P 34: Epidemiology and prediction model for root and stem rot diseases of sesame

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Sesame (*Sesamum indicum* L.) is an ancient oilseed crop. It plays an important role in the oilseed economy throughout the world. The export demand is an increasing trend promising trend a bright future for export potential. India contributes the highest sesame acreage of above 16.73 lakh hectare. The low productivity is attributed to poor crop management and exposure of the crop to a number of biotic and a biotic stresses. Literatures present to this aspect clearly indicate that sesame Root rot and Stem rot (*Macromophomina phaseolina)* is wide spread and destructive but difficult to control. This disease of sesame are the most important of Jabalpur area, disease incidence in field resulting in heavy yield losses. The pathogen attacks plant at all growth stages. A field experiment was conducted on sesame during *Kharif*, 2017 at PC unit sesame and Niger JNKVV farm field to find out the effect of climate factor and management for Root and Stem rot disease in sesame. In this experiment, sesame variety, VRI-I were sown with two treatments protected and unprotected. Protected (Soil Application of *Tricoderma viride* 2.5 kg/ha; Seed treatment with 1 gm Thiram+Carbendazim 50WP, 2g/kg) + Imidachlorprid 5 ml/kg of seed and two spraying with Sulphex (3g/lit of water), (0.1% Carbendazim50WP + 0.2% Mancozeb) at early and growth stage of crop. Unprotected (No-spraying). The severity Root and Stem rot disease was recorded at 10 days intervals. The disease severity was correlated with the weather parameters. The average of weather parameter *viz*., Maximum temp(X1)., Minimum Temp.,(X2) Relative humidity (morning) X3, Relative humidity (evening) X4, total rainfall (X5)and wind speed(X6) and prior to ten days of disease observation was used for correlation and regression analysis.

Correlation of diseases with the weather parameters indicated that *root and Stem rot* severity was significant negatively correlated with Relative humidity. Step wise multiple regression analysis was performed to select as the best fit for predicating the disease under normal epiphytic.

P 35: Management of insect transmitted disease : *Peanut bud necrosis virus* in groundnut

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First symptoms are visible 2-6 weeks after sowing as ring spots on leaves. The newly emerging leaves are small, rounded or pinched inwards and rugose with varying patterns of mottling and minute ring spots. Necrotic spots and irregular shaped lesions develop on leaves and petioles, stem also exhibits necrotic streaks. As the plant matures, it becomes generally stunted with short internodes and short auxiliary shoots. Leaflets formed on these auxillary shoots show a wide range of symptoms including in size, distortion of the lamina, mosaic mottling and general chlorosis. In advanced conditions, the necrosis of bud occurs. Drastic reduction in flowering is noticed and seeds produced are abnormally small and wrinkled with the dark black lesions on the testa. The virus is transmitted by thrips, *viz*, *Scirtothrips dorsalis*, *Franklinelli schultzei* and *Thrips palmi*. The causal agent of this disease is tomato spotted with virus (TSWV-Tospovirus). It appears generally a month after sowing and cause yield loss up to 50% late sown crop (late june) shows higher incidence of PBND as compare to early sown crop (first half of june). Higher incidence where plant population is less (<23 plants/m^2) as against optimum population (<33 plants/m^2). Sub- optimal plant population leaves bare patches in the field which attract thrips. For management of this disease grow tolerant varieties like Kadiri-3, Kadiri-4, Vemana, ICGS-11 and ICGS-44, etc. Maintaining of optimum plant population and adoption of spacing of 15x15 cm, inter cropping with millet crops like pearl millet, removal and destruction of infected plants up to six weeks after sowing were found effective. Application of Monocrotophos 500ml/ha, 30 days after sowing either alone or in combination with AVP (Anti viral principle) extracted from sorghum or coconut leaves spray the crop with 10 percent AVP 500 litres/ha, ten and twenty days after sowing and spraying of dimethoate 30EC 400 ml or methyl demeton 360 ml/ha, were also effective.

P 36: Destructive disease of forest tree damping-off and its control

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Damping-off organisms may be endemic in nursery soil without causing damage but may cause serious problems when environmental conditions are favorable for one or more of the pathogens but unfavorable for early seedling growth. Damping-off, caused most commonly by species of *Fusarium, Rhizoctonia, Phytophthora*, and *Pythium*, affects emerging nursery seedlings of most conifer and hardwood species. Pre-emergence damping-off occurs when germinating seeds are affected before their hypocotyls break through the soil surface. Post-emergence damping-off occurs shortly after emergence, while tissues are still succulent. Infection usually results in death of the seed or seedling. All damping-off pathogens grow and reproduce best when the pH of soil or growth medium is above the optimum for seedling growth (pH 5.2 to 5.8). Cool, wet soils slow germination and extend the time seeds and germinating seedlings are exposed to pathogens: losses to damping-off increase under such conditions. Soil fumigation is the most effective way to control damping-off. The currently recommended chemicals are mixtures of methyl bromide and chloropicrin. Fumigate when soil temperature, moisture, and physical condition are optimum. Soil fungicide drenches are effective against some damping-off fungi in container nurseries.

Key words: Damping-off, Fumigation, Fungicide, Emergence and Seedlings.

P 37: Present scenario of aggregate sheath spot of rice in India

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Rice is being cultivated since time immemorial, and the crop has the characteristic feature of growing under varying climatic conditions in almost all the countries of the world, including India. Rice crop is affected by plethora of diseases which results in significant yield losses. Aggregate sheath spot of rice familiarly as brown sclerotial disease is one of the important diseases affecting the rice production. The disease is engendered by *Rhizoctonia oryzae-sativae* (Telemorph: *Ceratorhiza oryzae-sativae*) (Moore 1989; Seint et al. 2009). Initially, the infections appear as oval lesions with greyish to straw coloured center surrounded by brown margin. Initially lesions occur on the lower leaf sheaths at water level. As the disease progresses, the lesions expands vertically and covers the entire leaf area upto upper leaf sheaths. The infected leaf blade of tillers often bright yellow and the finally pass away. In some cases a culm rot of rachis resulting in sterile grains or partially filled heads. Sclerotia produced by *Rhizoctonia oryzae-sativae* gives the appearance of mustard seeds colour, shape. The increased virulent nature of the pathogen increased the difficulties in appropriate disease control measures, particularly at early stages of the disease development.

Key words: Aggregate sheath spot, *Rhizoctonia oryzae-sativae,* brown sclerotial disease

P 38: Integrated wilt disease management in chickpea.

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In Rewa district (Madhya Pradesh) chickpea is one of the major rabi pulse crop which occupies more than 65 thousand ha of land out of 90 thousand ha of total Rabi pulses area, due to continuous mono cropping of chickpea in Rabi season without adopting any crop rotation incidence of wilt disease complex, *i.e. Sclerotium* wilt, *Fusarium* wilt and *Rhizoctonia* wilt established in major parts of chickpea growing areas in the district. To overcome this situation, KVK Rewa assess an Integrated management of wilt disease through tolerant variety JG 63, followed by seed treatment with Carbendazim+ Mancozeb (1:2) 3gm/kg seed followed by soil application of *Trichoderma viride* bioagent shows antagonistic behavior against soil borne plant pathogenic fungi @ 2.5 kg/ ha in 50 kg mass multiplied in Rice husk and incorporated in soil. Result was very encouraging which was reflecting from this facts that disease incidence was reduced to 8 % against 37% in farmers practice. Yield was increased by 64.44 % with additional income of Rs 12900. This technology was demonstrated in more than 100 of villages of the district in collaboration with State Agriculture Department under ATMA schemes and conducted more than 23 training individually as well as collaborative and popularize through new paper coverage, extension bulletin, Kishan mobile advisory in which 44500 farmers were registered. Ring KVK also took effective participation in management of this disease effectively in their respective district and launch a huge campaign to combat this devastative disease.

P 39: Effects of intercropping on management of chickpea wilt

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Chickpea is susceptible to Fusarium wilt in successively mono-cropped soil. To investigate the effect of intercropping with linseed on chickpea fusarium wilt; *In vitro* experiment were conducted to test the antifungal activity of linseed plant extract (whole plant @ 20,40,60 DAS) was screened by poison food method against *Fusarium oxysporum* f.sp. *ciceri*. The result revealed that the linseed plant extract @20DAS showed highest percent inhibition(71.85%) of *Fusarium oxysporum* f.sp. *ciceri* followed by 67.96% and 65.74% respectively extract at 60DAS and 40DAS. *Fusarium oxysporum* f.sp. *lini* and *Fusarium oxysporum* f.sp. *ciceri* are tested by dual culture method and found Fol suppress the mycelium growth of Foc with 59.33% inhibition of mycelium *growth.* The population of rhizospheric mycoflora were estimated in rhizosphere of different chickpea and linseed intercrop soils and the data as colonies/g have been presented. In chickpea rhizosphere the maximum fungal population (24.06x10^5) was recorded in sole chickpea followed by linseed:chickpea 2:2 intercrop. Linseed rhizosphere soil contain maximum (31.33x10^5) fungal colonies in linseed:chickpea 1:1 (15:15cm) intercrop. This suppressiveness, based fundamentally on microbiological interactions, relies on the complementary association of a general mechanism of competition for nutrients between the microorganisms.

P 40: Dynamics of potato late blight in major crop growing areas of Kolar district, Karnataka, India

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The roving survey conducted in five major potato growing talukas of Kolar district, Karnataka during three consecutive growing seasons, *rabi* 2014-15, 2015-16 and 2016-17 revealed the occurrence of late blight caused by *Phytophthora infestans* Mont. (de Bary) in all growing areas. However, the incidence varied with the location and year of cultivation. The incidence of the disease was highest during *rabi*, 2014-15 (17.89-34.39% PDI) followed by *rabi*, 2015-16 (16.17-31.88% PDI) and least incidence was noticed during *rabi*, 2016-17 (14.99-24.56% PDI). The varied incidence across the year is solely because of difference in existence of disease favourable environmental conditions. Further, among the different talukas, Mulbagal recorded the highest mean disease incidence of 28.17% PDI followed by Malur (24.11% PDI), whereas Srinivaspur taluka recorded the least mean disease incidence of 16.22% PDI. Thus the study gave an insight that, the occurrence of disease in these areas is clearly in line with rainfall pattern and area under the crop cover. Thus the Mulbagal and Malur talukas recorded highest incidence of disease as these are extensive potato growing areas of the district and receive good amount of precipitation in *rabi* compared to other potato growing talukas of the districts.

Key words: Late blight, *Phytophthora infestans,* Potato, and Survey.

P 41: Management of tomato late blight with the combination of antagonists and need based fungicidal application

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Late blight, caused by the *Phytophthora infestans*, is one of the most destructive and economically important diseases of tomato. The present investigation was carried out to develop an area specific effective management strategy against the disease by combining the antagonists and need based fungicidal application. Of the three disease management modules tested in the field conditions during rabi 2013-14 (On Farm Testing - OFT) by ICAR-KVK, Kolar, Karnataka, the module T3 consisting of soil application of antagonists (1 kg each talc formulation of *Trichoderma harzianum* and *Pseudomonas fluorescens* enriched in 100 kg well decomposed FYM) 15 days before planting, prophylactic spray with Mancozeb (0.2%) twice at weekly interval before onset of the disease (on onset of disease favorable conditions) followed by curative sprays with Metalaxyl + Mancozeb (0.3%), Fosetyl-Al (0.2%) and Dimethomorph (0.1%) + Polyram (0.2%) at weekly interval at onset of the disease was found most effective in reducing the disease severity and recorded the higher yield compared to other modules. Hence, this module serves as area specific effective management strategy against the disease under field conditions.

Keywords: Tomato, Late blight management, *Phytophthora infestans,* Antagonists and Fungicides.

P 42: Advanced machine learning techniques for Identification and Classification of plant diseases: A review

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Crop plant disease identification and classification is one of the most basic and important activities in agriculture. In traditional practices, identification is performed manually: (i) Visually or (ii) By microscopy. The visual assessment is a subjective task. It is prone to psychological and cognitive phenomena which may lead to bias, and ultimately to error. On the other hand, diagnosis by microscopy in the laboratory, such as molecular, immunological or pathogen culturing-based approaches are often time consuming, which may not provide the result in a timely manner. In this circumstance, it is compelling to develop automatic techniques capable of identifying diseases in a rapid and reliable way. Machine learning techniques has recently attracted a lot of attention with the aim to develop a quick, automatic and accurate system for identification and classification of image based plant disease in the last two decades. The machine learning techniques has been emerged as a powerful tool for disease identification and classification. However, the techniques proposed so far are usually limited in their scope and dependent on ideal capture conditions in order to work properly. The major challenges that have a significant impact on the effectiveness of the image analysis techniques are: (i) busy backgrounds (ii) lack of clear borders around symptoms (iii) variation in capture conditions (iv) diseases producing varying symptoms (v) symptoms produced by different disorders manifesting simultaneously and (vi) different disorders producing similar symptoms. The use of machine learning techniques for diagnosis of image of plant disease is still new, which means there are still many alternatives to be explored with the potential to minimize at least some of the issues pointed out herein. Further, the digital images of plant disease

will be a more trust worthy representation of the scene, which will certainly allow the development of more accurate and powerful image analysis tools in a very fast way. As a result, timely diagnosis of disease is done to avoid loss of crop production.

P 43: An impact of irrigation management on plant diseases: A review

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Irrigation water can be contaminated with pathogenic microorganisms which cause food borne outbreaks worldwide. The extent of contamination depends on the degree of treatment provided and the design of the irrigation system. The highest possibility of contamination is presented by the flooding irrigation and sprinkler irrigation technique, whereas dripping irrigation shows the lowest. Also, water used for fertilizers, pesticides and herbicides has to meet certain chemical and microbiological requirements before its use. Agricultural irrigation is crucial for improving the quality and quantity of food production. Therefore, there is a need to identify the possible sources and problems involved with its use. Irrigation is a major husbandry tool, vital for world food production and security. The purpose of this review is twofold- firstly drawing attention to the beneficial and deleterious aspects of irrigation resulting from interactions with the microbial world; secondly, forming a basis for encouraging further research and development. Irrigation is for example, a valuable component in the control of some soil borne pathogens such as Streptomyces scabies, the cause of potato common scab and *Fusarium cubense*, a cause of banana wilt. By contrast, applying irrigation encourages some foliar pathogens and factors such as splash dispersal of propagules and the retention of leaf wetness are important elements in the successful establishment of disease foci. Irrigation applied at low levels in the canopy directly towards the stem bases and root zones of plants also provides means encouraging disease development. Irrigation also offers means for the direct spread of microbes such as water borne moulds, Oomycetes, and plasmodial pathogens coming from populations present in the water supply. The presence of plant disease causing microbes in sources of irrigation has been associated with outbreaks of diseases such as clubroot (*Plasmodiophora brassicae*). Irrigation can be utilized as a means for applying agrochemicals, fungigation. The developing technologies of water restriction and root zone drying also have an impact on the success of disease causing organisms. This is an emerging technology and its interactions with benign and pathogenic microbes require consideration. Taking into account the work done, this review addresses the impact of irrigation management on plant diseases, considering the effect on crop grown, development and the impact on crop production.

P 44: Varieties response against the Blast (*Pyricularia grisea*) of finger millet under rainfed condition

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Blast disease is caused by *Pyricularia grisea* is a major problem in production of finger millet in Bastar region of Chhattisgarh. Field experiments were conducted during *Kharif* 2014 and 2015 crop season under rainfed conditions at SG College of Agriculture and Research Station farm Jagdalpur, Bastar for the screening and identify the resistant cultivars against the leaf blast, neck blast and finger blast disease. The total twelve varieties were tested viz., VR-708, RAU-08, KM 252, VL-149, GE-4449, PR 202, KMR-204, L-5, GPU-48, GPU-28, GPU-67, GE-4444 with one local susceptible check Udru mallige. The result revealed the lowest neck blast 2.3 %

and finger blast 3.8 % recorded in GPU-48 with the higher yield. The cultivars L-5, KMR-204, GE- 4449 VL-149 and GPU-67 showed moderately resistant reaction against the neck and Finger blast disease. No any cultivar showed resistance against the leaf blast but recover the crop growth.

Key words : Finger millet, Blast, *Pyricularia grisea,* cultivars, yield

P 45: Efficacy of new fungicides on sheath blight severity (Lesion length) of rice

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Sheath blight caused by *Rhizoctonia solani* Kühn (teleomorph: *Thanatephorus cucumeris(*A.B. Frank) Donk) is a major constraint (second only to rice blast) to rice production (Teng, Torres, Nuque, &Calvero, 1990), causing 5-10% yield losses in low land tropical Asia (Willocquet*et al*., 2004). Nine fungicide (Taqat, Captaf, Contaf Plus, Pulsor, Propiconazole, III-Hexacarb, Hexaconazole, Bavistin, and Folicur) were used to evaluate the efficacy against sheath blight disease. The different fungicide at recommended concentration (detailed elsewhere in result and discussion) in water (Taqat, Captaf, Contaf Plus, pulsor, Propiconazole, Hexacarb, Hexaconazole, and bavistin, Hexaconazole, Folicur) was sprayed with the help of hand sprayer. Plant of variety swarna was inoculated first and a day after the inoculated plants were sprayed with fungicides. Growth of runner hyphae originating from inoculum induced lesions at the surface of rice tissue, established penetration structures to produce primary lesion. Growth of runner hyphae originating from this lesion at the surface of rice tissues, establishes penetration structures to produce a new lesion, and typical symptoms of sheath blight which were observed 96 hrs. after inoculation. This refers to the progress of infection along a tiller, from its base to its upper leaves by means of expanding lesions or by means of short-range progress of, and infection by, mycelial structures of the fungus. Quantitative data was generated for the expanding lesion by measuring the total lesion length and width and individual lesion length and width. Sheath blight severity was calculated in reference to lesion length and sheath length. No differences were observed for the lesion width (data not presented). It was observed that plots sprayed with Thifluzamide (Pulsor S) (31µl/l), Thifluzamide (Pulsor S) (52µl/l), Thifluzamide (Pulsor S) (42µl/l), Thifluzamide (Pulsor S) 62µl/l, and Hexacarb 2400µl/l affected the sheath blight development by reducing the total lesion length (minimum and maximum % sheath area infected ranged from min 2.73 to 6.00 and 13.64 to 12.50 respectively) affecting the vertical spread of the disease. Rest of the other fungicides in different concentrations sprayed on the crop was not effective in reducing the vertical spread of the disease by reducing the lesion length.

Key words: Sheath blight, disease incidence, Fungicide

P 46: Nematode problem in protected cultivation and management

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Protected cultivation is a cultivation of different crops under controlled environmental conditions which gives manifold increase in yield per unit area. This is being done with green house, shade net, plastic tunnel and mulch. The application of greenhouse technology is feasible in the

tropical and subtropical climatic conditions of India for the cultivation of high value crops. To meet the demand for high quality vegetables, a high tech cultivation is required. There are different types of polyhouses based on shape, size and cost. The protected cultivation has shown high productivity, better quality produce and early maturity round the year cultivation in a hostile environment and use of microclimate to fulfil the individual requirement of plant. This is useful to cultivate healthy nursery or plant material, hardening of tissue culture plant, floriculture. Continuous growing of same crop increase problem of soil borne pest and diseases including plant parasitic nematodes. The problem of nematode after 3-4 crops increases due to build-up of initial population in first crop and shortening life cycle of nematode due to higher temperature. In polyhouse cultivation of vegetables, *M. incognita* spreads from 10 to 60% of the area because of the monoculturing and accordingly yield losses may go up to several folds under such environment. It is always better to prevent infection than to cure. To maintain Greenhouse clean, paths should be free of soil, organic matter, weeds, and algae, benches should be disinfected. Water sources should be pathogen-free and hose ends kept off the floor. Unhealthy plants and plant parts from the greenhouse have to be removed. Therefore, sanitation, proper fertilization, organic supplements, monitoring are other attributes to be taken care, as discussed below. Balance use of fertilizer containing major and minor elements helps in better plant growth and also checks the harmful pests like nematodes are less in potash applied soil and Calcium is good for development of micro flora. Soil born pathogen like nematodes are affected with irrigation as it can cause change in gases and also determine mineralization which may affect the survival of nematodes. Plants should be watered only as needed, reduced on cloudy days, and avoided late in the day. Plants should be watered thoroughly and then allowed a dry-down period. Proper spacing of plants to allow air circulation and drying will also decrease the incidence of moisture-dependent pathogens like nematodes. There is further need to develop viable options for nematode management, including use of bio control agents and antagonistic crop like crotalaria (a green manure crop).

Keywords: Polyhouse, parasitic nematodes, soil born pathogen, vegetables, management.

P 47: Compatibility of *Bradyrhizobium japonicum* with various fungicides used in soybean

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Soybean (*Glycine max (L.)* Merrill) is one of the most remunerative grain legumes popularly grown in the world. Under intensive cultivation of soybean, along with various inputs a wide range of fungicides, insecticides and herbicides are often used on large scale to combat diseases, insect-pests and weeds, respectively. These agrochemicals, exert either synergistic or antagonistic and / or both kinds of effects on the soil resident or introduced *Rhizobium* spp. Therefore, present study was undertaken at the Department of Plant Pathology, College of Agriculture, Latur, VNMKV, Parbhani (MS) during *Kharif,* 2017, to asses *in vitro* the compatibility of *Bradyrhizobium japonicum* with various fungicides used in soybean. Seven each systemic, contact and combi-fungicides were evaluated at three different dose (each @ recommended field dosages,

50% of RD and 125% of RD), by applying inhibition zone technique. Three separate experiments were planned in CRD and all the treatments replicated thrice.

The results revealed that out of seven each systemic, contact / non-systemic and combi-fungicides tested, systemic fungicides *viz*., carbendazim 50% WP and hexaconazole 5% EC, contact / non-systemic fungicides *viz*., mancozeb 75% WP and sulphur 80% WP and combi- fungicides *viz*., cymoxanil 8% + mancozeb 64% WP and carboxin 37.5% + thiram 37.5% WS, evaluated at all three dosages were found highly compatible with *B. japonicum* and rest of the fungicides tested were non-compatible.Thus, these fungicides found compatible with *B. japonicum* can be explored to manage various seed / soil borne diseases of soybean.

Key words : Soybean, *B. japonicum,* Fungicides, Compatibility

Technical Session-V :

Organic Cultivation of Crops using Microbes

Lead Lectures

LL 01: Role of soil microbes in organic agriculture: A general perspective

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Soil microbes play a vital role in organic agriculture as biofertilizers and biopesticide both in natural ecosystem and synthetic forms. Various forms of microbes- fungi, bacteria, algae and yeast are implicated in various processes of agro-ecosystems. Soil microbes operate through various ways, such as by developing symbiotic relationships with plant roots (mycorrhiza and endophytes- fungi, bacteria, algae) to protect the plant from disease; releasing nutrients from organic matter and stimulating plant growth; degrading pesticides and toxic substance; fixing atmospheric nitrogen, and improving soil structure. Addition of *mycorrhiza, Bacillus, Streptomyces, Azospirillum, Pseudomonas, Rhizobium, Trichoderma* and others to farm soil improve nutrient uptake and colonize the root surface creating healthy roots and healthy plants, helps improving soil health and creates disease suppressive soils thus reducing disease impact. The Biofertilizers group contains a wide variety of organisms categorized as N-fixing, P-solubilizing/mobilizing, K-mobilizing, Zn-mobilizing bacteria, and others. Biocontrol of diseases using soilborne organisms works by several different modes of action including competitive exclusion, hyperparasitism, production of natural antibiotics, systemic acquired resistance, and induced systemic resistance. Several biofertilizers and biopesticides are being manufactured and marketed for use in organic agriculture of various crops. Despite some rapid progress in adoption of organic farming practices during recent years, there is a long way to go in improving the farming system, technologies, and availability of quality biofertilizers and biopesticides on affordable price to farmers. Intensive research and development efforts are needed to develop new biopesticides with multiple mode of action against pest and diseases, and biofertilizers with multi-crop growth promoting activities that are most important for sustainable agriculture.

LL 02: Understanding and solving the problem of guava wilt for guava growers

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Guava *(Psidium guajava* Linn.) is a hardy crop and can be cultivated in all types of soil. In India, it is grown almost in all the states. Wilt of guava is the most destructive disease out of all diseases of guava and is limiting factor for guava cultivation in India. Affected plants show varied symptoms but two major symptoms are described i.e. slow and quick wilt. *Fusarium oxysporum* f. sp. *psidii, F. solani, F. chlamydosporum, Gliocladium roseum* were identified to cause wilt in guava though *F. oxysporum* f. sp. *psidii, F. solani* were identified as the major common pathogens. In the extensive collection of isolates from India, it was found that the frequency of *F. solani* was maximum and hence, classified as most frequent pathogen. *Gliocladium roseum* was identified as an aggressive pathogen, as all the collected isolates reproduced disease on inoculation in high percentage. The nematode *Heliocotylenchus dihystera* was found to enhance the incidence of wilt. Recently, *Meliodogyne* spp. was also found associated with the disease. Morphological variations were recorded in the isolates of *F. oxysporum* f. sp. *psidii,* and *F. solani* and were grouped on the basis of colony colour and texture, colour of metabolite released, frequency of their occurrence on culture, sporulation and macro-conidia production and type/percentage of wilting. High degree of variations were recorded among the different isolates. Partial sequencing of *F. oxysporum* f. sp. *psidii* isolate VKGF01, *F. solani* isolate VKGFS1 and *F. chlamydosporum* isolate VKGFC01 were done. Total 36 isolates each of *F. oxysporum* f. sp. *psidii* and *F. solani*, (6 from one location) collected from 6 different agro climatic zones of India were subjected to estimate the molecular characterization. Out of twenty RAPD primer screened, OPM 11(RBM3) was found best to produce good allelic band with all isolates of *F. oxysporum* f. sp. *psidii* and *F. solani.* Product size ranged from 200 bps to 2000 bps and 600pbs was obtained almost in all the isolates of *Fusarium* spp. For *F. solani* RAPD data were subjected to construct a dendogram using UPGMA software. It showed that isolates from Agra and Farukhabad regions were almost similar and form a group. Punjab and Ranchi region formed second group. *F. solani*, isolates of Allahabad region were distinctly related to isolates of other regions. Similarly, for *F. oxysporum*, RAPD data were subjected to construct a dendogram using UPGMA software. It showed that isolates from Agra and Farukhabad regions were almost similar and form a group. Punjab and Ranchi region formed second group. Histopathological studies revealed breaking and opening in the epidermis, through which pathogen enter in the host tissue. Presence of the pathogen and tylose formation was recorded in the root tissues. Necrosis in the internal tissue and vascular bundle restricts the movement of water and nutrient and thus results wilting. Though, different fungicides check the various wilt pathogens in laboratory but when applied in soil in field and once the effect of these fungicides diminish in soil, these pathogens increases it's aggressiveness with profuse spore mass production in the soil and hence cannot be recommended. In the cultural management of disease inter-cropping/ basin cultivation of turmeric or marigold was found to check the wilt incidence. The frequent tillage and flood irrigation needs to be avoided for the management of wilt. Bio-management found to be promising in the management of guava wilt. *Aspergillus niger* strain AN17 (Pusa Mrida), *Trichoderma* sp. and *Penicillium citrinum* were found effective. Multiplication and application details were standardised for their application. Resistant root stock (*Psidium molle X Psidium guajava*) was identified, which can be used for the effective management of guava wilt. Hence, guava wilt is now amenable to management by integration of resistant root stock, cultural practices and bio management.

LL 03: Mass multiplication of *Trichoderma* and *Pseudomonas fluorescens* using local substrates

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Trichoderma is a versatile class of fungi and used as a potent biocontrol agent. Studies on *Trichoderma* spp. under different aspects *viz*. mass multiplication in organic substrates, shelf life in different carriers, survival in soils, nutritional requirements and study on different media and some physiological factors like pH, temperatures and light was undertaken. The substrates used were wheat straw, pigeonpea husk, paddy bran soybean straw along with their combinations *viz*., wheat straw + pigeonpea husk, paddy bran + soybean straw, paddy bran + pigeonpea husk. However, the best organic substrate for all the *Trichoderma* spp. was wheat straw to give maximum number of propagules after 21 days after inoculation. Shelf life study was undertaken to assess the suitability of different carrier material. The carriers used were talc, fly ash, charcoal and lignite. The propagule count was taken upto 180 days. Talc was found as best carriers among all the carrier material to give maximum number of propagules at 180 days after storage while fly ash recorded minimum number of propagules. *Trichoderma* spp. differ in different ecological strategies, with this view quantitative estimation of *Trichoderma* population in different soils was undertaken. The different soils tested were laterite, loamy sand, vertisol, saline and sandy soil. The maximum population of *Trichoderma* spp. was recorded in laterite soil at 90 days after inoculation. Whereas, minimum propagules were recorded in saline soils. Nutritional requirements of the *Trichoderma* spp. was studied by altering the carbon and nitrogen sources in the Czapeks medium. Among the different carbon sources fructose found to give maximum growth of *Trichoderma* spp. while sporulation was recorded maximum in dextrose. Ammonium nitrate was the best nitrogen source and recorded maximum growth whereas sporulation was maximum in ammonium sulphate. Mannitol and urea found as poor source of carbon and nitrogen, respectively. Studies were carried out to evaluate different carriers for shelf life of *Pseudomonas fluorescens* stored at 25±2^{0}C over a storage period of 6 months. The population dynamics was recorded at monthly intervals. The population of *P. fluorescens* was increased significantly in all carriers i.e Talc, Spent mushroom substrate (SMS) a waste product of mushroom industry, Lignite, Charcoal, Farm yard manure (FYM) and Flyash up to 60 days storage and there was slow decline in number of viable propagules after 60 days of storage. Spent mushroom substrate (78× 10^8cfu/g) and fly ash (53.67× 10^8cfu/g) maintained viable population count at 90 days of storage. This population was very close to the population recorded in carrier's *viz*., Talc (86.33×10^8cfu /g), Lignite (80×10^8cfu /g) which were usually used in biofertilizer industry. Hence for short storage period, option of SMS and Fly ash can be used for developing commercial formulations of *P. fluorescens*. Talc was found to be the best carrier material that maintained better population of the *P. fluorescens* (18 ×10^8cfu /g) till the end of storage period.

LL 05: *Trichoderma* : Biocontrol and beyond

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Trichoderma spp. are widely used as plant disease biocontrol agents the world over. Mycoparasitism and antibiosis are believed to be the principal modes of action. *Trichoderma* spp., however, form intimate association with roots in a symbiosis-like relationship and benefit plants by improving nutrient uptake, growth promotion, tolerance to abiotic stresses and more importantly, by triggering plant defence against invading root and shoot pathogens. Most *Trichoderma*-pathogen and *Trichoderma*-plant interactions are non-specific, imparting broad-range benefits, but recent studies have demonstrated some degree of specificity in such interactions. *Trichoderma* spp. are successfully used to manage a wide range of soil-borne (e.g., *Sclerotium rolfsii*, *Rhizoctonia solani*, *Sclerotinia* spp., *Pythium* spp.) and foliar (e.g., *Botrytis cinerea*) pathogens, when applied as seed treatment and foliar spray, respectively. There are reports on biological control of *Phytophthora* spp. and fusarial wilt by application of *Trichoderma*. Recently, some products have been registered for biological control of nematodes and there are reports on suppression of insect pests due to application of *Trichoderma*. However, field use targeted against these pathogens is not widespread yet. Plant growth (particularly root) promotion is a direct benefit of application of *Trichoderma*, and production of phytohormones have been suggested as one of the mechanisms. In addition, several composting formulations contain active propagules of various *Trichoderma* spp. These plant-beneficial fungi also produce many bioactive secondary metabolites, some of which have anti-microbial and anti-cancer properties and hence are targets for drug development. The benefits of applying *Trichoderma* are thus multifaceted that go far beyond biocontrol.

LL 06: Application of beneficial microorganisms with multiple traits for plant growth promotion and biocontrol of crop diseases

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Sustainable agriculture relies on the use of natural resources for crop improvement as against conventional agriculture based on chemical fertilizers and pesticides. Excessive use of chemicals over a prolonged period for control of pests and pathogens, have led to harmful effects due to their residues which tend to be toxic. On the other hand, the last few decades have revealed the benefits of controlling diseases and achieving crop improvement through the use of biological resources which are eco-friendly without any damaging qualities. North Bengal region, with its forests, rivers and hilly terrain, a biodiversity hot-spot, is a virgin territory for isolation of microorganisms which can be potential resources in sustainable agriculture. In line with this approach, a large number of beneficial microorganisms have been isolated from different forests, river basins, rhizosphere of agricultural and plantation crops of six districts of North Bengal, and, following molecular characterization and analysis of functional diversity, used for crop improvement studies. Identification of isolates was based on 16SrDNA sequencing and their diversity analysis was done by RAPD-PCR and Denature Gradient Gel Electrophoresis (DGGE). The bacterial isolates were found to possess several beneficial traits. *Bacillus megaterium, B. pumilus, B. altitudinus, B. amyloliquefaciens, B. cereus, B.safensis, Paenibacillus polymyxa, Ochrobactrum anthropi* and *O. pseudogrignonense,* which showed plant growth promoting traits *in vitro* such as phosphate solubilization, siderophore production, IAA secretion and antagonism against fungal pathogens were selected for detailed studies. Further, some of these bacteria were found to be tolerant to water stress as well high concentration of salt. Plant growth promoting activities of the selected microorganisms *in vivo* were observed in plantation crops (*Camellia sinensis*) ,cereals (*Oryza sativa* and *Triticum aestivum*), and pulses (*Glycine max, Vigna radiate* and *Cicer arietinum)*. Either seed bacterization or soil drench significantly promoted growth of the test plants as evidenced by increased height, number of leaves, number of branches and biomass. These bacteria could also reduce root diseases of tea, mandarin, cereals and pulses. Application of the PGPR led to enhancement in activities of defense related enzymes- phenyl alanine ammonia lyase, peroxidase, chitinase and -1, 3 glucanase, in tea leaves. Total phenols also increased quantitatively, as determined by HPLC analysis,, along with an increase in isomers of catechins, which are important flavonoids of tea leaves. Immunological detection of the pathogens in soil revealed reduction in their population. The bacteria could survive in bioformulations of rice husk, talc powder, saw dust and tea waste for more than nine months. Interestingly, many of these PGPR could also alleviate abiotic stresses such as drought, salinity and high temperature in many of the crops tested. It is evident from the results of the present study that application of PGPR in the soil lead to biopriming of the plants through induced systematic resistance besides direct mechanisms of growth promotion and pathogen inhibition.

Invited Lectures

IL 01: An insight into microbial degradation of rice residues for their use in wheat cultivation

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The country produces around 501 million tons of crop residues every year out of which 70 % (352 Mt) is contributed by cereals. Among cereals, the contribution of rice and wheat straw is 34 and 22 percent, respectively. Wheat straw is being used as fodder for domestic cattle, while the higher silica content of rice straw makes it lesser suitable as animal fodder. Further the wider C: N ratio of rice straw makes it less suitable for direct incorporation in soil as it leads to nitrogen immobilization resulting in decreased grain yields. As per the data in various reports, >19 million tons of rice residues are being burnt on field every year to ensure timely sowing of wheat crop. Apart from loss of carbon, burning of straw also results in loss of up to 80 percent of nitrogen and sulphur, 25 percent of phosphorus and 21 percent of potassium. If the 19 million tons of rice residue is recycled, it can supply 1.25 lakh ton of N, 19 thousand ton of P, 2.85 lakh ton of K and 14.25 thousand ton of S. The on field burning of rice residues also leads to degraded soils due to very low organic matter, killing of the beneficial insects/ microbes that finally results in poor soil health in addition to environmental pollution.

The on field burning of rice residues is affecting the sustainability of the rice-wheat cropping system. Recycling of rice residues can help in maintaining the soil health and thereby sustainability of the rice-wheat cropping system. Out of two ways (*in situ* and *ex situ*) of microbial degradation, the *in-situ* degradation may be more practical as it will augment the ongoing efforts of mechanized rice residues management. The researchers have tried different combinations of microorganisms and the decomposition process has been studied over a period of 71-90 days with sampling at regular intervals for studying the changes in the composition of the acid detergent fibre (ADF), neutral detergent fibre (NDF) and crude fibre (CF), and the accumulation of the lignin-derived phenols (vanillyl, syringyl, cinnamyl) in soil. The natural inhabitants of the rice residue degradation sites have been studied for the activities of various lignocellulolytic enzymes like carboxy methyl cellulase, filter paperase, cellobiase, xylanase and laccase. At the same time the composition of the bacterial community has been studied using denaturing gradient gel electrophoresis (DGGE) of the amplified bacterial 16S rRNA genes, while the relative abundances of various phylogenetic groups by fluorescence *in situ* hybridization (FISH). These techniques have revealed that the composition of the bacterial community changes during the first 15 days and then become stable until the end of incubation. It has also been observed that the bacterial community colonizing and decomposing rice straw develops during the first 15 days of incubation and is dominated by members of different clostridial clusters, especially clusters I, III, and XIVa. The bacterial populations displayed distinct successions during different stages of residue decomposition and temperature was the key determining factor. Members of *Clostridium* dominated in the incubations, particularly in the early phase, while *Bacteroidetes* and *Chlorobi* in the later phases at 15 and 30°C and *Acidobacteria* at 45°C. It has also been presumed that the early successional groups were responsible for the decomposition of the easily degradable fraction of residues, while the late successional groups decompose the less-degradable fraction of plant residues. The bacterial succession has been reported to be related to resource availability during residue decomposition process.

IL 02: Use of plant pathogen for weed control

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In agriculture, weeds cause huge reductions in crop yields, increase cost of cultivation, reduce input efficiency, interfere with agricultural operations, impair quality, act as alternate hosts for several insect pests, diseases and nematodes. Weeds compete with crop plants for various inputs/resources like water, nutrients, sunlight etc. Crop yield loss due to weeds depends upon crop cultivar or competing ability of crop plant, type of weed species, severity and duration of infestation, cropping season, plant spacing, fertility and moisture status of the soil and climatic as well as environmental conditions affecting weed and crop growth. Reduction in crop yields due to presence of weeds thus vary from 10 to 90 per cent.

Biological control of weeds can be considered an 'unconventional' extension of plant pathology and entomology, in which a 'harmful' organism is used to mitigate the harmful effect of unwanted target plants without damaging the non-target ones, such as indigenous species or crops. The objective should be to reduce the presence of weeds to, or below, economically significant damage levels. According to definition, any organism that can cause damage in any way to a plant that is unwanted by humans, thus restricting its development, is a potential biocontrol agent. Viruses, bacteria, fungi, nematodes, insects and higher organisms have been examined as potential biological weed control agents.

Chemical herbicides are the most effective immediate solution to most weed problems but they are not the only or necessarily the best solution. Certain fungi can be used to control weeds and in some cases are more efficaceous than chemicals. The use of living organisms for weed control started over a century ago, and very encouraging results were obtained in the 1960s and the 1970s. During the 1980s, renewed interest in this research field led to many promising developments. It is foreseeable and desirable that in the near future, further studies will support the development of, and financial support for this research field. Such studies might be prompted by: (a) increasing public demand for reduced use of chemicals in food production ; (b) increasing consumption of organic foods and agro-industrial products; (c) the further banning of dangerous herbicides; (d) the increasingly high costs of developing and registering new synthetic active substances; (e) the lack of herbicides registered for minor crops; (f) the increasing rate of herbicide-resistant weeds appearing in many species; (g) the forbidden use of chemicals in some natural or humanised environments; (h) increasing awareness of the need to protect the environment; (i) the negative effects of the ineffectiveness of other existing weed-management practices under some conditions; (j) the need to control invasive weeds or weeds in non-agricultural environments; (k) the high cost of weed-management methods in natural environments and extensive crops; (l) the availability of new technologies, equipment and biotechnologies that can be extremely useful in increasing our knowledge of biocontrol agents, facilitating their production and distribution, elevating their aggressiveness, and more precisely determining the risks of their release. The central idea behind the use of biological control is to reduce the use of synthetic chemical substances. The increasing rate of appearance of herbicide-resistant weeds together with growing public concern about pesticide use will continue to be the driving force for investment in, and investigation of biocontrol and its agents. Advances in molecular biology and genetic engineering offer a wide range of opportunities to modify formulations and improve bioherbicidal performance. We foresee removal, or at least reduction, of the deterrents and suggest it is now appropriate to focus on the biotic and abiotic constraints to diseases in nature that impact on safety and efficacy of biological agents for weed control. This should clarify our perspective of the research that is needed on the fundamental ecology of plant pathogens in nature to guide further empirical development in this new cooperative research arena of plant pathology and weed science.

IL 03: Multiplication of *Trichoderma* sp using local substrate and its effect on plant growth

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The need for increasing agricultural productivity and quality has led to an excessive use of chemical fertilizers, creating serious environmental pollution. The use of biofertilizers and biopesticides is an alternative for sustaining high production with low ecological impact. Different soil-borne bacteria and fungi are able to colonize plant roots and may have beneficial effects on the plant. Some *Trichoderma* rhizosphere- competent strains have been shown to have direct effects on plants, increasing their growth potential and nutrient uptake, fertilizer use efficiency, percentage and rate of seed germination, and stimulation of plant defense against biotic and abiotic damage. Some *Trichoderma* spp. isolates have been shown to possess very high ligno cellulosic properties and were therefore useful for agricultural waste management. We report here is a simple technique of mass multiplication of *Trichoderma* sp using local substrate and its use on large scale at farmers field.

IL 04: Utilization of microbial technologies for eco-friendly crop production

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India has world famous bio-diversity vis-à-vis the microbial diversity which is yet to be adequately explored and exploited especially in the interest of farmers. Some plains areas like Chhattisgarh plains, which are exposed to extreme dry and hot climate for prolonged period during summer. They have actual need of stress tolerant microbial inoculation as identified by the soil sample analysis. Further, it was also concluded by the microbial analysis that soil samples of Chhattisgarh plains did not have native *Rhizobium* of one or more than one legume. The absence of native rhizobia at large area in Chhattisgarh plains is still observed for some legumes even after vigorous extension activities for popularization of biofertilizers among farmers. The low population density of other beneficial mesophilic microbes are mainly due to high temperature and low humidity for a prolonged period of summer season. The other reasons for insufficient population of such soil microbes have also been identified as the low vegetation in spite of high rainfall, low rain-water retention capacity of soils due to sloppy and shallowness of soils including the practice of leaving fallow land in rabi and summer seasons mainly due to lack of moisture/ irrigation, low soil organic matter content etc. Therefore, there is an urgent need to exploit vast and wide reserve of beneficial microbes of such regions for enhancing eco-friendly sustainable agricultural production by using location specific properly screened effective bio-inoculants.

Key words: *Rhizobium,* beneficial microbes, sloppy and shallow soils, properly screened bio-inoculants, low input technology, sustainable agriculture

Oral Presentations

OP 01: Role of microbes in organic farming and sustainability of agriculture system

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Population growth challenge our food and farming systems and provide arguments for an increased intensification of agriculture. The technology, particularly in India, led to many fold increase in food grains production, but has made demands on water, fertilizer and farm power. The effect of intensive cropping has resulted in deteriorating soil tilth and decreased organic matter content, high level of chemical inputs is increasing pollution hazard and result further degradation of soil health. A possible option is eco-functional intensification through organic farming, an approach based on making optimal use of internal natural resources and processes to secure and improve agricultural productivity, while minimizing negative environmental impacts such as loss of biodiversity, nutrient leakage and soil degradation. In this concept an active soil microbiota plays an important role for various soil based ecosystem services.

Soil microbes are key to the function of agricultural systems. Some bacteria and fungi produce substances during organic matter decomposition that chemically and physically bind soil particles into micro-aggregates. Microbial populations play roles in erosion control, pest and disease regulation, nutrient cycling, from fixing nitrogen to solubilising phosphorus. Some microbes assist in the formation of soil aggregates that improve pore space in the soil, which allows for higher infiltration rates, better water-holding capacity, and lowers the compaction that often impedes root growth. Other microbes are involved in extensive predator and prey relationships that can reduce the prevalence of disease. Finally, the way soil organisms carry out a wide range of processes, are important for soil health and fertility in both natural and managed agricultural system.

OP 02: Organic inputs management to overcome disease infection and higher productivity of Chilli in Sagar District of Madhya Pradesh

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Chilli, (*Capsicum annuum* L.) is an important vegetable and commercially grown condiment, is essential for all Indian dishes. It is a rich source of vitamin C, A and B. In India, it is an important cash crop, which is grown for the both domestic and export market. In changing weather temperature, infestation of white fly and thrips in chilli are the most limiting factors in production. Chilli crop also suffers with many fungal, bacterial and viral diseases resulting in huge yield losses. Among the fungal diseases, in recent years dry root rot of chilli caused by *Sclerotium rolfsii* is of major concern and causing the economic losses in chilli.

The present studies were conducted at farmer's field with farmer's participatory mode during summer season of 2015, *kharif* seasons 2016 and 2017 with medium fertility status soils in Sagar district of Madhya Pradesh for popularization of organic production of Chilli under National Horticulture Mission. Seed sowing was done in raised bed nursery treated with *Trichoderma viride* @ 50 gm/sq m with a seed rate of 0.5 kg ha^{-1} then planted in the fields after seedling treatment with *Trichoderma viride*. One hand weeding was done at 25 DAS for effective control of weed. Enrich FYM with PSB and *Azotobacter*, vermicompost and neem cake were applied as basal dose to fulfill the nutrient requirement of the crop. Naturamore Gold (Organic-25 kg) applied in standing crop to supply nitrogen. Yellow sticky trap (150 No. ha^{-1}), Blue sticky trap (150 No ha^{-1}) and Pheromone trap (20 No. ha^{-1}) per hectare were installed for monitoring and trapping of insect pest. Foliar spray of Neem beam 1500 ppm, Lastraw (1.0 L/ha), Super Parasmani (1.0 Lha), Onset (1.0 L/ha) were done at 10 days interval for management of insect- pest to check the leaf curl disease. The average incidence of wilt disease was noted as 3.3 per cent, pod borer as 0.2 larvae per plant and sucking pest were 7.0 per plant in technology demonstrated plot as against 8 per cent, 0.7 larvae per plant and 16 per pant in farmer's practices. Organic production system reveled more number of branches (24) and number of fruits (378 per plant) as compared to 18 and 282 per plant in farmer's practice during both the years which increased the green yield of chilli 34.8% (66 to 89 q/ha). Additional cost of Rs.12,600/ per ha in technology demonstrated plots of chilli gave an additional net return of Rs. 33,500/ per hectare to the farmers. The use of organic inputs in chilli cultivation also gave higher benefit cost ratio 2.72 as compared to 2.39 under farmers practice in the corresponding years.

OP 03: Host specific plant growth promoting activity of IAA producing and phosphate solubilizing fluorescent *Pseudomonas*

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Fluorescent *Pseudomonas* possesses many traits that make them well suited as biocontrol and growth promoting agents. Host specific plant growth promoting activity of fluorescent

Pseudomonas isolates was observed. Isolates #P72, P141, P151, P233, P124, P6, P143, P176, P76, P99, P167 were able to induce the formation of increased root and shoot length. Isolates used in the present investigation had the ability (although in different proportions) to solubilize inorganic phosphate, produce indole acetic acid (IAA) and PHB. Frequency of fluorescent *Pseudomonas* isolates which induced shoot length of crop plants more than fluorescent *Pseudomonas* isolates with the ability to induced root length. It was also observed that fluorescent *Pseudomonas* isolates reduced root shoot length as compared un-treated control.

OP 04: Potential fluorescent *Pseudomonas* isolates inducing drought tolerance in rice and wheat

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Drought is one of the major constraints on agricultural productivity worldwide and is likely to further increase. Drought affects plant in variety of ways by changing physiological and morphological traits in plants. Growth reduction under drought stress has been studied in several crops. Plant growth promoting rhizobacteria significantly improves the growth of their associative plant in soil. Fluorescent *Pseudomonas* could play a signi?cant role in alleviation of drought stress in plants by variety of mechanisms. We identified 12 fluorescent pseudomonas (P1, P2, P5, P7, P8, P10, P11, P17, P19, P28, P141) collected from different locations of Chhattisgarh which imparted water stress tolerance to rice and wheat following seed biopriming. Among the test for plant growth-promoting properties, isolate were able to produce the indole-3-acetic acid in tryptophan-supplemented media, ACC deaminase activity, solubilization of inorganic phosphate. Based on 16S rRNA gene sequencing bacterial isolate belonged to three different species of fluorescent *Pseudomonas.* Current leads forms the basis for concerted future research particularly on ?eld evaluation.

Poster Presentations

P 01: Studies on compatibility of *Trichoderma* with agrochemicals

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Fungal species belonging to the genus *Trichoderma* are worldwide in occurrence and easily isolated from soil, decaying wood and other forms of plant organic matter. *Trichoderma* species has an innate and/or induced resistance to many fungicides but the level of resistance varies with the fungicide. The combined use of *Trichoderma* and chemical pesticides has attracted much attention in order to obtain synergestic or additive effects in the control of plant diseases. Keeping this in view present investigation was conducted to identify the compatibility of *Trichoderma* with agrochemicals including fungicides and fertilizers. A set of seven fungicides namely Mancozeb 75%WP, Thiram 75%WP, Propiconazole 25%EC, Chlorothalonil 75%WP, Hexaconazole 5% EC, Tridemorph 70% WP and Thiophanate methyl were used at five different concentrations of 50 ppm, 100 ppm, 250 ppm, 500 ppm and 1000 ppm along with control. In total four fertilizers namely urea, murate of potash, single super phosphate and calcium ammonium nitrate were used at 5 concentrations of 100 ppm, 250 ppm, 500 ppm, 1000 ppm and 2000 ppm including control. *Trichoderma* was recorded compatible with

Mancozeb 75%WP upto 50 ppm. However, above 50 ppm concentration it started inhibiting the growth of *Trichoderma* spp. With thiram 75%WP and chlorothalonil it was observed that *Trichoderma* was more than 70 % compatible upto 100 ppm. However above that concentration fungicides greatly inhibited the growth of *Trichoderma*. However, tridemorph and thiophanate methyl 70% WP were not compatible with *Trichoderma* and inhibited more than 70 % growth of *Trichoderma* at 50 ppm concentration. Further, *Trichoderma* was completely incompatible with propiconazole 25% EC and hexaconazole 5% EC even at 50 PPM concentrations of these fungicides. Among fertilizers, *Trichoderma* was compatible with urea and murate of potash, while single super phosphate and calcium ammonium nitrate observed to have inhibitory effect on growth of *Trichoderma*.

P 02: Characterization of root associated fluorescent *Pseudomonas* from red lateritic soil

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Fluorescent *Pseudomonas* are ubiquitous soil bacteria that usually establish mutualistic associations with plants, promoting their growth and health by several mechanisms. This makes them interesting candidates for the development of crop bioinoculants. The objective of this work was to isolate plant-associated fluorescent *Pseudomonas* from lateritic soil (high iron content) and to characterize them for phosphate-solubilizing and siderophore producing ability. We report herein 17 fluorescent pseudomonads which were isolated from the red lateritic rhizosphere soil of naturally growing weed host. Because these isolates were recovered from the weed host growing in very harsh water stress conditions we also screened them for their ability to impart water stress tolerance to for different varieties of rice. All the isolates were screened for siderophore producing and phosphate-solubilizing ability. Isolates were also characterized based on gene specific markers.

P 03: *In vitro* evaluation of biorationals against *Erysiphe cichoracearum* an incitant of powdery mildew of cucumber

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Cucumber is the oldest vegetable cultivated throughout the world and around 50-55% losses have reported due to powdery mildew and downy mildew. In present study various systemic, combi fungicides, have evaluated in lab condition by following factorial design. *In vitro* efficacy of four bioagents with different concentrations revealed that all the bioagents were significantly superior over the control. Maximum conidial inhibition was recorded with *Bacillus subtilis* (55.74 %) at 6 g/L followed by *Pseudomonas fluorescens* (51.24 %) @ 6 g/L. Out of seven botanicals tested *in vitro* against *E. cichoracarum*, the effect of *Reynotriu sachalensis* on conidial germination was significantly superior over control and 20 per cent extract showed maximum conidial inhibition of 100 per cent followed by nimbicidin (64.13 %) minimum conidial germination inhibition was found with Sorghum leaf extract (33.25 %) at 15 per cent.

P 04: Antagonistic variability among the isolates of *Trichoderma* against *Fusarium oxysporum* f.sp. *ciceri*

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Trichoderma has attained importance as a substitute of chemical pesticides all over the world. Hence, an attempt was intended to corroborate the positive relatedness of antagonistic ability. Among different isolates of *Trichoderma* isolated from rhizospheric soils has brought attention due to its highly antagonistic activity. The study aimed to determine the potency of native *Trichoderma* isolates against *Fusarium oxysporum* f.sp. *ciceri* under *in vitro* condition. Maximum per cent inhibition was recorded in isolate T_3, followed by T_{15}, T_7 and T_5 in dual culture. All native rhizospheric isolates of *Trichoderma* were found significant in reducing mycelial growth of *Fusarium oxysporum* f.sp*. ciceri.* The significance of antagonistic potential of twenty *Trichoderma* isolates was scored on scale (1-5) for degree of antagonism against *Fusarium oxysporum* f.sp. *ciceri.* The result revealed that the highest antagonism was found in isolate T_3 (*T. harzianum*) against chickpea wilt.

P 05: *In vitro* evaluation of biorationals against *Bipolaris oryzae* an incitant of brown leaf spot of rice

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Antagonistic activities of three bio-agents and five commercially available botanicals were evaluated by dual culture technique and poison food technique under *in vitro* conditions against *B. oryzae* respectively. The results revealed that, maximum per cent inhibition of mycelia growth was observed with *T. harzianum* (64.44 %) which is followed by *B. subtilis* (41.48 %) and least per cent inhibition of (33.70 %) mycelia growth was recorded in *P. fluorescens*. Among the botanicals tested the maximum inhibition of mycelia growth varied significantly with different treatments. Among the five botanicals Neem gold (60.00 %) followed by Neem oil (54.69 %) and Nimbicidin (53.09 %) gave maximum mean per cent mycelia growth inhibition which were significantly superior to other treatment followed by Discheck (45.56 %). The least mean per cent of inhibition (34.44 %) of fungus was recorded in Soldier.

P 06: Inclusion of useful soil microorganisms under ecofriendly organic agriculture

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The present plight of Indian agriculture is degrading soil health condition at large due to indiscriminate use of insecticides, herbicides and chemical fertilizers. The soil is a living body full of soil microbes like bacteria and fungi and many more. These microorganisms are very much essential for decomposing organic matter and recycling old plant material for organic crop cultivation. Some soil bacteria and fungi form relationships with plant roots that provide important nutrients like nitrogen or phosphorus. Although soil organisms comprise <1% of the total mass of a soil, they have their vital functions as break down organic matter, recycling of plant and soil nutrients, soil microbes create humus, soil microbes create soil structure, soil microbes fix nitrogen, soil organisms promote plant growth and soil microbes control pests and diseases like soil bacterium *Bacillus thuringiensis* (Bt) to control caterpillar pests of crops. Soil microorganisms can be classified as bacteria, actinomycetes, fungi, algae and protozoa. Each of these groups has characteristics that define them and their functions in soil. Up to 10 billion bacterial cells inhabit each gram of soil in and around plant roots, a region known as the rhizosphere. Without inclusion of beneficial soil microbes the dream of green agriculture or natural agriculture or organic agriculture cannot be completed for healthy and sustainable crop production.

Key words: Organic agriculture, Sustainable crop production, Soil health and Soil microorganisms.

P 07: *In vitro* evaluation of botanicals and bioagents against blast disease of pearl millet caused by *Pyricularia grisea*

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Pearl millet belongs to family *Poaceae* is a staple cereal grown on about 29.0 m ha in the arid and semi-arid tropical regions of world. Among the biorationals tested, out of seven botanicals evaluated, the highest inhibition was obtained by commercial product Soldier (71.54%) and it was on par with tulsi (70.93%) and were significantly superior over onion and chilli (54.95% each) followed by neem (45.84%) and garlic (42.15%). ginger (21.30%) found to be the least effective in inhibition of mycelial growth. The competitive ability of antagonists against *P. grisea* was studied by dual culture method. Among the bioagents tested, it was noticed that maximum inhibition of the pathogen was observed in *Trichoderma koningii* (65.88%) followed by *Pseudomonas fluorescens* (64.26%), *Bacillus subtilis* (61.48%), *Gliocladium virens* (60.80%), *T. harzianum* (56.67%) and *T. viride* (51.08%).

P 08: *In vitro* evaluation of fungicides and bio-agents against *Dresclera tetramera, Bipolaris sacchari, Nigrospora sphaerica* and *Alternaria alternata* causal agent of leaf spot of medicinal and aromatic grasses

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India is a global leader in essential oil steam distilled from aromatic crops. Most of the species of *Cymbopogon* i.e. *C. winterianus* Jowitt, *C. flexuosus* (Nees) Wats. and *C. martinii* (Roxb.) Wats. have been cultivated for a long time for their essential oils. Few fungal pathogens like *Dresclera tetramera, Bipolaris sacchari, Nigrospora sphaerica* and *Alternaria alternata* are known to attack these grasses causing leaf spot which results into substantial yield losses. The present investigation was carried out to test the efficacy of fungicides and bio-agents *in vitro*. Among fungicides tested, the highest (100%) mycelial inhibition of *Dresclera tetramera, Bipolaris sacchari, Nigrospora sphaerica* and *Alternaria alternata* were recorded in Propiconazole (0.1%) and Propiconazole+ Difenacozole (0.1%). The results of dual culture technique revealed that maximum growth inhibition of *Dresclera tetramera* (61.60%), *Bipolaris sacchari* (62.00%), *Nigrospora sphaerica* (67.88%) and *Alternaria alternata* (55.00%) was observed with *Trichoderma viride* followed by *Pseudomonas fluorescens* and *Bacillus subtilis.*

Keywords: *Cymbopogon winterianus*, Citronella, *Cymbopogon flexuosus*, Lemongrass, *Cymbopogon martinii*, Palmrosa, *Dresclera tetramera, Nigrospora sphaerica, Bipolaris sacchari, Alternaria alternata*, Evaluation of Fungicides, Bio agents.

P 09: Significance of microbes in plant health management and organic crop cultivation for sustainable crop production

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Organic crop cultivation is an alternative agricultural system which originated early in the 20th century which generally relies on fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting. Biological pest control, mixed cropping and the fostering of insect predators are encouraged. In general, organic standards are designed to allow the use of naturally occurring substances while prohibiting or strictly limiting synthetic substances by sole objective to improve beneficial soil fauna under natural agriculture to regulate important processes in soils (e.g. biological nitrogen fixation, residue decomposition, mineralization/immobilization turnover, nutrient cycling, denitrification) are mediated by soil micro-organisms. The interaction between living organisms and their environment is crucial for a plant's health. Plant's health is more at risk in monocultures and on-farm diversification provide a balanced interaction between different plants and pests and predators. This is why a well-managed ecosystem can be a successful way of reducing the level of pest or disease population. The beneficial impact of microorganisms on plant growth include nitrogen fixation, acquisition and uptake of major nutrients, promotion of shoot and root growth, disease control or suppression and improved soil structure. Some of the commonly promoted and used beneficial microorganisms in agriculture worldwide include *Rhizobia, Mycorrhizae, Azospirillum, Bacillus, Pseudomonas Trichoderma, Streptomyces* species and many more. By significance use of microorganisms plant health and soil health can be managed, which would be helpful positively to sustain crop production and productivity under organic agricultural production system.

Key words: Eco-friendly cultivation, Microorganisms, Organic farming, Plant and Soil Health Management.

P 10 : Management of leaf blight disease of mungbean through botanicals

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Mung bean (*Vigna radiata* L.) is a legume cultivated for its edible seeds and sprouts across the Asia. The major fungal diseases which infect the crop are leaf blight, powdery mildew, web blight, *Cercospora* leaf spots and Anthracnose. Mung bean was observed severely affected by leaf blight caused by *Macrophomina phaseolina* in *Kharif* as well as during summer season. Occurrence of leaf blight disease has become a major constraint for cultivation of mung bean. Considering the fact, below investigation was carried out for this pathological problem. Some chemical fungicides like Benomyl, Thiophanate-methyl, Thiram, Thiabendazole and Captan have been proved effective in laboratory tests against *M. phaseolina*. However, synthetic agrochemical also causes environment pollution and ill effects on humans and animals health. Therefore, some alternative environmental friendly measures are needed to combat the hazard. In recent years, scientists have explored large number of natural resources such as phyto-extracts are being used as fungitoxicants against plant pathogens and very encouraging results have been obtained. The present investigation was carried out using following six natural phyto-extracts to see their antimycotic behaviour on the growth of *Macrophomina phaseolina* following poisoned food technique. The plant parts selected were clove extracts of garlic (*Allium*

sativum L.), finger extract of turmeric (*Curcuma longa* L.), finger extract of ginger (*Zingiber officinale* L.), leaf extract of Neem (*Azadirachta indica* L.), bulb extract of onion (*Allium cepa* L.) and leaf extract of black tulsi (*Ocimum sanctum* L.). The finger extract of turmeric having fungal colony diameter of 24.03 mm allowed minimum growth of the pathogen followed by clove extracts of garlic (68.44 mm), finger extract of ginger (78.13mm) and leaf extract of black tulsi (82.00 mm). Neem and onion having fungal colony diameter of 88.23 mm and 88.33 mm respectively were statistically at par with control which has a colony diameter of 89.00 mm.

P 11: Effect of seed borne mycoflora on seedling vigour of pea by seed inoculation technique

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Various factors are responsible for affecting the seed health, among which the most important is seed borne fungi that cause reduction in seed germination and seedling vigour. Seven pea varieties *viz*. IPFD 10-12, Paras, Indira matar, KPMR 400, Shubhra, Ambika and Local variety from randomly selected village were taken to test the effect of isolated seed borne fungi on seedling vigour under seedling symptoms in pot culture condition by using seed inoculation technique. Seedling vigour was markedly reduced by some of the seed borne mycoflora when evaluated by seed inoculation technique. Overall impact in reducing seedling vigour index was shown by *Rhizopus* sp. across all seven varieties evaluated as compared to that of control. *Rhizopus* sp. (94.57%) showed maximum reduction in seedling vigour index of pea varieties as compared to that of control followed by *Fusarium* sp. (91.27%). Minimum reduction in seedling vigour index of all pea varieties were recorded in seed inoculation with *Penicillium* sp. (11.62%) followed by *Aspergillus flavus* (52.63%). Overall, seedling vigour of pea varieties by *Trichoderma* sp. inoculation recorded as 133.50%. Seeds of pea varieties inoculated with *Trichoderma* sp. showed reverse trend among all mycoflora. *Trichoderma* sp. may exhibits plant growth promoting activity, hence it increased seedling vigour of pea varieties as compared to that of control. Most of the seed borne mycoflora reduced the seedling vigour index and some were not. Two seed borne mycoflora of pea seeds i.e. *Rhizopus* sp. and *Fusarium* sp. were found pathogenic and seed to plant transmissible in nature whereas increased seedling vigour of pea varieties were recorded due to growth promoting ability of *Trichoderma* sp.

P12 : Influence of bacterial consortia *Rhizobium* nodulation behaviour in chickpea

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The present investigation was conducted in glass house of Department of Agricultural Microbiology, College of Agriculture, IGKV, Raipur, Chhattisgarh during *Rabi* season, 2016-17 comprising 9 treatments (treatments were different bacterial consortia and control without inoculate in bacteria and 3 replications in CRD with the objective to find out the effect of non rhizobial nitrogen fixer of bacterial consortia on rhizobium nodulation behaviour in chickpea. The results of nodule study under pot experiment revealed that the highest nodulation was recorded in with T5: chickpea with rhizobium +75%NPK i.e. 39.33 followed 38 plant^{-1}by T3: (Chickpea +consortia of *Rhizobium*, *Azotobacter*, *Azospirillum*+75%NPK) and least plant nodule was recorded as uninoculated of control with 12.33 plant^{-1} at 45 DAS. The highest fresh nodule weight was T5 (48.33 mg plant^{-1}) followed by T3 (45 mg plant^{-1}) and fresh weight of control was (18.33 mg plant^{-1}). Dry weight in T5 (22.67

mg plant^{-1}) followed by T3 (19.33 mg plant^{-1}) and dry weight of control was 6.33(mg plant^{-1}).Further C1 also has maximum root length (27.00 cm) and root biomass (7.30g) as compared to other treatments. Overall results revealed that there is no significant reduction in nodulation by the presence of other non symbiotic nitrogen fixer. However, other plant growth was positively in presence of symbiotic and non symbiotic members in same microbial consortia.

P 13: Studies on *Azospirillum* with special reference as biocontrol agent for the control of soil borne plant pathogens

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Azospirillum population significantly varied from 3.81×10^{8} to 4.90×10^{8} in rhizosphere and from 2.09×10^{8} to 2.88×10^{8} in root tissues. Among the total six isolates, isolates LAIS-21, LAIK-06 and LAIJ-04 were more potential regarding nitrogen fixation and fixed 19.2 mg, 14.9 mg and 11.0 mg N g^{-1} malate, respectively. Out of these three isolates, isolate LAIS-21 recorded higher plant height (45.5 cm), number of fruits per plant (36.2), fruit diameter (4.8 cm), fruit weight (57.9), root length (10.3 cm), fresh root weight (23.7 g), yield per plant (2.1 kg) and N content in leaf (58.8 g kg^{-1}), in comparison to other isolates, and also recorded 31.8, 54.7, 23.7, 9.2, 60.9, 23.7, 110.0, 34.6 per cent respectively increased in above parameters over control under green house conditions. Isolate LAIS-21 also recorded the highest yield (808.3 q ha^{-1}) of tomato under field conditions.

For the studies on antagonistic activity of *Azospirillum* against important soil borne plant pathogens viz; *Fusarium* and *Rhizoctonia* and a bio-control agent *Trichoderma*, the best three local isolates of *Azospirillum*, regarding nitrogen fixation, was selected. Antagonistic activities were compared with one local and one national isolate as check. Under *in vitro* condition, all the *Azospirillum* isolates as LAIJ-4, LAIK-6, LAIS-21, LAIB-A and MTCC-C significantly reduced the hyphal growth of *Rhizoctonia* by 88.80, 88.82, 90.22, 88.78, 89.02% and of *Fusarium* by 8.62, 13.38, 19.46, 13.38, 16.12% and of *Trichoderma* by 59.78, 54.18, 79.16, 67.14 and 58.24%, respectively. Among the all isolates of *Azospirillum*, isolate LAIS-21 was the most effective bio-agent against all the test fungi by restricting the hyphal growth of *Rhizoctonia* (0.81 cm), *Fusarium* (5.88 cm) and *Trichoderma* (1.86 cm) with 90.22, 19.46 and 79.16% inhibition. Isolate LAIS-21 was the most effective against *Rhizoctonia* closely followed by *Trichoderma* and after that *Fusarium* regarding the inhibition of hyphal growth in dual culture technique. *In vivo* condition, LAIS-21 recorded the lowest mortality of tomato seedlings against *Rhizoctonia* and *Fusarium* (14.0 and 64%), the cause of damping off and wilting disease of tomato, respectively.

The best antagonistic isolate of *Azospirillum LAIS-21* was used for the preparation of formulation with locally available different carrier materials to find out the best carrier in terms of better survival of the inoculant, pH value and moisture retained content. Among different carrier materials used, vermicompost + fly ash was the best carrier material for the survival of *Azospirillum LAIS-21* as evident from its higher cell count for a period of eight months. Survival of microbial inoculants was estimated at monthly intervals over a storage period of eight months. Among the different carriers, vermicompost + fly ash was found to record a maximum population of 7.95 x 10^{8} cfu/g of carrier on the eighth month of storage with maximum moisture content of 35.90 % and pH content with 7.1.

P 14: Soil improvement by organic farming using crop beneficial microbes

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A field study was conducted during *Kharif* 2017 in Indira Gandhi Krishi Vishwavidyalaya, Raipur(Chhattisgarh) in Inceptisol with rainy season rice to find out the effect of combinations of different organic manures along with biofertilizers on soil health and crop yield. Three different types of organic manures i.e. FYM, Poultry manure and Vermicompost were mixed in different combinations and applied in field to fulfill the nitrogen requirement of the crop. Different non–chemical weed management techniques were also evaluated to find out the suitability for organic farming comparing with chemical herbicides. The experiment was laid split plot design with three replications and twelve treatments involving organic manures and two microbial biofertilizers *i.e. Azotobacter* and Phosphate solubilizing bacteria. The results of the experiment revealed that percentage organic carbon in soil due to incorporation of different organic manures and biofertilizers but non significant variation in organic carbon content was observed in soil due to different organic treatments put in main plots. Maximum amount of organic carbon was quantified in soil due to application of 50% N by FYM + 50% N by poultry manure + *Azospirillum* + PSB, followed by application of 50% N by FYM + 25% N by vermicompost + 25% N by poultry manure + *Azospirillum* + PSB. Among different weed management methods (excluding weedy check) maximum amount of organic carbon content in soil was accumulated in Green manuring treatment which found at par with rest of the treatments. Lowest amount of organic carbon was estimated in soil where recommended herbicides were applied.

The organic manures and biofertilizers improved the microbiological and biochemical properties of soil which was proved by higher dehydrogenises activity (DHA), microbial biomass carbon content (MBC) and basal soil respiration rate (BSR) of soil. Among different nutrient management treatments maximum DHA, MBC and BSR of soil was found due to nutrient management by 50% N through FYM + 50% N by poultry manure and application of PSB and *Azospirillum,* which was found at par with treatment 50% N by FYM + 25% N by vermicompost + 25% N by poultry manure and application of PSB and *Azospirillum.* Among weed management methods, DHA was found maximum in green manuring treatment (excluding weedy check). This was found at par with other weed management methods except motorized weeding (single row type) and recommended herbicides application. Similarly, MBC was found maximum in green manuring treatment (excluding weedy check), which was at par with other weed management methods. Minimum value of MBC was found in soil due to application of recommended herbicides.

Significant difference in grain yield of scented rice was found under different nutrient management practices. Application of 50% N (FYM) + 50% N (poultry manure) + *Azospirilium* + PSB produced significantly higher grain yield over 50% N (FYM) + 50% N (vermicompost) + *Azospirilium* + PSB. However, in weed management practices maximum grain yield was found under application of oxadiargyl 80 g /ha fb bispyribac Na 25 g /ha which was significantly superior to rest of the treatments. In case of other then chemical method of weed management hand weeding twice and motorized weeder (single row type) twice were equally effective and recorded comparable yield.

Looking to the above findings it is concluded that application of 50% N (FYM) + 50% N (poultry manure) + *Azospirilium* + PSB was the best organic manures and biofertilizer combination to produce highest rice grain yield and improve the soil quality. Among weed management treatments , hand weeding was found best to control the weeds in organic rice. However, the treatment was found equally effective with other non- chemical weed management methods like motorized weeding (double & single row type) etc.

P 15: Biodiversity of *Fusarium* species and their impact on the health of food grain

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The genus *Fusarium* Link with its different species are known to attack variety of food grain both in field as well as storage and the results found to be responsible for major cause of deterioration and poisoning of the food grains. It is certainly reveals that maximum numbers of *Fusarium* spp. have been recorded and 13 species, 35 strains were isolated from the food grain such as cereals, pulses, oil seeds and spices. However, importance *Fusarium spp.* and their different aspects like enzymatic nature and discolouration role in deterioration in food grain is very significant.

The impact of *Fusarium spp.* on the production of different toxins were remarkable when they were associated with the food grains and their toxicity response, which may result into mycotoxicosis when consumed by animals and human beings (Monoharachary 1986). The toxins or fusotoxins like Moniliformin, Zeralenone, T-toxin, Fusaric acid, Fumonisins, Trichothecene, Fusarin-C, Fumagillin, Deoxynivalenol (DON), Nivalenol (NIV) and Diacetoxyscirpenol (DAS) were produced by the species of *Fusarium* among these the Deoxynivalenol (DON), Nivalenol (NIV) and Diacetoxyscirpenol (DAS) were detected. The attention is given for the alternative management of *Fusarium* species by adopting the fungitoxic extract of plant parts to management of *Fusarium* spp.

P 16: Significance of microbes in plant health management and organic crop cultivation for sustainable crop production

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Organic crop cultivation is an alternative agricultural system which originated early in the 20th century which generally relies on fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting. Biological pest control, mixed cropping and the fostering of insect predators are encouraged. In general, organic standards are designed to allow the use of naturally occurring substances while prohibiting or strictly limiting synthetic substances by sole objective to improve beneficial soil fauna under natural agriculture to regulate important processes in soils (e.g. biological nitrogen fixation, residue decomposition, mineralization/immobilization turnover, nutrient cycling, denitrification) are mediated by soil micro-organisms. The interaction between living organisms and their environment is crucial for a plant's health. Plant's health is more at risk in monocultures and on-farm diversification provide a balanced interaction between different plants and pests and predators. This is why a well-managed ecosystem can be a successful way of reducing the level of pest or disease population. The beneficial impact of microorganisms on plant growth include nitrogen fixation, acquisition and uptake of major nutrients, promotion of shoot and root growth, disease control or suppression and improved soil structure. Some of the commonly promoted and used beneficial microorganisms in agriculture worldwide include *Rhizobia, Mycorrhizae, Azospirillum, Bacillus, Pseudomonas Trichoderma, Streptomyces* species and many more. By significance use of microorganisms plant health and soil health can be managed, which would be helpful positively to sustain crop production and productivity under organic agricultural production system.

Key words: Eco-friendly cultivation, Microorganisms, Organic farming, Plant and Soil Health Management

P 17: Effect of intercropping on managements of chickpea wilt

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Chickpea is susceptible to Fusarium wilt in successively mono-cropped soil. To investigate the effect of intercropping with linseed on chickpea fusarium wilt; *In vitro* experiment were conducted to test the antifungal activity of linseed plant extract (whole plant @ 20,40,60 DAS) was screened by poison food method against *Fusarium oxysporum* f.sp. *ciceri*. The result revealed that the linseed plant extract @20DAS showed highest percent inhibition(71.85%) of *Fusarium oxysporum* f.sp. *ciceri* followed by 67.96% and 65.74% respectively extract at 60DAS and 40DAS. *Fusarium oxysporum* f.sp. *lini* and *Fusarium oxysporum* f.sp. *ciceri* are tested by dual culture method and found FOL suppress the mycelium growth of FOC with 59.33% inhibition of mycelium growth. The population of rhizospheric mycoflora were estimated in rhizosphere of different chickpea and linseed intercrop soils and the data as colonies/g have been presented. In chickpea rhizosphere the maximum fungal population (24.06x10^5) was recorded in sole chickpea followed by linseed:chickpea 2:2 intercrop. Linseed rhizosphere soil contain maximum (31.33x10^5) fungal colonies in linseed:chickpea 1:1 (15:15cm) intercrop. This suppressiveness, based fundamentally on microbiological interactions, relies on the complementary association of a general mechanism of competition for nutrients between the microorganisms.

Technical Session-VI :

Mushroom Production Technology: An Important Agri-business

Lead Lectures
LL 01: Medicinal mushrooms as a potential source of nutraceuticals: Indian perspective

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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, *Lentinula*, *Pleurotus, Auricularia, Flammulina, Hericium, Grifola, Tremella* etc. Of them, *Lentinula* has immense medicinal value and is most widely cultivated world wide. Biologically active compounds produced by this mushroom include antitumour, antiviral, antimicrobial, hypocholesterolemic and hypoglycemic properties. 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 sinuses* 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 tumour 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 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.

LL 02: Nutritional and medicinal values of mushroom: An important source of health security

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Mushroom is a macro fungus with a distinctive fruiting body. Out of over 10,000 species of mushrooms, more than 2000 species are edible. Since ages, mushrooms have been serving the mankind not only as delicious dishes but also as nutrition's and medicinal commodity. Because of these virtuous properties, mushrooms were glorified as "Elixir of Life". Mushrooms exhibit a wide range of biochemical reactions. Further, they are endowed with the ability to secrete a wide variety of hydrolyzing and oxidising enzymes which have potential for biotechnological applications. Mushrooms are used as food, nutritive agents, medicinal anti ageing agent, hallucinogenic agent and in preparation of spiritual products. In view of recent up serge in interest in traditional remedies for treatment of various physiological disorders in human being, the study of the role of mushrooms as healer and health potentiator of mankind, is the need of the hour.

Hippocrate, father of medicine used to say, "Let the food be your medicine". Mushrooms, trace to this saying, have come up as "Ultimate health food". The medicinal power of mushrooms have been recognised for millennia but full orientation of their therapeutic properties remain largely untouched & unexplored. Owing mainly to realization of deleterious health effects of man made medicines and their unscrupulous uses for mere financial gains, world opinion, late, is gradually shifting favouring alternative system of medicine. Mushrooms, not only supplement and complement human diet, with various ingredients not encountered or deficient in food items of plant & animal origin, unique chemical composition makes mushroom suitable for specific groups suffering from physiological disorders or ailments. More than 20 medicinal mushrooms are being produced, seven are commercially marketed all over the world. Value wise most important ones are *Ganoderma lucidum, Grifola frondosa, Cordyceps sinensis, Lentinula edodes, Hericium erinaceous, Schizophyllum commune*. Edible mushrooms showing medicinal properties are species of *Lentinula, Hericium, Grifola, Flammulina, Pleurotus, Tremella.* Other mushrooms known only for medicinal properties are *Ganoderma lucidum* and *Coriolus versicolor*. They are non-edible because of their coarse texture and bitter taste. They are rich in polysaccharides, triterpenoid, lentinan, adenosine, linghi – B, polysaccharide krestine (PSK), polysaccharide peptide (PSP).

Ganoderma lucidum is univocally and unquestioned king of medicinal mushrooms. Its medicinal properties are attributed to presence of polysaccharide and triterpenoids in it. Biologically active compounds primarily present include polysaccharide (50 types have been isolated), tri-terpenoids (more than 100 types), low molecular weight proteins and immuno modulating compounds. Most promising mushroom derived product is the polysaccharides. Polysaccharide exhibits immunomodulatory, antitumor (anti cancer) and antivirus (including human viruses) activities. Active fraction of polysaccharide are β-D glucons, β-D glucon with heteropolysaccharide chain of xylose, mannose, galactose β-D glucan complex *i.e.* proteo-glucan may involve several agents including activated macrophages, natural killer cell (NK cell), cytotoxic T cell, & their secretary products such as Tumor Necrosis Factor (TNF), cytokines and interleukins, macrophages NK cell & T cells are stimulated. NK cell destroys tumor cells rapidly. Mushroom products are not drug, they should be used as adjuvant therapy. All said and done, there are certain words of caution which needs serious attention while evaluating the nutritional and medicinal properties of mushrooms:

- Over claims about health benefits and commercial consideration of mushrooms are presenting it as panacea (universal remedy) should be subjected to rigorous screenings, for validation.

· Mushroom products should be propagated as health supplements & not as a drug. They can be used as adjuvant therapy. They of course, can be marketed as 'over the counter medicine'. Strict quality control measures for production and marketing is warranted.

Last but not the least, it can be concluded beyond doubt that some mushrooms possess pharmacological properties. They usher wellness with minimum adversaries. There is however wide scope of screening other mushrooms both wild & cultivated for medical attributes. Future of mushrooms looks bright but demands greater perseverance and determined efforts (concerted).

LL 03: Enhancing nutraceutical potential of *Lentinus edodes* mushroom from a pharmaceutical point of view

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Mushrooms have been valued since ages due to their excellent nutritive value and remarkable therapeutic potentials. They are rich in various bioactive molecules and polysaccharides which makes them desirous both in the nutraceutical as well as the pharmaceutical industry. *Lentinus edodes,* the third largest consumed mushroom worldwide, is now a day's effectively utilized to manufacture drugs, extracts and capsules to treat diseases like cancer and tumors. The increasing commercial importance of fungal polysaccharides (glucans) envisages its global usage as a medicine/drug. In this regard, the present research was carried out to study the nutraceutical potential of *L. edodes* grown on different substrate combinations. The beta glucan content and was quantified using enzymatic hydrolysis. Different levels (2%, 3%, 5%, 10% and 20%) of wheat bran, cotton seed cake and mustard cake were used as supplements with the substrate, mix saw dust (MSD) for cultivation. The results revealed that the addition of nitrogen sources significantly enhanced the yield over control. The optimum concentrations of cottonseed cake, mustard cake and wheat bran in enhancing the yield of fruit bodies, was found to be 2, 3 and 5% respectively. Maximum B.E i.e. 60.87% was obtained in case of combination SD+2% CSC. Nutraceutical analysis revealed that the fruit bodies from supplemented substrates were rich in proteins (18.23-25.12 %) and micro as well as macro minerals. Glutamic acid and Tyrosine were the major non essential and essential amino acids with a content of 4.91g 100 g^{-1}dw and 2.99 g 100 g^{-1}dw respectively in the fruit bodies harvested from the combination of SD+2% CSC. Antioxidants such as total polyphenol and flavonoid contents were in the range of 18.87- 40.76 mg/g dw and 0.87-5.23 mg QE/g dw respectively. The maximum beta glucan content was found to be 56.71g/100 g in the fruit bodies from SD+2% CSC. The major bioactive molecules extracted by supercritical CO_2 extraction, tested by GC-MS analysis showed seventy two compounds including those associated with vitamin D synthesis. The study proved beneficial for successful utilization of wood waste (mixed saw dust) thereby producing nutraceutically rich edible *L.edodes* mushroom in India for pharmaceutical applications. All the data pertaining to yield and nutraceutical components of fruit bodies, from different treatments, extracted by different methods will be presented at conference.

Key words: mushrooms, nutraceuticals, *L.edodes,* beta glucans

LL 04: Present scenario of mushroom production in Chhattisgarh State

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Mushroom cultivation is one of the most proven income generating enterprise in different parts of the country to double or triple the income not in five years as conceived by the Hon'ble Prime Minster but in two or three years. It is the important source of food, nutrition, income and employment security in rural sector of the society particularly in Chhattisgarh state which is pre-dominated by tribal community. There are four types of mushroom which are mostly grown in the existing agro-climatic conditions of Chhattisgarh. Mushroom Spawn, being the most important input in mushroom cultivation has been well taken care of by the Krishi Vigyan Kendras (KVKs) apart from ICAR-AICRP on Mushroom at IGKV, Raipur by establishing Mushroom Spawn Laboratory and Mushroom Crop Production unit. KVKs of IGKV has made tremendous efforts to establish Mushroom Spawn Laboratory and Mushroom Crop Production unit in 14 KVKs (Bastar, Dantewada, Bijapur, Kanker, Dhamtari, Mahasamund, Rajnandgaon, Kawardha, Janjgir, Korba, Korea, Ambikapur, Raigarh, Bilaspur) of IGKV out of 24 KVKs and one KVK of Chhattisgarh Kamdhenu University (CGKV) i.e. KVK, Durg. Besides this, there are three colleges of our university namely SKS College of Agriculture and Research Station, Rajnandgaon, KL College of Horticulture, Rajnandgaon and SK College of Agriculture and Research Station, Kawardha which are technically supported by me as State Nodal Officer.

Oyster mushroom is one which is most pre dominantly cultivated by the tribals almost round the year due to ease of cultivation technology, availability of spawn, less time required for cultivation, low technical know how required and cheap availability of agro waste (>130 lakh tonnes of agrowaste in CG) mainly paddy straw, wheat straw substrates, mustard straw, sugarcane baggase, chickpea straw etc. It is very much liked by the tribal community followed by paddy straw mushroom, milky mushroom and button mushroom. Oyster mushroom is practiced by >1000 individual women /Women SHGs, >250 entrepreneurs in Dhamtari distt. are promoted by Sri Rajeev Lochan Agro Invention Producer Co. Ltd., Megha (Dhamtari distt.) whose members are involved in Mushroom Spawn production, oyster mushroom crop production, mushroom processing and mushroom marketing, >200 farmers in Rajnandagoan distt. by SHGs are practicing oyster mushroom production and processing. Similarly, paddy straw mushroom is demonstrated by our KVK, Janjgir and gradually picking up well in Janjgir-Chapa, Dhamtari, Mahasamund and Raigarh districts which are well connected by road to Odisha State. The farmers in these areas are growing paddy straw by procuring the spawn from our KVKs as well as Cuttack areas by regular bus services. At Janjgir distt., >500 farmers have made the Mushroom Federation called "Anndata Bahuuddeshiya Society" at Behradih of Janjgir distt. in which 50 farmers groups are working. This mushroom federation is registered under Deptt of Cooperative and growing paddy straw mushroom in a big way. The farmers are very well supported by the District Collector. Similarly, Raj Mushroom Kisan Nidan Club Training and Research Centre, Pathiapali is supporting paddy straw cultivation by >250 farmers of Mahasamund distt. In the same way, the Department of Forest, Pithora (Mahasamund) under our technical guidance is involved in training and cultivation of oyster and paddy straw mushroom to >300 farmers at Pithora Nursery of the Forest Department. They are at the completion of a big Mushroom Spawn Production Unit in their nursery under my guidance and supervision and soon going to establish a semi automated Mushroom Spawn Lab with the help of IIHR, Bangalore .

Under State Rural Livelihood Mission *i.e.* LIFE-MGNREGA Project, we trained 6308 farmers who have given their consent to follow mushroom as an income generating activity. Under this project, the farmers/labourers who have continuously served for 100 days in MGNREGA project without break were considered to be one who is the poorest and most needy person in the society and required to be supported by the government on top priority. The family members who showed their interest in mushroom cultivation were identified by the officials from SRLM and these farmers were imparted residential training of six days by 12 KVKs of Chhattisgarh during 2016-2017 under my guidance and close supervision as Director, Extension Services, IGKV, Raipur. Under this project, 432 farmers/labourers were trained by us by organising 6-day residential training programmes by 12 KVKs (Surguja, Bijapur, Dhamtari, Bastar, Raigarh, Korba, Rajnandgaon, Gariaband, Janjgir-Chapa, Kanker, Narayanpur and Bilaspur). Many of the farmers trained by us are now growing mushrooms in their household in a small scale. Similarly, Chhattisgarh State Skill Development Authority has identified Mushroom Production as an important income generating activity as a result we have been given the target to impart training on Mushroom Production Technology to the school dropouts who passed 8^{th} class/rural youths/farmers who are interested in mushroom growing.

As State Nodal Officer (Mushroom), I was asked to organise training programmes on Mushroom Production Technology through different KVKs/Colleges of IGKV, Raipur. Under this scheme, 132 farmers were provided 90 hrs. training on Mushroom Production Technology and they were trained at KVK, Janjgir-Chapa, Surguja, Jashpur, Bhatapara, Jagdalpur, Dhamtari and Dantewada distts. during 2016-17. KVK, Janjgir-Chapa and Korba have also conducted on farm trials (OFT) on paddy straw and oyster mushroom to demonstrate the technology to the rural farmers. The technology has also been demonstrated under the developmental project entitled "Developing Livelihood Opportunities for Reducing Poverty through Community Irrigation and Integrated Farming Systems" at Gotatola and Surgi villages of Rajnandgaon under SRLM.

Similarly, the training programme on Mushroom Production Technology was imparted to 40 farmers (Men/women) for 90 hrs. under a Ad-hoc project "Transfer of technology to develop human resources in alleviating nutritional and stress problems" sponsored by Chhattisgarh Council of Science and Technology, Raipur to Dr. M.P. Thakur as Principal Investigator during 2016-17. This was the off campus training programme and organised at Technology village Sirri and the farmers involved in the training were from Sirri, Chivri, Dhendha, Karana, Hatband, Karga, Kotgaon and Alekhuta villages based on their interest in this area. Farmers during training in general were explained about the latest technology package of cultivating oyster, paddy straw, milky mushroom with more emphasis on practicals. They were also prepared for writing of Detailed Project Report to get the financial assistance from the funding agencies. Similar training on Mushroom Processing Technology was provided to 45 and 47 women/men in two batches from the same villages during 2017-2018. They were trained in post harvest handling, processing and preparation of mushroom based value added products like mushroom papad, mushroom nuggets, mushroom pickle, royal oyster capsule, mushroom fortified wheat flour. The present paper dealt with the details of mushroom spawn units established, training programmes conducted under different schemes, on farm trials and FLDs conducted by KVKs on Mushroom Production Technology with reference to Chhattisgarh State.

Invited Lectures

IL 01: Global scenario of mushroom production and prospects in food and nutrition

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Agriculture is the backbone of farmers on which Indian economy depends and variety of agricultural crops is grown. We have achieved food security by production of food grains 277.49 million tons during 2017-18 (*Sally* and Bureau 2018).Govt. sets food grain production target at 284 MT for 2018-19. India produces about 600 million tones of agricultural wastes per annum and a major part of it is left out to decompose naturally or burnt *in situ*. These can be utilized to produce high value food *i.e.* mushrooms followed by utilization of spent mushroom substrate by converting it into organic manure (Pratap Singh and Prabha,2017). Mushrooms have been exploited commercially world over and cultivated gathered from the wild. Fungal biotechnology has become an integral part of the human welfare (Manoharachary *et al*. 2005). Hawks worth (1997, Chang ,2006) reported that out of 270,000 plant species about 70,000 fungal species have been described and suggested that around 14,000-15,000 species considered as macro fungi producing fruiting bodies and the total number of fungal species have been reported to be 1.5 million. Among them 14000 fungal species 50% i.e. 7000 species possess varying degree of edibility. Now more than 3000 species were reported under 31 genera which have edible characteristics. Around 5–10% of fungi can be cultured artificially. Only 200 of them are cultured, 100 economically cultivated, approximately 60 commercially grown and about 10 have reached an industrial scale (Chang and Miles, 2004). Furthermore, about 1,800 are medicinal ones. Over 2000 species of edible fungi known to man out of a total of 10,000 species of macro fungi reported to be growing in the world (Dhar and Singh, 1999).Archaeological evidences reveal that edible species are associated with people living 13000 years ago in Chile (Rojas and Mansur, 1995) but in China where the eating of wild fungi was first reliably noted several hundred years before birth the of Christ (FAO, 2004). Boa (2004) overviewed of wild edible fungi and reported a global overview of their use and importance to people collected for food and to earn money in more than 80 countries. There is a huge diversity of different types, from truffles to milk-caps, chanterelles to termite mushrooms, with more than 1100 species recorded. The people used to go the forests to collect wild species based on their personal knowledge of edible and poisonous mushrooms they used to collect the edible ones and sale in local market and also eat them. Hobbs (1995) stated that many cultures have been identified that certain mushrooms could have profound health-promoting benefit. In India, 914 species have been reported .One third of fungal diversity of the globe exists in India. Jain (2005, First Mycologist) reported that mushroom cultivation in India in early 1950 that have grown *Agaricus* and other species successfully on rotting apple tree twigs and branches, cow dung and wheat straw etc., popularized among the farmers of Himachal Pradesh. Now 100 countries are growing mushroom previously, the edible mushrooms were grown in France and Japan. Several reports on wild edible mushrooms have been collected and consumed by people since thousands of years.

China is the world's largest edible mushroom producer (Anonymous, 2003) produces about half of all cultivated mushrooms, and around 2.7 kilograms (6.0 lb) of mushrooms are consumed per person per year by over a billion people and 95% of mushroom production in China is consumed locally, the consumption per capita is likely to be over 10 kg/person/year (Chang, 2006). This is drastically higher than in US and many European countries where it is around 3 kg/person/year. With the development of the technologies in India was the production started in the 1970 but for environmental controls and understanding of the cropping systems, mushroom production started from mere 5000 tons in 1990 to about 1,20,000 tones in 2016. At present, the total mushroom production in India is approximately 0.13 million tons (Sharma *et al.* 2017).The cultivation programmes have been hosted by government and non-government organizations to upgrade the living standards of mushroom farmers. The mushroom cultivation is a profitable agribusiness for farmers for additional income, possesses high nutritional value, rich source of the antioxidants, ergothioneine and glutathione (Kelaras *et al*. 2017). It has high medicinal properties and high demand in local and international markets. China, India, and Indonesia are the most important global mushroom exporting countries in Asia, has canning industries. Global consumption amounted to 3.3 million tons. The other consumers are Canada, Japan, Russia, Australia and SriLanka (Thilakaratna and Pathirana, 2017; Muhammad and Suleiman, 2015)).Rudolf Mulderij (2016) overviewed global market of mushrooms with the arrival of autumn in the northern hemisphere; the demand for mushrooms usually increases. Europe is the largest market for cultivated mushrooms, accounting for more than 35 percent of the global market. Moreover, demand rose in North America and South America is also recording an explosive growth. Meanwhile, Africa and the Middle East recorded a reasonable growth focused on healthy and organic foods; demand in these countries will continue to grow. A recent survey shows that the market had a value of $35 billion in 2015. Between 2016 and 2021, the market is expected to grow by 9.2 percent. This would bring its size to nearly $60 billion in 2021

The current status of mushroom industry globally has expanded both horizontally and vertically in production with addition of newer types of mushrooms for commercial cultivation, both edible and non-edible mushrooms have reported that the industry has expanded very rapidly in the last two decades by the addition of newer types of mushrooms for commercial cultivation. India, being a developing country is fortunate to have a varied agro-climate, abundance of agro wastes, relatively low-cost labour and a rich fungal biodiversity. In India, 914 fungal species have been reported (Sharma *et al*. 2011, Sharma, 2013). The people used to go the forests to collect wild species based on their personal knowledge of edible and poisonous mushrooms they used to collect the edible ones and sale in local market and also eat them. These factors combined make India a potential major producer of temperate, tropical and subtropical mushroom species. Per capita consumption of mushrooms in India is less than 50 g as against over a kg in various countries. Moreover, its enormous population could support the large-scale consumption of nutritious mushrooms by a significant health-conscious urban population as well as the rural masses struggling with hunger and malnutrition, particularly vegetarians who rely heavily on a cereal based diet. There is good demand for processed and fast foods. Mushrooms may be canned to meet the demand in the off-season and in the non-producing areas. There is no denying the fact that production of mushrooms, especially of the white button mushroom, in India has gone up in the last few years, but it has also exacerbated its marketing problems. Therefore efforts should be made to increase the production and solve the marketing problems. From 2010-2017, the mushroom industry in India has registered an average growth rate of 4.3% per annum. Out of the total mushroom produced, white button mushroom share is 73% followed by oyster mushroom (16%), paddy straw mushroom (7%) and milky mushroom (3%).Compared to other vegetables; per capita consumption of mushrooms in India is meager i.e less than 100 grams per year. During 2016-2017, Indian mushroom industry generated revenue of Rs. 7282.26 lacs. The spawn demand in India is estimated about 8000-10000 tons per annum (Sharma *et al.* 2017).The marketing of fresh mushrooms would determine the future of mushroom industry in India (Karthick and Hamsalakshmi, 2017). Recently Kumar and Satishchandra, 2017) have recommended as a promising wild mushroom *(Polyporus grammocephalus*) for consumption and the for spawn production of wild mushroom *P. grammocephalus,* pearl millet is found to be the promising substrate.

Mushrooms are of excellent food value as they provide a full protein food containing all the twenty one amino acids besides containing useful amount of fats, vitamins and minerals. Mushroom protein being easily digestible (70-90%) is considered superior to vegetable proteins. Two essential amino acids lysine and tryptophan are enormously present in mushrooms which are not found in cereals. Being low in caloric value (300 – 390 Kcal/100 g dry wt, low fat and high protein, they are considered as 'delight of diabetic patients'. Mushroom has a rich source of the antioxidants ergothioneine and glutathione (Kalaras *et al*. 2017) as well as folic acid and vitamin B-12 which are normally absent in vegetarian foods are present in mushrooms (3 g fresh mushroom can supply 1 micro g vitamin B12, recommended for daily uptake). Thus mushroom has great potential and prospects to farmers should have to be made aware of the qualities particularly the nutritional and medicinal values of the cultivated species, so the Mushroom as a vegetable is yet to find regular place among the Indian diet in general and vegetable meals in particulars with increase in per capita consumption of mushroom. In the present article the global scenario of mushroom and prospects are discussed.

IL 02: Shiitake: An important medicinal mushroom which has great potential in lowering the cancer calamity in India

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In India mushroom has lower level of acceptance because of ethnological issues as it is called as "Saanp ki chatri" and "Kukurmutta" and this is not one reason, another is some people have misconception of it being non-vegetarian food. I most of the countries especially Yellow race countries like China, Thailand, Japan, Malaysia, Hong Kong, Singapore and Mauritius are the mushroom hubs. Shiitake (*Lentinula edodes*) is one answer to cure cancer because it increases the immunity of body by6 having Beta-1, 3 and 1, 4 glucans present in it. This compound is called as Lentinan. In the studies undertaken to grow this temperate mushroom in this arid region several experiments were conducted like development of new and improved strains through mycelia anastomosis, substrate standardization, chilling treatment, spawn rate, best time to start growing this mushroom. Out of these experiments it was found that anastomosis by taking eight improved strains across Asia like China (By Dr. M.P. Thakur), Thailand (By Dr. Sukanya), Israel (By Dr. S.P. Wasser) and two strains from DMR, Solan, there were total 21 cultures where clamp connections were formed. These were screened for their yield on standard substrate and ten strains were found promising which yielded up to 150% B.E. (Biological Efficiency). These ten strains were deposited to IMTECH, Chandigarh and their accession numbers were given. Several agro wastes were tried in combination with wheat straw and basal as saw dust. The 1:3 (Wheat straw: Saw dust) was found best giving 133% B.E. Further, this has to be sterilized in autoclave and poplar saw dust was most suitable. The formula 10 Kg dry mixture of substrate+2 Kg wheat bran+ 0.5 Kg $CaCO_3$ was the most suitable mixture as the desired pH and nutrition is available in this substrate. Spawn rate under ambient environment of Rajasthan in winters *i.e.* from October to March is 3% of wet weight of substrate. It takes 40-45 days to complete the spawn run and when browning of bags begin, they should be opened. After opening few holes 3-4 cm deep are made and chilling treatment in water having 5°C temperature for 2-3 hours as shock treatment gives very good initiation of bumping and ultimately large sized fruit bodies can be harvested. I have designed a chiller for this purpose which can maintain the desired temperature. It was a very interesting finding that once spawn run completes and chilling treatment is given regularly, it can fruit under high temperature also. However, temperature during spawn run should not be more than 18-20 degree C.

Key words: Shiitake, Chilling treatment, Mycelia anastomosis.

IL 03: Seasonal production of button mushroom *Agaricus bisporus* in India

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Mushrooms are fruit bodies of macro-fungi/ higher fungi, belong to Basidiomycetes but some are Ascomycetous also. The organisms comes in the phylum fungi are neither animal nor plants but of a separate entity. The mushrooms as vegetable, prized for their delicacy, nutritional and medicinal values besides an upcoming domestic and international trade. The mushrooms have unique ability to degrade cellulose, hemicelluloses and lignin of different agro and organic waste materials and utilize them to produce edible biomass (protein) of high nutritive and medicinal value. Among various edible mushrooms cultivated in India, (species of oyster mushroom *Pleurotus*, paral/paddy straw/straw mushroom *Volvariella*, dudhia/milky

mushroom *Calocybe*, shiitake mushroom *Lentinus* etc.), white button mushroom (*Agaricus bisporus*) is most important and accounts for 80% of the total mushroom production. *Agaricus bisporus* belongs to Family Agaricaceae, Class Basidiomycetes of Phylum Basidiomycota in kingdom fungi. In India earlier its production was limited to the winter season, but with development of new technology, the mushroom is produced almost throughout the year in small, medium and large farms, adopting different levels of technology. Cultivation of button mushroom started in the 16th century in the western countries but its production on commercial scale initiated around 17th century. India, with its diverse agroclimatic conditions and abundance of agricultural wastes, has been producing mushrooms, mainly for the domestic market, for more than four decades but commercial production picked up in nineties and several hi-tech export oriented farms were set up with collaborations of foreign technology. In seasonal growing low cost technology is adopted by majority of small and marginal farmers as the major share of mushroom production is still on small farms. In India common farmer/mushroom grower could not afford hi-tech facilities/controlled conditions for growing button mushroom throughout the year as the temperature shoots up from 30+ to 48+ in different parts of India during April to October and the required temperature for *Agaricus bisporus* is 15-20c with optimum at 16-18c for fruit body formation, although up to 25 C is safe for its mycelial or vegetative growth/spawn run. Most favorable time duration for its cultivation under seasonal/natural conditions in north-west and north-eastern plains, eastern and mid central part of India, is mid-October to February/mid-March, where the required temperature for button mushroom can easily be managed and growers can take two crops in winter season. In seasonal mushroom growing the farmer has to depend on the required season available and they coincide various operations accordingly. In seasonal cultivation marginal farmers can get minimum average yield of (500-600 kg/ton of wheat straw) on compost prepared by long method by growing 2 crop and earn a handsome amount apart with their other agricultural activities. Whereas in hill region like Kashmir, Himachal Pradesh, Uttarakhand, Darjeeling, North-East, Sikkim, Ooty and various other hilly regions of the country, button mushroom can be grown all year round where 3-4 crops can be taken. Mushroom cultivation requires straw of different cereal, legumes etc. for substrate preparation and there is abundant cereal straw available in India and even farmers of Punjab, Haryana and UP are burning the paral (rice straw) which they can utilized as a suitable substrate for mushroom growing.

IL 04: Mushroom spawn production in commercial scale

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Agri-business in mushroom production and marketing is becoming popular and flourishing. Educated youths are taking up this activity in nook and corner of country. There are number of units of spawn production, mushroom cultivation and mushroom processing in different regions. Most of the mushroom growers procure mushroom spawn from spawn laboratories established in their areas and few of them import spawn and then multiply at their units. There are few spawn laboratories which produces 350-400MT mushroom spawn annually and some laboratories produces around 100-150MT spawn annually and rest most of spawn laboratories produces and sale spawn around 50-100MT annually. These most of the small commercial units are large in number but they produce spawn to cater seasonal growers and operate only for few months in a year. Medium and big commercial units produces mushroom spawn from 8 to 12 months in a year to either for their own mushroom production units and or to supply spawn to small mushroom production units which produces fresh mushroom throughout the year in Environment Control Units. Commercial mushroom spawn production is a lucrative and profitable agri-business. Government is promoting this activity in every state through MIDH by way of giving 40% subsidy on the unit. There are few challenges in this sector also like erratic power supply, non availability of regular round the year demand and lack of spawn standards throughout the country.

IL 05: Evaluation of indigenous 'P' solubilizing and siderophore producing *Pseudomonas* strains for *Agaricus bisporus* (button mushroom) production

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Mushrooms like *Agaicus bisporus* are cultivated for food worldwide. Fruiting initiation in button mushroom requires a layer of soil, casing layer, which accelerates pin head initiation and fruiting. Development of primordia and induction of fruiting are stimulated by decrease in temperature and CO_2 concentration and the presence of saprophytic bacteria such as fluorescent psedomonads in casing layer. Bacteria are responsible for secretion of hormone like compounds, consumption of volatile self-inhibitor produced by vegetative mycelium of mushroom, organic and inorganic P solubilization and production of siderophore, which in turn is responsible for basidiocarp initiation and development of *Agaricus bisporus*. The objective of the present investigation was to identify the best 'P' solubilizing and siderophore producing bacterial strains as suitable inoculants for increasing *A. bisporus* yield.

Soil samples collected from different altitude of North-western Himalaya were used for enumeration and isolation of bacteria by plating serial dilutions of each samples. The bacteria were screened for phosphate solubilizing activity and siderophore producing ability. Biochemical tests for production of UV fluorescent pigments, oxidase, catalase and growth at 4and 15^0C were employed for identification of the strains. Fourteen strains identified as potent bacteria and having compatibility with *Agaricus bisporus* strain Delta were used for experimentation. For preparation of inoculum, all the strains were grown in King's B broth medium for 48h at 28^0C. Bacterial suspensions of 10^6cfu/ml were used for inoculation. During the casing, bacterial suspensions were applied to the casing layer of plastic bags containing mycelial colonized pasteurized compost (10 kg capacity). Inoculations were performed in a completely randomized design with 04 replications.

The results showed that pin head initiation period varied from 16.3 to 19.3 days after casing in different strains. The average yield of *Agaricus bisporus* was significantly higher in the casing soil inoculated bags with *Pseudomonas* sp. strain CS11RP1 (15.4 kg/Q compost wt.) followed by *Pseudomonas fragi* strain CS11RH1 (14.4 kg/Q compost wt.) which was 23.2% and 15.20% higher than the yield obtained in un-inoculated control (12.5 kg/Q compost wt), respectively.

IL 06: Oyster mushroom cultivation : An important income generating activity in rural areas

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Empowerment is a multi-faceted, multi-dimensional and multi-layered concept. Women's empowerment is a process in which women gain greater share of control over resources material, human and intellectual like knowledge, information, ideas and financial resources like money - and access to money and control over decision-making in the home, community, society end nation, and to gain 'power'. Indian agriculture is known for its multi-functionalities of providing employment, livelihood, food, nutritional and ecological securities. Mushroom production leads to the bioconversion of agro-residues into nutritious food. India produces about 600 million tonnes of agricultural byproducts, which can profitably be utilized for the cultivation of mushrooms Singh *et al.* (2011). Currently, we are using 0.04% of these residues for producing around 1.2 lakh tons of mushrooms. In the wake of increasing population, increase in awareness about health benefits of mushroom and changing food habits, the demand for various mushrooms is likely to increase sharply. It is considered as an alternative source of income to uplift the living standards of poor farmers. It also includes high quality protein in their daily diets which helps in eradication of mal nutritional problems. Mushrooms are popular for their delicacy, flavor and food value. Five main genera constitute 85% of the world's mushroom supply. *Agaricus* (primarily *A. bisporus* with some *A. brasilensis*) is the major genus, contributing about 30% of the world's cultivated mushrooms. *Pleurotus*, a close second, with 5 to 6 cultivated species, constitutes about 27% of the world's output while *Lentinula edodes* (shiitake), contributes 17%. The other two genera, *Auricularia* and *Flammulina* are responsible for 6% and 5% of the volume, respectively (Daniel J Royse,2014). Oyster mushroom has several advantages like requirement of the tropical or sub-tropical climate, fast growth rate, easy cultivation technology and good acceptability at consumers' level. Oyster mushroom (*Pleurotus* spp.) can easily be grown by the rural women with minimum efforts. It is a fast growing edible mushroom and easily cultivated on various lingo-cellulosic waste materials with minimum effort of decomposing the substrates and controlled environmental conditions. Out of various substrates maximum biological efficiency 84% was obtained from paddy straw followed by the biological efficiency 82% from the 1:1 combination of paddy straw and wheat straw. Minimum biological efficiency was obtained from the substrate sugarcane bagasse (47%). Results confirmed that blue oyster, *Hypsizygous ulmerius (*156.00 B.E.) was significantly superior in mean yield over *Pleurotus florida* (121.50 B.E.) and *Pleurotus sajor- caju* (115.50 B.E.) during the winter season (October – February).The biological efficiency of oyster mushroom was increased further up to 12.6 % by mixing of 5% rice bran to paddy straw substrate (107.52 %). Spawning of paddy straw @4% (dry weight basis) was found to be most appropriate in terms of yield and biological efficiency followed by 5 % and 3 % which were exhibited 105, 100.75 and 97.25 % biological efficiency respectively. On nitrogenous supplementation maximum biological efficiency (111.2%) was obtained from 5% saw dust supplemented substrate followed by 5% rice bran (106%) and mustard cake (101.8%). Lowest biological efficiency 88.4% and 87% were observed from 2% and 5% linseed cake supplemented substrates. Amendment of coconut oil @ 0.01 ml/ g showed its superiority among all the oils tested and gave highest yield 103.6% biological efficiency and minimum spawn run period i.e. 16 days followed by sunflower oil 96.4% and 17 days biological efficiency and spawn run period respectively. Nine fungi were found to be associated with the oyster mushroom beds *i.e. Trichoderma harzianum, Trichoderma viride, Penicillium sp, Aspergillus flavus, A. niger, (green moulds); Coprinus spp (incky caps); Sclerotium rolfsii ; Rhizopus sp and Mucor sp..* Among the fungi detected, intensity of green mould (*A. niger and Trichoderma* spp.) was observed highest with a range of (27.08%) over the period of investigation followed by inky caps (*Coprinus spp) 16.67% and Sclerotium rolfsii* (10.42%). *In vitro* study reveals that phyto-extract of neem shows minimum inhibitory effect on mushroom mycelia (4.44%) and inhibited competitor moulds in the range of 36.92- 47.06%. Datura, marigold, dudhia and arjuna phyto-extracts shows good inhibition against *S. rolfsii* i.e. 42.35%, 43.53%, 44.71% and 49.41% respectively. Bavistin and formalin combination shows superiority against mycelial growth of all the contamination in the range of 55.29% -76.92% followed by the application of single use of bavistin and formalin. SMS enrichment study with nitrogen fixing bacteria showed that maximum height (66.3 cm), average shoot biomass (129g), average root biomass (33.3g) and yield (1.48 kg) of tomato plant was obtained by introduction of biofertilizer produced from the combination of SMS with *Azotobacter* spp. and *Azospirillum* spp. (1:1). Spent mushroom substrate when bio-converted into vermin-compost with the application of earth worm *Eisenia foetida*, cow dung and *Azotobacter*, it gave highest plant height 72 cm, maximum average dry shoot biomass/ plant 136g, highest dry root biomass 43.67g and best yield 1.717 kg/ plant of tomato. The average biological efficiency of the small scale mushroom business was calculated as 92% i.e. 920g mushroom/kg substrate from approx. 10 months of crop season with 8-11 crops. The average yearly output of the business was 1380 kg fresh mushroom. It was revealed from the analysis that the cost of 1 kg mushroom as an average of business was Rs. 42.51/- under West Bengal condition that its average sales price was Rs. 80.00/-.

IL 07: Spawn production at small scale and cottage level in villages

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The word spawn is derived from an old French verb *espandre* which means to expand and it has been defined in various ways by different scientists. Vegetative growth of fungus is called the mycelium and material used for planting on beds is called as spawn. Thus, mycelium of mushroom and supporting medium which has nutrition to fungus during its growth called as spawn. Hence, it is equivalent to seed unlike other crops. It play an important role in mushroom cultivation because failure or success of crop depends on quality of spawn. The spawn should be silky or strandy type not cottony type and color should be more or less white not brown. Fresh spawn give better yield than older spawn. Spawn production is taken under aseptic conditions. For this a dedicated mushroom spawn production laboratory is required. The basic infrastructure and state of art facilities required for a spawn production laboratory are laminar air flow, autoclave, BOD incubator, lab refrigerator, LPG gas stove, hot air oven, weighing balance, racks, glass wares and plastic wares, polypropylene bags, PVC rings etc., cereal grains, calcium sulphate and calcium carbonate. Spawn is most commonly prepared in heat resistant polypropylene bags which have double sealing at the bottom. The ideal size of bags for half kg of spawn is 35 x 17.5 cm and for one kg of spawn is 40 x 20 cm. The grains after boiling for few minutes (soft but not cracked) are mixed with gypsum (calcium sulphate @ 2%) and chalk powder (calcium carbonate @ 0.5%) so that the pH is maintained to around 7-7.8 and to avoid the clumping of the grains. Twenty grams of gypsum and 5 grams of chalk powder is used for 1 kg of the grains used (on dry weight basis). the required quantity of gypsum and chalk powder is first mixed separately and thereafter thoroughly mixed with the grains. The grains are filled in polypropylene bags. Polypropylene neck ring (height 2 cm and diameter 4 cm) are placed near the top by passing the upper open end of bag through this ring. The bag is then folded back and plugged with non-absorbent cotton. These bags are sterilized at 22 p.s.i pressure for 1.5-2 hours and after these bags get cooled, shake them well before inoculation so that the water droplets accumulated inside the bag are well absorbed by the grains. These bags are thereafter put under UV for 20-30 minutes in laminar air flow chamber before inoculation. Under aseptic conditions in the laminar airflow chamber 10-15 grams of mother spawn are inoculated per bag. (If the small scale cultivation has to be taken up, then the mycelium of mushroom growing on slants can also be directly inoculated in these autoclaved bags). The inoculated bags are shacked well and incubated in BOD incubator at 25° C for 15-20 days. The bags are examined regularly for contamination during the incubation. The contaminated bags once observed should be immediately discarded. When the mycelial run is complete the bag becomes white. These bags can then be store at 4° C for future use. These can be stored up to one month or maximum two months

Certain innovations were recorded related to spawn production methodology at Sringarbhata, and Kokpur village, Kanker, Chhattisgarh. It was found that mushroom growers designed a highly innovative, easy to use and cost effective inoculation chamber for mushroom spawn production at home. The design of their inoculation chamber is such that it costs merely Rs. 800-1000/- . Basically it is a plastic container 75cm X 40cm X 40cm with a lid on its top. Use of plastic can be replaced with glass panels in alluminium or wooden frames. Towards one of it's face they had made two circular openings with provision to open and close them with the help of sliding flaps. The openings also had provision for attaching long gloves. Before inoculating the substrate with pure culture they just wipe the container from inside and outside with alcohol. Thereafter they load the packets (10-15) to be inoculated from the top. A spirit lamp, inoculating needle and pure culture petridish is also kept before closing the lid. The packets filled with sterilized substrate are inoculated manually with discs of pure culture against the flame which was possible through the two circular openings on one of it's face. Three to four times a day inoculation was performed. As a result they inoculate about 40-50 packets of sterilized grains in one inoculation chamber for producing spawn everyday on a regular basis. They are now not handicapped in terms of lack of availability of good quality mushroom spawn and have taken up oyster mushroom production at commercial level producing about 20Kg of fresh oyster mushroom daily. Similar type of inoculation chambers were also made by modifying an aquarium by fitting an UV lamp inside and openings for inserting hands for doing the inoculation work. For sterilizing grains autoclave is necessary, however mushroom growers can use pressure cookers for sterilization of grains. Most of the mushroom growers in Chhattisgarh procure pure culture and mother spawn from IGKV and prepare commercial spawn using these low cost inoculation chambers and pressure cookers. In fact mushroom growers are also considering taking up mushroom spawn production on a large scale which still due to its lack of availability is hindering people from taking up mushroom cultivation as a rural enterprise. Furthermore a novel technique of taking spore prints on small plastics for long term preservation of fungal specimens was also developed at IGKV which can prove highly informative regarding mushroom diversity even at places with less or no infrastructure for fungal identification. After taking the spore print, it can be transported to well equipped research laboratories, where the mushroom can be identified and spawn can be prepared of the identified edible and high yielding strains. The choice of grains for spawn multiplication can be based on availability. Wheat grains, jowar grains, bajra grains, kodo, kutki and other small millets are also used for oyster and milky mushroom spawn production. Chopped wheat straw supplemented with rice bran is also used to prepare paddystraw mushroom spawn. Wood chips of broad leaved trees are used to prepare *Lentinula* spawn in north-eastern states. Grains can be filled either in conical flask or empty glucose bottles (cost Rs. 5) for sterilization and further inoculation with pure culture. The total spawn production reported in Chhattisgarh is around 50 tonnes per annum. IGKV Mushroom laboratory at Raipur has been producing an approximated 5-6 tonnes of spawn per year. Paddy straw mushroom spawn around 10 tonnes is also supplied in Chhattisgarh from Orissa by many commercial spawn produces per year. IGKV Mushroom laboratory at Raipur has been producing an approximated 7-8 tonnes of spawn per year.

IL 08: Mushroom cultivation: Problems and prospects in Chhattisgarh

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"There is Market, Where is mushroom" ? Are my original lines and my favourite quote.

Chhattisgarh is tenth largest state in the country with 135191sq km land area. In Chhattisgarh state paddy production per year is more than 70 lakh tonnes. Paddy straw is very suitable agro-waste for mushroom cultivation. Need of the hour is suitable technology as per the agro-climatic conditions and development of affordable infrastructures as per the need of small and marginal farmers. Mushroom is regarded as super food. Work is required for optimizing the level of production.

Oral Presentations

OP 01: Mushroom production technology: An important agri-business

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Our country is vast and there is enormous potential for mushroom production and consumption. There is abundant availability of raw material and manpower along with varied climate. The substrate being used in mushroom production is agro based waste like stubbles of various crops which otherwise are becoming source of pollution due to burning in field. So, mushroom production is boon for rural areas. Our society is pre dominantly agrarian. Burgeoning population, prevalent malnutrition and under nourishment in society are key challenges to our nation. To provide employment and complete food to people as well to reduce the load on land, Mushroom Production is the best alternative source for income generation. The production of mushroom for income generation is fast becoming popular among educated youths besides farming community. There are number of success stories of youths in Haryana, Punjab, Himachal Pradesh, Uttar Pradesh and Uttrakhand who were earlier unemployed & running for job here and there but now they are successful mushroom entrepreneurs. Among various agri enterprises Mushroom Production has come up in big way as profitable agri-business as low cost seasonal cultivation as well as small, medium & large scale round the year cultivation in Environment Control Units. Presently, mushroom production of our country is approx. 1,30,500 MT out of which around 80% share is of button mushroom and in rest 20%, Oyster, Paddy straw, Milky and some share of Shiitake and wild edible mushrooms. Though Mushroom production is increasing every year but most of the production is contributed individually and growers are facing problems like non-availability of quality spawn, non availability of regular electric supply and non availability of market all over India as well as missing cold chain. These problems aggravated further due to lack of uniform policy in states for electricity rates. There is acute need of development of infrastructure in public sector at district level to make availability of mushroom spawn, pasteurized compost, casing soil and ready to fruit bags of mushroom besides training facilities and development clusters of mushroom cultivation. Above type of infrastructure has been developed and made functional by Govt. of Haryana and so why Haryana has come in a big way in mushroom production & hence it needs to be replicated in other states.

OP 02: Ganoderma : An important medicinal mushroom

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Ganoderma lucidum, an oriental fungus has a long history of use for promoting health and longevity in China, Japan, and other Asian countries. It is a large, dark mushroom with a glossy exterior and a woody texture. The Latin word *lucidus* means “shiny” or “brilliant” and refers to the varnished appearance of the surface of the mushroom. In China, *G. lucidum* is called lingzhi, whereas in Japan the name for the Ganodermataceae family is reishi or mannentake. In Chinese, the name lingzhi represents a combination of spiritual potency and essence of immortality, and is regarded as the “herb of spiritual potency,” symbolizing success, well-being, divine power, and longevity. Lingzhi is a polypore mushroom - it lacks gills on its underside and instead releases its spores *via* fine pores. It is a soft mushroom when fresh; cork-like; flat; and has a red-varnished, kidney-shaped cap. There may be white or brown pores underneath depending on the age of the mushroom. Among cultivated mushrooms, *G. lucidum* is unique in that its pharmaceutical rather than nutritional value is paramount. A variety of commercial *G. lucidum* products are available in various forms, such as powders, dietary supplements, and tea. These are produced from different parts of the mushroom, including mycelia, spores, and fruit body. The specific applications and attributed health benefits of lingzhi include control of blood glucose levels, modulation of the immune system, hepatoprotection, bacteriostasis, and more. The various beliefs regarding the health benefits of *G. lucidum* are based largely on anecdotal evidence, traditional use, and cultural mores. Chhattisgarh state is bestowed with natural forests and survey was done in the forest areas of Chhattisgarh to collect different species of Ganoderma. Owing to its irregular distribution in the wild and to an increasing demand for *G. lucidum* as a medicinal herb, attempts were made to cultivate the mushroom. Artificial cultivation of *G. lucidum* has been achieved using substrates such as grain, sawdust, sugarcane baggase, paddy straw and wheat straw.

OP 3: Studies on strain evaluation of button mushroom (*Agaricus bisporus* (L.) Sing)

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Three strains (CG-I, CG-II and CG-III) of button mushroom were evaluated during 2017, 2018 in October and February month respectively on long method prepared compost. The results revealed that the spawn run was differed significantly during both years. During October 2017, the quickest (20.4 days) spawn run was noticed in strain CG-I and the spawn run during the February month of 2018 was significantly fastest (25.9 days) in CG-III. On an average of both years, days required for spawn run was less (23.25 days) in CG-I. The pinhead initiation did not differed significantly in different strain during the October month of 2017 and varied from 14.0-15.8 days. While, during the February month of 2018, the significantly less time (14 days) recorded in CG-II. The average of two years indicated that CG-II took minimum period (14 days) for pinhead initiation. Stalk length was differed significantly in both the years. Highest (3.48 cm) average stalk length was noticed in CG-II. Stalk circumference showed significant difference during the month of October, 2017 and it was done not differed significantly during the February month of 2018. The average stalk circumference was found maximum (2.11 cm) in CG-III. Pileus diameter was found significant in both the year, average pileus diameter was highest (4.96 cm) in CG-I. The number of fruiting bodies differed significantly during the October month of 2017 while it did not found significant during the February month of 2018. During October month of 2017, significantly more number (37.83) of fruiting bodies were obtained in CG-II and same trend was observed during February month of 2018 and average of two years (30.83) in CG-II. The weight of sporophores did not found significant during both year and it was varied from 174.15-238.35g. The fresh yield of three strain of button mushroom differed significantly during October month of 2017 and during February moth of 2018 it did not differed significantly. During the October month of 2017, the highest (566.67g) fresh yield was recorded in CG-II with 11.33 % biological efficiency and during the February month of 2018, fresh yield varies from 389.25-525.43g with 7.42-9.62 %S biological efficiency. The pooled data of two year clearly indicate that strain CG-II gave maximum yield with highest biological efficiency.

OP 04: Yield performance of paddy straw mushrooms(*Volvariella volvacea) at* different locations of Chhattisgarh

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The paddy straw mushroom *(Volvariella volvaceae)* is worldwide one of the most widely cultivated mushrooms and paddy straw is the most popular basal substrate used for producing paddy straw mushroom. Paddy straw mushroom could be grown in Chhattisgarh successfully from March to October. Present study was carried out to find out the best isolate for spawn development and mushroom production. Twenty nine isolates

were evaluated for their yield performance. The experiment was laid down at 5 locations of Chhattisgarh *i.e.* Raipur, Kharsiya, Janjgir-Champa, Bilaspur and Raigarh during 2017. Among the evaluated isolates significantly fastest mycelial run (7days) was found in isolate VV-06 and slower mycelial run (12 days) was observed in isolate VV-11. Among isolate, earlier (10days) pin head development was noticed isolate VV-20 and VV-24 where as it was required (15 days) more time in isolate VV-11 and VV-21. Maximum numbers of fruiting bodies were obtained (40) from isolate VV-04 and minimum 15 numbers of fruiting bodies were found in isolate VV-29. Significantly superior yield (1168.75g/bed) was recorded in isolate VV-27 where as it was inferior (318.75g/bed) yield was obtain from isolate VV-25. The biological efficiency of each isolated was in accordance with their yield. Maximum biological efficiency was obtained 33.39% in isolate VV-27 and minimum biological efficiency was obtained 9.11% in isolate VV-25. All the isolate were tested at different 5 locations earliest mycelial run (7days) was recorded in isolate VV-06 at Raigarh and slower mycelial run (12 days) was observed in isolate VV-15 at Bilaspur. Among the isolate fastest (7days) pin head development was noticed in isolate VV-24 and VV-26 at Kharsiya where as it was required (17 days) more time by isolate VV-11 ,VV-21 and VV-25 at Janjgir-Champa. Maximum numbers of fruiting bodies were obtained (50) from isolate VV-13 at Bilaspur and minimum 7 numbers of fruiting bodies were found in isolate VV-18 at Kharsiya. Significantly higher yield (1290.23g/bed) was recorded in isolate VV-27 at Raigarh where as it was lower (190.54g/bed) obtain from isolate VV-18 at Kharsiya. The biological efficiency of each isolated was in accordance with their yield. Maximum biological efficiency was obtained 36.42% in isolate VV-27 at Raigarh and minimum biological efficiency was obtained 5.23% in isolate VV-28 at Kharsiya.

OP 05: Oyster mushroom home growing kit: An alternative marketing strategy adopted by women self help groups of district Gariyaband Chhattisgarh

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Mushroom growing is known to be an effective livelihood option for SHG women due to its low capital investment and high yields obtained even under controlled rural condition. Skilling rural women through vocational training has been shown earlier to positively impact family earning as well as supplementing family nutrition contributing to the mitigation of malnutrition problem. KVK Gariyaband in Aug. 2017 established a Mushroom Spawn Lab and started training women SHG members under skill development scheme of the state - Mukhya Mantri Kaushal Vikas Yojana. 122 women were trained from 6 villages in a span of approx. 8-10 months. Constrains in production and marketing fresh mushroom by the skilled women prompted to device a new production and marketing strategy by KVK. Technology of making mushroom home growing kit by the name Ghar Ghar Mushroom was standardized and is being transferred to skilled women who have started marketing the product with significant increase in net profits compared to the traditional mushroom growing and marketing of harvested fresh mushroom. It is hereby attempted to capture the events which led to product – Ghar Ghar Mushroom, description of the methodology of preparation of the kit and initial experience in estimating the net profitability of marketing the kits by women SHGs of Giariyaband district of Chhattisgarh state.

Key words : Oyster, Mushroom, Home Growing Kit, *Pleutorus* spp., KVK, Gariyaband

OP 06: Oyster mushroom cultivation in small place and low cost mushroom shed

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Oyster mushroom cultivation is easy and people want to cultivate in their home for self-use. But maximum people have a problem *i.e.* we have no sufficient space for mushroom cultivation. As a solution to this problem we developed two models for mushroom cultivation. These model are very successful and suitable to maintain required temperature, humidity in cultivation.

I personally conducted trials on terrace of my home with this low cost hutment in a months from November 2017 to May 2018, three to four types of oyster mushroom varieties were grown during this period. Model structure size used was 6x4x7 feet. Big size model 1 : Capacity 25-30 mushroom bag. We got fresh mushroom 300-500 g per day we dried mushroom and made pickle. Last mushroom harvesting was done on 10 May 2018. This low cost mushroom hutment is suitable for urban and rural people for self use.

Poster Presentations

P 01: Effect of different straw prepared compost and growing structures on growth and yield of button mushroom (*Agaricus bisporus* (L.) Sing)

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Present experiment was conducted to know the effect of different straw prepared compost [Wheat straw and Wheat straw + Paddy straw (1:1)] and growing structure (Growing room and Ecofrost cold storage) on growth and yield of button mushroom. The results obtained that on the different straw prepared compost, spawn run was found significantly fastest (13.30 days) in wheat straw while, the days required for pinhead initiation was less (15.60 days) in combination of wheat straw + paddy straw. The yield attributing characters did not differed significantly and the number of fruiting bodies varied from 23.60 - 31.00. The fresh yield of button mushroom on different straw prepared compost, significantly maximum (560g) with 11.2 % biological efficiency was recorded in combination of wheat straw + paddy straw. Under the different growing structure the quickest (16.80 days) pinhead initiation was recorded in Growing room and the stalk length, stalk diameter did not found significant and the pileus diameter was found significant with growing structure. The number of fruiting bodies varied from 44.60 - 32.80. The fresh yield of button mushroom was not differed significantly under the different growing structure and ranges from 559 – 662g with 11.18 – 13.24 % biological efficiency.

P 02: Effect of prevailing environment condition on growth and yield of *Hypsizygus ulmarius*

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Blue oyster mushroom is a novel species with very large fruit body, blue colored pinheads becoming light white on maturity, high yielder, palatable with meaty flavor and attractive keeping quality. This new mushroom variety has attractive shape and fleshy with excellent taste. The present investigation was under taken to find out the prevailing environmental conditions for growth and yield of *H. ulmarius*. The experiment was conducted in October 2016 to April 2017 on wheat and paddy straw substrate separately and standard for cultivation procedure was adopted. Maximum yield was observed during the month of December. when the minimum, average and maximum temperatures (20.56°C, 20.08°C, and 20.76°C, respectively) 83.16% (morning) to 85.90% (evening) relative humidity prevailed in the cropping room with biological efficiency 112.00% on wheat straw and 101.87% on paddy straw.

P 03: Studies on nutritional and physiological requirement for growth and biomass of *Hypsizygus ulmarius*

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Mushroom is a cash crop grown worldwide on small as well as commercial scale for domestic consumption and export. It is a rich source of proteins, minerals and vitamins with low calorie value with no cholesterol. It is well known alternate source of good quality protein which has higher concentration of amino acid *viz.,* tryptophan and lysine in comparison to vegetable protein. The present investigation was carried out to know the nutritional and physiological along with growth and biomass of *H. ulmarius.* Among the tested media potato dextrose agar medium was found most suitable medium for the growth (89.00mm) and biomass (fresh mycelium weight: 13.93gm and dry mycelium weight 0.57gm) of *H. ulmarius*. Optimum temperature required 26°C was most suitable. Maximum relative humidity for radial growth was observed at 75% relative humidity. Complete darkness or zero hrs light was excellent for mycelial growth and biomass of *H. ulmarius*. Maximum growth of *H. ulmarius* was obtained at pH 8.0 on potato dextrose agar medium.

P 04: Morphological variation in paddy straw mushroom (*Volvariella volvacea*) collected from different agro-climatic zones of Chhattisgarh

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Paddy straw mushroom (*Volvariella volvacea*) being the third most important cultivated mushroom in the world is well known for its pleasant flavour and taste. The present study aimed to collect and isolate the paddy straw mushroom from different agro-climatic zones of Chhattisgarh. The fruit bodies of Paddy straw mushroom (*Volvariella volvacea*) was collected from 29 places across the Chhattisgarh. The collected fruit bodies were observed for location, GPS (Longitude, Latitude and Altitude), habitat, colour of pileus, pileus diameter (cm), shape of pileus, stipe attachment, stipe colour, stipe length (cm), stipe diameter (cm), attachment of gill, colour of gill and edges of gill. All the pileus of collected isolates showed light brown to brown colour except VV-13 (Black), Maximum (14.6 cm) and minimum (3.5 cm) pileus diameter was recorded in isolate VV-12 and VV-13 respectively. Among the collected isolates, 9 isolates had bell shape pileus and convex shape was noticed in rest of the isolates. The attachment of stipe was central in all isolate similarly colour was white except VV-17 (Light Brown). The longest stipe was noticed in isolates VV-1 (9.6 cm) and smallest recorded in isolate VV-13 (3.2 cm). Isolate VV-14 had maximum (2.8 cm) diameter of stipe while minimum (0.5 cm) was recorded in VV-04. Gill colour was light brown to brown colour in all the collected isolates. Attachment of gill was entire in all the collected isolates.

P 05: Effect of grain substrates on spawn development and their impact on yield and yield attributing characters of *Pleurotus* spp.

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An experiment was conducted to know the effect of different grains *i.e*. sorghum (*Sorghum bicolor*) and wheat (*T. aestivum*) on spawn development of different species of *Pleurotus*. The processed grains of sorghum and wheat were inoculated with 12 species of *Pleurotus* (obtained from DMR). On sorghum grains, PL-17-04 and PL-17-05 species of *Pleurotus* required significantly less (8.00 days) time for spawn development and at par with PL-17-03 and PL-17-12 (9.00 days), whereas more period taken by species PL-17-10 (14.00 days) for complete spawn development. On wheat grains, among the evaluated species PL-17-05 and PL-17-12 took significantly less (10 days) period for spawn development and all the grains were uniformly covered by white mycelial growth, however, the grains inoculated with species PL-17-07 and PL-17-09 required more (15 days) period for complete spawn development. The other species required 11-13 days for complete spawn development.

The sorghum grains raised spawn of different species of *Pleurotus* was studied to see their impact on yield and yield attributing characters. Significantly less (7.00 days) period for complete spawn run was noticed in species PL-17-06, Pl-17-08, Pl-17-12 and it was significantly more (13.00 days) observed in species PL-17-05. Pin head initiation was significantly earlier (3.00 days) noticed in species PL-17-11 and PL-17-12 while, it was significantly more (10.0 days) in species PL-17-10. The species Pl-17-08 gave significantly bigger (8.38 cm) size of pileus and smallest (4.16 cm) noted in species PL-17-04. Significantly highest (3.8 cm) and shortest (0.88 cm) length of stipe was recorded in species PL-17-11 and PL-17-12 respectively. The yield in different species of *Pleurotus* differs significantly with each other and maximum (668.0 gm) yield was obtained from species PL-17-11 while species PL-17-10 gave minimum (251.0 gm) yield of *Pleurotus.* .

On wheat grains raised spawn, PL-17-12 gave significantly faster (7.00 days) spawn run and it was significantly slower (16.00 days) noticed in species PL-17-07. Significantly earliest pinhead initiation was observed in species PL-17-11 and PL-17-12 (3.00 days) while, it was slowest (9.00 days) noted in species PL-17-10. Significantly biggest (8.76 cm) pileus was found in species PL-17-08 and smallest (4.26 cm) was recorded in species PL-17-10. The highest (3.8 cm) stipe length was recorded in species PL-17-11 and shortest (0.87 cm) was recorded in PL-17-12. Wheat grains raised spawn showed significant difference in yield with respect to different species of *Pleurotus* and significantly more (546.00 gm) yield was obtained from species PL-17-11 and it was significantly less (298.00 gm) found in species PL-17-10. The biological efficiency in different species of *Pleurotus* in accordance with that of yield on both grains used for spawns development.

P 06: Effect of substrate treatment methods on yield of *Pleurotus* spp.

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An experiment was conducted in February (2018) to know the effect of different methods of substrate treatment (carbendazim + formeldehyde, hot water, lime 2% and plane water) on spawn run, pin head initiation and yield of *Pleurotus* spp. on wheat straw substrate. The results are clearly indicates that on an average time for spawn run period was significantly quickest (7.25 days) noticed in species PL-17-12, while PL-17-07 took more (14.25 days) time for spawn run. Among the evaluated different methods of substrate treatment, the average period recorded for spawn run was statistically differed and it was significantly less (9.94 days) recorded in carbendazim + formeldehyde followed by hot water and lime 2% (10 days) and which were at par with each other. While more (11.80 days) period taken by plane water. Interaction of species × substrate treatment method also showed significant difference for spawn run period of *Pleurotus* species. PL-17-12 required minimum (7 days) period for spawn run with carbendazim + formeldehyde, hot water and lime 2% than other combination and maximum (16.33 days) period taken by PL-17-07 with plane water.

The average days for pinhead initiation in different species of *Pleurotus*, recorded earlier (2.91 days) pinhead initiation was recorded in species PL-17-11 and it was significantly delayed (8.25 days), in PL-17-10. In different method of substrate treatment, faster pinhead initiation was found in hot water treated substrate (4.55 days) while it was took maximum (5.36 days) time in carbendazim + formeldehyde. On an interaction, pinhead initiation was quickest (2.33 days) found in species PL-17-12 with hot water treatment than other combination and more (9.33 days) period taken by carbendazim + formeldehyde and plane water in PL-17-07. The average yield of different species with substrate treatment varied significant with each other. The significantly higher (532.91 gm) yield was recorded in species PL-17-11 while PL-17-10 gave significant lower yield (159.56 gm). On different substrate treatment maximum yield (398.75 gm) was recorded in hot water treatment method and minimum yield (174.44 gm) was found in plane water. Interaction of species × substrate treatment method also showed significant differences in yield. The highest yield was recorded in species PL-17-11 (615.0 gm) with BE 123% in carbendazim + formeldehyde followed by hot water (595.0 gm) with BE 119% and lime 2% (591.0 gm) with BE 118.2% and they were statistically at par with each other, whereas, plane water gave minimum yield (48.33 gm) with BE 9.6% in species PL-17-10.

P 07: Role of different substrates and organic supplementation on growth and yield of different strains of *Calocybe indica*

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The mushroom defined as a macro fungus with a distinctive fruiting body, large enough to be seen with the naked eye and to be picked up by hand. Fungi are cultivated worldwide for the production of edible mushrooms. Among the cultivated mushroom, *Calocybe indica,* widely known as milky mushroom. It is grown at high temperatures, during summer and rainy season in India. The present study was undertaken to find out best suited substrate and supplements to enhance the yield of *C. indica*. Five strains (CI-1, CI-2, CI-3, CI-4 and CI-5) of *C. indica* were evaluated on unexplored locally available different (wheat straw, soybean straw, sugarcane bagasses, paddy straw and sesamum straw) substrate and organic supplementations (rice bran 2% and 5%, wheat bran 2% and 5%). Among the different substrate, earlier (18.44 days) spawn run and primordial initiation (15.44 days) was recorded on wheat straw and also gave maximum (320.04 g) yield. No spawn run was observed on paddy and sesamum straw. Wheat bran @ 2% took significantly less time (21.12 days) for spawn run and primordial initiation (11.24days) but higher (373.08 g) yield of *C. indica* was recorded in 2% rice bran.

P 08: Studies on nutritional and physiological requirements on growth and biomass of different strains of *C. indica*

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Milky mushroom (*Calocybe indica*) is a new addition to the domestic mushroom and next to paddy straw mushroom. Fungi are cultivated worldwide for the production of edible mushrooms. Among the cultivated mushroom, milky mushroom *(Calocybe indica* P&C*)* is a potentially new species to the world mushroom growers. It is a robust, fleshy, milky white, umbrella like mushroom, which resembles button mushroom. The experiments was conducted to explore the role of different temperatures, media, relative humidity, light duration and pH on growth and biomass of different strain (CI-1, CI-2, CI-3, CI-4 and CI-5) of *C. indica*. There was significant difference observed in radial growth, fresh mycelia and dry mycelia weight of *C. indica* on different media under study. The highest radial growth (87.00 mm), fresh mycelia weight (5.87g) and dry mycelia weight (0.39 g) of *C. indica* was noticed on potato dextrose agar medium and potato dextrose liquid medium. Temperature significantly influenced the radial growth of *C. indica* and significantly high (87.26 mm) radial growth of *C. indica* was recorded at 25°C but more fresh (3.83g) and dry (0.50g.) mycelia weight of *C. indica* was recorded at 28 °C. Maximum mycelium growth (85.93 mm), fresh and dry biomass (5.55 g, 0.53 g) was observed at 90 and 80 % relative humidity. The radial growth (72.60 mm), fresh and dry biomass (3.77g, 0.54) production was more at pH 6 than other tested pH. Higher mycelia growth (87.40 mm) fresh and dry biomass (6.40 g, 0.34g) was obtained when light was provided alternate cycle of 12 hr. dark and light.

P 09: Extracellular enzyme studies on different strain of shiitake mushroom

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Lentinula edodes (Berk) Pegler popularly known as “shiitake” is an exotic edible mushroom with therapeutic properties. Due to its culinary and medicinal properties the demand for its production is increasing many folds in the recent past and at present it is contributing around 22 percent of total mushroom production globally. Being wood rot fungi, extracellular enzymes play an important role in degrading the substrate and further production of fruiting bodies in shiitake mushroom. To understand the enzyme dynamics, Laccase (Lac) and MnP were chosen for the study considering its importance in substrate degradation and further mushroom growth. 19 diverse shiitake strains available at ICAR-DMR, Solan were used in the study. Extraction of Lac and MnP was done from the colonized substrate at six stages of mycelia colonization with seven days interval (7, 14, 21, 28, 35 and 42). The sterilized sawdust based substrate was spawned with different strains of shiitake and incubated at 25±2ºC temperature. The experiment was also laid out using factorial randomized complete block design (FRCBD). Laccase was estimated by 0.5mM 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) oxidation in 0.1M Na-acetate buffer (pH 5.0) at 420 nm spectrophotometry for 5 min. The spectroscopic absorbencies were recorded from colorless to the dark blue color. MnP was also estimated by change in absorbance at 465 nm for 5 min in 0.1mM $MnSO_4$, 0.1mM Guaiacol substrate in 0.5M sodium-tartrate buffer (pH 5.0). The reaction was initiated by addition of 0.1mM H_2O_2 at 22ºC (±2ºC). Data on yield of fruit bodies were also recorded for the yield of different strains. The correlation was calculated between yield and enzymes at different days of interval. The results suggested that the International Units per minute (IU/min) of extracellular Lac and MnP was significant. There was significant difference in strains for Lac and MnP activity. Moreover, the interaction of enzyme activity at different intervals with different genotypes used was also found highly significant. The hydrolytic activity of Lac and MnP enzymes (IU/min) was found the maximum for strains DMRO-2, 20, 7 and DMRO-34, 328 respectively, whereas lowest values recorded in DMRO-388(S) for both enzymes. Average relationship between yield was found non-significant with the enzymes activities.

Keywords: Laccase, MnP, *Lentinula edodes,* yields, correlation

P 10: A study on proximate analysis along with bioactive components in various strains of *Lentinula edodes* (Shiitake mushroom)

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Shiitake mushroom (*Lentinula edodes)* is white rot fungi contains abundant nutrients and bioactive molecules having therapeutic potential. This mushroom is known for its unique flavour, aroma and medicinal values. The present study entails to determine the comparability of proximate along with chemical analysis and evaluation of bioactive components in different strains of the shiitake mushroom *viz.* DMRO-623, DMRO-356, DMRO-388, DMRO-34 and DMRO-35. In all strains, the proximate analysis (ash, moisture and crude fibre), chemical analysis (protein, total reducing sugar and total carbohydrate content) and bioactive components (total phenolic, flavonoid content) were determined. The results showed that there was a significantly higher ash, moisture and total carbohydrate content in strain DMRO-356 in comparison to other strains. The highest bioactive components (total phenolic, flavonoid and free amino acid) were also found in strain DMRO-356 in comparison to other strains. Therefore strain DMRO-356 can be used for product formulation which increases medicinal property in any formulation as evidenced by its rich phenolic, ash, total carbohydrate, flavonoid and free amino acid content.

Key words: *Lentinula edodes*; reducing sugar; bioactive component; phenolics and flavonoids.

P 11: Impact of mushroom processing and value addition training on rural women adoption and knowledge level under CGCOST project in adopted village Tarra.

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Women are the significant partners in farming, farm management and other income generating activities. They are responsible for most of the inside and outside activities. Knowledge is one of the most essential part of behavior of human being. Ones knowledge is acquired, it produces significant overall changes in an individual's life. A study was conducted on impact of CGCOST project on rural women adoption behavior and knowledge in Mushroom Processing and value addition training organized by Home Science unit of Directorate of extension, Indira Gandhi Agricultural University, Raipur at adopted village Tarra (Abhanpur

Block) Raipur Chattisgarh state. It was evaluated through questionnaire for 50 selected trainees from adopted village Tarra. After receiving frequent training programmes under Home Science interventions such as improved method of mushroom preservation and Processing, low cost nutritious mushroom recipes, from locally available mushrooms were conducted. The study indicated the significant effect of training on knowledge level and adoption behavior in mushroom processing and preparation of its value added products 54.5 percent followed by low cost nutritious recipes ie 36.4 percent. Study also indicated that age and education had significant influence on knowledge and adoption levels of rural women. As 62.2 percent young (22-40 age group) and educated women trainees adopted this training with more interest with comparison to middle age 50 plus women ie 26.8 percent. It can be concluded from the study that Mushroom growing is such an ideal enterprise. It required less land, minimum water and raw material cost that's why it is not a big issue so even landless farmers/ farm women can augment their income through mushroom cultivation. The suggestions given by the trainees for further refinement of mushroom training that it should be more practical oriented and its duration should be increased by 4-5 days so the trainees might got more knowledge of mushroom processing with more satisfaction. It would be beneficial for them to start and flourish mushroom enterprise in future. Besides these suggestions, 42 per cent of the respondents felt that financial assistance by government should be also provided for trainees.

P 12: Standardization of different bed types for cultivation of paddy straw mushroom (*Volvariella volvacea)* in Janjgir -Champa District

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The climatic conditions prevailing in some part of Janjgir-Champa District are best suited for the cultivation of paddy straw mushroom. Most of the farmers in the district who are cultivating the paddy straw mushroom but they do not use the standard size of bed for paddy straw cultivation. It causes poor economical yield and low biological efficiency. The highest biological efficiency (23.1%) of paddy straw mushroom has been recorded in the compact bed of 1 Kg paddy straw with size 30cm x 20cm followed by the bed of 2 Kg square compact bed size 45cm x 45cm (20.8%). Average days for first harvest (ADFH) have also been recorded better (17.38 days) and (18.13 days) respectively. It has shown better performance might be due to the homogeneity of growing conditions in such beds. The variability in inefficiency may be attributed to certain physical factors such as temperature, aeration, wetness and compactness of the beds. Homogenous moisture level and bed temperature between the layers, which would have facilitated better proliferation of the mycelium, production of more pinheads, and buttons with ultimate increase in yield.

P 13: Effect of various grains on germination and yield potential of *Pleurotus sajor-caju*, *Pleurotus florida* and *Calocybe indica*.

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The mushroom fungi *Pleurotus sajor-caju*, *Pleurotus florida* and *Calocybe indica* were germinate on different kinds of grain *viz*., wheat sorghum, barley, bajra, gram and mungbean. *Pleurotus sajor-caju* germinated on all kinds of cereal and pulse grains; but the maximum germination was recorded on grains of gram 98.67%. However, the mungbean and wheat grain were also force suitable for better germination of spores of fungus *i.e.* 92 % and 90.6% respectively. The spore of *Pleurotus florida* germinated maximum on grains of gram *i.e.* 98.6%. Germination of fungal spores recorded on mungbean and wheat grains are also good *i.e.* 90.6% and 93.3% respectively. The lowest germination found on bajra grains *i.e.* 60%. The germination of *Calocybe indica* found maximum on wheat and gram grains similarly *i.e.* 100%. Mungbean and sorghum grains were also found suitable for fungal spores' germination. They showed better germination as compared to barley and bajra grains *i.e.* 98.6% and 96% respectively. Bajra showed lowest germination *ie.* 78.4%.

P 14 : Mushroom technology : A potential profit making business for marginal/ small scale farmers through e-marketing

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Recent global issues such as liberalization, privatization, democratization and decentralization determine the policy process for agricultural and rural development. Paddy being major crop of Chhattisgarh, paddy straw is available in abundance 120 lakh tonnes in the state. The small and marginal farmers with low cost input technologies can take up mushroom farming in the rural area. This will not only help in utilization of paddy straw but also create an additional source of income for the farmers. Because of the highly perishable nature of fresh mushrooms and poor transportation facilities for marketing, growers do not get a proper return. It is, therefore, essential to consume mushrooms immediately or preserve them in various forms. There are two channels of marketing first the conventional and the second using E-commerce(E-Marketing) the latter being more efficient and effective and fetches higher profit returns to the marginal small scale mushroom farmers.

P 15: Mushroom production technology: An important agri-business.

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Mushroom production has tremendous potential as an income generating activity. Mushroom is important not only from nutritional and medicinal point of view but for export also. It requires little space or land and hence it is of great importance for landless and marginal land holders. It grows independent of sunlight, feed on organic matter and does not require fertile soil. In addition to floor, air space is also utilized resulting in higher productivity. Mushroom cultivation can provide additional income to farmers who wish to take up this activity especially in their lean season. The greatest advantage of this venture is the fact that mushrooms have capacity to convert nutritionally valueless substance like wheat or paddy straw in the nutritious delicacies. It also enables recycling of agro wastes like dung and chicken manure which otherwise are posing pollution problems. Mushroom is a fungal body having no chlorophyll and, it is a parasitic plant. It depends upon other living or dead plants to obtain food. Mushroom is an excellent source of protein, vitamins, minerals, folic acid and is a good source of iron for anemic patients. Mushroom contains 19 to 35 per cent protein which is higher than most of vegetables and cereals. Its protein quality is as good as animal protein. Moreover, lysine and tryptophan protein which are absent in vegetables and cereals can be obtained through mushrooms.

Keywords: Mushroom, Enterprise, Income, Nutritious.

P 16: Need of trainings on mushroom processing technology among rural women in Raipur district

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Mushrooms are a good source of very good quality protein especially rich in lysine and thus supplement well the cereal based Indian diet. These are also rich in vitamins and minerals especially B-Complex and iron. Vitamin B-12 and folic acid, which are normally not found in vegetables are present in mushrooms and along with availability of iron and protein, are reported to maintain hemoglobin level as single source of diet. Anemia is rampant in India especially in pregnant women. Mushrooms are rich in phosphorus, potassium and iron, but are low in sodium. In addition to these some other important features in the nutritional qualities of mushroom is that the starch and fat content is low, high fibre contents and low calorific value. In Chhattisgarh 80% of the rural population depends on agriculture for their livelihood, in which 54% of the children and 49% of women are undernourished. One of the major reason for poor health of village women and children in chhattisgarh is the under nourishment resulting in protein energy malnutrition, iron, iodine, vitamin A deficiency and weight loss of children. The mushroom production by rural women is becoming popular day by day and it is not only improving their nutritional status but also helping in income generation by selling it in the market, thus increasing their socio economic status also. Processing of the mushroom is as important as its production. Various products like papad, badi, (noodles), pickles, sav etc. can be made after processing of mushroom. Training the rural women on the above mentioned areas *i.e.* production and processing technology will be a great tool to fulfill the demand and need of the rural women and children. A study was conducted in two villages of Raipur district. The rural women in these two villages were selected on the basis of their interest in mushroom. Around forty women were selected randomly for training related to various aspects of mushroom processing technologies. During the study it was found that the rural women were not aware of mushroom processing technologies, Hence, training was essential. After receiving the training on various aspects of mushroom processing 60% of the rural women adopted the mushroom processing technologies. The women also formed two SHG of 20 women each. They prepared nuggets, papad and biscuits by adding 3-5% mushroom powder. Pickles were also made after blanching of oyster and milky mushrooms. They are earning more then 2000/-per month per member as an additional income to their family. As a result there has been improvement in their socio-economic condition as well as their overall protein and other nutritional requirement were also improved.

P 17: Mushroom research and developmental activities at IGKV

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Mushroom cultivation is a potential biotechnological process wherein the waste plant materials or negative value crop residues can be converted into valuable food. Mushroom cultivation is recognized as an eco-friendly alternative for agro-waste recycling with tremendous capabilities to provide better nutrition for the vast vegetarian population, employment generation and a good income source. The AICRP on Mushroom since it's inception at IGKV, Raipur in the year 1989 had been instrumental in bringing out superior strains of paddy straw mushroom, milky mushroom and oyster mushroom. At present, four mushroom varieties namely, *Volvariella* spp, *Calocybe indica*, *Pleurotus* spp. and *Agaricus bisporus* have been recommended for round the year cultivation in the country. Chhattisgarh is an ecological hub of many natural wild edible species of macro-fungi which has been extensively surveyed, documented, characterized and preserved as dry and wet specimens from different agro-ecological zones. The dominant forest mushrooms identified as food is *Termitomyces microcarpus*, *Termitomyces eurhyzus*, *Termitomyces clypeatus*, *Rassula* spp, *Canthrellus* spp, *Rhizopogon*, edible *Amanita*, *Lentinus* spp*, Pleurotus* spp*, Macrocybe* spp*, Tricholoma* spp*, and Volvariella volvaceae*. The pure culture of edible mushroom species, their spore prints and dried specimens are submitted yearly at Directorate of Mushroom Research, Chambaghat, Solan H. P and is also being maintained at IGKV, Raipur. The production technology of different species of oyster mushroom like *Pleurotus eous, Pleurotus djamor, Pleurotus florida, Pleurotus, flabellatus, Pleurotus sajor-caju, Hypsizygous* and *Calocybe indica* has been standardized with reference to their production temperature round the year, suitable agro-wastes and supplements. Similarly, different production systems have been identified for *Volvariella volvacea* cultivation. Open cultivation of *Volvariella* in mango orchards, bamboo plantations, border rows of green houses in protected cultivation sheds and indoor cultivation in growing rooms have been popularized across Chhattisgarh. A low cost viable button mushroom production model with partial modification of environmental conditions has been developed for farmers using long method of composting. It has been tried in three agro climatic zones of the state and there are good potential that it can be used for two crops of button mushroom in a year which is widely demanded. Button mushroom production in solar panel enabled growing rooms have also been initiated at pilot scale and has been demonstrated for year round cultivation in tropical areas like Raipur. However, its economic viability needs to be refined. The recipes of various processed products of mushroom like mushroom pickles, mushroom nuggets (urd/mung), mushroom rice/mung/urd papad, mushroom biscuits, mushroom chakli, mushroom murku, mushroom cakes, royal oyster capsules, mushroom vermicelli, and mushroom soup powder have been standardized. The Mushroom Research Laboratory of IGKV is instrumental in capacity building of >15,000 students, entrepreneurs, women self help groups, landless farmers, farmer producer companies and unemployed youth with various on- campus and off campus National/State/District Level Trainings on spawn production, mushroom crop production and processing technologies. Awareness has also been created by organizing All India Mushroom Workshops/Seminars National Exhibitions. Under Tribal sub-plan, for the past five years three to four off campus trainings of four days are imparted in tribal areas of Chhattisgarh. Low cost spawn production methodology using inoculation chambers and pressure cookers have been popularized which has led to formation of many spawn hubs at village level. An estimated five tonnes of commercial spawn is being sold by IGKV Raipur for the past five years. As a results, oyster, paddy straw and milky mushrooms are now widely grown almost throughout the state of Chhattisgarh in a small/ medium/large scale by the growers. There are growers in Mahasamund, Raigarh and Janjgir districts who are purchasing paddy straw mushroom spawn from nearby State Odisha and growing this mushroom in a big way in the form of Mushroom Clusters. Pure cultures and mother spawn of superior strains of different varieties of mushroom are also being sold by IGKV, Raipur. The spent mushroom substrate has also been utilized to develop formulations of microbial consortium and is being popularized through demonstrations at farmer fields for pesticide free agriculture.

Technical Session-VII :

Farmers, Producers, Entrepreneurs, Scientists and Policy makers interactions

Lead Lectures

LL 01: Plant health clinic with special reference to online plant clinic

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Extension plant pathology precisely imply transfer of technology aimed at mitigating crop pests caused by biotic and abiotic agents to boost food security. Plant health clinic (PHC), known by various names such as plant clinic (PC), plant protection clinic, plant disease clinic (are not new but their importance in India was realized in late eighties of 20th Century. Global plant clinic program (Now Plantwise initiative since 2010} are operating in many Afro-Asian and Latin- American countries. However, most of them do not have in India Today. India next to USA has emerged as the second country to have maximum plant clinic. This increase has been due to sanction of about 180 plant clinic across the country operating in public and private sector. Most of SAUs have a plant clinic besides plant clinic with state government and corporate sector. Most of them have adequate infrastructure and human resource representing the four major disciplines so that farmer have not to rush from pillar to post. The clinic is primarily aimed at diagnostic and advisory support besides other work pertaining to plant pest surveillance, training farmers, keeping watch over the entry of alien pests and issuing pest alerts.

Online plant clinic on the other hand provide information through internet. The success of the online clinic lies in correctly sending the information and symptoms. In the absence of such information correct diagnosis is not possible. Two things are very important, knowledge and availability of internet and ability to describe the problem, Most of the defense officers have the ability of expressing their concern correctly. The information as far as possible should be accompanied by real picture of the problem. Dr M P Srivastava is first in the country to devote himself in this venture through XSGrowth Plant Health Clinic under the banner of www.xsgrowth.com which is widely cited as e non-profitable organization in managing plant disease and pests, Today a couple of online plant clinics have come-up providing digital photographs too.

LL 02: Sharing of field experiences on identification, diagnosis and management of diseases in horticultural crops

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In modern times pest and disease management in horticultural crops have been one of the biggest challenges faced by the farmers. Being a vegetable and fruit grower I'll limit my presentation to vegetable Crops and more specifically in to two major crop groups namely *Solanaceae* and *Cucurbitaceae*. As per my experience managing diseases and pests now requires an integrated approach where in several factors need to be considered for managing diseases. In and around Raipur over the past few years we have been facing problem of high population of whiteflies and thrips transmitting various viruses across the crops, to manage this problem a collective approach is required from the farmers of the particular area to schedule pest control sprays collectively at once so that pest population can be controlled. Apart from this, several protective measures are taken for protection against diseases based on disease forecasting on the basis of meteorological data being generated by weather stations installed in farms. For curative measures starting from nursery stage of the plant till harvesting different practices are being followed in order to successfully cultivate different vegetable crops. Use of plastic mulch and sticky traps are also effective measures in control of pest population. The information being shared is based upon my as well as fellow farmers' experiences gained over past 25 years upon cultivation of different vegetable and fruit crops.

Invited Lectures

IL 01: Entrepreneurship development through Rural Bio-Resource Complex with adoption of integrated farming with mushroom, aquaculture, organic farming and value addition in northern districts of West Bengal

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Indian farming has been suffering due to indiscriminate application of chemical fertilizers and pesticides and due to lack of farm based integrated farming based interventions. Further, the monocropping pattern also one of the major factors that have contributed for disinterest and apathy among farmers. The indiscriminate increase in cost of production, lack of assured market, price fluctuations, fragmentation of land holdings, timely non availability of critical inputs and decline in soil productivity are the serious concerns which affects farmers' economy. This has resulted in loss of soil fertility, productivity of crops as well as hazards to human health. According to the feedback from several quarters, farmers in general and farm youth in particular, are losing confidence in farming. More than 40 per cent of farming families want to leave farming in India. The situation is more or less same in many developing as well as few developed countries. Therefore, a network project was undertaken with the support of the Department of Biotechnology, Government of India on establishment of rural bio-resource complex in North Bengal implemented by University of North Bengal and Uttar Banga Krishi Viswavidyalaya in seven districts *viz,* Darjeeling, Jalpaiguri, Cooch Behar, Alipurduar, Uttar Dinajpur, Dakshin Dinajpur and Malda in West Bengal State. By understanding the importance of organic farming and introduction of high value crops, interventions on mushroom cultivation, aquaculture and solid waste management were taken up in the districts benefitting more than 2000 farmers including Self Help Groups. The programme implemented was evaluated through pre-and post-assessments of the technology introduced. Beside this, the demand for bio-inoculants and mushroom master spawn has increased significantly during the four years. During the project period, 9 commercial vermicompost units and 15 mushroom villages have been developed in this area. Regarding production of fingerlings by the farmers/ local entrepreneurs, atleast one unit has been developed in three districts. The successful local entrepreneurs have been created through this programme with the rural bio-resource complex utilizing sustainable bio-resources from the region which were resource based for exploitation and exploration.

Keywords: Rural Bio-resource Complex, Capacity development, Income generation

IL 02: Use of mobile apps in extension plant pathology and other agro-advisory services: A success story from sugarcane belt of western Uttar Pradesh

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Mobile and smartphone applications are means of low cost information and communication technology (ICT) tools having huge potential to deliver relevant and actionable informations to farmers in time for cropshealth management. Mobile voice calling, video calling, messaging, facebook, twitter, whatsapp, telegram and e-mailare some of the most commonly used individual and social media tools for sharing informations through mobiles. However, voice call assisted application of whatsapp emerged as most potent application for identification of crop pests and diseases and quick delivery of prescriptions for taking timely action.

ICAR- Indian Institute of Farming Systems Research, Modipuram, Meerut is providing need based agro-advisory services on regular basis to farmers associated with Institute through on-farm projects; *Mera Gaon Mera Gaurav* (MGMG) programme and also to independent needy farmers. The agro-advisory services include identification and management of pests and diseases in field and horticultural crops; integrated farming systems and organic farming. Out of 61 individual complaints attended between March, 2018 to July, 2018, 38 problems were attended through voice phone calling; 17 voice phone calling suffixed with farmers visit to institute; 6 voice phone calling suffixed with scientist visit to field; 17 voice phone calling suffixed with sharing of informations through whatsapp. Out of 31 problems listed from the farmers, maximum quarries (18Nos.) were on pest and diseases of sugarcane; 4 on integrated nutrient management in sugarcane; 8 on nutrient and pest management in mango; 8 on mushroom cultivation technology and pest management in mushrooms. The voice phone calling assisted with sharing of informations through whatsapp for photograph of infested/infected crop from farmer's side and identification and prescription from scientist/ subject matter specialist through whatsapp was found to be more efficient and cheapest way of managing plant health and providing other agro-advisory services in shortest time (5-10 mintutes). By using voice phone calling assisted whatsapp we have successfully managed several pest and diseases like pokkahboeng, mealy bug, borers and iron deficiency in sugarcane; stem borer, hopper, mealy bug, semi-loopers and die back in mango. The integrated nutrient management advisory services in sugarcane and mango led to success in increasing the productivity of these crops by using voice phone calling assisted whatsapp. We have also succeeded in starting mushroom cultivation on fields of five farmers by using this technology. Further, the advantages of this technology can be extended many folds by making crop specific farmers group and sharing of information to these groups.

IL 03: “Crop Doctor” - An android based mobile application for farmers

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Crop Doctor is an android based mobile application developed by Indira Gandhi Krishi Vishwavidyalaya for the farmers of Chhattisgarh. The application helps in internal communications and record keeping, besides creating awareness among the farmers. The objective of this application is to wider reach and easy accessibility of crop information and services among farmers. It enables offline browsing at farmers field. Farmer can upload content wherever internet connectivity is available. It disseminates the information related to disease, insect, nutrient disorder and other crop based information to the farmers. Farmers can make query with images of various nutrient disorders, disease, insects affected for obtaining the solution as required. Crop doctor helps farmers to manage their crops easier and faster. Even less educated and illiterate farmers can use this application, as it is a purely image based program. For any problem, there is a query and feedback mechanism which helps to the farmers as and when required. The concept is to provide solution on insects, diseases and nutrient disorder management of major cereals, pulses, oilseeds and vegetable crops. It is a powerful tool for farmers, student, scientists and government officials. It is available both in English and Hindi and can be downloaded from Google Play Store.

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Our Functions:

- Provide Credit/Refinance for production credit and investment credit to eligible banks and financing institutions.
- Development functions undertaken through Farm Sector Promotion Fund (FSPF), Financial Inclusion Fund (FIF), Watershed Development Fund (WDF), Tribal Development Fund (TDF), Rural Infrastructure Development Fund (RIDF), etc.
- Supervisory functions in respect of Cooperative Banks and Regional Rural Banks.

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इंदिरा गांधी कृषि विश्वविद्यालय

जैव नियंत्रण प्रयोगशाला

ठाकुर छेदीलाल बैरिस्टर कृषि महाविद्यालय एवं अनुसंधान केन्द्र, सीसल प्रक्षेत्र, चोरभट्टी, बिलासपुर (छ.ग.)

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