Presidential Address

Biopriming – Blueprint for the Better Crop

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Key words: Biopriming Hydrobriming, Osmopriming, Seed priming.

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Mini Review

Relevance of Fungicides in the Present Day Crop Protection and the Way Ahead

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Key words: Fungicides, fungicide residues, fungicide resistance, future of fungicides, new generation fungicides

Citation: Thind TS. 2015. Relevance of fungicides in the present day crop protection and the way ahead. *J Mycol Pl Pathol* 45(1) : 4-12.

Research Article

Antimicrobial and Cytotoxic Effects of the Bioactive Pigment Bikaverin Produced by *Fusarium oxysporum* f. sp. *lycopersici*

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Abstract

Fusarium oxysporum strains are known to be prolific producers of metabolites with potential application. A violet pigmented strain of *Fusarium oxysporum* f. sp. *lycopersici* was isolated from rhizosphere soil of tomato plant. The biomass was grown in PDB and the intracellular pigment extracted. The identity of the compound was established by comprehensive analysis of the TLC and spectral data *viz.,* UV- Visible absorption, LC-ESI-MS, FT-IR and ^{1}H-NMR. The pigment exhibited R_f of 0.76, λ_{max} at 605nm and the molecular ion peak at *m/z* 383.17 $[M+H]^+$ consistent to the molecular formula of $C_{20}H_{14}O_8$ indicating that the compound was Bikaverin. The pigment exhibited antibacterial activity against human and seed borne plant pathogenic bacteria. The MIC and IC_{50} values ranged between 5-10µg/ml and 10-50 µg/ml, respectively and it suppressed the growth of seed borne phytopathogenic *Curvularia* sp., *Chaetomium* sp. by 75 and 70%, respectively. In the cytotoxicity assay, the compound showed strong inhibitory effects on human lung carcinoma type II epithelial cells (A549), with IC_{50} value of ~13µg/ml.

Key words: Antimicrobial activity, bikaverin; cytotoxicity, *Fusarium oxysporum* f. sp. *lycopersici*

Citation: Nirmaladevi D, Ramesha A , Sunitha V H , Babu R L and Srinivas C. 2015. Antimicrobial and cytotoxic effects of the bioactive pigment bikaverin produced by *Fusarium oxysporum* f. sp. *lycopersici. J Mycol Pl Pathol* 45(1) : 13-21.

Research Article

Integrated Management of Pink Canker (*Corticium salmonicolor* Berk. & Br.) in Apple

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Abstract

Combined efficacy of six *in vitro* effective fungicides, three plant oils, three botanicals, and five antagonists revealed that combination of Contaf + *Brassica juncea* var *Cunefolia* provided maximum wound recovery (92.94%) and callus formation followed by combinaion of Score + *Brassica juncea* var *cunefolia* (91.86%). However, integration of Contaf + Cow urine + *Melia azedarach* + *Vitexnegundo* + *Artimisia roxburghiana* +*Juglans regia* +*Roylea elegans* and Score + Cow urine + *Melia azedarach* + *Vitex negundo* + *Artimisiarox burghiana* +*Juglans regia* +*Roylea elegans* exhibited maximum wound recovery (87.17 and 85.81%), respectively. A combination of Contaf + *Pseudomonas* sp., significantly resulted maximum wound recovery (82.35%) in 2011 than in 2012 with wound recovery of 78.59 per cent followed by combination of Contaf + *Trichoderma hamatum* with 81.37 and 78.52 per cent wound recovery, respectively. Callusing of more than 10 mm was also found maximum in integration of Contaf + *Pseudomonas* sp. and Contaf + *Trichoderma hamatum*. Combination of Avtar + *Bacillus subtilis* (BS_1), Score + *Bacillus subtilis* (BS_1), Contaf + *Bacillus subtilis* (BS_1) and Score + Actinomycetes sp. provided 74.92, 73.11, 71.11 and 74.18 per cent wound recovery, respectively. Hence combined application of fungicides with plant oils, botanicals, and BCAs is an important substitute for integrated management of pink canker in apple.

Key words: Apple, antagonists, botanicals, *Corticium salmonicolor,* integration, plant oils

Citation: Prashad D, Sharma I M and Dhiman S. 2015. Integrated management of pink canker (*Corticium salmonicolor* Berk. & Br.) in apple. *J Mycol Pl Pathol* 45(1): 22-29

Research Article

Sodium Alginate Entrapped Biocontrol Agents for the Control of Most Virulent Isolate of *Sclerotium rolfsii*

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Abstract

Most virulent isolate of *Sclerotium rolfsii,* SrSB3 was selected out of ten isolates based on its virulence on sugarbeet plants, tubers and leaf petioles. Among different isolates, SrSB3 caused wilting symptoms even at lesser population of sclerotia, recorded more lesion length on inoculated leaf petiole and more mycelial dia on inoculated tubers. Hence, SrSB3 was considered as a most virulent isolate and for which management practices were carried out. The sensitivity of sclerotia to culture filtrates of different bio-control agents was studied by poisoned food technique. Results clearly indicated the lethal effectiveness of different culture filtrates at different levels on sclerotia of *S. rolfsii.* The effective bio-control agents were entrapped inside the sodium alginate beads and tested individually and in-combination against the most virulent isolate of *S. rolfsii* (SrSB3) under pot culture and field conditions. The result from pot culture experiment revealed that next to chemical treatment, least root rot incidence (33.3 %) was observed for the combination treatment of Pf1 + TTH1 which was comparable with Pf1 + EPCO16 (36 %) as against control (83.3 %) and individual treatments. Similarly, minimum root rot incidence was observed for the same combination treatments than individual and control treatments under field conditions. The present study suggested that alginate beads based bio-formulations could control root rot of sugarbeet by the slow and continuous release of bio-control agents in to the soil in an eco-friendly manner.

Key words: Bio-control agents, encapsulation, sodium alginate, *Sclerotium rolfsii*, sugarbeet root rot.

Citation: Thilagavathi Rasu, Nakkeeran Sevugapperumal, Raguchander Thiruvengadam and Samiyappan Ramasamy 2015. Sodium alginate entrapped biocontrol agents for the control of most virulent isolate of *Sclerotium rolfsii. J Mycol Pl Pathol* 45(1): 30-39.

Research Article

Temporal and Spatial Epidemic Development of Early Blight (*Alternaria solani* Ell. and Mart) in Tomato as a Function of Different Fungicides Treatment

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Abstract

The field experiment was conducted at university Instructional farm, Kalyani under Bidhan Chandra Krishi Viswavidyalaya in the year 2009-10 and 2010-11 to study the temporal and spatial spread of early blight (*Alternaria solani* Ell. and Mart.) on tomato under different chemical treatments to know the nature of progression of the disease in all fungicides treatment and also to evaluate the minimum apparent infection rate that restrict disease development at low level. One susceptible tomato variety "Patharkuchi" (indeterminate type) was taken and natural epiphytotic condition was permitted. Disease severity recorded at 10 days interval and the infection rate (r or k) was calculated after logistic and gompertz transformation of the realized observed value of the disease severity (expressed as AUDPC). Among the six chemicals tested *i.e.*, mancozeb, propiconazole, hexaconazole, carbendazim, cholothalonil and difenconazole, mancozeb showed minimum disease severity (AUDPC: 98.44 and 96.84) followed by hexaconazole (AUDPC: 98.69) and carbendazim (AUDPC: 97.68), respectively for the year 2009-10 and 2010-11. Maximum disease severity was observed in propiconazole treatment (AUDPC: 102.89 and 102.06) for both the two experimental years. Here, AUDPC is used to quantify the disease over different point of time and two growth models logistic and gompertz tested, through which disease progress curve move over time. Results revealed that the two models were not equally fit for depicting disease progress in every treatment but for linearization of area under disease progress curve (AUDPC) following the two models (logit and gompit) revealed that gompit fit better than logit for the spread of early blight disease severity over time and this was confirmed by the low standard error estimate (MSE) value of gompertz in all the treatments.

Key words: Apparent infection rate, area under disease progress curve, early blight, gompertz model, logistic model, tomato.

Citation: Saha Poly and Das Srikanta. 2015. Temporal and spatial epidemic development of early blight (*Alternaria solani* Ell. and Mart) in tomato as a function of different fungicides treatment. *J Mycol Pl Pathol* 45(1) : 40-47.

Research Article

Pathogenic and Morphological Variations in *Fusarium* Isolates Causing Post Flowering Stalk Rot of Maize

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Abstract

Ten isolates of *Fusarium* were obtained from post flowering stalk rot infected plants collected from maize fields of Udaipur districts of Rajasthan. These were showing variable disease severity on different maize cultivars. Nine isolates belonged to *Fusarium moniliforme,* and one isolate from Kathar was confirmed as *F. oxysporum.* Among these three isolates of *F. moniliforme* and one isolate of *F. oxysporium* exhibited considerable variations in cultural characteristics and size of micro and macro conidia. Isolates of *F. moniliforme* varied in colour from fluffy to submerged and white to dull white with slightly pinkish tinge growth and colony diameter ranged from (71.1-88.6 mm) on potato dextrose agar medium. The size of macroconidia and microconidia of *F. moniliforme* isolates were ranged from 2.6 x 25.5 to 3.7 x 34.1 µm and 2.5 x 7.2 to 2.8 x 8.5 µm respectively, while in *F. oxysporum* the size of macroconidia and microconidia was of 5.2 x 18.1 µm and 3.6 x 24.7 µm respectively. Pathogenic variability among the isolates showed statistically significant ($P \leq 0.05$) variations in disease severity for the host lines, isolates and also for the host line x isolates interactions. Inbred HKI 193-2-2 exhibited highly resistant (HR) reaction while HKI 164-7-4 ER-3 and Bio-9637 exhibited resistant (R) reaction against all the four isolates. Isolate from Udaipur (*Fm*-01) was most virulent and aggressive with highest mean disease score (5.0) across 35 maize inbreds evaluated. It would be desirable to evaluate and promote more new hybrids and inbreds against several races of *Fusarium* prevalent in different regions for stable source of PFSR management.

Key words: *Fusarium* spp., inbreds, maize, post flowering stalk rot, resistance, virulence.

Citation: Bunker RN, Thori HR and Rawal P. 2015. Pathogenic and morphological variations in *Fusarium* isolates causing post flowering stalk rot of maize. *J Mycol Pl Pathol* 45(1): 48-54.

Short Communication

Identification of Sources of Resistance to Blast and False Smut of Rice and Their Management with Fungicides

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Key words: Blast, false smut, fungicides, resistance, rice (*Oryza sativa* L.).

Citation: Singh Ram and Sunder S. 2015. Identification of sources of resistance to blast and false smut of rice and their management with fungicides. *J Mycol Pl Pathol* 45(1) 55-59.

Short Communication

Survey and Molecular Identification of New *Fusarium* sp. Associated with Crossandra Wilt in India

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Key words: *Crossandra*, *Fusarium incarnatum,* Molecular, *Pratylenchus delattrei,* wilt.

Citation: Mallaiah B, Muthamilan M, Sethuraman K and Chinnamuthu CR. 2015. Survey and molecular identification of new *Fusarium* sp. associated with crossandra wilt in India. *J Mycol Plant Pathol* 45(1) : 60-63.

Short Communication

Occurrence of Black Point Disease of Wheat Associated with Different Varieties Growing in Banaskantha District of Gujarat

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Key words: Anthesis, black point, incidence, varieties, wheat, survey

Citation: Partap M, Solanki VA, Prasad J and Nathawat BDS 2015. Occurrence of black point disease of wheat associated with different varieties growing in Banaskantha district of Gujarat. *J Mycol Pl Pathol* 45(1) : 64-66.

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Oral Presentation (OP)

Session 1: Biodiversity and Biosystematics

BID-OP3. Culture-independent analysis of microbial diversity in soils naturally suppressive or conducive to *Sclerotium* root rot

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The present study aims to analyze the soil samples collected from both root rot suppressive and conducive locations of Tamil Nadu for their eubacterial community through culture independent metagenomic approach. In order to discriminate these two different soils, metagenomic DNA from both soil samples were subjected to PCR amplification of V4-V5 variable region of 16S rRNA gene followed by cloning, ARDRA grouping, sequencing and phylogenetic analysis. The phylogenetic tree of disease suppressive soil 16S rRNA clones revealed the presence of highly diversified eubacterial communities in the soil. The dominant phylogenetic group of disease suppressive soil is Actinobacteria and disease conducive soil is Gamma and Betaproteobacteria. Based on relative proportion of different eubacterial communities, the diversity and species richness of antagonistic eubacterial communities were more in disease suppressive soil than conducive soil. The present study identifies the probable basis behind the disease suppressive soil which could be a potential source for identifying new antagonistic micro organisms.

BID-OP4. Reaction of recombinant inbred lines derived from different Finger Millet (*Eleusine coracana* Gaertn.) crosses to blast

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Finger millet (*Eleusine coracana* Gaertn.) locally known as Ragi, Chodi, Tydalu, Mandua, Nagli, Kapai and Marwa occupies a special position in the hill agriculture of Andhra Pradesh occupying the largest area next only to Rice. Although, Finger millet is known to cope up with abiotic and biotic stresses, however, under vulnerable conditions some of the diseases cause enormous losses and can damage entire crop. Of the several fungal diseases that affect finger millet crop, blast incited by *Pyricularia grisea* (Cke.) sacc. is the most devastating and economically important disease of finger millet growing areas of Andhra Pradesh. An experiment was conducted at Agricultural Research Station, Vizianagaram, Andhra Pradesh during *Kharif* of 2013 with recommended agronomical practices on reaction of recombinant inbred lines (RILS) derived from different finger millet crosses to blast. Among the crosses, VR 708× GPU 48 showed 113 lines (leaf blast), 9 lines (neck blast) and 7 lines (finger blast) resistant to different stages of blast. Moreover the cross PR 202 × GPU 48 showed 89 lines (leaf blast), single line (neck blast) resistant and no line was found resistant to finger blast when comparison was made with parental line GPU 48.

BID-OP5. Diversity of endophytic fungi isolated from mangrove plants of Maravakadu and their antagonistic activity against *Fusarium oxysporum* f.sp. *lycopersisici*

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Three mangrove plant species such as *Avicennia marina, Suaeda monica* and *Rhizophora mucronata* in Muthupet mangroves were selected for the study on diversity of fungal endophytes. Among these Avicennia *marina* seems to be the dominant mangrove plant species recorded 95% of the vegetation cover. The width of *Avicennia* forest varies between 30-100m and the average height is between 20-22 feet. Because of the Grey colour of its bark, it was also called as Grey Mangrove. Pneumatophores the unique feature of *Avicennia* species. Two hundred segments of leave sample from each mangrove plant species were taken into account to isolate endophytic fungi pertinent to four seasons between October 2012 and September 2013. Similar to this rhizosphere soil sampling of the above three mangrove plant species were also collected to isolate mangrove soil fungi. Moist chamber incubation technique and serial dilution technique were adapted. Totally, forty-four soil fungi and twenty-seven endophytic fungi were isolated and enumerated. Of all these *Aspergilli*, *Penicillium* and *Trichoderma* were the predominant genera. *Trichoderma harzianum* present in marine soil as well as endophytic fungi of studied three plants. The antagonistic fungus *Trichoderma harzianum* was very effective in inhibiting the mycelial growth of the pathogen *Fusarium oxysporum* f.sp. *lycopersisici* in Dual culture. The antagonistic fungus produced lytic enzyme (Chitinase) which found to inhibit the growth of the pathogen *in vitro*. In green house experiments, the antagonist *Trichoderma harzianum* was effective in the suppression of the pathogen *Fusarium* causing wilt in Tomato plants. Seed treatment with *Trichoderma harzianum* broth recorded an increase in the seed vigour index by 69.02 % over the control also promoting the Plant Growth (PGPF).

BID-OP6. Stem rust (*Puccinia graminis* f.sp *tritici)* pathotype of wheat from Nilgiris

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Stem rust [(*Puccinia graminis tritici* (*Pgt)*] limits the productivity of wheat globally. Collection of rust samples from field and analyzing the virulence patterns of rust races evolved in Nilgiri hills is an important and continuous activity to assess the prevailing races of rust and the occurrence of new rust variants which pave ways for formulating the breeding strategies. The stem rust resistant gene *Sr*36 is considered to be effective gene which confers resistance to many stem rust races including Ug99. Incidentally in our field conditions, we noticed a moderately resistant reaction type in wheat breeding line LMPG that carries *Sr*36 gene. Stem rust infected samples were collected from this particular line *Sr*36 (LMPG). The rust isolate from this sample was inoculated on nine days old seedlings of a universally susceptible genotype (Agra local) and the pathogenecity was established before race analysis. Subsequently, uredospores from Agra local were inoculated on standard differential sets meant for stem rust race analysis. The isolate from LMPG *Sr*36 expressed the same reactions as that of the race 40A. This isolate was again tested for its virulence on seedling of a set of CIMMYT lines that carries stem rust resistant genes such as *Sr*24, *Sr*31 and *Sr*36. The seedlings of CIMMYT line with *Sr*36 gene expressed susceptibility to this particular isolate of *Pgt* with an infection type of 3+. However, the CIMMYT lines which carry the gene *Sr*24 and *Sr*31 were resistant under SRT. The stem rust races 40-2(58G13-3) and 40-3(127G29=PTTSF) virulent on *Sr*36 and avirulent on *Sr*24 and *Sr*31gene have been reported earlier. Our initial works indicates a variable reaction of *Sr*36 gene against field isolate of *Pgt*. Here we are reporting our preliminary observations. However, further confirmation works on the identity and virulence nature of *Pgt* isolate on other wheat lines with *Sr*36 gene and evaluating the adult plant resistant of CIMMYT line that carries the same gene is under progress

Session 2- Plant Microbe Interaction, Omics and Genetic Engineering Applications

PMI-OP3. Gene pyramiding and selectable marker gene elimination in rice for fungal and insect resistance

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Rice is the staple food for more than half of world's population. Availability of limited cultivable land and yield losses due to biotic and abiotic stresses are the major factors limiting the productivity of rice. Rice is affected by about 45 fungal diseases and is a host for 75 insect pests. This necessitates the development of novel strategies to develop genetically modified rice varieties with multiple traits. Pyramiding entails stacking multiple genes leading to the simultaneous expression of more than one gene in a variety to develop durable resistance expression. Molecular gene stacking involves the introduction of gene constructs simultaneously or sequentially into the target plant by standard delivery systems such as *Agrobacterium*-mediated transformation. Combinatorial expression of fungicidal and insecticidal gene would enhance the resistance of a plant against the biotic stress. The dire need to address the environmental concerns of genetically modified crops has instigated the need for marker-free plants. In the present study, an attempt was made to isolate a novel mannose binding lectin gene from *Allium ascalonicum (AAL)* & *Allium cepa (ACL)* to deploy their insecticidal property for genetic engineering insect resistance in rice. The 500 bp full length lectin gene from onion was amplified, cloned and sequenced. C*hitinase gene (Chi11),* a well characterized antifungal gene from rice was used for developing sheath blight disease resistance in transgenic rice. High copy number marker-free binary vector with the *Chi* 11 and AAL/ACL genes were constructed and were mobilized into an *Agrobacterium* strain harbouring a cointegrate vector with the marker gene (*hph*) and reporter gene (*gus*). The marker-free binary vector harbouring the antifungal gene (*chi*11) and the insect resistance gene (*Allium* lectins) will be used in combination with the cointegrate vector harboring the marker gene for co-transformation and subsequent marker elimination in transgenic rice plants.

PMI-OP5. Antimicrobial activity of nano particles against soil borne pathogen

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Soil and seed-borne pathogen, *Macrophomina phaseolina* (Tassi) Goid causes severe yield loss in pulses and oilseeds and can managed *via* seed and soil application of benzimidazole group of fungicides. Bulk delivery of fungicides causes environmental pollution. The same cannot apply to grains for reasons of pesticide toxicity. As an alternative to chemical pesticides, use of metal nanoparticles as antimicrobial agent has become more common as technological advances have made their production more economical. Nanotechnology is an emerging technology and promises substantial help to agriculture, which can lead to a new revolution. Synthesis of nanoparticles is one of the main steps in the area of nanotechnology research. The synthesis, characterization, and application of synthesized nano material have become an important branch of nanotechnology. Hence, there is significant current interest in preparing nano-materials of small size. The metallic nanoparticles of Zinc Oxide (ZnO), Silver (Ag) and Titanium dioxide (TiO_2) were synthesized by chemical method to investigate the antimicrobial activity against major soil born pathogen of *M. phaseolina.* Synthesized nanoparticles were characterized using Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Particle Size Analyzer (PSA) and X-ray diffraction (XRD). Size of ZnO, Ag and TiO2 nanoparticles was measured 35-45nm, 20-80 nm and 85-100 nm, respectively to conform the nano-size. Further these synthesized nanoparticles were evaluated their antimicrobial activities had been increased with their higher volume. Best antifungal activity against *M. phasolina* was observed in Ag nano particles *than* ZnO and TiO_2 nanoparticles. Complete inhibition of mycelial growth was achieved by Ag nano particles were observed at 1000ppm while at 2000ppm for ZnO and TiO_2. Exerted hyphal abnormality and abnormality of sclerotial formation on *M. phaseolina* when tested *in vitro.* This result confirms the synthesized Ag nanoparticles can be used as a good antimicrobial agent.

PMI-OP6. Changes in various sugars and phenylalanine ammonialyase (PAL) activity in groundnut genotypes during stem rot disease

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Stem rot caused by *Sclerotium rolfsii* is a potential threat to groundnut production. Host plant resistance is one of the most effective forms of disease control and offers a very good alternative to the use of pesticides. To develop disease resistant varieties, it is essential to identify, characterize and categorize effective sources of resistance. Therefore, in present investigation groundnut genotypes differing in disease reaction were studied for biochemical defense mechanism during host pathogen interaction. Groundnut genotypes showing high (GG20, TG37A and GG16) and low disease incidence (CS19 and CS319) were grown under green house during *Kharif*-2013 at DGR. One set was kept as control and one set infected by *Sclerotium rolfsii.* Stem samples were collected at 24, 48 and 96 h after infection at 30 and 60 days after sowing (DAS). Sugars were extracted from both infected and non-infected stems and analyzed by Ion chromatography. Results showed that myo-inositol and glucose content decreased in infected stem of all genotypes as compared to non-infected stems at 30 DAS. While at 60 DAS (24 h after infection), glucose content decreased only in genotypes which showed higher disease incidence.These results revealed that glucose and myo-inositol were utilized by pathogen for growth and disease development. A constitutive higher level of myo-inositol was observed in non-infected leaves of CS319 and CS19 at 60 DAS. Phenylalanine ammonia lyase (PAL) enzyme activity was observed higher in CS319 and CS19 at 30 DAS and 60 DAS. Thus our results showed that genotypes showing less stem rot incidence had higher induce PAL activity and glucose and myo-inositol content.

PMI-OP7. Comparative metabolic changes in resistant and susceptible genotypes of maize to *Peronosclerospora sorghi*

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Downy mildew caused by *Peronosclerospora sorghi* (Weston & Uppal) Shawis one of the most destructive diseases of maize (*Zea mays* L.) worldwide. Few resistant genotypes identified against this disease. It is well known that all higher plants, irrespective of whether they are resistant or susceptible, are equipped with a wide array of constitutive chemical or mechanical barriers that limits pathogen infection and its spread. In addition, plants respond to infection by pathogens by triggering a variety of defense mechanisms. Among them metabolic alteration is a common response in both compatible and incompatible plant-pathogen interactions. Comparing metabolic response of resistant and susceptible genotypes upon infection by pathogens conceivably represents a powerful tool to unravel the biochemical pathways involved in plant defense. In the present study, the metabolic response of resistant (MAI 756) and susceptible (CM 500) maize genotypes to *P. sorghi* was assessed 0, 24, 48 and 72 h after inoculation by using gas chromatography coupled to electron impact ionization-time of flight-massspectrometry (GC/EI-TOF-MS).A total of 95 metabolites were identified and annotated using the Golm Metabolome Database and Tag Finder software. Infection by *P. sorghi* substantially altered the plant metabolic profile, including significant changes insugars, amino acids, and phenylpropanoids.

PMI-OP8. RAPD-PCR for Analysing Variations in the Genetic Makeup of *S. rolfsii* Isolates

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In the present investigation ten cultures of *S. rolfsii* isolated from different host plants and locations in Tamil Nadu, India were studied for their cultural characters. The result showed that cultures were varied in their colony morphology, mycelial growth rate, sclerotial numbers, size colour and weight varied in number of days taken for sclerotial production. Cultures producing big sized sclerotia observed with less numbers of sclerotia and vise versa. After identifying cultural variations among ten *S. rolfsii* cultures, they examined for any variations in their genetic makeup using RAPD-PCR analysis with five random primers. RAPD banding patterns of ten cultures revealed that polymorphic fragments ranged from 100bp to greater than 1kb were amplified by all random primers *viz*., C3, OPA02, OPC20, OPF01 and OPX07. Dendrogram generated for *S. rolfsii* cultures shown that they formed two main clusters, sub clusters and overall 54 per cent similarity coefficient indicated that they closely related. Hence, study about cultural and genetic background of the groups should support understanding the ecology aspects of *S. rolfsii*.

PMI-OP9. Infectivity of Rice Blast Pathogen, *Magnaporthe oryzae* on Certain Economically Important Cereal Hosts in India

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Rice blast caused by *Magnaporthe oryzae* (Ana. *Pyricularia oryzae*) is one of the most serious diseases and dominant factor limiting yield potential in rice worldwide including India. The rice blast pathogen attacks a wide range of grasses and also infects small grains. However, there is no information on infectivity and host range of rice blast pathogen on other economically important cereals in India. With this background, experiments were conducted under controlled climatic conditions to test the infectivity of rice blast fungus on other cereal hosts. We have further genotypically confirmed that the isolates reisolated from these hosts were identical. Seedlings of wheat, oat, barley and rice at two- to three- leaf stage were inoculated with rice blast isolate (Mo-ei-mbi 1). Only in case of wheat, adult plants at grain formation stage were also inoculated.Typical blast symptoms were observed on inoculated leaves of wheat, barley, oat and rice within 7 days after inoculation, and subsequently lesions coalesced all along the leaf. Wheat plants inoculated at heading stage exhibited bleached spikes and chaffy grains. Pathogen was re-isolated from the infected tissue and upon re-inoculation on healthy seedlings of these hosts produced the same symptoms satisfying Koch's postulate. Further, thirty six elite wheat, three barley, two oat and four rice varieties grown in different agro-climatic zones of India screened for infectivity revealed that most of the varieties were found infected to rice blast pathogen.Rice blast fungus, *M. oryzae* found infecting these cereal hosts under artificial inoculation were characterized byadopting multilocus sequence typing (MLST) using Actin (500bp), β-Tubulin (550bp) and Calmodulin (500bp) gene sequences. The gene sequences generated from *M. oryzae*

reisolated from wheat, oat and barley were found to be exactly identical as there was no sequence polymorphism for these selected loci. Phenotypic and genotypic data generated in the present work clearly revealed the infectivity of rice blast fungus *M. oryzae* on other economically important cereal hosts, particularly wheat.

PMI-OP12. Genome Mining for the Identification of Regulatory Elements of Mycotoxin Biosynthesis using *Aspergillus nidulans* as a Model System

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Aspergillus spp. produce several secondary metabolites. Some of these compounds are beneficial to humankind, for example antibiotics whereas others are deleterious, such as mycotoxins. The model filamentous fungus *Aspergillus nidulans* produces mycotoxin called sterigmatocystin (ST). This mycotoxin is similar to carcinogenic mycotoxin compounds called aflatoxins (AF). Furthermore, ST is the penultimate precursor in the conserved AF biosynthetic pathway found in related species such as *Aspergillus flavus* and *A. parasiticus.* Genes for ST production are clustered within 60 kb region in chromosome IV. This cluster contains 24 structural genes (stcA to stc X) and one regulatory gene *aflR*. In addition to ST mycotoxin gene cluster, *veA* gene which is not in the mycotoxin gene cluster is necessary for the biosynthesis of several secondary metabolites, including ST. *VeA* deletion leads to loss of ST production. In order to find new genetic regulatory elements of mycotoxin biosynthesis that are implicated in *veA* dependant ST gene cluster activation, mutagenesis of *A. nidulans* strain lacking *veA* was carried out. Upon chemical mutagenesis, several mutants showing restoration of ST production were generated. The mutants that restored ST biosynthesis were characterized followed by the identification of mutated gene responsible for regulation of the mycotoxin synthesis. Two genes, *rtfA* which is a *veA*-dependent RNA-pol II transcription elongation factor-like protein and *mtfA* which is a putative C_2H_2 transcription factor, were found to be new regulatory elements controlling the biosynthesis pathway of ST gene cluster. Functional role and importance of these two proteins on secondary metabolites biosynthesis in addition to ST biosynthesis are discussed.

PMI-OP13. Pathogenicity Gene Homologs in Red Rot Pathogen *Colletotrichum falcatum*

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Sugarcane red rot caused by the fungus *Colletotrichum falcatum* is a major constrain for sugarcane cultivation and evolution new races play a major role in breakdown of resistance in sugarcane varieties. Hence, attempts have been made to characterize genes which define critical factors for pathogenesis. In the present investigation, about 28 pathogenicity gene homologs were referred from other *Colletotrichum* spp. *viz.,*gene responsible for conidiation (*ArpA*); spore formation and germination (*RAC1* and *CTR2*); appressorium formation (*Cap3*, *Cap5*, *Cap20* and *Cap22*); appressorium morphogenesis (*MAF1*); melanin biosynthesis (*PKS1*, *SCD1* and *THR1*); appressorium penetration (*ICL1*, *RPK1*, *SNF1*); cell wall degradation (Pectate-lyase-*Pel1*, *Pel2* and *PelA*; Pectin lyase–*PnlA*; Polygalacturonase–*Pg1* and *Pg2*); establishment / maintenance of biotrophic gene (*ClTA1*); genes responsible for switch from biotrophy to necrotrophy (*ClNR1* and *Pnl1*); genes for the protection against host defense (*ClaSSD1* and *APH1*); carbon catabolite repressor gene (*CreA*) and hexose transporter genes (*Hxt1*,*HXT3*, *HXT2* and *Hxt4*) involved in various functions of pathogenesis were amplified using specific primers. The specific amplicons were sequenced to confirm their identity. Results of the present study revealed that the sequences have both intra- and inter specific variations among phylogenetically identified virulent and least virulent isolates. The key gene *PKS1* involved in melanin biosynthesis was found to show variation in *in vitro* and *in vivo* among the isolates varying in virulence. The gene responsible for appressorium penetration *RPK1* was found amplified only in virulent isolate and not in the least virulent. Similarly another gene *APH* involved in appressorium penetration was highly expressed during host pathogen interaction in the virulent isolate. Our results confirm the role of selected pathogenicity related genes during pathogenesis of *C. falcatum*. Further studies are in progress to validate the gene(s) expression by *qPCR*. Subsequently the candidate pathogenicity genes will be subjected for functional analysis. The present study forms basis to determine the pathogen virulence and design management strategies.

Session 3-Molecular Diagnostics of Plant Diseases

MDP-OP1. Exploitation of Viral Gen(e)ome for Management of Viral Diseases with Special Reference to Tuber Crops

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Plant viruses constitute one of the main problems of the agricultural production worldwide. Up till now, more than 1600 plant viruses have been reported which include 250 of those viruses that cause significant losses in crop yield. These, thus have a negative impact on agricultural crop production throughout the world. Virus infestation of cultivated areas results in a range of effects, from reduced crop quality to complete plant devastation. Disease management strategies need extensive knowledge of virus infection and its effect on host plants to allow the correct control procedures to be implemented. Reduction of crop loss is based on controlling the pathogen dissemination rather than the treatment of infected plants, as usually done with fungal or bacterial diseases. To date, there are no therapeutical measures available for the control of plant-virus diseases in the field and the main control strategy used in practice is based on prevention measures. Before the dawn of genetic engineering, traditional plant breeding methodologies were sometimes successful in creating resistance to viruses in agronomically important crops which was by far the most effective way to control plant viruses. Genetic engineering offers a means of incorporating new virus resistance traits into existing desirable plant cultivars. The initial attempts to create transgenes conferring virus resistance were based on the pathogen-derived resistance concept. The expression of the viral coat protein gene in transgenic plants was shown to induce protective effects similar to classical cross protection, and was therefore distinguished as 'coat-protein-mediated' protection. Since then, a large variety of viral sequences encoding structural and non-structural proteins were shown to confer resistance. Subsequently,

small, double stranded, non-coding viral RNA was shown to be a potential trigger for virus resistance in transgenic plants, which led to the discovery of a novel innate resistance in plants, RNA silencing. RNAi/PTGS is a potential tool for rendering transgenic plants virus-resistant and involves the expression of a sequence homologous to the invading virus. We have generated gene construct having replicase gene of Indian cassava mosaic virus (ICMV) and number of RNA silencing constructs to induce resistance against ICMV, Sri Lankan Cassava Mosaic Virus (SLCMV) and Dasheen mosaic virus (DsMV). Due to the serious problems inherent with transformation of cassava & amorphophallus and subsequent resistance screening, these constructs were tested for efficiency either by transient or by transgenic expression in *N. benthamiana*. Complete immunity was reached in transgenic *N. benthamiana* against DsMV using inverted repeat constructs. In contrast, virus resistance against ICMV/SLCMV using single amiRNA constructs was not successful. Results from the experiments to generate virus resistance against DsMV and ICMV/SLCMV will be shown and strategies to develop efficient resistance against RNA and DNA viruses in cassava and amorphophallus will be discussed.

MDP-OP2. Development of Highly Sensitive Molecular Diagnostics for *Phytophthora* and Greening, Two Economically Important Diseases of Citrus

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The fungal-like pathogen, *Phytophthora* spp. and a phloem restricted fastidious bacterium; C*andidatus* Liberibacter asiaticus causing citrus greening disease are prevalent widely in the citrus nurseries and orchards causing considerable economic losses in India. Almost all the field nurseries were found infested with these pathogens and were the primary source of spread of these diseases to virgin areas. Hence production of disease-free nursery stock is mandatory for a sound and productive citrus industry to avert decline and death of citrus plants in the country. Although these diseases cause some characteristic leaf and fruit symptoms but very often non-specific nature of the foliar symptoms make it easy to confuse them with nutrient deficiencies and other stress - related factors. With the aim of developing a rapid, specific and reliable method for identification of these pathogens, a PCR (polymerase chain reaction)-based molecular detection assay was worked out. Restriction digests of the ITS region of the genomic ribosomal RNA gene repeat (rDNA) was used to characterize *Phytophthora* spp. isolates from root and soil samples collected from various citrus orchards. For rapid detection of citrus greening bacterium, PCR was performed with different sets of greening-specific primers for amplification of 16S rDNA, ribosomal protein genes and 16S/23S intergenic regions. All the infected samples yielded specific amplification products and the size of PCR products obtained were found similar to that amplified from C*andidatus* Liberibacter asiaticus. PCR amplicons were sequenced and the sequencing and subsequent phylogenetic analyses confirmed amplification of '*Ca.* L. asiaticus' DNA from the GenBank database. A real-time PCR based assay has also been standardized for rapid and sensitive detection of greening bacterium. Use of these PCR-based diagnostic tools for citrus greening and *Phytophthora* diseases were adopted in screening programme for commercial production of disease-free citrus plants with a view to averting these diseases in the planting material.

MDP-OP3. PCR-based Method for Detection of *Phytophthora* in Citrus spp

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Citrus is one of the most popular fruit crops of the world cultivated in around 140 countries. During recent years, there has been significant increase in the citrus production mainly on account of its increased use as nutritious and healthy drink, but with increasing area production has not been increase because of several reasons including diseases and pest. Among which *Phytophthora* diseases cause major losses to agricultural and horticultural production in India and worldwide which is most damaging causes serious losses in production. Many *Phytophthora* spp. belong to the most aggressive and most important plant pathogens of the world leads to more than 66 % of all fine root and more than 90 % of all collar rots of citrus species. *Phytophthora* diseases are soil borne and difficult to control, making disease prevention an important component of many disease management strategies. However, *Phytophthora* is very often not detected leading to wrong diagnoses. Detection and identification of the causal agent, therefore, is an essential part of effective disease management. Symptoms included slow decline, moderate leaf chlorosis, reduced growth, lack of tree vigor and dieback which is associated to extensive canker lesions and gummosis at the base of the trunk, and root rot, often extending from the main roots into the feeder roots. The polymerase chain reaction (PCR) was used for the specific detection of *Phytophthora* spp. in citrus field. Primers were used based on the nucleotide sequences of the internal transcribed space regions (ITS) of different species of *Phytophthora*. The results of RFLP analysis ITS region of rDNA of all the isolates revealed a difference in their restriction pattern for MspI and AluI digestions. Control of these diseases has become possible through the use of disease-free nursery seedlings, removing diseased trees by using molecular diagnosis approaches like PCR, RT-PCR, and microarray etc.

MDP-OP4. Comparison of Marker System for Genetic Diversity of *Pyricularia oryzae*

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Rice being the most cultivated cereal in the world and a staple food for the majority of the world's inhabitants earned a synonym to food. As many as 70 diseases known to hamper the production reflecting yield losses of staggering dimension. Rice blast disease incited by *M. oryzae* having widespread threatens rice production across the globe. The disease has gain special emphasis, as it is extremely difficult to manage and yield losses of cent per cent recorded under congenial conditions. Thus, disease considered as humanitarian problem. Further, the ability of fungus to overcome resistance within a short time after the release of a resistant cultivar made breeding for resistance as a never-ending challenge. Thus, analysis of genetic variation in plant pathogen populations is an important pre-requisite for understanding co-evolution in the plant pathosystem (McDonald et al 1989). In the history, endurous march has been made to understand the diversity of pathogen using a vast number of markers. However, few studies given impetus on comparison of these marker for their efficacy in assessing the diversity of test pathogen. In this study, an effort was made to compare RAPD and REMAP for their efficacy in assessing diversity of *M. oryzae* population.Twelve RAPD and seven REMAP primers were used to obtain polymorphic profiles. The polymorphism in each case documented and grouping done using

Jaccards similarity coefficient. The two marker systems compared for their efficacy in assessing the genetic diversity of *P. oryzae* isolates from different geographical locations. Various parameters viz., observed number of alleles, effective number of alleles, Nei's gene diversity, Shannon's Information index, fraction of polymorphic loci, polymorphic information content (PIC) value and assay efficiency index (AEI) were recorded as criteria to differentiate their efficacy. The result indicated REMAP was superior to RAPD in all the parameters mentioned apart from this grouping of isolates based on REMAP was in accordance with geographical origin of isolates. In addition to this, the overall topology of dendrogram in RAPD was not in agreement with clustering based on principal component analysis (PCA); however, dendrogram based on REMAP perfectly matched with PCA. Thus, REMAP marker concluded to be efficient and specific enough to differentiate *P. oryzae* isolates.

MDP-OP5. Detection of Panama Disease in Banana by using Molecular Approaches

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Banana and plantain (*Musa* spp.) are among the most important commercial fruit crops in the world as a staple food and source of minerals and vitamins. Banana is also the world's leading fruit crop and represents the fifth most important agricultural crop in world trade. Among the major global constraints on production in banana there are several diseases occurs among panama is serious disease caused by the soil-borne fungi, *Fusarium oxysporum*. f. sp. *cubense* (*Foc*). Symptoms of fusarium wilt start with yellowing and wilting of the older leaves, which progresses to the younger leaves until the death of the entire plant. Internally plants show discoloration of the rhizome and necrosis of xylem vessels in the pseudostem is found in throughout the world. It causes heavy losses to yield as well as quality of fruit. To control such diseases there is need for planting disease free material as well as soil testing for the disease causing organism. PCR was identified as the rapid and reliable molecular diagnostic technique for screening of banana planting materials for panama disease. Specific primers identified the presence of *F. oxysporum* f. sp. *cubense*, respectively in infected banana planting materials. The planting material tested using intergenic spacer region specific primer for occurance of pathogen. Which reduces the income of inoculums in the field and ultimately it can be protected from the serious infestation of panama disease.

Session 4 - Fungicides/Bactericides – A Global Perspective from Industries

FUB-OP1. Management of Frog-eye Spot Disease in Bidi Tobacco Nursery

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Frog-eye spot disease caused by *Cercospora nicotianae* is a dreadful disease in nursery and field crop of bidi tobacco. Carbendazim recommended managing the disease. Now-a-days, numbers of new compounds are available in the market. Present experiment was conducted in nursery for three consecutive years (2010 to 2013) at BTRS, AAU, Anand to study the bio-efficacy of the said compounds. Seven treatments *viz.*, 1. carbendazim + mancozeb @ 0.225%, 2. hexaconazole @ 0.1%, 3. propiconazole @ 0.05%, 4. difenoconazole @ 0.05%, 5. propineb @ 0.225%, 6. carbendazim @ 0.025% and 7. control were tried in RBD keeping four replication of each treatment. Bidi tobacco cv. A 119 seeded @ 5 kg ha^{-1}. All agronomic practices in vogue followed. The fungicide sprayed at initiation of the disease and as and when required. Pooled results revealed that all the fungicides significantly reduced the disease compared to control and increased transplants barring propiconazole with minimum disease in carbendazim + mancozeb @ 0.225%. Looking to the effectiveness and economics, farmers advised to apply two sprays of carbendazim + mancozeb @ 0.225% at ten days interval starting from initiation of the disease.

FUB-OP2. Effect of Biosynthesised Copper Nanoparticles on paddy Germination and its Shoot and Root Length

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Nanoparticles may be more toxic and or beneficial and they have the potential ability of passing the cell membrane of plant because of their general size between 1 to 100nm. In the present study, the potential effects of biosynthesised copper (5-15 nm) nanoparticles, leaf aqueous extract of *Datura innoxia*; Potassium dihydrogen phosphate and water on germination paddy studied. Hundred healthy paddies are soaked at 24hrs in the above-mentioned solution. Among the various methods evaluated, biosynthesised nanoparticle proved to be efficient to increase the germination rate (97%) followed by water (89%), potassium dihydrogen phosphate (89%), *Datura innoxia* leaf aqueous extract (85%). The shoot elongation after fifth day, tenth day and fifteenth day of inoculation were also measured and they are 5.07±0.671, 3.95±0.497, 3.87±0.434 and 3.87±0.371cm respectively. Similarly the root length after fifth day, tenth day and fifteenth day of inoculation were also measured and the root length are 3.81±0.842, 2.44±0.715, 3.3±0.815 and 2.74±0.782 respectively. We observed that the copper nanoparticles enhanced paddy germination when compared to other solutions. Biosynthesised copper nanoparticles not accumulated in the shoot and root.

FUB-OP5. Fungicides and Time of Application for Management of Leaf Rust Disease in Coffee

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Leaf rust caused by *Hemilea vastatrix* Berk et Br. is a serious disease in coffee growing areas of Tamil Nadu. The detailed field investigations for three years were undertaken to study the effect of fungicides on incidence of leaf rust in coffee cv S9 during 2010-13. The trials were under taken at Shervaroy hills and Thandikudi areas of lower Kodai hills. Fungicidal spray was given for three times in a year as pre monsoon (First week of September), monsoon (Second week of November) and post monsoon (Second week of February) season in the crop. Among the five fungicides and their combinations tested, the reduction of rust index was observed in the plants sprayed with fungicide of Trifloxystrobin 25% + Tebuconazole 50% at 250 g ha^{-1} level. The rust incidence gradually increased over time in untreated control plant. A significant increase in yield of fruits *viz.*, fruits and beans was observed in the plants sprayed with the same fungicide over the control during the period.

FUB-OP9. Bio-efficacy of Different Fungicides Against *Rhinocladium corticolum Causal Agent of Black Banded Disease of Mango*

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Regarding the *in vitro* evaluation of different chemicals against *Rhinocladium corticolum* causal agent of Black banded disease of Mango *viz*., the combi products, (Saaf, Avatar and Taqat) systemic fungicides (hexaconazole, propiconazole and difenconazole) and non systemic fungicides (copper oxychloride and Bordeaux mixture) were tested at different concentrations by poisoned food technique. The study revealed that all the three class of fungicides gave good results in inhibiting the fungus. But, in the field level, systemic fungicides and combi fungicides were not much effective. Application of Bordeaux paste was highly effective in eradication of the fungus and checking the progress of the pathogen on the infected branches and also economically cheaper when compared with other fungicides.

FUB-OP11. Bioefficay of Azoxystrobin and Flutriafol against Early Blight of Potato

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Tomato (*Lycopersicon esculentum* Mill.) is one of the important solanaceous crops in India. Under *terai* conditions of Uttarakhand, tomato plants are subject to many biotic and abiotic stresses. However, fungal diseases, especially early blight caused by *Alternaria solani* (Ellis and Martin) Jones and Grout, causes significant reduction in the quantity and quality of fruit yield. Various fungicides used to control the disease. Since, tomato fruits are mostly consumed fresh, thereby spraying of commonly used fungicides just before harvesting resulted in high fungicide residue in the fruits, which cause great hazard to the human health.Therefore, present work was mainly planned to evaluate the bio efficacy of strobilurin and tiazole groups of fungicides which are excellent inhibitors of spore germination and known for their protectant activity with low residual activity.In a field experiment bio efficacy of azoxystrobin and flutriafol, alone and their combined product was tested against early blight of tomato. First spray given just after the appearance of the diseases symptoms and second spray given at fruit setting stage. Observations recorded 15 days after the second spray on blighted proportion of whole plant visually on 10 randomly selected plants per plot on 0-5 scale (Vakalounakis, 1983) and per cent disease index (PDI) was calculated.The experimental results revealed that early blight severity ranged from 49.33 to 89.33 PDI. All the treatments found effective in minimizing the disease severity and increasing the fruit yield significantly over control. Azoxystrobin 125 + flutriafol 125 g l^{-1} SC @ 1000 ml ha^{-1} was found best in minimizing the early blight severity and provided the highest yield.

FUB-OP12. Evaluation of Newer Insecticide Fungicide Combi Product for Control of Location Specific Pests and Disease of Kuttanad

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Field experiments were conducted at Rice Research Station, Kerala Agricultural Unversity, Moncompu during *kharif* 2009, *kharif* 2010 and *Rabi* 2010-11 to evaluate the pesticides against major rice disease of sheath blight and insects like stem borer and leaf folder. A new insecticide and fungicide combination product flubendiamide 3.5 % + hexaconazole 5 % WG (Origin 8.5 WG) with two different doses of 1.7 g and 2.0 g lit^{-1} were tested against the rice sheath blight disease, stem borer and leaf folder pests. The individual molecules were used as standard check. Uma (MO 16) was used as test variety with four replications for each treatment. The crop was sprayed with chemicals immediately after the appearance of pests under natural conditions. The pooled analysis of three seasons showed that Origin 8.5 WG @ 2 g lit^{-1} was found effective against the sheath blight disease, stem borer and leaf folder incidence than individual molecules. It was promoted as farm trials at 10 different farmers field of Kuttanad region during rabi 2011-12. The farm trial results proved that the combi product flubendiamide 3.5 % + hexaconazole 5 % WG (Origin 8.5 WG) @ 2 g lit^{-1} restricted the appearance of sheath blight (24.34 %), stem borer (16.8 %) and leaf folder (17.2 %) incidence than individual standard check molecules of carbaryl 25 WP @ 4 g lit^{-1} + zineb Z 78@ 4 g lit^{-1} (30.35, 20.80 and 19.01 %). There was significant difference in the grain yield data showed that the highest yield (4779 kg ha^{-1}) was recorded by the Origin 8.5 WG followed by standard individual check of carbaryl 25 WP @ 4 g lit^{-1} + zineb Z 78 @ 4 g lit^{-1} (4092 kg ha^{-1}). By this study, 50% spray cost can be reduced by using the combi product Origin 8.5 WG @ 2 g lit^{-1} to control both sheath blight disease and stem borer and leaf folder pests of rice in the Kuttanad region of Alleppey, Kottayam and Pathanamthitta Districts.

Session 5-Bio-inoculants and Biocontrol Agents

BIO-OP3. Biological Control of Stem Rot (*Sclerotium rolfsii* Sacc.) of Groundnut (*Arachis hypogaea* L.) with *Trichoderma* sp. and *Pseudomonas fluorescens*

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Sclerotium rolfsii (Sacc.) is a soil inhabitant of worldwide significance and an incitant of stem rot, a destructive disease of groundnut. Hence, a field experiment was conducted on Plant Pathology field at ICAR-DGR, Junagadh to manage this menace through bio-control agents in both *kharif* and summer season of 2011. The experiment replicated thrice in 5 × 4.5 m^2 (single plot) using randomized block design and groundnut variety GG2 with an ideal untreated control. A total of four bio-control agent were applied in this experiment *viz*., *Trichoderma harzianum* isolate T-170 (ICAR-DGR), *T. viride* isolate (Dharwad), *Pseudomonas fluorescens* (TNAU) and *P. fluorescens* (DGR). The bio-control agents used as single and their combinations as seed and soil applications. In both the seasons all treatments applied, significantly reduced the per cent stem rot incidence over untreated control, while lowest per cent stem rot incidence was reported in T_{13} (10.5 and 18.5 respectively) where soil application of *T. harzianum* isolate T-170 enriched in FYM @ 1 ton ha^{-1} and seed

treatment with *P. fluorescens* (TNAU) and *P. fluorescens* (DGR) @ 10 ml kg^{-1} seed were applied. The highest PEDC (per cent efficacy over disease control) was also reported in the same followed by T_5 (soil application of *T. harzianum* isolate T-170 enriched in FYM @ 1 ton ha^{-1} + seed treatment of *P. fluorescens* @ 10 mL kg^{-1} seed (TNAU)) while T_1 (soil application of *T. harzianum* isolate T-170 enriched in FYM @ 1 ton ha^{-1}) is the least effective. All the treatments showed significantly higher yield over control. The highest biological yield (pod & haulm) was observed in T_1 (1287 kg ha^{-1} and 2252 kg ha^{-1}, respectively) while it is at par with most of the treatments. The highest benefit: cost (B: C) ratio is recorded in T_1 where as highest incremental cost benefit ratio (ICBR) is in T_3 & T_4. Therefore, it concluded that the biological control agents could be play a major role to manage the stem rot and soil application of *T. harzianum* (ICAR-DGR) and seed treatment with *P. fluorescens* (TNAU) or *P. fluorescens* (ICAR-DGR) may used as better options.

BIO-OP4. Mass Multiplication, Shelf Life Study of Intact Coconut Fruit Liquid Formulation of *Pseudomonas aeruginosa* Migula and their Effect on PGPR of Finger Millet

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Maximum population of *Pseudomonas aeruginosa* was recorded when 3 ml suspension of *P. aeruginosa* was injected into intact coconut fruit (2.98×10^{10} cfu ml^{-1}). In shelf life study, the population of *P. aeruginosa* was increase on first day (2.22×10^{10} cfu ml^{-1}) of inoculation and reached its highest. Then after, it was observed to decrease up to 7th days (2.2×10^{8} cfu ml^{-1}). Thus can be stored for 7 days. The proposed protocol of coconut water formulation suggested is absolutely was cost effective and easy to prepared at small scale level. Maximum germination (93.67 %), root (8.60 cm) and shoot (5.50 cm) length and root bacterization (5.33×10^{4} cfu g^{-1}) was recorded in intact coconut water formulation *P. aeruginosa*.

BIO-OP5. Bio-efficacy of Dextrose and liquid based *Pseudomonas fluorescens* against *Fusarium* wilt of Brinjal (*Solanum melongena* L.)

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Brinjal is a native of India and one of the most popular vegetable crops grown in almost all the parts of the country. There are many wild relatives of brinjal (egg plant) are being grown in their kitchen garden. The unripe fruits are used as cooked vegetable alone or mixed with other vegetables. Because of highest protein content in the egg plants it affected by large number of pests and diseases. Among the various diseases, fungal wilt caused by *Fusarium oxysporum*, is of great economic importance which causes great loss in almost all brinjal production. Keeeping this fact in mind the trial was conducted at Agricultural Research Station Phondaghat against the efficacy of *Pseudomonas fluorescens* of different formulations of *Fusarium oxysporium* wilt pathogen.It was revealed from the data that the germination per cent was significantly higher in seed treatment of dextrose based *Pseudomonas fluorescens* @ 10 gm kg^{-1} seed (T_4) and seed treatment of thiram 2 gm kg^{-1} of seed (check T_8). These treatments were significantly superior over rest of the treatments and were at par with each other. These were followed by the seed treatment of talc based *Pseudomonas fluorescens* @ 10 gm kg^{-1} seed (T_1). The next in the merit were the seed treatment of dextrose based Pseudomonas *fluorescens* @ 7 gm kg^{-1} seed. (T_3). Seed treatment of liquid based *Pseudomonas fluorescens* @ 10 ml kg^{-1} seed (T_7) and seed treatment of dextrose based *Pseudomonas fluorescens* @ 5 gm kg^{-1} seed; whereas per cent wilt also significantly reduced by application of dextrose based *Pseudomonas fluorescens* @ 10 gm kg^{-1}. Seed (T4) and seed treatment of Thiram 2 gm kg^{-1} of seed (Check) (T_8) followed by T_1, T_2, T_3, T_6 and T_7 and were equally effective. Similarly the cost benefit ratio of treatment T4 was 1: 1.37 which was more cost effective than rest of the treatments. This was followed by the seed treatment of thiram 2 gm kg^{-1} of Seed (Check) T_8. Further the phytotoxicity study showed that, *Pseudomonas fluorescens* does not shown any phyto-toxic effect on brinjal at given concentration.

BIO-OP8. Exploring the Diversity of *Trichoderma viride* from Western Ghats for the Management of *Fusarium* wilt of Banana (*Musa.* spp)

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Incidence of *Fusarium* wilt disease was surveyed in eight varieties of Banana *viz.* Red, Rasthali, Neivalai, Poovan, Nadu, Hill, Karpuravalli and Green in Dindigul district of Tamil Nadu. One hundred isolates of *Trichoderma* spp. were isolated by serial dilution technique from 100 banana rhizosphere soils samples infected with wilt disease. The *Trichoderma* isolates were identified based on phenotypic and genotypic charateristics. The isolates were identified genotypically based on the amplified sequence from the ITS region. All the *Trichoderma* isolates were screened for their antagonistic activity against *F. oxysporum* such as colonization behavior, competitive saprophytic ability, propagule lysis, inhibition, speed on overgrowth of pathogen against *Foc* was scored and the effective strains which had highest competitive saprophytic ability was selected MSSRFT 5, MSSRFT 10, MSSRFT 20, MSSRFT 29, MSSRFT 33, MSSRFT 36, MSSRFT 57, MSSRFT 66, MSSSRFT 79 and MSSRFT 97. The mycoparasitic activity of *T. viride* on *F. oxsporum* was confirmed by scanning electron microscopic (SEM) studies which confirmed the colonization of *T. viride* over *F. oxysporum*. Among the isolates MSSRFT 5 and MSSRFT 29 and MSSRFT 66, MSSRFT 36 recorded maximum production of IAA, cellulase, chitinase and -1, 3-glucanase enzymes and also were found to be compatible with *Pseudomonas fluorescens, Bacillus subtilis* and *Paecilomyces lilacinus* and with fertilizers such as urea, ammonium sulphate, super phosphate, and fungicides *viz.*, captan, and carbendazim and thiram.

BIO-OP10. Pre-harvest Application of Chitin-based Formulation of Fluorescent Pseudomonad Strains for the Management of Post Harvest Anthracnose Disease in Mango

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Fluorescent pseudomonad strains were isolated from different mango growing areas of Tamil Nadu, India, and were tested for their efficacy against the anthracnose pathogen *Colletotrichum gloeosporioides* under *in vitro* and field conditions for two seasons. Totally fifty fluorescent pseudomonad isolates were obtained and tested against the mycelial growth of *C. gloeosporioides*. Among the isolates, *Pseudomonas* KFP1 and FP7 showed higher inhibitory effect on the mycelial growth of anthracnose pathogen. Further, pre-harvest application of KFP1 + FP7 bioformulation amended with chitin significantly reduced the anthracnose incidence and improved flower initiation and yield parameters (mean number of fruits and fruit yield) in all the field trials. The delay in latent symptom expression due to KFP1 + FP7 + chitin treatment was recorded up to 15 consecutive days in fruits stored at room temperature (282 C) in all the field trials conducted in two different seasons. Mechanisms involved in disease resistance were also studied and the results revealed that the enhanced induction of defense-related proteins *viz.*, peroxidase (PO), polyphenol oxidase (PPO), phenylalanine ammonia lyase (PAL) and chitinase and phenolics in mango leaves, flowers and fruits treated with KFP1 + FP7 + chitin bioformulation mixture.

BIO-OP14. Effect of Biocontrol Agents on Flowering Parameters and Management of White Rust in Cut Chrysanthemum (*Dendranthema grandiflora* Tzvelev)

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White rust infection on chrysanthemum cultivars caused by *Puccinia horiana* (Basidiomycetes: Uredinale) is the major problem in chrysanthemum cultivation in worldwide causes severe economic loss. Biocontrol is an alternate way to control this disease. On the basis of this presidence, the present study was conducted with an objective to study the effect of bio control agents on growth, physiology of disease resistance and yield of Chrysanthemum var. Punch under protected condition during 2012-2013 at Yercaud in a randomized block design (RBD). The experiment consists of 14 treatments which include combinations of *Bacillus* and *Pseudomonas* at 1 % and 2 % supplemented to FYM and foliar application at fortnightly intervals including a farmers practice and an untreated control. The results revealed increased microbial diversity, density and competition occurred in the rhizosphere environment (31 × 10^6 CFU g^{-1} of soil) when chrysanthemum plants supplemented with 2 % *B. subtilis* to FYM along with foliar spray of 2 % *B. subtilis*. Enhanced activities of defense related enzymes PO (0.3950 abs min^{-1} g^{-1}), PPO (0.23 abs min^{-1} g^{-1}), PAL (164.83 nmol min^{-1} ml^{-1}) and phenols (5825.0 µg g^{-1}) was observed in the endophytic bacterial treatments at peak vegetative stage of the crop when soils supplemented with 2 % of *P. fluorescens* to FYM along with foliar application of 2 % *P. fluorescens.* Significant increase in growth parameters *viz.*, plant height (155.33 cm), leaf area (1302.84 cm^2), earliness in flower bud appearance (50.15 days) and flowering (101.35 days) and flower yield (75.26 stems/m^2) observed when individual or combined applications of *Bacillus* or *Pseudomonas* isolates than untreated control and farmers practice. *Bacillus* and *Pseudomonas* isolates with different antibiotic genes indicating that biocontrol agents increased the flower parameters due to growth promotion and disease reduction.

BIO-OP 17. Pathogenicity of Entomopathogenic Fungi against Chilli Thrips, *Scirtothrips dorsalis* Hood

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The pathogenicity of eleven fungal isolates belonging to *Beauveria bassiana* (Balsamo-Crivelli) Vuillemin (isolate from Tamil Nadu Agricultural University, Sugarcane Breeding Institute, Coimbatore and National Bureau of Agriculturally Important Insects, Bangalore), *Metarhizium anisopliae* (Metschinikoff) Sorokin (isolate from SBI, NBAII and TNAU), *Lecanicillium lecanii* (Zimmerman) Zare &Gams (isolate from NBAII and TNAU) and *Metarhizium flavoviride* Gams & Rozsypal var *minus* (isolate from Brown Plant Hopper) against chilli thrips, *Scirtothrips dorsalis* Hood was studied using detached leaf bioassay technique. All eleven fungal isolates were found to be pathogenic to *S. dorsalis* at a concentration of 10^5 spores ml^{-1}. Among the isolates, *Bb111* isolate of *B. bassiana* caused highest per cent mortality (81.67%) and also recorded the lowest LT_{50} value of 99.07h against chilli thrips.

Session 6-Impact of Climate Change on Plant Diseases

CCP-OP1. Disease Complex of Mango under Hot and Humid Climate of Konkan Region

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Konkan region of Maharasthra is known for hot and humid climate. Alphonso is the premium mango variety which is being grown in Konkan region. Due to hot and humid conditions prevailing in Konkan region, mango is infected by various diseases. Alphonso is the commercially important variety having thin skin fruits on which various diseases found throughout the year anthracnose, dieback, gummosis, grey leaf blight, powdery mildew, branch drying, black sooty mould, pink disease are observed and which cause severe damage to plants. The incidence increased due to favourable hot and humid climate. Normally anthracnose, pink disease, black banded disease are found throughout the year. Severity of anthracnose increases during rainy season where as powdery mildew is observed mainly during 15th January to 15th March period on flowering panicles and pedicels of small berries. Grey leaf blight is normally observed during heavy rains under ill drainage conditions. Branch drying is observed during rainy season and gummosis during summer. This leads to development disease complex in mango orchards throughout Konkan region.

CCP-OP2. Climatic Factors Influencing the Growth and Development of *Botrytis cinerea* Causing Blossom Blight on Carnations

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Carnations are the mostly preferred cut flower varieties next to rose. World's affinity towards carnation due to wide variety of available colours and long shelf life increases the demand for them all over the world. Carnations are affected by many diseases that drastically reduce the quality of the produce. Among them blossom blight caused by *Botrytis cinerea* is the most important. The pathogen is fast growing and covers the entire flower with grey mycelium during storage and transport. Climatic conditions plays a major role in influencing the growth and development of the pathogen. Field survey was conducted during 2013 for the occurrence of blossom blight in, Ooty and Kotagiri regions of Nilgiris district. The results revealed that maximum per cent blossom blight incidence was observed at Kotagiri in the susceptible variety Gaudina red 15.6%. The results indicates the influence of climatic factors prevailing in Kothagiri in disease establishment. High relative humidity prevailing in Kotagiri aided disease development. Influence of climate in the life cycle of the pathogen was studied under *in vivo* and *in vitro* conditions. Under field conditions, during rainy season, high relative humidity favoured profuse sporulation. After prolonged days of clear sunshine when the humidity and temperature decreases, the fungus produced black irregular flat sclerotial bodies inside the flowers in order to survive the hostile environment. Under *in vitro* conditions, when cultured on PDA the fungus was fast growing and covered entire Petri plate within 4 days at 15 C. Profuse sporulation was observed when exposed to alternate light and dark hours at 15 C. The culture produced scattered, large, dark black, irregular, flat sclerotial bodies on PDA when incubated in complete darkness at 20 C. The sclerotia produced mass of conidia when incubated in moist chamber, at 15 C staging the importance of relative humidity.

CCP-OP5. Studies on Epidemiology of Pearl Millet Smut caused by *Moesziomyces penicillariae* (Bref.) Vánky

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Smut is the most important floral disease of pearl millet. The disease is more severe and damaging in F1 hybrids than in open pollinated varieties because protection by pollination is more effective in varieties than in hybrids. The disease can be best managed through host plant resistance as well as critical examination of various environmental factors responsible to create congenial condition. The present investigation was therefore, undertaken in randomized block design with four replication on two commercially released hybrids *viz.*, HHB 67 Imp and HHB 197 with three different date of sowing (Early *i.e.* 2nd fortnight of June, normal *i.e.* 1st fortnight of July, and late *i.e.* 2nd fortnight of July) to find out the effect of sowing time & weather variables in development of pearl millet smut. Observations on emergence of seedlings after 10 days of sowing and smut severity were recorded at milk stage, dough stage and physiological maturity stage. Smut severity was highest *i.e.* 13% in long duration hybrid when sown at recommended time of sowing followed by late sown crop and early sown crop at physiological maturity stage. The smut severity was higher *i.e.* 6.3% in late sown crop at milk stage.

CCP-OP6. Pathogenic Spectra and Epidemics of Nursery Diseases of *Pongamia pinnata* in Relation to Climate Change

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Pongamia pinnata (L.) Pierre a biofuel yielding tree species of wide adoptability succumbs to losses by seedling diseases. High rainfall and low rainfall receiving nurseries of different agro climatic zones recorded five diseases of varied intensities. New invasions of *Fusicladium* leaf spot and blight, *Colletotrichum* leaf blight, *Rhytisma* tar spot, *Dothiorella* leaf spot and blight and *Cephaleuros* red rust in forest nurseries of south India and their alarming increase indicated role of climate change. Highest per cent combined foliar diseases incidence (68.10%) and Per cent disease index (66.22%) was recorded in high rainfall receiving nursery. Foliar disease calendar in specific has revealed all seasonal occurrence of *Fusicladium* blight with moderate to high intensity followed by long period existence of *Colletotrichum* blight. Per cent disease index of *Fusicladium* leaf spot was found to be positively and significantly associated with relative humidity (0.564). The mean yearly disease induced defoliation was high (30.38%) in high rainfall receiving forest nursery compared to low rainfall receiving nursery (14.78%). The mean yearly defoliation percentage recorded in the high rainfall receiving forest nursery was 30.38 per cent compared to low rainfall receiving nursery (14.78%). Four phases in disease progression were identified viz., log phase (August to first fortnight December), stationary phase (first fortnight December to first fortnight of February), declining phase (first fortnight of February to first fortnight of June. Disease induced seedling mortality was very high in high rainfall receiving nursery (30.03%) compared to low rainfall receiving nursery (8.1%).

Session 7 - Disease Complex / IDM Approach

IDM-OP1. Evaluation of Pigeonpea (*Cajanus cajan*) Entries against Wilt Disease

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A total eighty nine entries of Pigeonpea were screened in the wilt sick plot under high disease pressure in field condition to find out levels of their resistance against wilt. Test entries were sown in single row with 20 cm × 50 cm spacing and after every two entries one row of ICP2376 a highly susceptible entry was raised to serve as an infector row. The plot was artificially inoculated with chopped stem pieces of wilted plants of pigeonpea at the time of final land preparation. Observation was recorded on the basis of total number of plant and number of wilted plant in each entry, per cent wilt incidence was calculated and the entries were classified as resistant, moderately resistant and susceptible.Out of eighty nine entries of pigeon pea, fifteen entries *viz.*, BSMR571, BSMR 2, IPAC68, GRG2009, IPA204, KPL44, BRG2, ICP8863, ICP 12739, ICP12752, ICPL96061, ICPL99008, ICPL99055, ICPL99091 and ICPL99098 were found resistant and twenty eight entries viz., BSMR736, BSMR853, BSMR579, BWR133, BSMR243, BSMR528, JKM189, RVKT260, ICPL87119, MAL13, RVSA07-10, GRG811, CORG9701, BRG 3, WRP1, IPAC66,ICP 12728, ICPL94062, ICPL20123, ICPL20124, ICPL20135, ICPL20136,

ICPL90011, ICPL99009, ICPL99044, ICPL99048, ICPL99095and ICPL99099 were recorded moderately resistant and remaining entries showed susceptible reaction against the disease. Entries found resistant to moderately resistant may either be used as donor parent in breeding programme for development of resistant varieties or if yield level is comparable with existing varieties it may be released for general cultivation.

IDM-OP3. Epidemiology and Management of *maydis* Leaf Blight of Maize

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Maize production in peninsular India is severely limited on account of the severe incidence of foliar diseases during monsoon season, mainly *maydis* leaf blight. *maydis* leaf blight, a foliar disease caused by *Drechslera maydis* (Nisikado and Miyake) Subramaniam and Jain is a wide spread disease in tropical and subtropical parts of world including India. Losses upto 40 per cent have been reported in artificially inoculated trials with race O. Hence, the present study was conducted to investigate epidemiology and find out effective and economical control measures. Field experiments were conducted at University of Agricultural Sciences, Dharwad, during 2012 and 2013 rainy seasons using hybrid 900M. The progress of blight intensity was recorded at periodical intervals and studied in relation to weather parameters. Test fungicides were applied to crop as foliar spray twice at 15 days interval starting from the initiation of the disease. Temperature ranging from 20-28 C combined with more than 89% relative humidity and moderate to heavy rainfall (59.6-97.0mm) was very much congenial for the disease development. Disease has a significant effect in reducing the yield in late sown crop. Hybirds viz., DKC 9133, DKC 9126 and 30 R 77 registered moderately resistant reaction under epiphytotic situation. Fungicide propiconazole 25 EC @ 0.1% was superior in reducing in the blight index (21.19%) followed by tebuconazole 250EC @ 0.1% (24.91%). Significant increase in grain yield was registered in plots that received propiconazole 25 EC treatment (72.66 q ha^{-1}) followed by tebuconazole 250EC (69.57 q ha^{-1}). propiconazole 25 EC @ 0.1% found most cost effective fungicide.

IDM-OP5. Cold Tolerant Rhizobacteria as a Bionematicide for Burrowing Nematode, *Radopholus similis on* Black Pepper at Hilly Regions

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Surveys were made in the hilly region of Yercaud, Burliyar, Thadiyankudisai and Kolli hills during 2012-13 and two hundred soil samples were collected for the presence and isolation of virulent rhizobacteria strains. Among them eight isolates *viz*., KBR16, KBR23, BBR16, BBR 22, TBR10, TBR25, YBR17 and YBR21 were identified as virulent against burrowing nematode, *Radopholus similis* and formulated individually with talc base. At Horticultural Research Station, Yercaud (TNAU) two pot culture experiments with black pepper were conducted with a nematode inoculation @ 1Juvinile g^{-1} soil. Each pot was treated with 10 gram of talc based rhizobacteria isolates and replicated thrice. The nematode population and morphometric characters of black pepper were recorded on 30 Days After Treatment. The result showed that the isolate KBR16 was found to be significantly superior in reducing the nematode population (107.20 $5g^{-1}$) in roots compared to untreated control (312.35 $5g^{-1}$). The isolate KBR16 exhibited more number of lignified cells of black pepper in cortex when compared to untreated control. This isolate also showed significantly increased plant height (64.52cm) and root length (39.24cm) compared with untreated control (29.65 and 15.13 cm respectively). It is concluded that the isolate KBR 16 may be further exploited for the management of *R. similis* in black pepper.

IDM-OP6. Strategies for Management of *Phytophthora* Root Rot and Gummosis in Citrus

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A survey of different citrus orchards was undertaken from Akola, Amravati and Nagpur districts. Almost all the samples collected from citrus orchards of these districts were found positive to *Phytophthora*. Propagule density of *Phytophthora* in soil was in the range of 16.66-26.33 cfu g^{-1} soil in Akola, 29.50-31.50 cfu g^{-1} soil in Amravati and 27.50-32.00 cfu g^{-1} soil in Nagpur district. The population density of *Phytophthora* spp. cfu g^{-1} soil was non significant when recorded at the start of the experiment. Amongst organic amendments, Neem seed cake (M_1) was found to reduce population of *Phytophthora* up to 50.78 % whereas Groundnut cake reduced population upto 33.82 % . Combination of fungicides with bioagent significantly reduced propagules g^{-1} soil. Drenching of Metalaxyl + Mancozeb @ 0.2 % along with *Trichoderma harzianum* 50 g with 50 Kg FYM (S_1) reduced propagules up to 57.40 %. However, drenching of Fosetyl AL @ 0.2 % + *Trichoderma harzianum* 50 g with 50 kg FYM (S_2) and Metalaxyl + Mancozeb @ 0.2 % along with *Pseudomonas fluorescense* 50 g 50 kg^{-1} FYM (S_3) were at par with this treatment. Significant reduction was observed with the integration of organic, amendments, chemicals and bioagents. Among all combinations drenching of metalaxyl + mancozeb @ 0.2 % + Bordeaux Pasting 1:1:10 + 50 g *Trichoderma harzianum* per 50 kg FYM + Neem seed cake 2 kg $tree^{-1}$ was effective to reduce propagules upto 62.01 % followed by M_1S_3 (60.37 %). In M_1S_1 initial propagules count in soil was 16.66 g^{-1} of soil which was decreases up to 6.33 g^{-1} soil after completion of experiment. There was significant increase in population of *Phytophthora* spp. observed in M_2S_5 from 17.33 to 20.33 cfu g^{-1} soil. neem seed cake (M_1) was found effective to reduce root rot upto 35.60 % whereas, Groundnut cake (M_2) was found to reduce root rot upto 21.68 %. The present study revealed that drenching of Metalaxyl + Mancozeb @ 0.2 % along with *Trichoderma harzianum* 50 g with 50 kg FYM (S_1) significantly reduced root rot upto 41.86 %. Drenching of Metalaxyl + Mancozeb @ 0.2 % along with *Pseudomonas fluorescens* 50 g 50 kg^{-1} FYM (S_3) statically at par with S_1.

IDM-OP9. Disease Scenario of Cotton in Andhra Pradesh

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Cultivation of Bt cotton since its approval in 2002 led to quick replacement of non-Bt cotton. At present Boll Guard II occupies more than 90% area under cotton. Andhra Pradesh stands third in area with 21.42 lakh ha and production of 65.50 lakh bales but

sixth in productivity with 571 kg ha^{-1} during 2013-14. An analysis on verification of disease scenario in Bt cotton revealed that there is no difference in the occurrence of diseases between Bt and non Bt cottons. In Bt cotton bacterial blight, leaf spots caused by Alternaria, Helminthosporium, Cercospora, Myrothecium, grey mildew, rust, dry root rot, wilt and Tobacco Streak Virus (TSV) diseases are recorded. Among the foliar diseases Alternaria leaf spot occurred every year while bacterial blight became severe in certain years. Grey mildew, favoured by cool weather, has attained major status in recent years. Rust disease though occurs late in the season could cause considerable losses when diurnal variation in the temperature is high with cool nights. TSV occurs throughout season in mild to moderate form. Monitoring the disease revealed that TSV incidence was relatively less on non Bt varieties / Hybrids. Symptoms were confined to few leaves at the growing point to four to five twigs $branches^{-1}$. Avoidable losses due to these diseases varied from 33 to 38 % under congenial conditions. Chemicals as well as biological methods were evaluated and integrated disease management modules were developed to minimize the losses and increase seed cotton yields.

IDM-OP10. Integrated Management of Twisting Complex in Onion

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Onion is one of the most important commercial vegetable crops of India. In the recent years twister disease of onion has become endemic in coastal tracts and other onion growing regions of the Karnataka state. Both seed and bulb crops are infected with disease severity of 20-30 per cent and 50-70 per cent respectively. Therefore, an attempt was made to manage the disease in an integrated manner during 2010-11 and 2011-12 in the farmer's fields of the coastal parts of Karnataka state. The results of the experiment revealed that, seed treatment with carbendazim @ 2g kg^{-1} + soil application of neem cake @ 5 q ha^{-1} + *Trichoderma harzianum* @ 2kg ac^{-1} + dipping the seedlings in *Pseudomonas fluorescens* @ 10g l^{-1} + spray with boron @ 2g l^{-1} + multi K @ 5 g l^{-1} + spray with Hexaconazole @ 0.1 per cent was found to the superior treatments in reducing the twister disease incidence (5.49%) with maximum yields of 279.81q ha^{-1} and maximum net returns of Rs. 2, 38,486 ha^{-1}. Therefore, this integrated treatment or module can be adapted in twister endemic areas of onion for maximum production and returns.

IDM-OP11. Integrated Disease Management of Mango under Konkan Region

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The experiment was conducted at Regional Fruit Research Station, Vengurle during 2012-13 to 2014-15. Mango is very susceptible fruit crop to climatic change from its vegetative growth stage to flowering and fruiting stage. The present studies concluded that the clean cultivation of mango orchard was found to be effective in checking incidence of different diseases such as Anthracnose, Pink disease branch drying, etc. and destroyed primary inoculums which were responsible for further dispersal of diseases. Spraying schedule of fungicides at different concentrations at different stages of mango were found to be effective which are recommended by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli. Among this spraying sulphur (80% WP) @ 2 gm lit^{-1} as solution form was found effective in controlling Powdery mildew of mango. Spray schedule includes 0.1% bavistin spray; 1% Bordeaux mixture spray; 0.3% copper oxychloride spray which were found to be most effective for controlling many of these diseases. Prophylactic spray of 1% Bordeaux mixture before onset of monsoon and one spray immediately after rains were found to be most effective.

IDM-OP14. Interactive Studies on Nematode-*Pratylenchus delattrei* and Fungal Pathogen-*Fusarium incarnatum* Associated with Crossandra wilt in Tamil Nadu, India

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Crossandra (Fire cracker) is an important commercial flower, mainly grown in India, is affected by wilt disease caused by *Fusarium* spp.The treatments imposed in the first experiment includes T_1-Inoculation of nematode alone (1 g^{-1} soil), T_2-Inoculation of pathogen alone (3%) w/v, T_3- Inoculation of pathogen (3%) + inoculation of nematode (1 g^{-1}), T_4-Inoculation of pathogen (3%) + inoculation of nematode (1 $2g^{-1}$), T_5-Inoculation of pathogen (3%) + inoculation of nematode (1 $4g^{-1}$), T_6-Inoculation of pathogen (2%) + inoculation nematode (1 g^{-1}), T_7-Inoculation of pathogen (1%) + inoculation of nematode (1 g^{-1}), T_8-Control (No pathogen/No Nematode.The treatments imposed in second experiment includes:T_1-Inoculation of nematode (1 g^{-1}) + pathogen (3%), simultaneously T_2- Inoculation of nematode (1 g^{-1}) seven days earlier followed by pathogen (3%), T_3- Inoculation of pathogen (3%) seven days earlier followed by nematode (1 g^{-1}) T_4-Control check (No pathogen/No Nematode). The results of first experiment revealed that the plant growth parameters *viz.,* shoot and root length, shoot and root dry weight were decreased significantly in all the treatments when compared to uninoculated check. The maximum per cent reduction of shoot length and shoot dry weight was recorded in T_3- (49.8 and 52.6%), followed by T_6 (25.8 and 39.7%) respectively.The maximum per cent reduction was observed in T_3 (47.0 and 47.4%) followed by T4 (38.8 and 35.8%) respectively, where as T_4 and T_6 are statistically on par with each other. Highest reduction in flower yield was observed in T_3 (82.6%) followed by T_6 (51.8%). Overall the combination of fungus and nematode resulted in more reduction of plant growth and yield than by either of them alone. It was also observed that the population of nematode was more in combined application than each one alone, indicating the synergistic effect of fungus and nematode.The maximum population of nematode 365 per 200 cc soil and root lesion index of 3.9 was recorded in T_3 followed by T_6 with nematode population of 353 and root lesion index of 3.7, whereas maximum number of pathogen colony forming units were recorded in T_3 followed by T_4. Wilt incidence was also maximum in T_3 (50%) followed by T_6 with wilt incidence of 25.2%. In the second experiment, all plant growth parameters such as root length, shoot length, shoot dry weigh root dry weight and flower yield are decreased and pathogen population (nematode + fungi), root lesion index and wilt incidence are higher in T_2 than T_1 or T_3. These investigations provide baseline data for understanding the relationship of nematode and fungus and their role in causing wilt in crossandra.

IDM-OP15. Pathogenic and Genetic Variability in *Xanthomonas oryzae* pv. *oryzae* and the Integrated Management of Bacterial Blight Disease

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Bacterial blight of rice is a major threat in rice cultivation causing huge yield loss to the crop. A series of surveys conducted in 14 locations of three major rice growing districts (Alappuzha, Palakkad and Thrissur) of Kerala during September 2007 to find out the occurrence of bacterial blight disease. The pathogen causing bacterial blight of rice was isolated from 14 locations of the said districts and their pathogenicity was established. Based on the cultural, morphological and biochemical characters, the pathogen was identified as *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) (Ishiyama) Swings et al. The 14 isolates showed slight variation in their cultural, morphological and biochemical characters. Pathotype studies were conducted in net house using 14 isolates on 20 popular and commonly cultivated rice varieties, six near isogenic lines having different R genes gene^{-1} combination and two rice differentials with no genes. It could distinguish the virulence spectrum of the isolates into three groups/categories namely 'highly virulent', 'moderately virulent' and 'weakly virulent' isolates/strains. The study on the kresek symptom also confirmed the above finding. BOX and ERIC-PCR fingerprinting depicted the existence of high level of genetic variability among the pathogen population in the rice growing areas of Kerala. *In vitro* sensitivity of six bactericides against the four highly virulent isolates of *Xoo* revealed that tetracycline 250 ppm, tetracycline 100 ppm, tetracycline 50 ppm, streptocycline 250 ppm, streptocycline 200 ppm and Bactrinashak 250 ppm were effective against the pathogen. *In vitro* sensitivity of different organics and agrochemicals revealed that cow dung extract 2% + vermicompost extract 2%, cow dung extract 2% + *P. fluorescens* 2%, vermicompost extract 2% + *P. fluorescens* 2%, vermicompost extract 2 %, copper hydroxide 0.15% were found effective against the pathogen, in that order.The 110 bacterial isolates obtained from rice rhizosphere, rice endosphere and cowdung and vermicompost, screened against the Polpully virulent pathogen could yield six prominent bacterial isolates *viz.,* RE-1, RR-26, RR-53, CB-39, VB-67 and VB-69 and were tentatively identified as *Pseudomonas* sp. Pot culture experiment, showed that tetracycline 250 ppm, tetracycline 100 ppm, streptocycline 250 ppm, Bactrinashak 250 ppm, tetracycline 50 ppm, bacteria from cow dung (CB-39), bacteria from vermicompost (VB-69), endosphere bacteria (RE-1), rhizosphere bacteria (RR-26), cow dung extract 2% + *P. fluorescens* 2%, vermicompost extract 2% + *P. fluorescens* 2% and cow dung extract 2% + vermicompost extract 2%, rhizosphere bacteria (RR-53) and copper hydroxide 0.15% were found best in managing the bacterial blight disease. Seven bacterial antagonists *viz*., RE-1, RR-26, RR-53, CB-39, VB-67 VB-69 and Pf1 when subjected to compatibility studies against *Xoo* under *in vitro* showed 17 combinations, showing synergistic effect in inhibiting the *Xoo.* In the compatibility study of seven antagonists with nine pesticides, 71 two way combinations were found synergestic effect against *Xoo.* The compatibility of 13 agrochemicals under *in vitro* against *Xoo,* revealed that 50 two way combinations showed synergistic action in inhibiting the pathogen. Three two way combinations showed compatible action in inhibiting the pathogen. In the compatibility of four fertilizers *viz*., urea, rajphos, muriate of potash and ammonium sulphate showed that five two way combinations proved synergistic action in inhibiting the pathogen. All the seven antagonistic bacteria and 17 agrochemicals showed the compatible reaction in inhibiting *Xoo.* The seven bacterial antagonists were subjected for various growth promoting characters *viz.,* 'P' solubilization, NH_3 and HCN production. The six isolates differed slightly for the above characters. All the isolates could produce siderophore and IAA. A few isolates could produce non volatile metabolites. The field study established the most practical finding that the tetracycline 50 ppm, tetracycline 100 ppm, bacterial consortium (RE-1 + CB-39), bacterial consortium (CB-39 + VB-69), bacteria from cow dung (CB-39), endosphere bacteria (RE-1), bacteria from vermicompost (VB-69), streptocycline 250 ppm, Bactrinashak 250 ppm, cow dung extract 2% + KAU-(Pf1) 2%, rhizosphere bacteria (RR-26) and KAU-(Pf1) 2% were found promising in managing bacterial blight disease of rice. Thus, apart from bactericides, there was a variety of highly promising organic management possibilities to combat the disease.

IDM-OP16. Mode of Spread and Survival of Pomegranate Wilt Pathogen *Ceratocystis fimbriata* in India

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The pathogen *Ceratocystis fimbriata* inoculated through wounds and the growth of the fungus observed on both upward and downward directions on the bark of the plant.The fungus migrated up to 155 cm from the wounded tissues to the soil in duration of 69 days through water conducting tissues. After 90 days, the pathogen established in the soil and infected plant expressed wilting symptoms.There was no blue stain on the bark in without inoculated plants.The pathogens establishes in the xylem and further migrates through water conducting tissues and then reaches to the soil before wilting of the plant. In new gardens, the infected plants expressed wilting symptoms within six months to one year.This was due to the source of pathogen which came from the infected seedlings. In many gardens, it was observed during the survey of 1774 fields in India, replanted seedlings in the infested soil showed wilting symptoms within few months. Hence, the infested soil contains the pathogen and carries from one plant to other through irrigation water and farm implements and cause the wilt. The soil population of *C. fimbriata* in the infested soil was ranged from 75 to 114 cfu g^{-1} of soil and the propagules in the infested soil spread from one plant to other through irrigation water, implements during cultural operations. Once the host dies, the fungus survives either in the soil or in the infected bits. The infected bits were collected from the wilted plant and placed on PDA medium with an interval of 15 days.The fungus colony of *C. fimbriata* recovered up to 190 days from the infected stems portions. As per these results the fungus survives in the infected bits up to 190 days. This study helps to remove the source of inoculums in the field by eradicating the infected plants in the field.

IDM-OP17. Role of Micronutrients in Management of Collar Rot and Root Rot Diseases of Groundnut

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Groundnut (*Arachis hypogea*) is one of the most important oilseed

crops of the world. Diseases render the crop uneconomical in the rainy season, which is the major period of groundnut cultivation. Collar rot (*Aspergillus niger*) and dry root rot (*Macrophomina phaseolina*) are an important diseases of ground nut and frequently causes considerable losses in both pod yield and quality. Therefore, a field experiment was conducted in kharif seasons of 2013 and 2014 to find out the comparative and combined efficacy of different micronutrient, and a bio control agent for the management of these diseases on a susceptible groundnut cv GG-20. The randomized block design was followed with three replications maintaining a plot size of 4 X 3.2 m. Pooled data of two years revealed that soil application of *Trichoderma* and individual micronutrient except zinc were found effective in reducing disease incidence. Result further indicated that different combinations of micronutrients coupled with soil application of *T. viride* (2.5 kg ha^{-1}) recorded less incidence of root rot and collar rot in comparison to application of individual micronutrient or Trichoderma. Minimum incidence of root rot (3.80%), collar rot (1.87%) and maximum pod yield (2836 kg ha^{-1}), haulm yield (7484 kg ha^{-1}), net return (Rs 83447 ha^{-1}) & cost benefit ratio (Rs 2.18/Rs invested), recorded in treatment where soil application of Gypsum 250 kg ha^{-1} + Zn SO_4 20 kg ha^{-1} + Fe SO_4 20 kg ha^{-1} + K_2O30 kg ha^{-1} + Trichoderma 2.5 kg ha^{-1} was done. Maximum disease incidence (root rot, 18.15% and collar rot, 7.50%) and minimum yield (pod, 1250 kg ha^{-1} and haulm, 3070 kg ha^{-1}) and monetary return (net return Rs. 21148 ha^{-1} & cost benefit ratio Rs 0.66/ Rs invested) recorded in control plots.

Session 8-Regulatorry and Policy Issues

RPI-OP1. PCR-Based Detection of (*Puccinia horiana* (Henn) Chrysanthemum White Rust

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Chrysanthemum (*Dendranthema grandiflora*) being an important export oriented cut flower crop, the cultivable area is going on increasing in India and Tamil Nadu. Diseased cut flower chrysanthemum with symptoms of white rust was observed during 2012-2013 in Tamil Nadu in India. Chrysanthemum varieties were surveyed for the occurrence of white rust in Kothagiri of Nilgiris district and Yercaud of Salem district in India. Historically, identification protocols for white rust relied upon macroscopic symptom development and microscopic examination of infected leaves for teliospores. Symptoms become visible 7 to 10 days after initial infection under favorable conditions followed by the production of telia. Infected plants can therefore evade detection before symptoms and fruiting bodies are evident. White rust were detected in symptomatic leaves of two varieties using PCR with *P. horiana* genus specific primer (Ph-F1 and Ph-R1') amplified a fragment of approximately 240bp. Yet another, *P. horiana* genus specific primer (Ph-F2 and Ph-R1) amplified a fragment of approximately 340 bp corresponding to the region of the 16S-23S rDNA intervening sequence, specific for *P. horiana*. The nucleotide sequence analysis of a 240-bp and 340-bp fragment had 100% identity**.** Amplified DNA fragments of 240bp and 340bp were ligated to the pBS based T/A plasmid vectors using T4 DNA ligase separately. The *P. horiana* primers did not amplify the rDNA target using DNA isolated from leaf tissue infected with *P. chrysanthemi*. The partial sequence of *P. horiana* isolates were submitted to the NCBI, Genbank, New York, USA. The isolates were assigned with accession numbers *KC291657*, *KC291658, KC291659* and *KC291660*. Phylogenetic analyses of *P. horiana* based on 16S-rDNA sequences were grouped in cluster-I.

RPI-OP2. Innovative Tools for Identification of Plant Quarantine Pathogen *Xanthomonas axonopodis* pv. *dieffenbachiae* in Anthurium

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Detection of harmful bacteria in plant material is essential to ensure safe and sustainable agriculture. Various techniques have evolved in last few years to achieve reliable and rapid detection of pathogens. Anthurium (*Anthirum andreanum* Linden ex Andre) is an important export oriented cut flower crop. Bacterial blight of anthurium was caused by *Xanthomonas axonopodis* pv. *dieffenbachiae*, a plant quarantine pathogen. Pathogen causing bacterial blight was identified up to genus level in MALDI-TOF MS as *Xanthomonas*. The pathogen associated with bacterial blight of anthurium was further confirmed as *Xanthomonas axonopodis* pv. *dieffenbachiae* through FAME analysis, BIOLOG and by polymerized chain reaction using specific primers. House keeping genes like ATP synthase subunit (*atpD*), molecular chaperone dnak (*DnaK*), elongation factor (*efp*), Ton-B dependent receptor (*fyuA*), Glutamine synthetase type 1(*glnA*) and DNA gyrase subunit B(*gyrB*) of *Xanthomonas axonopodis* pv. *dieffenbachiae* also confirmed the identity of plant quarantine pathogen.

RPI-OP3. Evaluation of New Generation Fungicidal Molecules for the Management of White Rust of Chrysanthemum caused by *Puccinia horiana* (Henn.)– A Quarantine Disease

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An investigation was carried out to study the evaluation of new generation fungicidal molecules for the management of white rust of chrysanthemum caused by *Puccinia horiana* (Henn.) at M/s Salem Green Plants (P) Ltd., located at Yercaud, Salem district, Tamil Nadu during the period from August 2012 to June 2013. Among the different fungicide modules revealed that, the foliar spray with module (M_3) comprising of Tebuconazole 0.5 % (Folicur 25 EC), Kresoxim methyl 0.1% (Ergon 44.3 SC), Azoxytrobin 0.2% (Amistar 250 SC), Probineb 0.2 % (Antracol 70 WP), Carboxin 0.2 % (Vitavax 75 WP) and Myclobutanil 0.05% (Systhane 400 WP) were sprayed individually at weekly intervals was most effective in reduced the infection of chrysanthemum white rust (6.43 %, 6.00 % and 4.56 % disease intensity at vegetative, bud appearance and flowering stage respectively) under protected cultivation.

RPI-OP4. Detection and Management of New Disease on *Polianthes tuberosa* caused by *Lasiodipodia theobromae* in india

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Tuberose is commercially grown for cut flower, loose flower as well as for extraction of essential oil and perfume. Peduncle blight, up till now an unknown disease was found to be a major limiting factor to the cultivation of tuberose, as the disease incidence was noticed up to 42.60 per cent in pockets of Madurai district. In May 2010, an occurrence of peduncle blight was observed on tuberose (*Polianthes tuberosa*) plants grown in Madurai and Dindugal districts of Tamil Nadu, India. The crop was found to exhibit a disease syndrome. Symptoms included blossom blight, peduncle rot and leaf blight at tips. Based on morphological and pycnidial characters, the complete internal tran- scribed spacer (ITS) ribosomal RNA gene sequence analysis, and pathogenicity tests the fungus was identified as *Lasiodiplodia theobromae* Pat.The present investigation was made to manage the peduncle blight of tuberose.The efficacy of fungicides and biocontrol agents effective *in vitro* was evaluated in pot culture experiment to manage peduncle blight of tuberose. Foliar application of carbendazim at 0.1 per cent on 60, 90 and 110 days after planting (DAP) was found to be highly effective in reducing the disease incidence up to 95.5 per cent. Among the bioconrol agents, bulb treatment at 10g per Kg followed by three foliar sprays at 0.5 per cent on 60, 90 and 110 DAP using the combination of Tv_1, Pf_1 and Bs_{10} was equally effective as that of Pf_1 and Bs_{10} with 65.6 per cent and 64.4 per cent disease reduction respectively. This is the first report of peduncle blight caused by *L. theobromae* on tuberose in India.

Session 9 - Food Mycology

FML-OP1. Detection of Latent Infection of *Colletotrichum gloeosporioides* and *Lasiodiplodia theobromae* in unripe Mango Fruits

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Mango *(Mangifera indica),* the "King of Fruits" is amongst the most important fruit crops grown in India. Post-harvest loss of mango fruits accounting to 25-40 per cent of the total production, worth billions of dollars is a cause of major concern worldwide. In India, during post-harvest handling, the mango fruit is subjected to infection by twenty different genera of fungi. Among the post-harvest diseases, anthracnose caused by the ubiquitous fungus *Colletotrichum gloeosporioides* (Penz and Sacc.) and stem end rot caused by *Lasiodiplodia theobromae* are of field as well as post-harvest significance. The disease symptoms occur on leaves, twigs, petioles, panicles and fruits.The most important characteristic feature of the two pathogens is latency, wherein the development of the pathogen in young fruits is arrested and establishes only upon fruit ripening. Thus, fruits that appear apparently healthy at harvest can develop symptoms of anthracnose or stem end rot upon ripening. Hence, devising methods to detect the presence of the pathogen in the fruits at an early stage would be ideal to prevent post-harvest losses. Such methods would be of quarantine importance, which would help to prevent spread of the anthracnose pathogen to newer areas.Thus, in the present study an effort was undertaken to detect the presence of the pathogens in latent form in green mango fruits by two different methods, *viz*., chemodetection and serological detection methods. Chemodetection involved the use of paraquat while serological method employed ELISA, using polyclonal antibodies raised against mycelial proteins of *C. gloeosporioides* and *L. theobromae*. Chemodetection was done using dofferent concentrations of paraquat ranging from 1000-5000 ppm. Results revealed that paraquat at a concentration of 3000 ppm was most effective in detecting latency of *C. gloeosporioides* in apparently healthy green mango fruits. Treatment of young fruits with paraquat causes senescence of the tissues and thereby enables the dormant pathogen to grow saprophytically on the dead tissues. Moreover, it has been reported that in paraquat treated fruits, the sugar content is increased and phenolic content gets reduced. Serological method using ELISA was also effective in detecting the presence of *C. gloeosporioides* and *L. theobromae* in latent forms in unripe mango fruits. Hence, paraquat and polyclonal antibodies can be employed as a successful aid in early detection of pathogens that survive in dormant forms in apparently healthy mango fruits, much earlier than the natural expression. Early detection of the presence of *C. gloeosporioides* and *L. theobromae* in green mango fruits would not only reveal the extent of infection, but would also enable the scheduling of management strategies in order to reduce post-harvest losses.

FML-OP2. Post-harvest Incidence of Mycoflora and Aflatoxin Elaboration on Wheat Grains of West Bengal

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Wheat is the second largest cereal crop cultivated worldwide and consumed as foods and feeds in various ways. In India the total area of cultivation of this crop is about 29.8 million hectares, whereas in West Bengal (WB) it is cultivated about 0.32 million hectares and the total production is about 0.88 million tonne (2010-11). Amongst all food commodities, cereals are the best food sources for harbouring various mycotoxigenic fungi. India being a tropical country has great diversity in agro-climatic conditions which adversely affect the standing crops as well as stored food materials by favouring the growth of moulds and production of various types of mycotoxins. In WB harvested wheat grains are stored by farmers for considerable period in various types of storage structures, usually made up of mud, bamboo strips, palm leaves, paddy straw, in gunny bags or in plastic sacks. These variable storage systems make the wheat grains more vulnerable to *Aspergillus flavus* contamination and aflatoxin elaboration.Only few fragmentary reports are available on aflatoxin elaboration in wheat grain in WB. Thus present study will be undertaken to bridge the gap and to determine the severity of aflatoxin elaboration in wheat by aflatoxigenic fungi in this region. Several dominating fungal genera such as *Aspergillus*, *Penicillium*, *Fusarium*, and *Alternaria* were reported in this region of which *A. flavus* is more common and equally reported in all the samples. However only few grain samples have been reported as aflatoxin positive and the quantity of aflatoxin production is also found to vary with samples.

FML-OP4. Profiling of Volatiles to Discriminate the Post Harvest Diseases of Mango Inoculated with Toxigenic Fungal Pathogens

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The volatile metabolites of mango fruits, artificially inoculated with two toxigenic fungi isolated from infected mangoes were

profiled using gas chromatography/mass spectrometry. Expressional differences of volatile metabolites were observed. The chromatographic profiling study afforded numerous (a total of 52) different volatile metabolites. Healthy ripe mango fruits yielded twenty-three metabolites predominated among them were silane, cyclohexyl dimethoxy methyl-, crocetane, myristic acid, cetane and 1,2-benzene dicarboxylic acid. Mango fruits inoculated with *C. gloeosporioides* yielded 29 volatile metabolites; while that inoculated with *L. theobromae* yielded 26 different volatile metabolites. Among them only 3 volatile metabolites occurred relatively consistent in fruits inoculated with *C. gloeosporioides* and *L. theobromae.* while 2,6,10-trimethyltetradecane, crocetane and phellandrene occurred relatively consistently in fruits inoculated with these fungi. 2-propylmalonic acid, 1,4 Cyclohexadiene, 1-methyl-, Boronic acid, cyclohexyl dimethoxymethyl, Acetic acid, methyl ester, and Thujol was common in fruits inoculated with *C. gloeosporioides* while fruits inoculated with *L. theobromae* had specific volatiles 1,3-dimethoxy-2-(methoxymethyl)-2-methylpropane, Oxalic acid, cyclohexyldecyl ester, Cyclopentanepropionic acid, 2,5-cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)-, Carbonic acid, octadecyl phenyl ester, Spiro-1-(cyclohex-2-ene)-2'-(5'-oxabicyclopentane), 1',4',2,6,6-pentamethyl- and stearic acid. This study suggests that these unique metabolites can be used as biomarkers to detect post harvest diseases or toxigenic fungal pathogens of mango at an early stage of disease progression and to manage mango diseases in storage and outbreak of food borne disease, after further validation under commercial conditions.

FML-OP7. Detection of Aflatoxin B1 in Food and Feeds by Enzyme Linked Immunosorbant Assay

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Aflatoxins are carcinogenic secondary metabolites produced by toxigenic strains of *Aspergillus* species, such as *A. flavus* and *A. parasiticus*. *Aspergillus* and aflatoxins are major contaminant of crops and food products. Contamination of agricultural commodities with aflatoxins is often unavoidable, even with good agricultural practices. To secure the safety of food and feed, regular monitoring of aflatoxin levels in food grains and livestock feeds is necessary. Various analytical methods such as liquid chromatography, gas chromatography and mass spectrometry are available for its detection in foods and feeds. However, these methods though they are sensitive, but cumbersome and need an extensive clean up of the samples and require expensive instruments. Enzyme-linked immunosorbent assay (ELISA) is gaining wide acceptance for estimating the concentrations of aflatoxins because of its rapid, no requirement of extensive sample clean up, cost effective and relatively easy to adapt to situations in developing countries. Hence attempts were made to develop and standardize an ELISA method for detection of aflatoxin B1 from foods and feeds. To develop a highly effective immunogen, aflatoxin B1 (AFB1) was conjugated to keyhole limpet hemocyanin (KLH) and polyclonal antibodies were raised against AFB1-KLH in a New Zealand White inbred rabbit. By using the developed antibody, a sandwich ELISA method was standardized for quantifying AFB1 in foods and feeds. Totally, 68 samples consisting of maize-based foods and poultry feed samples collected from retail shops, supermarkets, poultry farms and poultry feed dealers of Tamil Nadu were analyzed for AFB1 contamination by ELISA. AFB1 contamination in maize based food products was detected in nine samples out of 17 samples tested. However only one sample exceeded the tolerance level of 20 µg kg^{-1}. AFB1 contamination in feeds was observed in more than 88% of the samples tested and its level ranged from 5.4 to 125.4 µg kg^{-1} and 31 samples exceeds the maximum permissible level (20 µg kg^{-1}).

FML-OP8. Good Agricultural Practices (GAPs) and their Role in Groundnut Aflatoxin Management

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Aflatoxin contamination in groundnut by *Aspergillus flavus* has assumed global significance in view of the significant trade losses and hazards on human and animal health. Significant reductions in aflatoxin contamination of pods can be achieved through adoption of certain good agricultural practices (GAPs) at both pre and post-harvest stages of the crop. In our present study, we have evaluated the performance of these GAPs in farmers' fields of Anantapur district of Andhra Pradesh, India during the rainy seasons of 2013 and 2014. The GAPs evaluated were a) application of farm yard manure; b) a protective irrigation during the last 3-4 weeks of the crop to reduce drought stress; c) gypsum application at 500 kg ha^{-1}; and d) drying of pods to 8% moisture levels. Post-harvest GAPs include use of tarpaulin sheets for pod drying and pod storage in triple-layered plastic bags. A total of 9 demonstrations during 2013 and 40 demonstrations during 2014 were taken up in farmers' fields of Rapthadu, Dharmavaram, Kudaeru and Atmakur mandals of Anantapur district of Andhra Pradesh. Pod samples were harvested separately for GAPs followed and fields with normal farmers' practices followed. Per cent seed infection by *Aspergillus flavus* and aflatoxin contamination by enzyme linked immunosorbent assay (ELISA) were estimated after harvest. Plots with farmers' practice and with no adoption of GAPs were served as controls. Our results indicate that the seed infection in plots with GAPs were up to 5% whereas, seed infection in farmers' plots were up to 96% during both the years. The aflatoxin levels in kernels were more than 10,000 µg kg^{-1} in plots with farmers practice. In plots with GAPs, the aflatoxin levels were within India's regulatory limits (30µg kg^{-1}). Overall, our results proved the efficacy of pre and post-harvest GAPs in minimizing aflatoxin contamination in groundnut under the conditions evaluated.

Session 10- Extension Plant Pathology

EPP-OP1. TNAU Agritech Portal: Linking Extension Plant Pathology

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Crop yield looses are a huge concern in agriculture. Soil nutrient depletion, weather parameters, pests and pathogens incidences are causatives. Majority of losses are due to pest and disease incidences. Diseases play a biggest part making agriculture commodities unusable at both field and consumption level. The right information on controlling them is primery objective. Agritech portal (http://agritech.tnau.ac.in) deals as a web based platform to disseminate recent technologies on various plant protection aspects. It emphasizes more on identification and solutions for various crops from sowing to consumption stage. The portal is an open access knowledge repository, not only to the subject of plant pathology but the entire aspect of agriculture under

single platform. Besides various unique features, it educates students, farmers, extension officials and stakeholders on various format of plant disease symptoms, causal organs, life cycle, preventive and control mechanism. This paper explains the details of Agritech portal involving such pages that have been developed on providing information and solutions on diseases of various agriculture and horticulture crops. Information had also been focused on new pages that include organic interventions and sericulture technology.

EPP-OP3. Mobile Based Farm Specific Agro Advisory System for Crop Diseases Management

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The multimedia based interactive advisory system besides images and videos, has a strong voice component which is unique and the voice component could be developed in multiple regional languages to provide customized advisory to the farmers via experts/extension workers through mobile phones. The farm plot historian data has been created by using simple mobile device (paper less data collection technique) over a period of time as and when individual farmers register for the service. The farm plot data base which includes specific details such as farmer biographies, cropping history, spatial and non-spatial biophysical data. This project has been implemented at three districts of Tamil Nadu namely Kancheepuram, Erode and Dharmapuri for providing farm-specific agro-advisory services via mobile funded by the NAIP. In the pilot phase, we have collated database from 1,200 individual farmers and uploaded in the central data base (on line). TNAU and RTBI (IIT, Madras) have jointly developed multimedia based mobile software, which has facilitated the farmers to ask queries in the form of image, text and voice to the experts via mobile phone. The farmer's queries via mobile could be sent to central data base which could automatically segregate and update in the individual farmer's personal historian database. Once the queries sent to the experts via central database, the expert could open the farmer's queries along with the concerned farmer's historian data base for diagnosing the individual farmer's problem. Based on expert's diagnosis, farm specific agro advisory services could be sent to the concerned farmers within short time through mobile phone. The effectiveness of the mobile-based farm specific agro advisory services was found to be more effective in terms of solving the farmer's farm related problem. Multimedia mobile software was also user friendly and solving important farm related issues in timely and accurately, expressed by the beneficiary farmers. The project out come could also be extended and scaled up to all the states for providing farm specific agro advisory services.

EPP-OP7. Challenges of Soil Borne Plant Pathogens and Biocontrol Agents, A Dreadful Competition for Healthy Crop

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The threat of soil plant pathogens *viz., Fusarium, Verticillium, Rhizoctonia, Macrophomina, Sclerotium* and *Pythium* is becoming key constraint for the cultivation crops in tropical agro ecosystem under irrigated and rain fed conditions. In Vellore and Villupuram districts, the major crops associated with the diseases are *Fusarium* in cotton, banana, redgram, watermelon and tomato, *Rhizoctonia* in cotton, *Macrophomina* in groundnut, *Sclerotium* in jasmine and vegetable crops, *Verticillium* wilt in brinjal. The disease incidence ranged from 34.6 to 67.5 per cent. The competitive saprophytic ability by beneficial organism's *viz., Trichoderma, Pseudomonas, Bacillus* was not observed in the field. To enhance the competitors, the delivery system of the biocontrol agents was studied through on farm trials and Front Line Demonstration for past three years to manage soil borne diseases. In water melon, a trial was conducted for management of wilt disease at Vanur Village, Villupuram District. The results revealed that mulching of water melon field with silver lined poly ethylene mulching sheet (30µ thickness) and drenching of nursery portray 2 days before planting with liquid *P. fluorescnes* @5 ml lit^{-1} of water and soil drenching with liquid *P.fluorescens* @ 5 ml lit^{-1} on 15th and 30th DAP. The drip biofertigation was found to be effective to contain the disease incipient was nil against control 41.4 %. In case drenching redgram plants with liquid formulation of *P. fluorescens* and *T. viride* @ 4 ml lt^{-1} on 60, 90, & 120 DAT. The results revealed that Drenching with liquid *Pseudomonas* and *Trichoderma* effectively controlled wilt incidence (1.49%) in redgram when compared to chemical spraying(17.06%).In groundnut, on farm trial was conducted for the management root rot caused by *Macrophomina phaseolina* by biocontrol agents at Poigai village. The each biocontrol agents *viz.*, *Pseudomonas* and *Trichoderma* were mixed with Farm Yard Manure (FYM) separately for multiplication in career materials with an incumbent day of 4 and 12 days respectively. The bio enriched FYM were applied during the earthing up operation and results revealed that soil application of *P. fluorescens* @ 2.5kg ha^{-1} mixed with 50 kg of decomposed FYM at 15 and 30 DAS was found to effective to contain root rot disease in Groundnut and recorded 4.3 per cent against control 37.6 per cent in control. From the above studies, it is concluded that the bio inoculants are working against plant pathogens while facilitating as an efficient competitor at the infection site.

EPP-OP8. Evaluation of High Yielding Varieties / Strains of Oyster Mushroom (*Pleurotus* species*)* under Haryana Conditions

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The six varieties / strains of *Pleurotus* species were cultivated under natural mushroom house conditions during September - October 2012 (temp > 20 C) and January – February 2013 (temp < 20 C) using chemically treated wheat straw as substrate. During September - October 2012, the P-04 strain of oyster mushroom gave significantly higher yield (650.0 g kg^{-1} substrate) followed by P-02, P-05, P-03, P- 06 and P-01. No significant differences were observed among the six varieties/strains of *Pleurotus* species regarding spawn run, pin head appearance and harvesting period. During January – February 2013, the strains evaluated differed significantly among themselves regarding the time taken for spawn run 2nd, 3rd flush and yield. On the other hand differences were observed for pinhead formation and time taken for 1st flush but these were not significant. The P-02 variety of oyster mushroom gave the highest yield (679.3 g kg^{-1} substrate) followed by P-04, P-01, P-05, P-03 and P-06. Spawn growth was earliest in case of P-03 and P- 01 strain while it was slowest in case of P- 04 strains. Incidence of green mould, inky caps and mushroom flies were recorded in all the evaluated strains.

EPP-OP9. Entrepreneurship Development for Rural Youth in Thoothukudi District of Tamil Nadu Through Sustainable Milky Mushroom Production Technology

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Entrepreneurship Development programme for Rural Youth in Thoothukudi District has been initiated on sustainable milky mushroom production by providing skilled training courses from 2012 – 2014 with financial assistance from DBT. A total of 23 training programmes and 17 demonstrations on milky mushroom and spawn productions were conducted. Importance of mushroom production, isolation, multiplication and maintenance of milky mushroom varieties, production techniques including bed preparation and casing soil preparation, post harvest technology, value added products and marketing feasibilities were focussed as major training modules. Training kits including spawn bottles, Polythene bags and casing soil were distributed to the trainees to get acquaintance on Milky mushroom cultivation.Necessary technical guidance was also given for the establishment of milky mushroom cultivation shed by using locally available materials. Thirty one trained members have so far initiated growing milky mushroom in trial basis in the available space of their home and production unit were established by them. In addition students of Adithanar college, Tiruchendur also got training on mushroom and spawn production. Mr.K.Jesurajan a PG student initiated the production of milky mushroom in commercial way and establishing spawn production unit.Mr.M.Mariappan a gold smith of Thoothukudi district is successfully cultivating and marketing about 140 to 210 Kg of mushroom per month at a cost of Rs.130 kg^{-1}. The spawn production unit established by a beneficiary group of HFO is constantly supplying seed spawn to the members of the group by availing loan. Another two women SHG leaders viz. Mrs. Jayakani and Mrs. Rani of Thoothukudi are also involved in the mushroom production and they are earning an amount of Rs.3700/- per month. Mr. Shahul Hamed has become an entrepreneur by constantly supplying spawn to other growers by earning net income of Rs.7,600/- per month. Another group leader Mr. Sivamani of Kovilpatti is actively involved in the production of both spawn and mushroom by fetching additional income of Rs. 11,500/- per month. Further, motivation of the beneficiary growers to adopt regular post harvest technology of milky mushroom is continued effectively to make them better entrepreneurs.

Poster Presentation (PP)

Session 1-Biodiversity and Biosystematics

BID-PP4. Diversity of Diseases in Cut Flowers of Shevaroys Hilly Regions

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Cut flowers such as anthurium, gerbera, carnation, orchids, cut chrysanthemum and bird of paradise are the most popular of the tropical regions, which are being grown commercially for export as well as for the local market. These cut flowers are infected by various biotic and abiotic stresses among these; bacterial blight, bacterial wilt, anthracnose, leaf spots and viral diseases are major constraint to the production. The present study, the identification of major diseases occurred in cut flowers at Shevaroys hills *viz*., bacterial wilt, bacterial blight, anthracnose, leaf spot and some viral diseases were studied. The results revealed that, bacterial blight of anthurium showed the water-soaked spots occur on the underside and along margins of the leaves later stage necrotic spots surrounded by yellow halo and bacterial wilt of anthurium was showed Leaf yellowing (chlorosis) in entire leaf surface, turning veins in the leaves and stems a brown to bronze colour. Anthracnose disease of gerbera and bird of paradise plants leaf showed concentric rings in the leaves and Necrotic grey to brown spots may develop on leaves. Moreover, orchids plants showed circular leaf spots on the leaf surface and necrotic margins in the flowers. These may be concluded that, growers have been struggling with these major diseases outbreaks in cut flowers. For these, good cultural practices help to reduce losses when growing the cut flowers, but they are insufficient for disease control. Use of disease free cuttings for propagation is a risk even when propagative materials are grown at high elevation, so establishment of pathogen-free microplants *in vitro* is essential for large-scale cut flowers production and chemical control also recommended.

BID-PP6. Genetic and Morphological Variability Among the Different Isolates of *Fusarium oxysporum f. sp. cepae*

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Basal rot is the most destructive disease of onion caused by *Fusarium oxysporum* Schlechtend: Fr. f. sp. *cepae* (Hans.). Genetic variability among isolates of *Fusarium oxysporum* f. sp. *cepae* isolates obtained from different onion growing areas of Tamilnadu, India. RAPD analysis was carried out using twelve random primers each of them consisted of 10 base pairs. Analysis of the genetic coefficient matrix derived from the scores of RAPD profile, showed that minimum and maximum per cent similarities among the *Fusarium oxysporum* f. sp. *cepae* isolates were in the range of 14 to 85 %, respectively. Cluster analysis, using the unweighted pair-group method with arithmetic average (UPGMA), clearly separated the isolates into 2 clusters (A and B) confirming the genetic diversity among the isolates of *Fusarium oxysporum* f. sp. *cepae* from onion. The length of macroconidia varied from 20.25 to 27.43 µm and the width ranged from 2.36 to 3.16 µm. The length of microconidia varied among the isolates from 7.10 to 8.43 µm and the width ranged from 2.14 to 2.67 µm. Compact, fluffy and sparse colony types were observed among the isolates. Significant variation was observed in morphologically and genetically among the *Fusarium oxysporum* f. sp. *cepae* isolates.

BID-PP7. Identification of Resistant Sources for Sheath Blight in Kodo Millet (*Paspalum scrobiculatum*)

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Kodo millet (*Paspalum scrobiculatum*) locally known as arikelu, arika, varagu, kodra, kodon and kodo is cultivated throughout India in the states of Tamil Nadu, Orissa, Bihar, Jharkhand, Maharashtra,

Madhya Pradesh, Chattisgarh, Andhra Pradesh and Karnataka, as cereal crop under extreme soil and climatic conditions of agriculture. Kodo millet is rich in nutrients like proteins (8.3g), fiber (9g), minerals (2.6g), iron (9.3mg) and calcium (27mg). Nutritionally the grains are comparable or even superior to major cereals. The crop is hardy and provides reasonable harvest even in degraded soils and unfavorable weather conditions. The crop was found infected with sheath blight caused by *Rhizoctonia solani* kuhn. Leading considerable loss in grain yield under favorable environmental conditions. An experiment was conducted at Agricultural Research Station, Vizianagaram, Andhra Pradesh during Kharif 2014 with recommended agronomical practices with basal 25N: 40P: 25K and top 25N in kg ha^{-1}. The percentage disease intensity was calculated as number of infected nodes divided by total number of nodes, multiplied with hundred. Twenty six genotypes of different maturity groups of kodo millet were screened for sheath blight susceptibility under natural field conditions using susceptible check TNAU-26. Among the 26 entries of kodo millet, screened against sheath blight KAVT- 22, 5 and 20 were recorded as immune genotypes and KAVT- 10, 11 and 14 were recorded as susceptible genotypes.

BID-PP10. Morphological Variability in *Sclerotium rolfsii* Causing Jasmine (*Jasminum sambac*) Wilt

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Jasmine (*Jasminum sambac*) is a flowering plant and its blossoms are beautiful and they emit a delicate fragrance which is a source of an essential oil. Jasmine production is amenable for both biotic and abiotic constraints. Among the biotic constraints the wilt disease incited by the *Sclerotium rolfsii* is the most devastating one which inflict severe yield loss. A field survey was conducted during December 2013-March, 2014 in jasmine growing areas. The incidence of the wilt disease ranged from 5.2 to 17.0 per cent.The maximum wilt incidence (17.0%) was observed in Sathyamangalam followed by Thottampalayam (14.7%). The minimum disease incidence of 5.2 per cent was noticed in Thimmampalayam. A total of eight isolate of *S. rolfsii* were collected from jasmine growing areas and an attempt was made to study the morphological variation between these isolates. The results indicated that four isolates showed dull white mycelia with sparse growth, three isolates were white with fluffy mycelial growth and one isolate exhibited white colour with sparse mycelia growth. The highest number of sclerotia (285 no.) was recorded in Sathyamangalam isolate and followed by Thimmampalayam isolate (150 no.). Therefore, considering the variation more work is needed to differentiate races in Jasmine wilt pathogen.

BID-PP13. Variation in Isolates of *Sclerotium rolfsii* Sacc. Causing Stem Rot of Groundnut

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Sclerotium rolfsii is an omnivorous soil borne fungal pathogen cause's disease on a wide range of agricultural and horticultural crops. Isolates of *Sclerotium rolfsii* was collected from rhizospheric zone of stem rot infected groundnut crop from different regions of Tamil Nadu. In the present study, the isolates of *S. rolfsii* varied in all of the morphological characters *viz*, mycelial growth rate, colony morphology, sclerotial production, sclerotial numbers and colour, growth in different medium, utilization of carbon source, nitrogen source and growth in different pH. Among the 5 different isolates, 3 isolates colonies were fluffy (I_3, I_4, I_5) and 2 isolates were compact (I_1, I_2). Mycelial growth rate was also varied with isolates; I_3 was fast growing than other isolates with 9.0 cm diameter on forth day. The isolate I_3 formed sclerotia within 12 days and produced more number of sclerotia than other isolates. The colour of the sclerotia varied from light brown to dark brown in colour. Among the different medium tested potato dextrose agar medium was recorded the maximum mycelial growth of 532.45 mg followed by oat meal agar medium of 486.34 mg. The utilization of carbon and nitrogen source was highest in isolate I_3. Different carbon sources *viz.*, sucrose, glucose, fructose, lactose, maltose and dextrose were tested for the growth of *Sclerotium* rolfsii. Among the carbon sources, sucrose recorded the highest growth of 334.9 mg followed by glucose with 321.9 mg. Different nitrogen source *viz.*, sodium nitrate, potassium nitrate; ammonium nitrate, ammonium chloride, ammonium sulphate and urea were tested for the growth of *Sclerotium* rolfsii. Among the nitrogen sources potassium nitrate recorded the highest growth of 89.4 mg followed by sodium nitrate with 88.6 mg. Maximum mycelia growth of *Sclerotium rolfsii* was observed in pH level of 6.0 and 6.5.

Session 2 - Plant Microbe Interaction, Omics and Genetic Engineering Applications

PMI-PP1. Physical properties of Tobacco Streak Virus Causing Necrotic wilt of sunflower (*Helianthus annuus* L.)

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Sunflower (*Helianthus annuus* L.) a member of Compositae family is the second most important oilseed crop in the world which has contributed to the "Yellow revolution" in making India self sufficient. Maharashtra especially Marathwada region ranks second in sunflower production in India. The crop has been found to be infected by many viruses *viz.*, Tospo virus, Cucumo virus, Beet Yellow Western Virus, Poty virus and Ilar group virus. Among the virus diseases of sunflower, necrosis disease has gained importance because of its heavy devastating nature in most of the sunflower growing states in India. From the studies, it is confirmed that this major crop loss is attributed by Tobacco Streak Virus belonging to Ilar group .Infected sunflower leaves were used to isolate the virus using 0.05 M potassium phosphate buffer and pH 7.0 containing 0.02 M 2-mercaptoethanol. Two different strains of Tobacco Streak Virus viz. Isolate N (I-N) and Isolate Y (I-Y) are identified as virus isolates causing necrosis and yellowing symptom respectively. Studies were conducted on the physical properties of Tobacco Streak Virus viz. Thermal Inactivation Point (TIP), Dilution End Point (DEP) and Longivity Invitro (LIV) using *Nicotiana glutinosa* leaves with symptoms for I-N and *Nicotiana tabacum*, cv. White Burley leaves with symptoms for I-Y. Isolate –N was found to be inactivated between 50 to 55 C and between dilutions of 10^{-2} to 10^{-3}. The number of local lesions decreased progressively as temperature was increased. Isolate Y was inactivated between 50 to 55 C and between dilutions of 10^{-1} to 10^{-2} .Both the virus isolates remained viable upto 5 hours at room temperature of 28 to 30 C.

PMI-PP2. Variation in Response of *Solanum* Rootstocks to *Fusarium oxysporum* f.sp. *lycopersici*

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Fusarium wilt, caused by *Fusarium oxysporum* f.sp. *lycopersici*, a soil borne disease can result in severe losses to tomato (*Solanum lycopersicum*) growers in Tamil Nadu, and grafting with resistant rootstocks may be an effective strategy for managing this disease. Hence, the study was carried out under glass house condition at the Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore during 2012-2013 to identify resistant rootstocks of *Solanum* species for grafting of tomato against *Fusarium* wilt. Seven wild *solanum* rootstocks, one *Physalis* wild rootstock and two tomato F_1 hybrids were screened against the *Fusarium* wilt. The experiment was conducted in a completely randomized block design with three replications. The seedlings of the wild rootstocks and tomato hybrids were planted in the pots artificially inoculated with fungal pathogen. The results revealed that the species *S. torvum, S. sisymbrifolium*, and *Physalis peruviana* was found to be superior with absence of disease symptom. The biochemical activities like phenols, OD phenols and the activity of host enzymes *viz*., peroxidase, polyphenol oxidase, phenylalanine ammonia lyase and acid phosphatase showed superiority in the species *S. torvum*, *S. sisymbrifolium* and *Physalis peruviana* by recording higher values followed by *S. incanum* and *S. aethiopicum*. The peroxidase, polyphenol oxidase isozymes and protein profile pattern also confirmed the resistance in *S. torvum, S. sisymbrifolium*, and *Physalis peruviana.*

PMI-PP4. Screening of Cotton Hybrids Against *Tobacco streak virus* and Study of Metabolite Alteration in TSV Infected Cotton Plants

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Cotton (*Gossypium* spp) is one of the most important commercial cash crop of India locally known as white gold or king of cash crop. Intensive cultivation of cotton has resulted in the severe outbreak of fungal, bacterial and viral diseases. The total production of cotton in Tamil Nadu during 2013-14 was about 5 lakh bales. In recent days, cotton industry is threatened due to *Cotton leaf curl virus* in North India and *Tobacco streak virus* damage in South India. As Coimbatore is a hub of cotton industry in Tamil Nadu, a study was conducted to explore the severity of TSV in cotton hybrids which affects the production and productivity, a total of 55 entries were screened. The overall Per cent Disease Incidence recorded was 22.95%. Highest incidence was recorded in the entry 4563 as 60.83% which was double times higher than the susceptible check RCH2 were the incidence was only 35.98%. whereas two entries did not record any existence of TSV showing 0% incidence. An attempt was also made to study the metabolite changes in virus infected samples through GC-MS analysis. The results revealed both the infected as well as the healthy samples detected the presence of entirely different fatty acids. This study reveals that, upon infection by TSV one form of fatty acids are being converted into another form which indirectly conveys that the signaling pathway is interrupted by TSV infection.

PMI-PP8. Occurrence of Wilt Disease in *Gerbera* incited by *Fusarium oxysporum* f. sp. *gerberae*

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A detailed survey was undertaken to assess the incidence of *Fusarium* wilt of *Gerbera* in Nilgiris and Salem districts of Tamil Nadu, India. The wilt incidence ranged between 10.00% and 20.00% in *Gerbera* varieties namely Bellwater (White), Donavan (Yellow), Avimaria (White), Valetta (Yellow), Snowflake (Cream) and Blessing (White). Maximum incidence of 19.81% was observed in susceptible variety, Donavan. Symptoms associated were yellowing of lower most leaves that subsequently spread to entire plant. Affected leaves drooped down and the plant finally wilted. The pathogen initially produced white mycelium on PDA medium and later turned light to dark pink. Macroconidia was sparse, fusoid, 2-3 septate and measured 16.0-29.0 × 2.5-4.2 µm. Microconidia were abundant, hyaline, continuous, ovoid and measured 3.8-8.5 × 2.0-3.5 µm. Chlamydospores were hyaline, spherical and measured 4.0 – 7.5 µm in diameter. Molecular characterization of the pathogen was carried out using specific primers. The primer amplified a fragment of approximately 389 bp corresponding to the region of the 18S-23S rDNA intervening sequence and there by the pathogen was confirmed as *F. oxysporum.* The pathogen was further confirmed by partial sequencing. The sequence analysis revealed that it had nucleotide sequence identity of 98 per cent with *F. oxysporum*. Since the pathogen was isolated from Gerbera plants, the identified pathogen was referred as *F. oxysporum* f.sp. *gerberae.* The sequence identified as *F. oxysporum* f.sp. *gerberae* was submitted in NCBI and provided with accession number KJ 570974

PMI-PP10. Transient Expression Study to Identify RNA Silencing Suppressor (RSS) in *Sugarcane streak mosaic virus*

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Viral genes encode proteins that suppress the RNA silencing defense mechanism of plants. It helps in unveiling a new and promising way to understand the regulatory pathway in the host at the time of viral infection. Potyviral HC-Pro gene was the first proven RNA silencing suppressor (RSS) belonging to *Potyviridae* family. *Sugarcane streak mosaic virus* (SCSMV) of the same family earlier referred as an unclassified virus was characterized as a newgenus *Susmovirus* based on its more evolutionary divergence with other genera of *Potyviridae*. Later, *Poacevirus* was proposed in place of Susmovirus in which SCSMV along with *Triticum mosaic virus* were included. Recently we characterized complete genome of SCSMV from India as SCSMV-IND with a size of 9,786 nucleotides excluding the poly (A) tail and encoded a polyprotein of 3,131 amino acid residues. We continued further to identify and characterize RSS part of the viral genome viz. SCSMV P1 and HC-Pro in model plant tobacco through silencing assays. The complete coding regions of both P1 and HC-Pro were first cloned into pTZ57R/T vector and sequenced. The sequences were analysed for the absence of restriction sites within the coding regions suitable for cloning into gene silencing hairpin vector

pHANNIBAL specific for dicot. Further new primers for P1 and HC-Pro genes flanking with the restriction sites KpnI and XbaI were designed, PCR amplified and cloned into pTZ57R/T. The recombinant plasmids were then restricted with KpnI and XbaI to release the target gene from the vector. The PDK (pyruvate dehydrogenase kinase) intron from the pHANNIBAL was removed and the vector was linearized followed by ligation with the restricted target gene and cloning into the *E.coli* DH5α strain. The confirmed gene expression cartridge expressing under the 35SCaMV promoter and OCS terminator was then mobilized into the binary vector pART27 as a NotI fragment. The positive colonies were selected by blue/white screening for **β-**galactosidase and mobilized into the *Agrobacterium* strain LBA4404.pING71-GFP binary vector anchored in the *Agrobacterium* strain C58C1 (DSMZ, Germany). Agro-infiltration of the culture was carried out in the five leaf stage of eight weeks old wild type *Nicotiana tabacum*. To one side of the leaf blade GFP, P1 and HC-Pro were infiltrated separately whereas on the other side GFP + P1 and GFP + HC-Pro were given. GFP fluorescence was recorded using a portable UV-Lamp by 2-4 dpi. The GFP expression level increased after 2dpi and at the 7dpi the GFP signal was meagre in the GFP,HC-Pro + GFP infiltrated leaves and not in case of GFP + P1 which confirmed that P1 has the potent suppressor activity. Further confirmation on GFP expression was carried out through PCR assays and this confirmed that P1 is the suppressor that allowed the GFP gene to express at high level by overcoming the PTGS of the host tobacco. This study revealed that SCSMV P1 is the potent viral RNA suppressor rather than HC-Pro. Thus, transient expression in the model plant shortens the timeline to further focus on P1 gene than HC-Pro to map the silencing pathways in the highly complicated polyploid sugarcane crop through RNAi approach.

PMI-PP11. SA, JA, Ethylene and Resistance in Arabidopsis Lines with Vascular wilt Pathogen of Banana *Fusarium oxysporium* f.sp. *cubense*

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Fusarium wilt of banana, commonly referred to as Panama Disease, is caused by *Fusarium oxysporum* Schlechtend.: Fr. f. sp. *cubense* (E.F. Sm.) W.C. Snyder & H.N. Hans (Stover and Waite, 1954). From the *inplanta* symptom expressions of FOC on Arabidopsis, there is a clear indication of involvement of SA, JA for disease resistance. When the mutations occur in synthesis of SA and JA, which modulates disease resistance with the evident of severe veinal necrosis on leaves and petiole. The typical symptom of leaf rosetting was the clear indication of the active participation of SA biosynthesis for FOC resistance in nahG, npr-1 plants. This analysis revealed that Salicylic Acid (SA), Ethylene (ET) and Jasmonic Acid (JA) pathways influence the FOC disease outcome in Arabidopsis. All the three signaling pathways interact in a positive way in the activation of Arabidopsis resistance to FOC. Hence, there must be co-ordinated regulation of both SA and JA for FOC resistance in Arabidopsis. Constitutive expressions of some transcriptional regulators of these pathways are sufficient to confer enhanced resistance to FOC and it might be an oligogenic trait. Moreover, the C-24 ecotype is having a single dominant locus (VET1), specific to root pathogen resistant mechanism located in xylem and may be identified for disease resistance QTL mapping against FOC. From the disease ratings, we would like to conclude that the strain FGSC#8359 might be able to produce typical symptoms of panama wilt with vascular browning & necrotization of tissues in Arabidopsis lines and much easier to identify the genes involved in potentiating the SA regulatory mechanisms for developing disease resistance strategies in banana cultivars.

PMI-PP12. Disease Scenario of Cotton Genotypes under High Density Planting System (HDPS) in Rainfed Conditions

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The disease incidence for three diseases *viz*., bacterial blight, *Myrothecium* leaf spot and grey mildew were recorded for various cotton genotypes in the field experiment conducted at CICR Research farm, Nagpur to study the disease scenario under high density planting system (HDPS) in shallow and medium black soil types with three different spacings in rain fed conditions. Among 14 cotton genotypes under shallow soil, lowest per cent disease incidence (PDI) was observed in Arogya (7.13) and CINHTi2 (8.99) for bacterial blight, Supriya (9.25) and CINHTi2 (13.75) for *Myrothecium* leaf spot and Suraj (6.66), Arogya (9.44) and ADB 532 (9.44) for grey mildew. In three different spacing, 45 × 10 cm recorded lowest average PDI for bacterial blight (32.0) and grey mildew (11.4) and 45 × 15 cm for myrothecium leaf spot (17.18) compared to 60 × 10 cm. Among 14 genotypes under medium soil, lowest PDI was observed in CINHTi2 (20.75) and ADB 532 (23.93) for bacterial blight, C1412 (12.69), Supriya (14.94) and Vikram (16.0) for *Myrothecium* leaf spot and Supriya (3.44), CINHTi1 (4.55) and Suraj (7.22) for grey mildew. In three different spacing, 60 × 10 cm recorded lowest average PDI for bacterial blight (30.75), 75 × 10 cm for *Myrothecium* leaf spot (19.28) and grey mildew (12.74) compared to 45 × 10 cm.

PMI-PP13. Biological Characterization of Bitter Gourd Yellow Mottle Viral Disease

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Bitter gourd (*Momordica charantia*) belonging to the *Cucurbitaceae* family, is one of the most important vegetable of high nutritive and medicinal value. The crop is cultivated throughout India and other tropical countries. In October 2013, a severe disease of bitter melon with virus-like symptoms was observed in Navsari (Gujarat). Initially all the branches of the infected plants were not showing symptoms and characteristics symptoms of plant virus was observed from the young actively growing top portion of the few plants. Symptoms consisted of yellow colored mottling, upward curling, shortening, and distortion of leaves. Gradually the disease spread in the actively growing apical portion of the other branches of the plant. Severely infected plants produced less no of small size and deformed fruits. The disease spread in the entire field within 45 days covering almost entire field. DNA was extracted from the infected bitter gourd plant and PCR was performed by using the specific primers for the *Begomovirus*. PCR amplification yielded a specific band of approx 700 bp indicating that the virus is whitefly transmitted *Begomovirus*.

PMI-PP14. A Promising Strategy for Enhanced Production of Polyhydroxyalkanoates (PHAs) in Plants – A Review

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Polyhydroxyalkanoates (PHAs) are biopolyesters produced by microorganisms as intracellular energy reserves in the presence of excessive carbon source or under micronutrient limiting conditions. Industrial PHA production technology is currently based on bacterial cultivation using pure cultures grown in well-defined nutrient deficient synthetic media with single substrate, the only problem faced by the PHA production is its cost. Due to specific culture requirements, the procedure still becomes costly and more over the carbon sources used is actually an edible raw material like corn, wheat, potato etc. which is expensive. Hence improvements and future developments in fermentation/ separation technology will help in bringing the production costs slightly down. New developments in this field are being focussed in searching for new bacterial strains, creating new types of recombinant strains, use of low cost substrates to reduce the cost of production. Based on these views, this study aims to provide an outline about the existing strategies involved in genetic engineering of bacterial *pha* C gene. One such promising approach is cloning *pha C* to plants. This challenge requires the expression of several genes along with optimization of PHA synthesis in the host. Although excellent progress has been made in recombinant hosts, the barriers to obtaining high quantities of PHA at low cost still remain to be solved. The metabolic pathway of PHA production in microorganisms are being bioengineered into a variety of plants for making PHAs. Numerous challenges are associated with while commercializing this technology as it is difficult to achieve a high level of polymer production in the plant without a decrease in crop yield as well as to economically recover the polymer from the plant biomass. This study summarizes the progress of the work in analysing the process economics for PHAs production in agricultural crops. Initially in 1992, PHA production was carried out in *Arabidopsis thaliana* as a model plant(14% yield). Corn plants rich in carbon content, are being directly used as substrate for PHA production, the edible part of the plant is getting wasted. Hence, incorporation of bacterial *pha*C gene in the plant which helps in accumulating PHA, using the other parts of plants like roots, leaves, stem etc might prove helpful to overcome this problem. It has been reported that PHA are produced in plastids of transgenic plants like *Arabidopsis thaliana* and *Brassica napus*. While in few, *peroxisomes* also serve as storage bags for PHAs. *Nicotiana tabacum, Gossypium hirsutum, Medicago sativa, Elaeis guineensis* and *Linum usitatissimum* are some of the other plants which produces PHAs by transgenic methods. Transgenic sugarcane (*Saccharum* sp.) (70% yield) is used extensively now-a-days for production of PHAs. The commercially viable production of PHA in crops, however, appears to be a realistic goal for the future.

PMI- PP15. Broad Spectrum Disease Resistance in Transgenic Tobacco Plants Expressing a Fungal Glucose Oxidase Gene

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Hydrogen peroxide (H_2O_2) production is one of the most important defence responses to pathogen attack in plants. In the current study, the endogenous H_2O_2 level of tobacco plants (*Nicotiana tabacum* L. cv. SR1) was enhanced by the constitutive expression of a glucose oxidase (GO; EC 1.1.3.4) gene isolated from the fungus *Aspergillus niger*. The effects of elevated level of H_2O_2 production in transgenic tobacco plants on fungal (*Rhizoctonia solani*) and bacterial (*Ralstonia solanacearum*) infections were studied under controlled conditions, using detached leaves or whole plants. The enhanced accumulation of H_2O_2 has led to delayed infection by the *R. solani*, wherein artificially infected control tobacco leaves showed 100% of leaf area infected within 7 days after inoculation (DAI), while transgenic tobacco leaves showed only 50-70% leaf area infected at the same time. In the case of bacterial wilt (*R. solanacearum*) assay, 80-100% of the non-transformed tobacco plants exhibited wilting symptoms at 15 DAI whereas, only 30-50% of the transgenic GO-tobacco plants wilted at 15 DAI. Interestingly, the level of H_2O_2 was also increased two-fold in transgenic plants challenged with pathogens than uninfected transgenic plants. The results of the present study clearly demonstrate that by the elevation of endogenous H_2O_2 level, plants can be engineered to have broad spectrum disease resistance.

Session 3 - Molecular Diagnostics of Plant Diseases

MDP-PP2. Molecular Data Mininig Diagnosis of Wilt Disease in Tomato (*Solanum lycopersicum* L.) caused by *Fusarium oxysporum* f.sp. *lycopersici*

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Tomato (*Solanum esculentum* L.) is the second most important widely cultivated vegetable crop in the world after potato. It is affected by many fungal and viral diseases. The *Fusarium* wilt (*Fusarium oxysporum* f.sp. *lycopersici*) is a major soil borne disease of tomato causing severe yield loss. The maximum per cent disease incidence ranged from 9 –15% in tomato growing areas of Tamil Nadu. The infected plants exhibited xylem discoloration was a typical symptom. Fifteen isolates of *F. o.* f. sp. *lycopersici* collected from different tomato growing areas of Tamil Nadu. All the fifteen isolates were tentatively identified as amplicon of 560 bp corresponding to the region of the 18S-28S rRNA intervening sequence for *Fusarium* sp. The phylogenetic analysis revealed that fifteen isolates showed 42 per cent to 54 per cent similarity coefficient. The fifteen isolates were separated into three clusters *viz*., A, B and C. After this A is divided into two clusters *viz*., A1, A2. The cluster A1 represented isolates of Fol1, Fol 5 and Fol 6. These three exhibited 52.6 per cent similarity coefficient. The Cluster A2 represented isolates of Fol 3, Fol 4, Fol 7, Fol 9 and Fol 8 which exhibited 54 per cent similarity coefficient. The cluster B has two sub clusters *viz*., B1 and B2. The cluster B1 represented the isolates of Fol 10, Fol 13 and Fol 15. These three exhibited 46.3 per cent similarity coefficient. Another sub cluster B2 represented the isolates of Fol 11, Fol 14 and Fol 12. These three exhibit 50.6 per cent similarity coefficient and the C represented the isolate Fol 2.

MDP-PP4. Rapid Diagnosis of Leaf curl Virus in Cotton through Molecular Technology

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Cotton (*Gossypium hirsutum*) is an important cash crop that plays a dominant role in Indian industrial economy. It is most widely grown and contributes to about 80% of the total cotton production in Asia. Among all the diseases infecting cotton, leaf curl disease, caused by the whitefly transmitted geminivirus which is the most damaging constraint to the cotton production. Cotton leaf curl virus (CLCuV) was first detected from SriGanganager district of Rajasthan during 1993 and Punjab in 1994. Cotton leaf curl virus infected plants may show a range of symptoms including thickening and yellowing of small veins on the lower surface of young leaves. It is very complicated to calculate the precise estimates because the incidence of CLCuV varies from year to year and also varies from area to area under cotton condition. Nucleic acid based technique to be more reliable and sensitive for detecting the presence of viruses even in very small quantities of test samples. Several degenerates' primers have been designed for the detection of these viruses. With the help of primers uncharacterized Gemeniviruses can be amplified and primers designed on the basis of non-conserved sequence can be exploited to detect a particular virus and strain of that virus. Thought the solution of various diseases is the development of disease tolerant varieties but disease management is quite appropriate when resistance source are inadequate.

MDP-PP5. Molecular Characterization and Genetic Relatedness of Yellow Mosaic Virus in Grain Legumes

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Pulses are the second most important crops after cereals. In India, they form the important constituent in the vegetarian diet and are cultivated under different agroclimatic conditions. It is grown in an area of 10.84 million hectares in India with a production of 17.09 million tonnes (productivity – 699 kg ha^{-1}). Pulse production is limited by the various constraints. Among these yellow mosaic disease caused by the genus *Begomovirus* of the family *Geminiviridae* is a serious problem of the grain legumes (Malathi, 2007). Knowing the genetic relatedness of legume infecting viruses is crucial for the management of the diseases for developing resistant cultivars. Hence the present study is focused on the genetic relatedness among YMV isolates and screen for the resistance. A survey conducted, on the incidence of yellow mosaic disease during summer 2012-13 and infected samples were collected from different grain legumes *viz*., blackgram, greengram, dolichos and redgram. The full length of viral DNA was cloned and sequenced from each sample. The sequence analysis clearly showed that the clones from blackgram showed 97-98% identity with *Mungbean yellow mosaic virus* (MYMV) and one of the clone from blackgram showed 99% identity with *Mungbean yellow mosaic India virus* (MYMIV); greengram showed 98% identity with *Mungbean yellow mosaic virus*, where as clones from *Dolichos* showed 99% identity with *Dolichos yellow mosaic virus* (DoYMV) and clones from Pigeonpea showed 93% identity with *Horsegram yellow mosaic virus* (HgYMV). Blackgram samples having mixed infection of both MYMV and MYMIV. The results of the present study indicate that there is high genetic variability among isolates of yellow mosaic virus collected from different hosts. The variability in genetic makeup among the isolates of yellow mosaic virus should be taken in to consideration when screening the resistance source for resistant breeding programme.

MDP-PP8. Quantification of R gene (CYR1) Expression in Mungbean Yellow Mosaic India Virus (MYMIV) Resistant and Susceptible Blackgram Genotypes by Real Time PCR

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Blackgram (*Vigna mungo* L. Hepper) is one of the major pulse crops grown in India. Yellow Mosaic disease (YMD) is an economically significant one. The disease is caused by a *Yellow mosaic virus* (YMV) of the genus *Begomovirus* and family *Geminiviridae*. Plants have developed complicated defense system to protect themselves from harmful pathogens as they encounter. Disease resistance of plants is often triggered by plant disease resistance (R) gene products upon specific recognition of its corresponding pathogen Avr genes. In blackgram, a R gene (CYR1) for MYMIV resistance was cloned and sequenced (Maiti *et al*., 2011). A specific primer to amplify 140bp of CYR1 gene was designed (CYR1- F- TGCAGTCTAAAGTACATCGCC; CYR1-R- TCAACGATCCT GC TACCAATC) using online software (www.biosearchtech.com) and PCR conditions were optimized. Actin is used as house keeping gene for normalization of results . The qPCR was conducted in Rotor Gene 5-flex with HRM (Corbett,USA) to investigate CYR1 gene expression in MYMIV resistant and susceptible genotypes after inoculation with MYMIV by whitefly feeding. Total RNA was isolated from resistant (PU31 & TBG104) and susceptible (LBG623 & LBG752) genotypes by Triozol method after 21 DAI . cDNA was prepared using revertaid reverse transcriptase (Thermo) enzyme as per manufacturer protocol. The threshold cycle (C_t value) for susceptible genotypes is 27.3 (LBG623), 27.1 (LBG752) and for resistant genotypes, it was 25.45 (TBG104) and 25.14(PU31) respectively after normalization (lower Ct value means more gene expression). These results shows that R gene expression in TBG104 – a blackgram genotypes with shiny seed developed through MAS at Tirupati is on par with PU-31 a dull seeded MYMIV resistant genotype.

MDP-PP 11. Diagnostics and Characterization of Viruses in Vegetable ecosystems of Tamil Nadu

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Field samples of vegetable crops *viz*., Tomato (*Solanum lycopersicum* L.), Chilli / pepper (*Capsicum annuum* L.) and the cucurbitaceous vegetables *viz*., snake gourd [*Trichosanthes cucumerina* (L.) Kuntze], ribbed / ridge gourd [*Luffa acutangula* (L.) Roxb.], *bitter gourd [Momordica charantia* L.*], bottle gourd [Lagenaria siceraria* (Molina) Standl.*],* ash gourd [*Benincasa hispida* (Thunb.) Cogn.*]*, pumpkin [*Cucurbita maxima* L.], scarlet gourds [*Coccinia* sp.*]*, chou chou [*Sechium edule* (Jacq.) Sw.*]*, gherkins (*Cucumis sativus* L.) and watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai]) showing virus-like symptoms were collected from farmers' fields in Tamil Nadu. These samples were

tested for the presence of begomo-, tospo-, cucumo-, tobamo- and potyviruses by PCR / RT PCR and DNA amplified was cloned and sequenced. Sequences were compared with corresponding sequences available in GenBank for identification of viruses. Similarly the serological techniques *viz*., ELISA, DIBA, TBIA and immunostrips assay were also carried out to confirm the viruses. Most of the tomato samples were found to be infected with *Tomato leaf curl New Delhi virus* (ToLCNDV) and *Groundnut bud necrosis virus* (GBNV). The presence of *Capsicum chlorosis virus* (CaCV) and *Chilli veinal mottle virus* (ChiVMV) were confirmed on chilli pepper by serological and molecular methods. The viruses *viz*., *Cucumber mosaic virus* (CMV), *Papaya ring spot virus* (PRSV), *Zucchini yellow mosaic virus* (ZYMV), *Cucumber green mottle mosaic virus* (CGMMV), *Tomato leaf curl New Delhi virus* (ToLCNDV), *Squash leaf curl China virus* (SLCCV) and *Watermelon bud necrosis virus* (WBNV) were documented using serological and nucleic acid diagnostic methods on different cucurbitaceous vegetable crops in Tamil Nadu. As a part of our studies on ecology and epidemiology of viruses identified on different vegetable crops in Tamil Nadu, we have also monitored the weed plants in vegetable ecosystems of Tamil Nadu and the samples were collected from those plants showing virus-like symptoms from different locations around vegetable crops and tested for the viruses mentioned above. The results indicated the presence of CMV in Datura inoxia and begomoviruses in *Melothria pendula*, C*orchorus capsularis* and *Mirabilis jalaba*. The molecular characterization of the above viruses was also done and their diversity was studied.

Fungicides/Bactericides – A Global Perspective from Industries

FUB-PP1. Screening of New Fungicide SAAF (Carbendazim 12% + Mancozeb 63%) for its Bioefficacy against Chilli Leaf Spot Incited by *Cercospora capsici*

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Chilli (*Capsicum annuum* L.) belongs to the family solanaceae and is a variable red pepper species comprising of cultivated and wild accessions that differ in many characters such as fruit shape, fruit weight, fruit colour, pungency, plant height, maturity and yeild. Chilli leaf spot *Cercospora capsici* is the most destructive and explosive diseases of chilli and incur heavy losses. In the event of identifying new fungicide molecules for the management of this diseases, SAAF was tried in the farmers' filed at Coimbatore district of Tamil Nadu. All the treatments were more effective in comparison to untreated control. However, after 10th day of 2nd application the foliar spraying of SAAF @ 1000 g ha^{-1} provided the maximum control (PDI 3.52) of the leaf spot disease which was on par with SAAF at the rate of 750 g ha^{-1} (PDI 3.87). Both these treatments were significantly superior as compared to rest. The spraying of the carbendazim 50% WP @ 300 g ha^{-1}, mancozeb 75% WP @ 2000 g ha^{-1} and SAAF chemical @ 500 g ha^{-1} proved next best effective treatments differing insignificantly to each other with PDI of 5.57, 6.31 and 6.76 respectively. Hexaconazole 2% SC @ 3000 ml ha^{-1} provided least control of leaf spot disease (PDI 9.45). The data on terminal disease severity index (TDI) also gave the same trend and controlled the disease up to the extent of 76.50 – 75.90 % by two superior dosages of SAAF @ 1000 and 750 g ha^{-1}. The highest Cost benefit ratio of 1:5.04 and 1:5.03 was obtained in the treatments of SAAF@ 1000g ha^{-1} and SAAF @ 750 g ha^{-1}, respectively. In untreated control the ratio of 1: 2.84 was observed.

FUB-PP2. Efficacy of Fungicides in Management of Damping-off in Bidi Tobacco Nursery

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Damping-off caused by *Pythium aphanidermatum* is a serious threat in successful raising of bidi tobacco nursery. Metalaxyl MZ is recommended to manage the disease since 1987. Now-a-days new compounds are available in the market. Therefore, an experiment was carried out seeding bidi tobacco cv. Anand 119 @ 5 kg ha^{-1} in nursery for three consecutive years (2010 to 2013) using the new products at BTRS, AAU, Anand. The six treatments *viz*., 1. metalaxyl MZ @ 2.16 kg ha^{-1}, 2. fenamidon + mancozeb @ 0.12%, 3. fenamidon + mancozeb @ 0.18%, 4. azoxystrobin @ 0.023%, 5. copper hydroxide @ 0.2% and 6. control were tried replicating four times in RBD. Fungicidal solution was drenched @ 2 l m^{-2} in case of metalaxyl MZ while spray drenched in the remaining treatments @ 100 ml m^{-2} except in control. All the treatments were applied at initiation of the disease and as and when required thereafter. All agronomic practices in vogue were followed. Pooled results revealed that all the treatments significantly reduced the damping-off disease and increased the number of transplantable and total surviving seedlings compared to control with maximum in azoxystrobin. Looking to the effectiveness and economics, farmers raising bidi tobacco nursery are advised to apply two to three spray drenches of azoxystrobin @ 0.023% at initiation of the disease and as and when required thereafter.

FUB-PP4. Management of Castor Grey Mold Incited by *Botryotinia ricini*

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India is the world leader in castor production followed by China and Brazil. India accounts for 59 per cent of global castor area and 81 per cent of world castor production and ranks first in area and production in the world. India meets more than 80 per cent of world's requirement of castor oil and its derivatives. In India, the major castor growing states are Gujarat and Andhra Pradesh followed by Rajasthan and Tamil Nadu. Grey mold caused by *Botryotinia ricini* is a serious air borne fungal diseases especially under favorable conditions like cloudy weather, high humid *etc*. It may survive in nature from one season to the next through continued activity and growth, either parasitically or other host parts. It almost always present in the environment and waiting for the congenial weather to become active. It appears at flowering or capsule development stage with the prevalence of continuous cyclonic weather for a few days. For effective management of grey mole of castor, some of the fungicides were used in this study. A field experiment was conducted at Tapioca and Castor Research Station, Yethapur for two years (2011 and 2013) to find out the effective management measures for control of castor grey mold under field conditions. The experiment comprising of six treatments conducted in RBD with four replications. Castor hybrid YRCH 1 seeds were sown in a spacing of 90 cm × 60 cm with plot size of 6 m × 4.5 m. Foliar spray was given on before disease

appearance and second spray at 10 days interval. Observation on grey mold incidence on primary and secondary spikes and seed yield and its components were recorded. B:C ratio was also calculated. Pooled results revealed that minimum grey mold incidence of 21.84% and maximum seed yield of 1695 kg ha^{-1} with B: C ratio of 2.8 and maximum yield components(13 spikes $plant^{-1}$, 77.15 capsules/spike and 35g of 100 seed weight) when compared to control which recorded highest grey mold incidence of 41.3% and lowest seed yield of 851 kg ha^{-1} with the lowest yield components (7.5 spikes $plant^{-1}$, 40.2 capsules $spike^{-1}$ and 23g of 100 seed weight).

FUB-PP16. Effect of Fungicides on *in vitro* growth of *Sclerotium rolfsii* Causing Root Rot of Tuberose

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Sclerotium rolfsii is a soil-borne fungal pathogen that cause wilt disease in wide range of agricultural and horticultural crops. The experiment on the effectiveness of different fungicides namely carbendazim 50% WP, cymoxanil 8% + mancozeb 64%, captan 70% + hexaconazole 5% WP, tebuconazole 50% + trifloxystrobin 25% WG, hexaconazole 5% EC and azoxystrobin 23% SC at concentration of 100, 200 and 500 ppm was conducted *in vitro* against *Sclerotium rolfsii* at Department of Plant Pathology AC & RI Madurai. The poisoned food technique was followed for this experiment and the radial growth of pathogen was measured at different concentrations. Among the different chemicals tested hexaconazole 5% EC, captan 70% + hexaconazole 5% WP accounted 100% inhibition at 100ppm, 200ppm and 500ppm. Other chemicals such as tebuconazole 50% + trifloxystrobin 25% WG inhibit 84.44 per cent at 100 ppm, 86.66 per cent at 200 ppm and 90 per cent at 500 ppm. Azoxystrobin 23% SC inhibited 72.2 per cent at 100ppm, 75.55 per cent at 200 ppm and 85.55 per cent at 500 ppm. cymoxanil 8% + Mancozeb 64% inhibited 17.77 per cent at 100 ppm, 55.54 per cent at 200 ppm, and 74.44 per cent in 500ppm. Carbendazim 50% WP inhibited 12.22 per cent at 100 ppm, 13.33 per cent at 200 ppm and 67.77 per cent in 500 ppm.

FUB-PP17. *In vitro* Efficacy of Different Fungicides and Bio Agent Against wilt of Groundnut (*Fusarium oxysporum* (Schlecht.))

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Groundnut or peanut (*Arachis hyphogaea* L.) is an important oil seed crop. Groundnut is grown on a large scale in almost all the tropical and subtropical countries of the world. Groundnut is susceptible to many foliar and soil-borne fungal diseases. Among them certain soil-borne diseases *viz*., dry root rot, stem rot and wilt cause serious losses to the crop which is extensively grown under rain fed conditions. Evaluation the effect of six fungicides against *Fusarium oxysporum in vitro* and in glasshouse revealed that carbendazim, benomyl and SAFF (carbendazim 12% + mancozeb 64%) inhibited the fungal growth completely. Isolates of Trichoderma, Bacillus and Pseudomonas from rhizosphere soils were evaluated for their ability to control *Fusarium oxysporum in vitro* and promote seedling growth in the greenhouse. Bioassays were conducted using dual cultures and diffusible compound production analysis. *Trichoderma viride* (Tv_1), *Pseudomonas fluorescens* (Pf_1) and *Bacillus subtilis* (Bs_{10}) effectively inhibited the growth of *F. oxysporum* to an extent of 71.59, 54.13 and 49.54 per cent over control respectively. Seed treatment followed by soil drenching of carbendazim 0.1 per cent at 30 and 60 days after sowing was found to be effective in reducing the disease incidence up to 91.02 per cent. Among the biocontrol agents, combined application of Tv_1 + Pf_1 + Bs_{10} reduced the wilt incidence up to 18.32 followed by the application of Tv_1 + Bs_{10} with contributing to 70.65 per cent disease reduction.

FUB-PP23. Efficacy of Different Fungicides and Bio Agent Against Powdery Mildew of Pea (*Erysiphe polygoni* f. sp. *pisi* (Linford))

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Pea is a valuable vegetable crop grown all over the world belonging family *Leguminaceae* and it's a cool season crop grown best in slightly acidic and well-drained soils. Pea grow with an average productivity of 9.5 tonnes ha^{-1}. The crop is grown in an area of 3.698 lakh ha with the production of about 35.17 lakh tonnes (Indian Horticultural Database, 2011). But even though the yield was reduced due to attack of some fungal diseases among that, the most important constraint disease is powdery mildew of pea caused by *Erysiphe polygoni* f. sp. *pisi* (Linford), (Anonymous, 1979). The powdery mildew alone results in to a huge economical loss. It becomes severe under dry weather and responsible for heavy losses. The losses in yield in a 100 per cent infected crop were estimated by Munjal et al. (1963) to be 21-31 per cent in pod number and 26-47 per cent in pod weight. Recently several fungicides *viz.,* propicanozole, penconozole and hexaconazole were introduced in India for control of powdery mildew pathogens. Even though new fungicide molecule is required with novel mode of action is needed to replace the failing compounds. In the quest for find newer and more efficacious molecules, the present investigation was carried out by using a new formulation UPF 807 (Sulphur 80% WG) and along with biocontrol agents. In both glass house and field study, UPF 807 @ 0.36% concentration followed by *P. fluorescens* (0.2%) + *B. subtilis* (0.2%) + UPF 807 (0.36%) effectively reduced the powdery mildew disease of Pea in both the seasons and also recorded the maximum pod yield..

FUB-PP24. Bioefficacy of Mandipropamid (Revus 25 SC) against Late Blight Disease in Tomato, Potato and Grapes

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The bioefficacy of mandipropamid (Revus 25 SC) was evaluated at different concentrations *viz*., 0.6, 0.8 and 1.0 ml l^{-1} along with standard fungicides (Ridomil Gold 68 WP, Curzette 72 WP, Acrobat 50 WP and Mancozeb 75 WP) against late blight of tomato and potato and downy mildew of grapes under field conditions for two seasons. The results revealed that the disease progression of tomato and potato late blight and grapes downy mildew was successfully arrested by mandipropamid. Spraying of mandipropamid 25 SC at various doses revealed that 1 ml l^{-1} was considered as the optimum dose for the control of these diseases of

tomato, potato and grapes. The treatment also recorded the highest fruit yield of 11.20 and 11.78 q acre^{-1} in tomato, 11.16 and 11.19 t ha^{-1} in grapes and highest tuber yield of 12.5 and 12.95 t ha^{-1} in potato in the first and second season, respectively. No phytotoxicity symptoms were observed in all the tested concentrations of mandipropamid 25 SC on tomato, potato and grapes.

FUB-PP26. Bioefficacy of Azoxystrobin 125 g l^{-1} SC + Flutriafol 125 g l^{-1} SC against Downy Mildew and Powdery Mildew Diseases of Grapes under Field Condition

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A field experiment was carried out on five year old grape variety Panneer at Surulipatti village of Cumbum at Theni (Dt), Tamilnadu during 2013 and 2014 in a Randomized Block Design to assess the bioefficacy of Azoxystrobin 125 g L^{-1} SC + Flutriafol 125 g L^{-1} SC against downy mildew and powdery mildew diseases on grapevine. First spray was given at 15 – 20 days after pruning at 4 – 5 leaf stage and four sprays were given at 15 days interval. The experimental results revealed that downy mildew incidence on leaf and fruits ranged from 35.00 to 41.00 PDI (per cent disease index) before imposing treatments. The results showed that there was significant disease reduction in all the treatments of CHA 2440-01.The treatment, CHA 2440-01 @ 500 ml ha^{-1} was the best with PDI of 23.03 followed by CHA 2440-01 @ 1000 ml ha^{-1} and CHA 2440-01 @ 250 ml ha^{-1}. In case of Powdery mildew disease, the results revealed that CHA 2440-01 @ 500 ml ha^{-1} recorded minimum incidence of 18.02 PDI followed by CHA 2440-01 @ 1000 ml ha^{-1} 18.57 PDI. The next best treatments were CHA 2440-01 @ 250 ml ha^{-1} 21.21PDI, CHA 1322 @ 250 ml ha^{-1} 24.79 PDI and Azoxystrobin 23% SC @ 500 ml ha^{-1} (26.08 PDI.

FUB-PP30. Efficacy of Different Newer Molecules of Fungicides and Essential oils for the Management of Turcicum Leaf Blight Disease Incidence in Maize

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The field trial was laid out to test verify the effectiveness of the different newer molecules of fungicides and essential oils for the management of *Turcicum* leaf blight in different seasons during 2011-13. Based on the pooled mean analysis of different season trials among the different newer molecules of fungicides tested, Derosol (0.1%) and Folicur (0.05%) recorded the lowest per cent disease incidence of turcicum leaf blight 13.29 % and 16.71% respectively followed by Mancozeb M45 (0.2%) (20.63%) and Mancozeb Z78 (0.2%) (20.82) against control which recorded 46.90%. Derosol (0.1%) reduced lesion length of 1.79 cm followed by Folicur (0.05%) (2.08cm), Mancozeb M45 (0.2%) (2.61) and Mancozeb Z 78 (0.2%) (2.69) against control which recorded 15.16cm. The lesion width was also very much reduced by the above treatments when compared to control. Derosol (0.1%) recorded the highest cob yield of 6760 kg ha^{-1} followed by Folicure (0.05%) (6683kg ha^{-1}), Mancozeb Z78 (0.2%) (6381kg ha^{-1}) and Mancozeb M45 (0.02%) (6328kg ha^{-1}) against control which recorded 4983 kg ha^{-1}. Similarly among the different essential oils tested, Palmarosa oil (0.05%) recorded the lowest TLB incidence of 18.94% followed by eucalyptus oil (0.1%) 21.05%, lemon grass oil (0.05%) (22.09%), geranium oil (0.05%) (24.47%), Neem oil 3%) (24.85%), NCE 3% (25.70%), NSKE 5% (26.11%). The lesion length and width was also reduced by the above oil against control. With regard to cob yield Palmarosa recorded the highest of 6466 kg ha^{-1} followed by Eucalyptus oil (6356 kg ha^{-1}), lemongrass oil (6285 kg ha^{-1}), geranium oil (6098 kg ha^{-1}), Neem oil (5967 kg ha^{-1}), NSKE 5% (5966 kg ha^{-1}) and NCE 3% (5878 kg ha^{-1}) against control which recorded 4879 kg ha^{-1}.

FUB-PP31. Developing Management Strategies for Powdery Mildew in Gerbera under Poly House Condition

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Gerbera (*Gerbera jamesonii* Bolus ex. Hook f.) is in high demand as cut flower in the world market and has a very good export potential. Powdery mildew is one of the most destructive fungal diseases of gerbera causing significant economic losses under greenhouse conditions. It is caused by two fungal species *viz*., *Erysiphe cichoracearum* DC and *Sphaerotheca fusca* (Fr.) S. Blumer. They are obligate parasites and can affect all parts of the plant including flowers. The study on the efficacy of chemical and bio-fungicides in controlling powdery mildew of gerbera has been conducted with thirteen treatments for the moderately susceptible variety Goliath under poly house condition. The treatments for the management of powdery mildew were imposed in RBD from 120 days of planting at 15 days interval. The observations on the disease ratings based on the 0-6 scale were recorded on 120 days, 150 days and 180 days after planting from which the per cent disease incidence (PDI) was calculated. The data recorded were analysed and the results revealed that the spray with the fungicide Azoxystrobin @ 0.5 ml L^{-1} was very effective in reducing the powdery mildew incidence followed by Wettable Sulphur @ 2 g L^{-1} and Karathane @ 0.4 ml L^{-1}.

FUB-PP32. Management of Fruit Rot of Brinjal through Fungicides

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Brinjal is one of the important vegetable crops of Karnataka. The brinjal grown in northern Karnataka suffer mainly due to fruit rot caused by *Phomopsis vexans, Fusarium* spp and *Colletotrichum capsici.* A field experiment was conducted during *kharif* 2013-14 at College of Horticulture Bagalkot, Karnataka in order to manage this disease through fungicides. Brinjal crop was grown according to package of practices. First Spray was given immediately after the appearance of the symptom on leaves and the second spray was given 30 days after the first spray. Among the seven fungicides evaluated in field, Propiconazole @ 0.1 % recorded least leaf spot (21.6 PDI) and fruit rot (26.2 PDI) and highest yield (96.8 q ha^{-1}) than all other treatments.

FUB-PP33. Management of Fruit Rot of Chilli through Fungicides

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Chili is one of the important commercial crops of India. The Byadgi chillies especially grown in transitional belt of Karnataka suffer due to fruit rot caused by *Colletotrichum capsici* (Syd.) Butler & Bisby. A field experiment was conducted during *kharif* 2012 at Horticulture Research Station, Haveri, (Devihosur), Karnataka in order to manage this disease through new generation fungicides. Variety Byadgi Dabbi was transplanted with spacing of 60 × 60 cm and crop was grown according to package of practices. First Spray was given immediately after the appearance of the symptom and the second spray was given 30 days after the first spray. Among the ten fungicides evaluated in field, Azoxystrobin @ 0.1 % recorded least fruit rot (33.3 PDI) and highest yield (7.86 q ha^{-1}) than all other treatments as compared to control (77.7 PDI) with least yield (4.18 q ha^{-1}). The economics for management of fruit rot of chilli through fungicides was also estimated. Azoxystrobin @ 0.1 per cent (Rs. 3.56) recorded more benefit cost ratio followed by Tebuconazole at 0.1 per cent (Rs. 3.33). Control recorded least cost benefit ratio (Rs. 1.80).

FUB-PP35. Effect of Fungicides on *in vitro* Growth of *Fusarium oxysporum* f. sp. *cepae* Causing Basal Rot of Onion

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Fusarium oxysporum f.sp. *cepae* is a soil-borne fungal pathogen, a serious disease in onion growing areas causing considerable economic losses. The experiment on the effectiveness of different fungicides namely Carbendazim 50% WP, Cymoxanil 8% + Mancozeb 64%, Captan 70% + Hexaconazole 5% WP, Tebuconazole 50% + Trifloxystrobin 25% WP, Hexaconazole 5% EC and Azoxystrobin 23% SC at concentration of 100, 200 and 500 ppm was conducted *in vitro* against *Fusarium oxysporum* f.sp.*cepae* on Onion plant at Department of Plant Pathology AC & RI Madurai. The poisoned food technique was followed for this experiment and the radial growth of pathogen was measured at different concentrations. Among the different chemicals tested Carbendazim 50% WP were found to be highly effective in inhibiting the radial growth of the pathogen at all the concentration tested when compared to other chemicals and untreated control. The Pathogen inhibition was 100 per cent at 100ppm, 200ppm and 500ppm was recorded in above chemical. Other chemicals such as Hexaconazole 5% EC inhibit 88.59 per cent at 100ppm, 98.59 per cent at 200 ppm and 98.99 per cent at 500ppm. Captan 70% + Hexaconazole 5% WP inhibits 73.5 per cent at 100ppm, 80.87 per cent at 200ppm and 94.29 per cent at 500ppm. Tebuconazole 50% + Trifloxystrobin 25% WP inhibits 59.77 per cent at 100ppm, 55.54 per cent at 200ppm, and 92.57 per cent in 500ppm. Azoxystrobin 23% SC inhibits 13.82 per cent at 100ppm, 15.59 per cent at 200ppm and 69.07 per cent inhibition was recorded in 500ppm. Cymoxanil 8% + Mancozeb 64% inhibits 10.96 per cent at 100ppm, 12.65 per cent at 200 ppm, and 63.07 per cent inhibition was recorded in 500 ppm.

FUB-PP37. Efficacy of Newer Fungicides in the Management of Foliar Diseases of Groundnut

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Foliar diseases *viz.,* early leaf spot, late leaf spot and rust diseases are causing considerable yield loss in groundnut crop. Out of which, the concurrent occurrence of late leaf spot disease caused by *Cercospora personata* and rust disease caused by *Puccinia arachidis* is considered to be the major cause for the severe yield loss. Most of the plant pathogens are reported to be developing resistance to the commonly recommended fungicides. Hence newer fungicides belong to triazole group *viz.,* Propiconazole, Hexaconazole, Difenoconazole, Tebuconazole were evaluated for the management of foliar diseases of groundnut *viz*., late leaf spot and rust. Efficacy of triazole fungicides was compared with the fungicides Thiophanate methyl, Carbendazim and Tridemorph. Field trials were conducted at experimental plots of ARS, Vaigai Dam during three consecutive years 2010-11, 2011-12 and 2012-13. The results of the field experiments revealed that the foliar spraying of Propiconazole 95%TC @ 500ml ha^{-1} at 60 and 75 DAS controlled the late leaf spot disease effectively with 64.99 PROC and CBR of 1:1.80. It was followed by the foliar spraying of Hexaconazole 5% EC @ 1000 ml ha^{-1} and it also controlled the rust disease effectively. Though the efficacy of Propiconazole 95% TC in controlling rust disease was lower than Hexaconazole 5% EC with 40.80 PROC, the yield was found to be significantly higher in the plots sprayed with Propiconazole 95% TC @ 500 ml ha^{-1}. Hence Propiconazole 95% TC @ 500 ml ha^{-1} may be recommended for the management of both late leaf spot and rust diseases of groundnut.

Session 5 - Bioinoculants and Biocontrol Agents

BIO-PP3. Effect of Different Microbial Consortia Against Major Soil Borne Diseases of Cotton

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The cotton crop is attacked by a number of soil borne diseases. Among these, damping off (*Pythium ultimum*), root rot (*Rhizoctonia solani*/*R. bataticola)* and wilt (*Fusarium oxysporum* f.sp. *vasinfectum*), can devastate the crop and causes heavy yield losses. Biocontrol with beneficial microorganisms seems to be a promising approach to managing cotton soil borne diseases. Two field experiments were conducted during 2010-11 and 2011-12 at Cotton Research Station farm, Veppanthattai, Perambalur Dt., Tamil Nadu to assess the effect of fungal *Trichoderma viride* (Tv) and bacterial antagonistic *Pseudomonas fluorescens* (Pf1) and *Bacillus subtilis* (Bs) strains individually and in combinations against major soil borne diseases *viz*., damping off, root rot and wilt. The results revealed that the plots treated with the mixture of Pf1 + Bs + Tv recorded only 3.18% and 1.12% of pre and post emergence damping-off, respectively and 0.00, 0.37 and 0.91% wilt incidence and 0.00, 0.21 and 0.72% root rot incidence at 30, 60 and 90 days after sowing (DAS), respectively. This treatment also recorded higher germination per cent, plant height, number of bolls $plant^{-1}$ and seed cotton yield (23.45 q ha^{-1}).

BIO-PP8. Eco-friendly Management of Root Rot Disease Caused by *Macrophomina phaseolina* in Blackgram

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Blackgram plants showing the typical root rot disease symptoms were collected from seven different growing areas of Tamil Nadu. All the isolates differed in their morphological, cultural and its physiological characters. Among the *Trichoderma viride*, *Pseudomonas fluorescens* and *Bacillus subtilis* isolates tested *in vitro* the *Bacillus subtilis* SB_4 and MB_3 were most effective against the *Macrophomina phaseolina*. Among the plants oil and oil cake extracts tested *in vitro*, neem oil (3%) and neem cake extract (5%) effectively reduced the growth of *M. phaseolina.* The results of the pot culture experiment showed that soil application of mixtures of biocontrol agents *Bacillus subtilis* (SB_4) SA @ 600 g ha^{-1} recorded maximum disease reduction over control. The results of the field experiment indicated that the treatment *Bacillus subtilis* (SB_4) besides maximum disease reduction and blackgram yield.

BIO-PP11. Effect of Different Fungal and Bacterial Antagonists Against Root Rot Disease caused by *Macrophomina phaseolina* in Cluster Bean

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Cluster bean (*Cyamopsis tetragonoloba* L. Taub.) is one of the most important and potential vegetables cum industrial crop grown for its tender pods. Cluster bean plants showing the typical root rot disease symptoms were collected from six different growing areas of Tamil Nadu. All the isolates differed in their morphological, cultural and its physiological characters. Among the fungal and bacterial antagonists, *Trichoderma viride*, *Pseudomonas fluorescens* and *Bacillus subtilis* isolates tested, *T.viride* (T_V1) and (T_V2) were most effective against the *Macrophomina phaseolina* followed by *P. fluorescens*(Pf_1) and (Pf_2) which showed inhibition up to 81.77per cent. The results revealed that the treatment T_7, seed treatment with Tv_1 appplied @ 4g kg^{-1} of seed + soil application of Pf_1 @ 2.5 kg ha^{-1} at 30 DAS + soil application of Bs_{10} @ 2.5 kg ha^{-1} at 45 DAS + soil application of Tv_1 applied @ 2.5 kg ha^{-1} at 60 DAS recorded the least disease incidence, highest disease reduction and increased cluster bean yield.

BIO-PP15. Biological Control of Castor Wilt Incited by *Fusarium oxysporum* f. sp. *ricini*

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Castor is an important oilseed crop known for its numerous industrial applications. Among several diseases affecting the yield, wilt of castor caused by *Fusarium oxysporum* f. sp. *ricini* is the most important soil and seed borne disease in the major castor growing regions of the country. *Trichoderma* and *Pseudomonas* has been established as potential bio-control agents during fast few decades. Continuous use of agrochemicals for controlling the diseases may cause several problems like toxic to non target organisms, development of resistance in the population of the pathogens and environment pollution. Bio agents are considered as new rays of hope because they are ecofriendly and can be used as an effective alternative measures to control wilt disease. Based on this, the present study was undertaken to test verify the effect of bio-control agents on castor wilt. A field experiment was conducted at Tapioca and Castor Research Station, Yethapur for two years during 2011 and 2012 to find out the effective management measures for control of castor wilt under field conditions. The experiment comprising of nine treatments conducted in RBD with three replications. The experimental field was inoculated with *Fusarium oxysporum* f. sp. *ricini*. The castor hybrid seed used for this study was YRCH1. Seeds were sown in a spacing of 90 cm × 60 cm with plot size of 6 m × 4.5 m. Before sowing, seeds were treated with bio control agents and fungicides and soil applied with bio control agents (mixed with FYM kept for a month) at the time of seed dibbling. Observation on field stand on 15 days after sowing, wilt incidence on 150 days after sowing and seed yield were recorded. B: C ratio was also calculated. Among all treatments, seed treatment and soil application of *Trichoderma viride* and *T. harzianum* respectively recorded very good field stand of 95% and 90%, wilt incidence of 21.7% and 23.5% and seed yield of 1255 kg ha^{-1} and 1246 kg ha^{-1} with B: C ratio of 2.25 and 2.16 when compared to control which recorded field stand of 70%, wilt incidence on 60.27% and seed yield of 906 kg ha^{-1}.

BIO-PP17. Antimicrobial Activity of Citrus Peel: A Byproduct of the Essential Food Industry

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There is increasing epidemiological evidence for the beneficial health effects of regular intake of fruits and vegetables as part of a healthier diet. Polyphenols from fruits, vegetables and cereals, herbs and spices have been shown to have beneficial effects on human health, and some extracts of polyphenol-rich plants have been used in functional foods or as supplements. Among polyphenols, flavonoids are secondary metabolites well documented for their biological effects, including anticancer, antiviral, antimutagenic and anti-inflammatory activities. The term flavonoid includes the following commonly occurring polyphenols: flavanones, flavones, flavan-3-ols, flavonols and anthocyanins. Flavonoids can function as direct antioxidants and free radical scavengers, and have the capacity to modulate enzymatic activities and inhibit cell proliferation. In plants, they appear to play a defensive role against invading pathogens, including bacteria, fungi and viruses. The present study was to evaluate the antimicrobial properties of citrus fractions rich in flavonoids. In addition, the influence of enzymatic deglycosylation on their antibacterial activity against Gram-negative bacteria, Gram-positive bacteria and yeast was investigated. The peel contains the characteristic Citrus species flavanone rutinosides and neo-hesperosides derived from naringenin, eriodictyol and hesperetin. Moreover, a small amount of flavone O- and C-glycosides, not previously found in orange and lemon peels, have been identified. A byproduct of the Citrus fruit processing and essential oil industries is a potential source of natural antimicrobials. Many natural compounds, including plant phenolics and terpenoids, have been widely used because of their strong antimicrobial properties against food-borne pathogens, and therefore they can be applied as novel preservatives in the food industry. In this way the byproduct of food industry can be utilized as a biocontrol agent even these chemical can be purified and used in agriculture for the management of diseases in crop.

BIO-PP18. A Combination of Plant Growth-Promoting Rhizobacterial (PGPR) Strains Improves the Management of Root Rot and Wilt Disease in Cotton

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Plant growth-promoting rhizobacterial (PGPR) strains were isolated from different cotton growing regions of Tamil Nadu, India, and were tested for their growth promoting activity in cotton and relative efficacy against root rot (*Rhizoctonia solani*) and wilt (*Fusarium oxysporum* f.sp. *vasinfectum*) pathogen under *in-vitro conditions*. The results revealed that APKP4, VPNP5, SVLP1 and VPNP2 strains were significantly enhanced the vigor index of cotton seedlings compared to other strains. The PGPR strains *viz*., APKP4 and VPNP5 showed higher antagonistic activity against wilt and root rot pathogen. The talc-based formulation of individual and mixtures of PGPR strain was developed and tested their efficacy against root rot and wilt disease under glass house and field conditions. Among the different treatments, the bioformulation mixture containing APKP4 + VPNP5 + KYIP5 strains applied as seed treatment (10g kg^{-1}) and soil application (2.5kg ha^{-1} at 30 DAS) recorded the lowest incidence of root rot and wilt and also recorded significantly higher germination %, plant height, no. of bolls $plant^{-1}$ and seed cotton yield than other treatments.

BIO-PP20. Antifungal Activity of Essential Oils against *Sclerotium rolfsii* Sacc. causing Collar Rot of Peppermint

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Peppermint (*Mentha arvensis* L.) is an aromatic perennial herb, and is commercially cultivated in tropical and sub-tropical climates, belongs to the family Labiatae. The oil and by-product (menthol, menthone, methyl acetate, terpenes, linalyl acetate) of this plant have the highest share in the global mint trades. In India, mint is grown throughout the year and it is affected by fungal diseases caused by *Rhizoctonia bataticola*; *Verticillium dahliae*, *Colletotrichum cocodes*: *R. solani* and *Sclerotium rolfsii*. Among these, collar rot caused by *S. rolfsii* is a major constraint in the mint cultivation in Tamil Nadu. Nowadays, application of chemical compounds is considered as the most inexpensive and common method in plant disease control. However, their adverse affects on human health and the environment, promoted man to produce natural pesticides. Biologically active compounds found in plants appear to be more adaptable, acceptable and safer than synthetic compounds and display a wealthy source of potential to control pathogens. Extracts and essential oils of medicinal plants were effective against fungal and bacterial pathogens; meanwhile they are biodegradable compounds which have high potential for using in integrated pest management programs. Hence the present study was carried out with sixteen essential oils were tested against *Sclerotium rolfsii* causing collar rot of peppermint, by using poisoned food technique. The results revealed that, oils like citronella, *Eucalyptus*, geranium, lemongrass and thulasi were found more effective and caused complete growth inhibition of pathogen at minimum lethal concentration of 0.002%. While other oils did not exhibit any inhibitory action against the test pathogen. These plant oils having antifungal compounds which might be responsible for the strong inhibition of pathogen.

BIO-PP21. Effect of Agrochemicals on *Trichoderma harzianum* (Th_4 isolate) and its Biocontrol Potential against Chickpea Collar Rot Caused by *Sclerotium rolfsii*

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Pot culture experiments were conducted to study the effect of most commonly used selected agrochemicals *viz*., carbendazim (0.2%), chlorpyriphos (0.25%), pendimethalin (0.66%) and zinc sulphate (0.2%) alone and in combination with amendment gypsum (2%) on the biocontrol efficacy of *Trichoderma harzianum* (Th_4) as seed treatment/soil application against collar rot of chickpea caused by *Sclerotium rolfsii*. Among all seed treatments, seed treatment with Th_4- chlorpyriphos- *S. rolfsii* had shown the highest per cent germination (96.75), high plant stand per cent (55.93) and high colony forming units (cfu) recovery (20.67×10^6 cfu g^{-1} soil) and from among all soil application treatments, soil application with Th_4-chlorpyriphos- *S. rolfsii* recorded the high per cent germination (83.07) and soil application with Th_4-chlorpyriphos- gypsum- *S. rolfsii* had shown high plant stand per cent (25.42) and high cfu recovery of 20.67×10^6 cfu g^{-1} soil.

BIO-PP25. *In vitro* Antifungal Bioefficacy of Cow Urine and Dung against Sugarcane Red Rot Pathogen *Colletotrichum falcatum*

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The present study deals with the antifungal effect of cow urine and cow dung for controlling phytopathogenic fungus, *Colletotrichum falcatum.* The efficiency was measured in terms of percentage mycelial growth inhibition (MGI). The work was carried out on nine *C falcatum* isolates collected from south Gujarat region. Data were recorded 3, 5 and 7 day after incubation (DAI). In case of cow urine supplemented oat meal agar media *i.e.*, CUOMA, highest percentage MGI (56.52%) was recorded for cfCHA isolate and minimum MGI was recorded for cfGAN (10.41%). Surprisingly both were recorded three DAI. Efficacy of cow dung was found to be varied greatly for all *C falcatum* isolates, depends on resistance power and sensitivity of the strain. Media supplemented with cow dung (CDOMA) shown highest per cent MGI for cfCHA8 (54.93%) and minimum per cent MGI (5.68%) for cfVES three DAI. Results reveal that the radial mycelial growth of phytopathogens on oat meal agar decreased or suppressed and varied greatly between different isolates, days of incubation and kind of bio matters used. In most treatments the inhibition was recorded highest after five days of incubation. It was concluded that both the bio-matters were found effective in controlling the growth of *C falcatum*. The use of cow urine and dung can be the cost-effective and eco-friendly approach for controlling red rot in sugarcane.

BIO-PP28. Evaluation of Antagonistic Potential of Microbes from Spent Mushroom Substrate against *Ralstonia solanacearum* infecting Ginger

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Spent mushroom substrate (SMS) is the composted organic material remained after the harvest of a mushroom crop. Recent findings illustrate that this substrate can be used for disease management. Bacterial wilt incited by *Ralstonia solanacearum* is posing a serious threat to ginger cultivation in Kerala. *Pleurotus sajor-caju* is reported to have better substrate degradation capacity and that facilitates better colonization by plant growth promoting and disease controlling microorganisms. Hence a study was taken up to evaluate the antagonistic potential of microbes from paddy straw SMS of *P. sajor-caju* against *Ralstonia solanacearum* of ginger under *in vitro* condition. Fungal and bacterial microflora was isolated from SMS collected from 6 different locations of Kerala, at three different periods of the year *viz.,* March-April, June-July and November-December. A total of 49 fungal isolates and 42 bacterial isolates were evaluated *in vitro* for their inhibitory effect against *R. solanacearum* by dual culture technique. Out of 49 fungal isolates, 16 were most effective, showed antagonistic property ranged from 60-100%. Out of 42 bacterial isolates, 5 showed antagonistic property of more than 40%. Hence from the present study it was concluded that SMS is rich in microflora with antagonistic effect and it can be used for the management of bacterial wilt in ginger. Fungal antagonists from SMS, especially *Trichoderma* sp. were more effective than bacterial antagonists in inhibiting the pathogen. Disposal of SMS is of great concern as it is produced nearly five times the quantity of mushrooms produced. So recycling of SMS for disease management is one of the best options to solve disposal problem and to get 'wealth out of waste'.

BIO-PP30. Surfactant Producing PGPR for Management of Rhizome rot of Ginger and Turmeric

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Rhizome rot disease caused by *Pythium* spp is serious on ginger as well as turmeric. Three bacterial isolates *viz.*, *Bacillus tequilensis, Pseudomonas korennsis* and *P. monteilii* were isolated from rhizosphere of turmeric and ginger. The surfactant production was examined in various mineral salt medium grown with the isolates and the reduction of surface tension was observed from the isolated PGPR grown in the medium. Among the isolates, *B. tequilensis* have performed better in reducing the mycelial growth of the *Pythium* spp. In the pot culture experiments, *B. tequilensis* had also increased the growth of the ginger as well as turmeric. From the field experiment conducted during 2013-14, it was observed that the rhizomes of ginger and turmeric treated with the cultures of the PGPR for 20 min had increased level of plant growth and less rhizome rot incidence in ginger and turmeric.

BIO-PP32. Biological Control of Common Blight of Bean (*Phaseolus* sp.*)* caused by *Xanthomonas* spp at Kodaikanal hills, Dindigul (dt.)

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The study was carried out to evaluate the efficiency of the biocontrol agents *Trichoderma viride (TV), Pseudomonas flouroscens (PS)* and *Bacillus subtilis* (BSC5) for protection of bean plants against common blight disease caused by *Xanthomonas* sp. Beans (both French and butter beans) are cultivated in higher altitude of Kodaikanal hills, have shown the incidence of multiple fungal and bacterial pathogenic concomitant diseases that limits the production. Of which the most prevalent problem observed from farmer's field was common blight caused by *Xanthomonas* spp. Farmers have been using multiple spray of chemical bactericides mixed with fungicides. Various combinations of bioinoculants and chemical treatment were evaluated on beans field at Kodaikalnal Taluk, Dindigul. The bioinoculants *viz*., *T.viride, P. flouroscens* and *B.subtilis* were experimentally applied in two methods - basal with manure and foliar spray. In two consecutive seasons, the farmers were advised to apply the combinations of bioinoclants and with farmer's method of chemical treatments as a control. The overall results from the present study indicated that during the first year, the most effective treatments were *B. subtilis T. viride,* and *P. fluorescens*, which reduced disease incidence more than 40 and 50 % than the control for blight respectively. The survived beans plants were 50 to 68 %, respectively *viz*., 35 % for the control. On the other hand, the most effective treatments for increasing the yield was higher than the control. The control of disease trend was increased from 50 % to 70% during the second season. It could be suggested that such bioagents might be promising as alternatives to control common blight in bean caused by *Xanthomonas*. Apart from its disease control efficacy use of such bio inputs based disease management definitiely helps to protect the hilly agro-ecosystems by reducing the use of chemicals. Thus the efficacy of investigated bioinoculants was found to have antagonistic activity against the disease causing fungal pathogens at field competence in turn assisting crop protection for beans plants.

BIO-PP34. Efficacy of Seaweed Extracts Against Soil Borne Pathogens of Pulse Crop

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Pulses are the basic ingredient in the diets of a vast majority of the Indian population, as they provide a perfect mix of vegetarian protein component of high biological value when supplemented with cereals. India is the largest producer and consumer of pulses in the world with 24 % share in the global production. But soil borne pathogens *viz*., *Macrophomina phaseolina* and *Rhizoctonia solani* cause severe yield loss in pulses. In this second green revolution era, management of these pathogens by using bio inputs gain attention by scientists. Hence the present work was carried out with a view to develop a bio-formulation with seaweed. *In vitro*

efficacy of three seaweed species *viz.*, *Caulerpa racemosa*, *Sargassum myricocystuom* and *Gracillaria edulis* against the above soil borne pathogens was tested at different concentrations *viz.,* 5%, 10%, 15%, 20% and 30%. Maximum inhibition on the growth of the pathogen was observed at 30 % concentration. The result of *in vitro* techniques *viz*., Poisoned food technique, Well diffusion method and Paper disc method revealed the efficacy of *Sargassum myricocystum*. Inhibition of mycelial growth of the pathogens by *S. myricocystum* was maximum and its efficacy was comparable with that of the commercial formulation Zymegrow. In artificially inoculated condition also the efficacy of *S. myricocystum* 5% (66.69 Per cent Reduction Over Control –PROC) was appreciable and comparable with the commercial seaweed formulation (69.16 Per cent Reduction Over Control -PROC), but its efficacy was less than the efficacy of bio-control agents and chemicals. Hence *S. myricocystum* can be used as one of the best components of eco-safe management practices along with bio-control agents which could afford good bio-control of soil borne pathogens of pulse crop.

BIO-PP36. Influence of Glyphosate on Plant Growth Promoting Rhizobacteria PRS-3 and PRP-5 Against Sheath Blight Suppressive in Acidic Soil of Kuttanad, Kerala

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Sheath blight of Rice caused by *Rhizoctonia solani* is an economically important disease curtailing rice production.Twelve *Pseudomonas* strains isolated from rhizosphere of rice seedling collected from acidic soil of Kuttanad, Kerala. Strains showing *in vitro* antagonism against *Rhizoctonia solani*. *In vitro* study also showed production of siderophores, herbicide resistance and promotion of plant growth. The evaluation of cell mass and production of siderophores in different synthetic media with herbicides showes that the herbicide had no effect on the PGPR potential strains up to 500ppm concentration. The effect of PRS-3 and PRP-5 strains on seed germination, seedling growth was evaluated in gnotobiotic and green house condition. The study showed seed inoculation significantly enhanced seed germination, seedling vigour of rice and also antagonistic against *Rhizoctonia solani*. Inoculated rice seeds significantly increased shoot length, root length, fresh and dry weight and yield. The main objective of the study was to determine antagonism, siderophore production, herbicide resistance, seed germination, growth parameters of rice seedling in gnotobiotic and green house condition.

BIO-PP37. Characterization of Native Fluorescent Pseudomonads and Identification of Suitable Carrier Material for Mass Production in Kuttanad Ecosystem

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Bacterial antagonist fluorescent pseudomonads for sheath blight disease were isolated from different locations in Kuttanad region. Three effective strains *viz.,* PF 43, PF 46 and PF 47 were tested individually and also in combination against sheath blight disease of rice under glass house condition. The confirmation tests *viz*., physiological and biochemical characterization of the efficient isolates were carried out at Rice Research Station, Kerala Agricultural University, Moncompu. Various physiological tests on growth at different pH, Iron toxicity and aluminium toxicity level showed that the isolate PF 43 grew at pH ranges from 1.0 to 14 and tolerate upto 1000 ppm of iron toxicity and 90 ppm of aluminium toxicity level. The biochemical tests indicated that three efficient isolates were confirmed as gram negative, rod shaped, fluorescent in King's B medium and showed a positive response for growth at 4 C, levan formation, gelatin liquefaction and Catalase tests. However, there was a negative response for growth at 41 C, Methyl red, Voges Proskaur and Indole tests. Thus, based on morphological and biochemical characteristics, the isolated strains were identified to be *Pseudomonas fluorescens*. *P. fluorescens* PF 43 product survived upto 150 days with required population of 1.01 to 1.63 × 10^8 cfu per g in talc based, dolomite based and gypsum based formulations. After 240 days of storage, also about 1 × 10^7 cfu were detected in talc, dolomite and gypsum based formulations. The cheapest and easily available carrier material, gypsum and dolomite can be used for mass production of native *P. fluorescens and* recommended to 66,000 ha rice growing tract of Lower, Upper and Karilands of Kuttanad regions like Alleppey, Kottayam and Pathanamthitta District for ecofriendly management of diseases.

BIO-PP39. Hydrolytic Enzyme Producing Genes of *Trichoderma asperellum* in the Management of Stem Rot of Carnation

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Carnations are the most wanted cut flower varities of the world next to rose. Stem rot caused by *Sclerotinia sclerotiorum* (Lib.) de Bary was found predominant in all varieties. The survey results indicated that maximum per cent disease index calculated for stem rot ranged from 25-30%, in the susceptible variety charmant light pink. The study on mode of infection indicated that the primary mode of infection is through soil borne mycelium and the secondary mode of infection through airborne ascospores. Sclerotia residing in soil plays a major role in the establishment of infection through myceliogenous and carpogenous germinations. Diverse strains of *Trichoderma* were isolated from the Nilgiri biosphere and their efficacy was tested *in vitro* against *S. sclerotiorum*. The *Trichoderma* strains were subjected to molecular characterization of the ITS 1 and 4 regions. They were sequenced for the identification up to species level and submitted in NCBI. Molecular screening for the presence of hydrolytic enzyme producing genes through PCR techniques revealed that *T. asperellum* strain NVTA2 possessed 3 hydrolytic enzymes producing genes *viz.*, *cbh1*, *ech42*, *eg14* pertaining to cellobiohydrolase, endochitinase and endoglucanase activity respectively. The genes were detected using specific primer pairs and also confirmed by sequencing. The per cent inhibition of mycelial growth of the pathogen by *T. asperellum* (NVTA2) was 53.70 under *in vitro*. The biocontrol agent also inhibited sclerotial formation, colonized sclerotia and apothecium of *S. sclerotiorum* under *in vitro* conditions.

BIO-PP41. Combination of Endophytic *Bacillus* and *Beauveria* Enhances Resistance in Tomato Plants Against *Fusarium* wilt Disease and Fruit Borer Pest

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Most of the approaches for biocontrol of pests and diseases have used a single biocontrol agent as antagonist to a single pest or pathogen. This accounts for the inconsistency in the performance of biocontrol agents. The development of a bioformulation possessing a mixture of bioagents could be a viable option for the management of major pests and diseases in crop plants. Leaves from bioformulation-treated tomato plants with or without fruit borer insect infestation and challenged by the pathogen were collected at 24 h intervals from 0 to 7 days and used for enzyme assays. Application of mixture of *Bacillus* and *Beauveria* significantly increases the induction of defence related enzymes. The results showed the higher induction of PO and PPO in plants treated with bioformulation mixtures (B2 + EPC8) than the plants treated with individual strains, chemical and untreated controls. Further, B2 + EPC8 combination showed a greater accumulation of SOD and Catalase which plays an important role in induced resistance. In addition to this, the LOX enzyme activity was greater in bioformulation-treated plants. Specific isoforms of PO, PPO, SOD and CAT were induced in plants treated with B2 + EPC8 bioformulation after challenge inoculation with pests and pathogens and their expressions were prominent when compared to untreated control. Moreover, a significant increase in growth parameters and yield was observed in tomato plants treated with B2 + EPC8 compared with the individual bioformulations and untreated control.

BIO-PP43. Studies on the Effect of Compatible VOCs and Biocontrol Agents for Enhancing Resistance in Mango Fruits against *Colletotrichum gloeosporioides* and *Lasiodiplodia theobromae*

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The induction of systemic resistance and biochemical changes were studied in mango fruits, to elucidate the role of compatible lipoxygenase volatile compound hexanal and biocontrol agents *viz., Pseudomonas fluorescens* (Pf1) and *Bacillus subtilis* (EPCO 16) in major post harvest diseases of mango against challenge inoculation with *Colletotrichum gloeosporioides* and *Lasiodiplodia theobromae*. The activity of defense related enzymes *viz*., peroxidase (PO), polyphenol oxidase (PPO), phenylalanine ammonia lyase (PAL), superoxide dismutase (SOD) and catalase (CAT) were found to be increased in the inoculated and treated fruits compared to the corresponding healthy fruits. Total phenols, ortho di-hydroxy phenols, starch, proteins and the activities of the enzymes were at the maximum 2 - 3 days after inoculation and thereafter declined sharply in untreated fruits, whereas slowly in hexanal and biocontrol treated fruits. In comparison with untreated fruits, treated fruits were more resistant as they showed higher accumulation of total phenols and also higher activities of enzymes. Increased expression of specific isoforms of PO, PPO, SOD and CAT was also observed due to Induced Systemic Resistance (ISR) induction against pathogens.

BIO-PP45. Management of Leaf Blight Disease of Coconut caused by *Lasiodiplodia theobromae* (Pat.) Griffon and Maubl. using Microbial Consortium

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Coconut is an important source of food, drink, oil and shelter for human beings. The production and productivity of coconut is affected by several factors of which, the pest and disease damages accounted a major share. Recently, leaf blight disease of coconut caused by *Lasiodiplodia theobromae* (Pat.) Griff. and Maubl. (Syn: *Botryodiplodia theobromae* Pat.) is a serious problem in Tamil Nadu and Karnataka states. Since the photosynthetic area is reduced, it causes 10 to 24 per cent of economic yield loss in coconut. In the present study, several rhizosphere bacterial (*Pseudomonas fluorescens*, *Bacillus subtilis*) and fungal (*Trichoderma viride*) antagonists were isolated and screened against *L. theobromae*. The *in vitro* screening revealed that the rhizosphere bacteria *P. fluorescens* (Pf1) and *B. subtilis* (Kam.) and the fungi *T. viride* (Tv1) were found highly effective against the leaf blight pathogen and recorded an inhibition zone of 12.7mm, 6.7mm and 6.3 mm, respectively. Hence, a microbial consortium was developed with all the three effective antagonists and evaluated under field conditions at different locations from the year 2011 to 2014. Pre and post treatment observations were recorded based on 0-5 scale and the per cent disease index (PDI) was calculated. Root feeding of Carbendazim @ 2g 100 ml^{-1} water for 3 times at 3 months interval was found to be the effective treatment in reducing leaf blight disease incidence in all the evaluation trials. Among the biological treatments, soil application of microbial consortium @ 300g + FYM 5 kg at quarterly interval $palm^{-1}$ was effective and reduced the leaf blight incidence within a range from 8.00 per cent to 14.53 per cent and it was also on par with soil application of BS1 mixture -TNAU @300g + FYM 5kg at quarterly interval $palm^{-1}$ with or without Neem cake 5 kg $palm^{-1}$ $year^{-1}$ in all the trials.

BIO-PP47. Antifungal Activity of Secondary Metabolites of *Bacillus* spp. against *Fusarium oxysporum* f. sp. *gerberae*

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A study was conducted in order to assess the antifungal activity of secondary metabolites of *Bacillus* spp. against *Fusarium oxysporum* f. sp. *Gerberae* infecting *Gerbera* plants. The crude antibiotics were extracted from the effective bacterial isolates *viz*., *Ochrobactrum* sp.(BSD5), *B. licheniformis* (BSD1) and *B.subtilis (*PSB5). The secondary metabolites were extracted by using organic solvent, ethyl acetate. The crude antibiotics extracted from *Ochrobactrum* spp.(BSD5) and *B. licheniformis* (BSD1) inhibited the mycelial growth of *F. oxysporum* f.sp. *gerberae* to an extent of 219 mm^2 and 206 mm^2 at 100 l concentration. It was followed by *B.*

subtilis (PSB5), which inhibited the pathogen up to 194 mm^2. The secondary metabolites were subjected to GC/MS study in order to identify the antifungal compounds. Compounds belonging to aliphatic hydrocarbons, terpenes, phenols and fatty acids were identified and reported to have antifungal activity.

BIO-PP48. Management of Turcicum Leaf Blight of Maize by Using Biocontrol Agents

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Turcicum Leaf Blight (TLB) disease incidence in maize was found to be predominant throughout the cropping season. To control TLB disease different biocontrol agents *viz., Pseudomonas, Bacillus* and *Trichoderma* were isolated from the maize rhizosphere. Efficiency of above mentioned isolates and already commercially available biocontrol agents *viz.*, *Pseudomonas fluorescens* and *Trichoderma viride* were tested against Turcicum Leaf Blight pathogen *Helminthosporium turcicum* through dual culture method. Among the different isolates tested *Pseudomonas fluorescens* effectively inhibited the growth of *Helminthosporium turcicum. Pseudomonas flourescens* was taken as the main component to manage Turcicum Leaf Blight disease. Seed treatment + Soil application + Spray application of *P. flourescens* recorded lowest lesion length, lesion width, disease incidence and disease severity (2.15 cm, 1.10 cm, 11.32 % and 1.0 respectively) against control (10. 25 cm, 3.40 cm, 40.00% and 5.0 respectively). Seed treatment + Soil application + Spray application of *P. fluorescens* recorded highest cob yield (6900 kg ha^{-1}) against control (4000 kg ha^{-1}).

BIO-PP49. Efficacy of *Trichoderma longibrachiatum* against Amaranthus Foliar Blight caused by *Rhizoctonia solani* Kuhn

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Amaranthus (*Amaranthustricolor* L.), the most nutritious leafy vegetable of the tropics, is a rich and cheap source of many of the vitamins and minerals. Foliar blight caused by *Rhizoctonia solani* Kuhn (Kamala *et al*., 1996) is a serious disease affecting amaranthus. The disease causes considerable economic loss owing to reduction in marketability of the produce. The recommended chemical control using mancozeb is quite hazardous on account of the persistence of the fungicide deposited on the leaves and it is carcinogenic also. Hence an attempt was made to manage the disease through fungal antagonists isolated from the rhizosphere of amaranthus. The fungi isolated from the rhizosphere included *Trichoderma harzianum*, *T. longibrachiatum*, *Aspergillus niger, A. wentii*, *F. oxysporum*. These fungal isolates were tested *in vitro*for their antagonism against *R. solani*. Both the *Trichoderma* isolates completely overgrew and parasitized *R. solani*.The mode of *Trichoderma* was found to be coiling and penetration of the host hypha leading to its disintegration and death. The isolate which showed the maximum inhibition (50.86%) was identified and characterized as *T. longibrachiatum*. This isolate was mass multiplied by liquid fermentation technology and the dry mycelial mat was powdered and mixed with talc @ 10 per cent w/w containing 10^7CFU per gram. The fermented biomass contained mycelial fragments, immature and mature chlamydospores. At 120 days after storage, the formulation contained 32 × 10^6 CFU per gram. Different methods of delivery of the formulation was tested in glasshouse among which soil application followed by one per cent foliar spray was found to be the most effective in reducing the intensity of the disease. *T.longibrachiatum* was mass multiplied in bran for soil application and applied @30 g per plant. *Trichoderma* treated plants showed a disease index of 2.85 per cent and 14.44 per cent at 40 and 60 DAT respectively. The results of the field experiment revealed that application of talc based formulation of *T. longibrachiatum* was the most effective in reducing the disease severity and on par with mancozeb.

BIO-PP50. *In vitro* Evaluation of Rhizosphere *Bacillus* spp against Wilt and Root Rot Pathogens of Pigeonpea

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Pigeonpea (*Cajanuscajan* (L.) Millsp.) is one the most important grain legumes grown in semi-arid tropical and sub-tropical environments. It is cultivated purely as a rainfed crop. The yield gap observed between potential yield and on-farm yield is attributed to many biotic and abiotic stresses.The major yield limiting factors in pigeon pea are the soil-borne diseases viz. vascular wilt caused by *Fusarium udum,* capable of causing30-100% loss in grain yield and dry root rot caused by *Macrophomina phaseolina.* Though chemical control of the disease is feasible, it's continuous use leads to toxic residue in soil and resistance development to chemicals by the pathogens. Biological control is widely accepted as an alternative to chemical management. Hence, an attempt was made to identify promising rhizosphere *Bacillus* strains for the management of root rot and wilt of pigeon pea. A total of 139 isolates of bacteria were collected from different pigeon pea growing areas of Tamil Nadu. The bacterial isolates were characterized by biochemical and molecular methods. The *Bacillus* isolates were tested for their *in vitro* efficacy against *Fusarium udum* and *M. phaseolina* by dual culture technique. Among the 139 isolates tested, 72 showed inhibition against wilt pathogen *F. udum* and 69 strains inhibited root rot fungus *M. phaseolina*. Of these, 18 isolates showed more than 30 per cent inhibition against both the pathogens. The isolate CCB7 inhibited the mycelial growth of *F. udum* and *M. phaseolina* by 51.48 per cent and 58.89 per cent respectively. The isolate CCB4 showed 61.48 per cent and 39.63 per cent inhibition of *F. umudum* and *M. phaseolina* respectively. These 18 isolates were further screened for their growth promotion activities by Standard Roll Towel Method. CCB7 showed a vigour index of 3655.4 followed by CCB4 showing a vigour index of 3524.4. Thus CCB7 was found to be a promising isolate of *Bacillus* which showed the maximum inhibition of *F. udum* and *M. phaseolina* and also contributed to maximum growth promotion in pigeon pea.

BIO-PP52. Effect of Biocontrol Agents and Organic Amendments on the Management of Charcoal Rot of Maize under Field Conditions

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The field trials were conducted to test verify the various biocontrol agents and organic amendments during different seasons in from 2010 – 2013 in Maize Research Station, Vagarai. All the season data were pooled and the mean values were arrived. Among the

different treatments tested, seed treatment and soil application of *Pseudomonas fluorescens* enhanced the plant height of 185.3 cm and followed by soil application of *P. fluorescens* (183.3 cm) and seed treatment with carbendazim 9179.3 cm) against control which recorded 152.6 cm. Similarly the above treatments recorded cob height of 69.6 cm 68.3 cm respectively against control (58.6 cm). Seed treatment and soil application of *Trichoderma viride* also enhanced the plant height and cob height to some extent. Cob length was also increased by seed treatment and soil application of *P. fluorescens* (19.9cm) followed by soil application of *P. fluorecens* (19.3cm) and seed treatment with carbendazim (18.3 cm) against control which recorded 15.6 cm only. Based on the pooled mean values, among the various organic amendments and biocontrol agents tested, seed treatment and soil application of *P. fluorescens* recorded the lowest disease incidence of 2.75% followed by soil application of *P. fluorescens* (5.10%) and seed treatment with *P. fluorescens* (7.91%) against control which recorded 33.37 %. Seed treatment and soil application of *T. viride* recorded 10.05% disease incidence, soil application of *T. Viride* recorded 9.98% and seed treatment with *T. viride* recorded 12.20%. With regard to yield seed treatment + soil application of *P. fluorescens* recorded the highest of 7222 kg ha^{-1} followed by soil application of *P. fluorescens* alone (7060 kg ha^{-1}) against control which recorded 5144 kg ha^{-1}.

BIO-PP57. Identification of Antifungal Metabolites/proteins from *Trichoderma* during Interaction with *Colletotrichum falcatum*

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Detailed studies were taken up to determineantifungal metabolites/ proteins produced by *Trichoderma harzianum* on during its mycoparasitism on *Colletotrichum falcatum.* In the study, *C. falcatum* (Cf) and *T. harzianum* (Th) were grown individually and the antagonist *T. harzianum* (Th) was inoculated on 5th day *C. falcatum* culture filtrate in complete medium broth and incubated for fifteen days. Secondary metabolites were extracted from all the three samples using ethyl acetate (EtoAc) and the samples were analyzed by GC- MS. Results revealed that 57 and 58 volatile compounds were expressed in *C. falcatum* and *T. harzianum,* respectively. However, out of 59 volatile compounds, 33 were newly expressed in *T. harzianum*grown on *C. falcatum* filtrateincluding styrene, octodeconic acid, 2-Heptanone etc. For identification of antifungal proteins, intra and extracellular protein samples were precipitated by 80% of ammonium sulphate and protein samples were separated using 2-dimensional gel electrophoresis. Gels were scanned for image analysis with the Image Master 2D platinum software ver. 7.0. Comparative 2-D gel analyses, in intracellular protein profile 592, 636 and 477 spots were expressed and in extracellular protein profile 691,446 and 424 spots were expressed in Cf, Cfx Th, Th, respectively. Totally 50 protein spots were identified as differentially expressed during the interaction (intra and extra) and they were subjected to MALDI-TOF analyses. The results revealed that most of the proteins were involved in defence reaction *viz*., 14-3-3 homologous, peroxidase, lonprotease homolog, ATP synthase, antagonist of mitotic exit network protein 1, 60s acetic ribosomal protein P0, lipoyl synthase etc. Bioassay study with extracted antifungal metabolites/ proteins indicated complete inhibition of *C. falcatum* conidial germination and proved their efficacy. Further, expression of unique antifungal genes is being validated by Real-Time PCR.

BIO-PP58. Ecofriendly Management of Leaf Folder pest and Sheath Blight Diseases in Rice Plants using a Potential Microbial Consortia

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To test the efficacy of *Pseudomonas fluorescens viz.,* Pf-1, AH-1 and entomopathogenic fungus, *Beauveria* against rice sheath blight disease (*Rhizoctonia solani* Kuhn) and leaf folder insect (*Cnaphalocrocis medinalis* Guenee) under glass house and field conditions. The leaffolder bioassay was done in rice leaf tissues treated with Bioformulations of fluorescent pseudomonads and *Beauveria.* The microbial strains at individual and combination of bioformulation showed greater reduction than individual bioformulation. The larval mortality, adult malformations were significantly increased and pupal weight and leaffolder incidence was reduced in Pseudomonas (Pf-1 + AH-1) + *Beauveria bioformulations* treated plants compared to control. Detection of antibiotic biosynthetic genes reflected the presence of 2,4-diacetylphloroglucinol (DAPG) and phenazine carboxylic acid (PCA) against *Cnaphalocrocis medinalis* and *Rhizoctonia solani* was noticed in Pf-1 + AH-1 + *Beauveria* treated rice plants. In Glass house and field trials recorded higher grain yield with significant reduction of leaffolder and sheath blight incidence in Pf-1 + AH-1 + *Beauveria* treated plants compared to control plants. Bioformulations enhanced natural enemies populations in individual as well as in combinations. *Pseudomonas* strains Pf1 and AH1 and *Beauveria* isolate B2 showed that they are compatible with each other. This compatible interaction has permitted the combination of the entomopathogenic fungus *B. bassiana* isolate B2 with *Pseudomonas* strains Pf1 and AH1 for the development of a new combination of microbial consortia and the design of a new strategy in the biological control of leaffolder insect and sheath blight disease on rice.

BIO-PP59. Morphological and Biocontrol Potential of *Chaetomium* spp. against *F. oxysporum* f.sp. *cepae* under *in-vitro*

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Chaetomium globosum is a potential biocontrol agent against many plant pathogens. Thirty two isolates were isolated from different locations of Tamil Nadu. Morphological and cultural characters were studied for the 32 isolates. Most of the isolates showed raised fluffy to flat mycelial growth and were able to produce perithecia and ascospores in Potato dextrose agar (PDA) medium. The antagonistic activity of all the 32 isolates were studied against basal rot pathogen. Among the 32 isolates, five isolates namely TNAU-Cg6, TNAU-Cg9, TNAU-Cg 24, TNAU-Cg25 and TNAU-Cg33 were found to be effective against *F. oxysporum* f.sp. *cepae* under *in-vitro*. The isolate TNAU-Cg6 showed maximum inhibition of 81.01 per cent followed by TNAU-Cg9 which recorded 77.4 per cent inhibition. Onion bulbs treated with ascospore suspensions of different *Chaetomium* sp. showed enhanced plant growth vigour. In this study all the isolates induced the plant growth characters significantly over untreated check. Among the isolates, TNAU-Cg6 significantly increased, the root

length of 9.3cm, shoot length of 21.3cm and vigour index (2928.85) compared to untreated control. Since, the TNAU-Cg6 was found to be best in all parameters, it will be further tested in glasshouse and field studies for its efficacy.

BIO-PP60. Morphological and Cultural Characterization of *Ampelomyces* spp, a Hyperparasite of Bhendi Powdery Mildew

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Ampelomyces is a naturally occurring hyperparasite on powdery midews. Totally ten *Ampelomyces* spp were isolated from powdery mildew infected leaves of various crops in Tamil Nadu. All the isolates were identified by their morphological and cultural characters. Different synthetic and non-synthetic media were tried for the growth and sporulation of *Ampelomyces* spp. Among the 12 medium, carrot extract agar (CEA) supported higher sporulation and growth. The colour of the colonies in various medium were brownish black to greenish white. The pycnidia of different isolates of *Ampelomyces* varied in their shape and were mostly ovoid, ellipsoid, cylindrical, pyriform to globose in shape. Pycnidiospores are hyaline, unicellular and guttulate in shape. The pycnidial production was higher in TNAU-AQ 1 and TNAU-AQ 3. Influence of temperature on the mycelial growth was tested ranging from 15-40 C .The mean mycelial growth was maximum at 30 C and minimum at 15 C. Among different pH ranging from 5-9, maximum growth was observed in neutral pH 7 as compared to other pH.

BIO-PP65. GC-MS Analysis of Antifungal Metabolites of Antagonistic *Bacillus subtilis* Strain G-1

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Biological control is non-hazardous strategy to control soil-borne diseases and improve crop productivity. Several PGPR (plant growth promoting rhizobacteria) have long been used as biocontrol agents for controlling plant diseases. PGPR produce a wide range of secondary metabolites that may act as signals that include antibiotics and volatile metabolites. In previous study, an isolate of *Bacillus* sp. from grapevine was isolated which showed *in vitro* antagonistic activity against *Aspergillus niger*. In the present study through biochemical and 16S rRNA gene sequence phylogenetic analysis, the selected bacterium was identified as *Bacillus subtilis* strain G-1. The antibiotics produced by the antagonistic *Bacillus subtilis* strain G-1 were partially purified and characterized. Thin-layer chromatography (TLC) analysis of the metabolites produced by *B. subtilis* G-1 showed a fluorescent compound at Relative front (R_f) 0.48 under UV light. The metabolite with R_f 0.48 purified from preparative TLC inhibited the mycelial growth of *Sclerotium rolfsii* and *Macrophomina phaseolina in vitro*. Gas chromatography-mass spectrometry (GC-MS) analysis of the antifungal compound at R_f 0.48 revealed the presence of 22 different kinds of antibiotics which included aldehydes, fatty acids, alkanes, esters and sulphur containing compounds. The above result will be presented.

BIO-PP66. Exploration of *in vitro* Studies and Molecular Analysis for Identifying the Entomopathogenic Potential of *Beauveria bassiana* (Bals.) Vuill. against *Helicoverpa armigera* (Hubner)

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In vitro study was undertaken to exploit the entomopathogenic efficacy of fungal antagonist *Beauveria bassiana* (Bals.) Vuill. against the tomato fruit borer *Helicoverpa armigera (*Hubner). Twenty isolates of *B. bassiana* were isolated from soil and infected insects at different regions of Tamil Nadu and studied there, *in vitro* efficacy at three different conidial concentrations *viz.,* 10^{-4}, 10^{-6}, 10^{-8}. All these concentrations of *B. bassiana* isolates were found pathogenic to third instar larvae of *H. armigera* with regard to concentration gradient. Among them, 10^{-8} conidial concentrations of Chinnasevathur and Thondamuthur isolates were exhibit higher percentage of larval mortality 78 and 76 per cent respectively, against *H. armigera.* The PCR of ITS region of *B. bassiana* was studied. The ITS1 and PN16 primers amplified a fragment of 930 bp corresponding to the ITS1 and PN16 regions of the 5.8s rDNA of *Beauveria isolates* examined. Totally, 12 best isolates were examined for the amplification of ITS region and these isolates showed amplified product with size range of 930 bp. It is thus suggested that *B. bassiana* has potential to be a microbial control agent for this insect.

BIO-PP67. Mycolytic Enzymes Produced by Plant Growth Promoting Endophytic Bacteria Inhibits Sheath Blight of Rice incited by *Rhizoctonia solani* Kuhn

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Sheath blight of rice incited by *Rhizoctonia solani* is one of the important diseases of rice causing huge economical loss to the farmers in the tropical and sub tropical areas. Various strategies have been undertaken to manage the disease but viable control measure is lacking till date. In this context, biological control of the disease using Plant Growth Promoting Endophytic bacteria (PGPE) is a potential alternative to the presently available chemical control methods. In this study, endophytic bacteria have been isolated from different rice tissues *viz*., root, stem and leaves and characterized. A total of eighty endophytic bacteria were isolated and identified as *Bacillus subtilis* based on the partial 16S rRNA gene sequence. All the isolates were tested for their ability to promote growth in rice seedlings and to inhibit *Rhizoctonia solani* under *in vitro* conditions. Among them, twenty five *Bacillus* spp significantly promoted the growth of the rice plant and inhibited the mycelial growth of *R. solani.* The isolates were further characterized for for the presence of chitinase gene (chiA) and β-1,3 glucanase gene using polymerase chain reaction. Most of the isolates could amplify the chitinase gene and β-1,3-glucanase genes encoding a product size of 270 bp and 415 bp respectively. The selective isolates could also inhibit the mycelial growth of *R. solani* under *in vitro* conditions when compared to the non mycolytic producing isolates. It can be inferred from the study that,

mycolytic enzymes producing *Bacillus* spp. play a major role in the lysis of the mycelium of *R. solani* and could be used for the management of sheath blight of rice.

BIO-PP68. Management of *Alternaria* Leaf Blight in *Jasminum grandiflorum* using Biocontrol Agents

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Jasminum grandiflorum is one of the leading traditional loose flowers of India and Tamilnadu has an immense potential to produce jasmine with an annual production of 1577 MT ha^{-1}. Among the different varieties of jasmine, *Jasminum grandiflorum* (Pichi) is cultivated in more than 60% of the area. Now-a-days, foliar diseases are found to be a major problem in Jasmine production. Large scale awareness on the environmental hazards of chemical management has led to the popularization of biocontrol agents. An experiment has been undertaken for finding out the causal organism of leaf blight in *J. grandiflorum* and its management using biocontrol agents. From the leaf blight infected samples the fungus was isolated and was identified as *Alternaria alternata* based on colony morphology and spore structure. Under *in vitro* dual culture experiment using 7 biocontrol agents, the BSD-4 strain of *Bacillus subtilis* was found to be the best, giving 81.25 per cent inhibition over the control. A pot culture experiment was laid out in CRD with 9 treatments including fungicide and one absolute control maintaining 3 replications for testing the efficacy of *Bacillus* and *Pseudomonas* strains. The different treatments were: T1: BSD–4 foliar spray @ 0.2%, T2: BSD–5 foliar spray @ 0.2%, T3: BSD–3 foliar spray @ 0.2%, T4: BSC–7 foliar spray @ 0.2% T5: BAC– 5 foliar spray@ 0.2% T6: BS– 2 foliar spray @ 0.2% T7: *Pseudomonas fluorescens* foliar spray @ 0.2% T8: Fungicide (Tropiconozole) foliar spray 0.1 % and T9: Absolute Control. The treatments were given as foliar sprays 10 days after the inoculation of the fungal pathogen. Among the different treatments given, foliar spray with BSD– 4 strain of *B. subtilis* @ 2% effectively reduced the disease incidence by 4.1%.

BIO-PP69. Mechanisms of Action of Biocontrol Agents against Anthracnose of Anthurium Incited by *Colletotrichum gloeosporioides* (Penz) Sacc.

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Seven isolates of *fluorescent pseudomonads*, six isolates of *Bacillus* spp. and four isolates of *T. viride* were tested against *Colletotrichum gloeosporioides* causing anthracnose of anthurium. Among the seventeen isolates of biocontrol agents tested, Isolate Pf1 of *P. fluorescens,* BsW2 of *B. subtilis* and Tv2 of *T. viride* were found to be highly antagonistic to *C. gloeosporioides in vitro* when tested by dual culture. The isolates of biocontrol agents exhibited various mechanisms *in vitro* to restrict the growth of the pathogens. The crude antibiotic from Pf1 was highly inhibitory to the growth of *C. gloeosporioides.* Isolates Pf1 and CFP1 were found to produce DAPG and phenazine as antibiotics. Diffusible non volatile metabolites of Tv2 and Volatile released by Tv1 caused maximum growth reduction in *C. gloeosporioides.* Among the elite six biocontrol agents tested five produced Hydrogen cyanide (HCN) and six are produced siderophore *in vitro.* The isolates CFP1 and Pf1 of *P. fluorescens* were found to produce salicylic acid, indole acetic acid and ammonia.

BIO-PP72. Combination of Bioagents with Rice Husk Assay and Composted Coir Pith against Soil Borne Diseases of Rainfed Groundnut

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An experiment was conducted the application of organic matters, either fresh rice hush Ash or composted coirpith, application of bioagent *Trichoderma* sp., *Pseudomonas fluorescens* and *Bacillus subtilis* was conducted to suppress basal stem rot. Root rot and color rot diseases under rainfed conditions in Groundnut. The research was conducted at dry land Agricultural Research Station, chettinad. The experiments were arranged as random block design with the application of organic matter and bioagents invidualy and combinations.. The bioagent *Trichoderma* sp. was applied 50 g $plot^{-1}$ as powder in the same time of organic matters application (before planting the seeds). The results showed that application of composted organic matters reduced disease incidence 10-26%, while application as Rice hush Ash reduced 10-15%. Combination between application of bioagent *Trichoderma* sp. with Rice husk ash and or composted coirpith suppressed disease incidence 20-45% and 20- 41% respectively. Application of bioagent alone on planting medium reduced disease incidence 35%. Applications of rice hush ash and composted coirptih with bioagent *Trichoderma* sp. decreasing the soilborne disease (Root rot and stem rot) and increasing the yield.

BIO-PP77. Efficacy of Different Organic Amendments against Wilt Disease of Ashwagantha (*Withania somnifera*) Caused by *Fusarium solani* (Mart.) Sacc

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The growing use of chemical fertilizers has been witnessing the grave consequence of global economic imbalance as well as environmental pollution. Application of organic amendments to soil enhances soil health besides reducing the leaching, volatilization and other losses due to chemical fertilizers. Ashwagandha (*Withania somnifera* L. Dunal) is a medicinal plant that is used in the Indian traditional systems of medicine Ayurveda and Unani. This crop is suffered from many diseases. Among them wilt disease is a major problem and causes severe yield losses. Present study was carried out to investigate the antifungal activity of various organic amendments *viz.*, neem cake, groundnut cake, vermi compost, gingelly cake, and FYM at 10 per cent concentration were tested against ashwagandha wilt pathogen, *Fusarium solani.* The results revealed that a minimum mycelial growth of 20.75mm in neem cake at ten per cent concentration and the maximum growth inhibition of 76.11 per cent. The next best effective treatment was FYM at ten per cent concentration, which produced a mean colony diameter of 22.81mm and a mycelial

growth inhibition of 73.74 per cent. The minimum mycelial growth inhibition of 62.28 per cent was observed in sesamam cake (10%) with a mean colony diameter of 32.77 mm.

BIO-PP85. Rhizobacterial Antagonism Against Cotton Root Rot (*Rhizoctonia solani* Kuhn)

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India has been the traditional home of cotton which is the dominant raw material of the textile industry. Cotton requires adequate protection from a large number of diseases that cause damage at different growth stages of the crop. Root rot caused by *Rhizoctonia solani* Kuhn is the most serious soil borne disease in the cotton growing areas causing substantial stand loss. Protection against cotton diseases can be achieved by venturing into the area of biological control using rhizobacteria, as an alternative to the use of chemicals. The present investigation, involves rhizosphere bacteria of cotton to manage the root rot. Sixty rhizobacterial isolates were isolated from the rhizosphere soil of cotton collected from various cotton growing regions of Tamil Nadu. On assessing the antagonistic potential of these isolates against *R. solani in vitro* revealed that the isolate DGL9 was highly effective in inhibiting the growth of the pathogen by 54.28 per cent over control. Production of volatiles, indole acetic acid, salicylic acid, -1, 3-glucanase and antibiotics are some of the mechanics by which DGL9 isolate was found to exhibit antagonism against *R. solani*. Based on biochemical tests isolate DGL9 was identified as *Bacillus* spp. Further, amplifications of the 16S–23S rDNA intervening sequence of the isolates by PCR also grouped DGL9 as *Bacillus subtilis*.

BIO-PP 87. Oleic Acid: A Mycoherbicide from *Cochliobolus lunatus* for the Management of Weeds in Rice Ecosystem

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Rice is one of the important food crops of the world and is the second emerging crop in India after wheat. The average per hectare yield in India is less as compared to China due to various factors. Amongthem weed emergence is the major contributor in the loss of rice production. Due to weeds, heavy rice yield losses have been occurred and sometimes to the extent of complete crop loss under extreme conditions. Keeping in view, experiments were designed to develop environmentally safe products for controlling notorious weeds in rice crop. For this purpose, field survey was conducted in ten districts of Andhra Pradesh and found *Echinochloacrusgalli* as dominant weed occurring in paddy fields.The naturally infected weed samples were collected and isolated 56 fungal pathogens. Among them three fungal pathogens *Fusarium proliferatum*, *Alternaria alternata* and *Cochliobolus lunatus* are identified as virulent pathogens against *E. crusgalli*. Extracted crude metabolites from all three pathogens and tested on *E. crusgalli* under greenhouse and field conditions. The metabolites extracted from *C. lunatus* are found very effective in controlling weed even at lower concentrations after 7 days of treatment. Optimized cheaper nutrient media for large scale production of potential metabolites. The effective metabolite was purified with preparative HPLC and characterized through LC- MS, IR and NMR spectroscopy. The potential metabolite was identified as Oleic acid with molecular weight 283 and molecular formula $C_{18}H_{34}O_2$. Further studies on development of both organism and metabolite based formulations and generation of required data (Bio-efficacy, Chemistry, Shelf life and Toxicity) for statutory approvals is under progress.

BIO-PP 91. Synergistic Effect of Bio-fertigation and Nutrigation on Growth, Yield and Disease Management of Dutch Rose var. Tajmahal under Protected Cultivation

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An experiment was conducted to study the growth, yield and management of powdery mildew in response to bio-fertigation and micronutrigation in rose variety "Tajmahal" under naturally ventilated polyhouse. It consists of 22 treatments which include T_1 - 75% of RDF @ 125:62.4:62.4 g NPK m^2 yr^{-1}, T_2 -100% of RDF @ 166.4: 83.2:83.2 g NPK m^{-2} yr^{-1}, T_3 - 125% of RDF @ 208:104:104 g NPK m^{-2} yr^{-1}, T_4-150% of RDF @ 250:125:125 g NPK m^{-2} yr^{-1} and other treatments. Highly significant results were observed with respect to various plant parameters. Among the treatments, the plants of T_{19} significantly recorded highest plant height (167.26 cm), plant spread (47.82 cm^2), early flower bud appearance (26.93 days), minimum duration for harvest (49.08 days), increased stem length (83.77 cm), increased flower bud circumference (12.81 cm), flower stem girth (0.83 cm), increased number of cut flowers per plant (27.07) and extended vase life of 11.50 days, higher values for uptake of micronutrients [iron (149.23 mg $plant^{-1}$ and 167.01 mg $plant^{-1}$), zinc (121.12 mg $plant^{-1}$ and147.66 mg $plant^{-1}$), manganese (82.27 mg $plant^{-1}$and 94.50 mg $plant^{-1}$)] during bud appearance and flowering stage respectively and higher benefit cost ratio of 3.15 in T_{19}. Minimum per cent disease index (5.40, 5.69 and 6.10) was recorded in (T_{20}) followed by T_{19} and maximum per cent disease index (21.74, 34.00 and 39.53) was registered in treatment T_{22} (control) during the vegetative, bud appearance and flowering stage respectively. It is clear from the study that plant growth parameters, yield and quality of flowers were found to be superior in T_{19} applied with ***1***25% of RDF @ 208:104:104 g NPK m^{-2} $year^{-1}$ + foliar application of 0.5% EDTA + soil and foliar application of *B. megaterium* and *B. amyloliqufaciens* each @ 10 ml m^{-2} for the Dutch rose var. Tajmahal.

Session 6- Impact of Climate Changes on Plant Diseases

CCP-PP2. Development of Bacterial Blight Disease in Cotton as Influenced by Weather Parameters

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Bacterial blight of cotton caused by (*Xanthomonas axonopodis* pv *malvacearum* (Smith) is an economically important disease in

Andhra Pradesh. The effect of weather factors on the development of bacterial blight in cotton varieties viz., L761, L604, Narasimha, LRA 5166 and *Bt* Cotton hybrid bunny was investigated during kharif 2007 to 2012 in vertisols at Regional Agricultural Research Station, Lam, Guntur under rainfed conditions. Scoring of disease was done at weekly intervals by adopting 0-4 scale on randomly labelled plants up to mid February. Development of disease expressed as Per cent disease intensity (PDI), along with meteorological data (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rain fall, sunshine hours) was recorded. Correlation between progress of bacterial blight and weather factors was calculated. This study indicated that the disease progress was negatively correlated with temperature while relative humidity and sun shine hours were positively correlated. Regression analysis revealed the significant influence of minimum temperature, relative humidity and sun shine hours in different genotypes. This study is useful to plan the management strategies against this important disease and take up preventive and or protective measures with recommended fungicides like 0.3% copper oxy chloride + 0.01% streptocycline.

CCP-PP3. Influence of Some Important Abiotic Factors on Sclerotial Viability under *in vitro*

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The relationship of different abiotic factors on viability of sclerotia of *S. rolfsii* was tested under *in vitro*. The result showed that sclerotial viability was not disturbed regardless of different soil depths. Complete reduction in sclerotial viability was observed at 80 and 90 per cent moisture levels than at 60 and 70 per cent moisture after five months. However, sclerotial viability was not affected in dry soil. Significant reduction in sclerotial viability was observed at lower temperatures 20 and 25 C than higher temperatures 30 and 35 C. Decreased level of relative humidity (RH) and increased time of incubation decreased the germination of sclerotia upto six months. Regarding soil texture, reduction in sclerotial viability was observed in clay and clay loam soil types than sandy and sandy loam soils. Overall result revealed that increasing level of soil moisture, soil clay content and declining level of temperature, RH significantly reduced the sclerotial viability.

CP-PP4. Studies on Epidemiology of Pearl Millet Blast

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Blast disease of pearl millet caused by *Pyricularia grisea* was considered as disease of minor importance. Some researchers have reported that the incidence of blast is increasing at an alarming rate in the recent past, particularly on commercial hybrids in several states of India. The disease can be best managed through host plant resistance as well as critical examination of various environmental factors responsible to create congenial condition. The present investigation was therefore, undertaken to find out the effect of sowing time and role of weather variable in pearlmillet blast development. The cultivar ICMB 95444 was sown on three different date and the observations on disease intensity were recorded at panicle initiation, flag leaf visible, 50% stigma emergence and dough stage. The disease development was maximum *i.e.* 54.29% at dough stage in early sown crop and disease was almost at par at dough stage in late sown crop and at 50% stigma emergence stage in early sown crop while there was no incidence at panicle initiation stage and flag leaf visible, when these stages coincided with environmental conditions of temperature range between 25 C to 32 C, RH (M) around 94%, RH (E) around 78% coupled with rains.

CCP-PP5. Pre Disposing the Head Rot Disease in Banana caused by *Erwinia carotovora* sub sp *carotovora* under Higher Temperature in Vellore District, Tamil Nadu

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The study was undertaken to ascertain the role of temperature for causing of soft rot (or) head rot disease in Banana by *Erwinia carotovora* sub sp. *carotovora*. Banana crop is cultivated in Vellore district nearly 3200 ha. The major problem in cultivation is soft rot disease during the month of march to may. The disease incidence ranged from 34.6 to 67.9 %. The occurrence of disease was higher in Grand Naine, Karpooravalli and Poovan varieties. The highest temperatures of 39.6, 38.0 and 39.1 C were recorded during the months of april 2012, 2013 and 2014 and the incidence was 34.6, 67.9 and 53.4 % respectively. The banana pseudo stem contains about 90% of water (Stem Juice). The stem juice is boiled during the month of april due to increasing temperature of 43 C. This temperature created sensitivity to cigar leaf (recently emerging leaf still rolled as a cylinder) and predispose the tender tissue burning and followed by rotting due to *E. carotovora* sub sp. c*arotovora.* The leaf was tightly coiled and fragile in nature.

CCP-PP6. Seasonal Incidence and Population Dynamics of Purple Blotch and Thrips in Onion

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Onion is an economically important vegetable crop used throughout the year for culinary purposes and also used in the form of salad or condiments. In Tamil Nadu, aggregatum onion, *Allium cepa* var. *cepa* is cultivated in an area of 22,270 ha with production of 3,33,870 tonnes. Purple blotch of onion caused by *Alternaria porri* is an important disease affecting onion which occurs at all stages of the growth of the crop, and yield loss upto 50 per cent has been recorded (Evert, et al 1985). Besides, thrips damage causes yield loss upto 80 % which may also predispose the purple blotch disease of onion. Hence, it is important to understand the seasonal occurrence of the purple blotch disease and population dynamics of thrips during the cultivation which will help us in designing the management strategy. In this study, monthly planting of aggregatum onion cv. Co4 was done at fortnightly interval starting from 1st, June upto 15th, January for three years. The experiment includes four treatments replicated thrice, which includes spray with fungicides (T1) or insecticides alone (T2) or both (T3) and unprotected from pests and diseases (T4). The results revealed that purple blotch incidence was low in protected plot during June 1st planting (6.5 PDI) while it was the highest in August 1st planting (21 PDI). Correlation of the weather parameters with the incidence of purple blotch of onion revealed that, the incidence was more during October – November (42 - 45 standard week) in which the rainfall and relative humidity (> 90%) was found to be maximum. With regard to thrips, the results revealed that thrips population was low in the protected plot during October 15th planting (12

Nos), while it was highest in the December 15th planting (32 Nos). Correlation of the weather parameters with the population of onion thrips revealed that, maximum rainfall and relative humidity (>90%) occurred during October- November in which the population of thrips was minimum. Thus the farmers can design their strategy for timely planting to evade the loss due to purple blotch and thrips in onion.

CCP-PP9. Cultural and Physiological Studies of *Macrophomina phaseolina* (Tassi.) Goid. Causing Root Rot of Medicinal Coleus (*Coleus forskohlii* Briq.)

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Macrophomina phaseolina (Tassi.) Goid., a soil-borne pathogen, causes root rot disease in Coleus (*Coleus forskohlii*) and hampering their yield. *In vitro* studies were conducted on the effect of temperature, pH levels, carbon, nitrogen and amino acids on the mycelial growth and biomass production of *M. phaseolina*. The pathogen inoculated plates were kept under different temperatures *viz.*, 10, 15, 20, 25, 30, 35 and 40 C. The results revealed that the maximum mycelial growth of *M. phaseolina* was recorded at 30 C which was reduced significantly below 25 C and above 35 C. Different pH levels *viz.,* 4.0, 5.0, 6.0, 7.0, 8.0 and 9.0 were tested. Among them, the maximum mycelial growth was observed in pH 6.0 and it was followed by pH 5.0. The carbon sources *viz.,* sucrose, glucose, maltose, fructose, dextrose and lactose were tested. Among the carbon sources, sucrose supported the maximum mycelial growth (88.33 mm) and dry weight (234.00 mg). While the six nitrogen sources namely ammonium nitrate, ammonium sulphate, calcium nitrate, potassium nitrate, sodium nitrate and urea were evaluated for the mycelial growth and dry matter production of pathogen. Among them, potassium nitrate was the best nitrogen source recorded highest mycelial growth (85.00 mm) and biomass production (227.5 mg).

IDM-PP2. Management of Foliar Diseases of Cotton using Chemical Fungicides and Biocontrol Agent

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Cotton is one of the most important fiber and field crops in India. However, the production potential of the crop has not been fully exploited due to several biotic and abiotic factors. The crop suffers from many fungal and bacterial diseases, of which foliar diseases take a heavy toll. Among the foliar diseases *Alternaria* blight (*Alternaria macrospora*), *Cercospora* leaf spot (*Cercospora gossypina*), grey mildew (*Ramularia areola*) and bacterial blight (*Xanthomonas axonopodis* pv. *malvacearum*) are the important ones and they cause the yield loss of 26-30 per cent. The use of fungicides and biocontrol agents has become inevitable in controlling the foliar diseases in the absence of suitable resistant cultivars. *Two field* experiments were conducted to assess the efficacy of different chemical fungicides and a bioagent Pseudomonas *fluorescens* at Cotton Research Station farm, Veppanthattai during September 2011 –March 2012 and September 2012 –March 2013. Field evaluation of fungicides indicated that the foliar application of propiconazole (0.1%) on 60, 90 and 120 DAS was effective in controlling the foliar diseases *viz*., *Alternaria* leaf blight, leaf spot, grey mildew and bacterial blight and recorded a maximum seed cotton yield of 23.10 q ha^{-1}. In another experiment, seed treatment with *Pseudomonas fluorescens* (TNAU-Pf1) @ 10 g kg^{-1} + foliar spray @ 0.2 per cent on 50, 65, 80, 95, and 110 DAS gave better control of the foliar diseases and recorded higher seed cotton yield (21.8 q ha^{-1}) compared to chemical fungicide.

IDM-PP3. Promising Botanicals Against Crown Rot of Banana

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The crown rot is considered as an important post harvest disease of banana (*Musa* spp.) in Assam. The present study was undertaken to identify the fungi associated with the disease complex and to evaluate the efficacy of a few botanicals against the disease complex. Studies reveal that *Colletotrichum musae* and *Fusarium solani* were associated with the disease complex under Assam condition and a synergistic effect of both the fungi was recorded. The botanicals were more effective in managing the disease complex when applied under post – inoculated (botanicals were applied before 24 h of inoculation) condition. Out of the five botanicals, leaf extract of *Ocimum basilicum* (Sweet basil) was most promising in managing the disease followed by leaf extract of *Azadirachta indica* (Margosa tree) . The shelf life of banana was extended up to 8 days when treated with leaf extract of *Ocimum basilicum*. The details of the disease record and shelf life extension have been discussed in the paper.

IDM-PP5. Management of Black Rot of Cabbage caused by *Xanthomonas campestris* pv. *campestris* under Field Condition

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Xanthomonas campestris pv. *campestris* is the causal agent of crucifers black rot, a disease responsible for severe economic losses. Plants belonging to this family are susceptible to this disease in all developmental stages. The black rot occurs more frequently in humid soils and temperatures ranging from 20 to 30°C, which are common in tropical and subtropical regions. Increasing the productivity of crucifers by improving the phytosanitary measures with sustainability has been a great challenge for mankind in modern society. This objective has been achieved through the use of chemicals, biocontrol agents, organic amendments and botanicals under field condition for the management of black rot of cabbage. Total seventeen treatments were evaluated with the use of single or combination of chemicals, biocontrol agents, organic amendments and botanicals against *Xanthomonas campestris* pv. *campestris* under field condition. The results revealed that the treatments are combination of seed treatment with *S. exfoliatus* @ 10g kg^{-1} plus soil application of neem cake @ 150 kg ha^{-1} plus foliar application of *S. exfoliatus* @ 0.2 per cent 17 and 45 DAP recorded the least disease incidence of 12.78 PDI as against 62.78 PDI in the unsprayed control and thus accounted for the highest disease reduction of 79.64 per cent over control and the treatment of seed dipping in streptomycin (100 ppm) for 30 min plus foliar application of combined application of copper oxy chloride (0.2%) plus streptomycin (100 ppm) recorded the PDI of 12.23 which accounted for 80.53 per cent disease

reduction over control under the field experiment. It is conclude that, combination of chemicals or bicontrol agents with organic amendments were effective against *Xanthomonas campestris* pv. *campestris* under the field condition.

IDM-PP7. Management of Sheath Blight of Rice (*Oryza sativa* L.) with Bio-agents and Fungicides

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Paddy is the most widely cultivated food crop in the world . Sheath blight disease of rice caused by *Rhizoctonia solani* is a major production constraint in all rice producing areas of the world. The annual losses due to sheath blight of rice are estimated to be 25 per cent under optimum conditions of disease development. The experiment was conducted in central research farm of Department of Plant Pathology SHIATS, Allahabad during *Kharif* season in the year of 2014. For present study seven treatments including control were tested for management of sheath blight of rice which were *Trichoderma harizanum* (Seed treatment) + *Trichoderma viride* (Foliar spray), *T. viride* (ST) + *Psudomonas fluorescens* (FS), *P. fluorescens* (ST) + *T. viride* (FS), *P. fluorescens* (ST) + *T. harizanum* (FS), *T. viride* (ST) + *T. harizanum* (FS), carbendazim (ST) + propiconazole (FS) and Control. Observations recorded on 90 DAT pertaining to mean per cent disease severity reveal that it was lowest with *P. fluorescens* (ST) + *T. harizanum* (FS) 17.586, followed by *T. viride* (ST) + *T. harizanum* (FS) 18.956, carbendazim (ST) + propiconazole (FS) 19.773, *T. harizanum* (ST) + *T. viride* (FS) 21.180, *P. fluorescens* (ST) + *T. viride* (FS) 21.996, *T. viride* (ST) + *P. fluorescens* (FS) 22.290 and control 29.103.

IDM-PP9. Integrated Approach to Tackle Finger Millet Blast in the North Western Agroclimatic Zone of Tamil Nadu

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Finger millet [*Eleusine coracana* (L.) Gaertn] is a widely cultivated crop of the tropical and subtropical regions of the world. It is indispensable to Indian agriculture as a source of grain and straw in a vast dry land area. India is the largest producer of finger millet in the world. In Krishnagiri district, it is a major staple food crop and grown in an area of 52,000 ha comprising 16% of total production of the state. Of the several diseases that affect finger millet, blast caused by *Pyricularia grisea* is the most serious one causing considerable grain loss in many finger millet growing regions. The disease occurs almost every year during rainy season but the extent of crop loss depends on the severity and the time of onset of disease. Disease infected plants show greater reduction in yield and sometimes 100% yield loss is also observed in severe cases (neck blast). An integrated approach was used to manage the disease during 2013-2014 under field conditions. Bioagents and mew fungicide molecule were used either alone or in combinations. Results showed that among the treatments tested use of biocontrol agent *Psuedomonas fluorescens* as seed treatment @ 10g kg^{-1} and foliar application of new fungicide molecule @ 2g lit^{-1} at maximum tillering stage and heading phase recorded minimum leaf blast incidence of 4.7% and no neck blast incidence and maximum grain yield of 3974kg ha^{-1} as against control under field conditions.

IDM-PP11. Screening of Sunflower Entries under Field and Artificial Inoculated Conditions for *S. rolfsii* Resistance

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Chemicals and cultural practices have been considered as potential management practices for plant disease control. But these are associated with certain limitations. Hence exploiting host plant resistance in the management of disease is an attractive proposition. The present work was carried out to find the reaction of All India Coordinated sunflower entries to sunflower stem rot pathogen *Sclerotium rolfsii* under field as well as artificial conditions. Out of 25 IHT entries screened, the stem rot incidence ranged from 2.1(KSFH-335) to 5.5(CSFH-8031and KBSH-70) per cent. Out of 6 AHT screened the stem rot incidence ranged from 2.5 (NSSH-1084) to 4.3 (Morden). Similarly in the case of AHT (O), stem rot incidence ranged from 2.5 (PAC-3794) to 5.0 (Morden) per cent. The stem rot incidence was significantly higher in all the sunflower entries when screened under artificial conditions compared to field screening. The highest incidence of 18.2 was recorded in LSFH-176 followed by RSFH-1887 (18.1%). The lowest incidence was recorded NDSH-11 with 7 per cent. No entry was found to be resistant to stem rot caused by *S. rolfsii* under artificial screening.

IDM-PP14. Survey of Seed-borne Fungi Associated with Seeds of Rice (*Oryzae sativa* L.) in Tamil Nadu

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Rice (*Oryza sativa* L.) is the most widely cultivated food crop in the world. It is being cultivated in 114 countries throughout the world, and more than 50 countries have a minimum annual production of 100,000 t. Frequent and heavy rainfall and floods particularly near harvest in the different parts of the country wet the crop and make panicles more prone to invasion by fungal species. Seed borne diseases caused by fungi are relatively different to control as the fungal hyphae get established and become dormant. Apart from being seed borne pathogens, fungi may grow on storage products. These fungi may decrease the seed germinability cause seed discoloration, produce toxins that may be injurious to man and domestic animals and may reduce seed weight also. Hence, seed health testing is one of the conventional methods to detect the presence of seed-borne fungi. The purpose of seed health testing is to assure the safe movement of seeds of different crops for research or trade. In the present study, total of 30 rice seed samples consisting of 7 cultivars were obtained from different locations of Tamil Nadu, India were used for testing their health status by using blotter paper and agar plate method.The results revealed that a total of 9 pathogens (*Alternaria padwickii, Curvularia lunata, Fusarium moniliforme, Helminthosporium oryzae, Sarocladium oryzae, Pyricularia oryzae, Rhizopus oryzae, Aspergillus niger* and *Trichoderma species*) were obtained from the respective samples and they were identified based on the morphological characters. Among them, the most predominant one was *Helminthosporium oryzae* which was associated with 62.36 per cent seed samples, followed by *Alternaria padwickii* (36.63%), *Sarocladium oryzae* (30.63%), *Fusarium moniliforme* (28.63%), *Curvularia lunata* (26.00%). These findings suggest that there is a

need for proper storage of rice seed to minimize the fungal infestation and their mycotoxin production.

IDM-PP18. Management of Powdery Mildew of Coriander through Botanicals

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Powdery mildew disease of coriander (Coriandrum sativum), caused by Erysiphe polygoni is becoming sever under field conditions. Among the various botanicals and organics tested Panchagavya was most effective with least PDI of 11.81 in comparison with 45.33 PDI in control and it was on par with treated check Wettable sulphur with 9.07 PDI and seed yield of 5.15 q ha^{-1}. The efficacy of Panchagavya was similar over the years also with mean seed yield of 5.37 q ha^{-1} and it was on par with Wettable sulphur with 5.87 q ha^{-1} mean seed yield

IDM-PP20. A New Report on the Occurrence of Whitefly Transmitted Yellow Vein Mosaic Virus (YVMV) in Ribbed Gourd (*Lufa acutangula.* Roxb.) and Integrated Disease Management

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Ridge Gourd or Ribbed Gourd (*Lufa acutangula*) is a popular vegetable crop belonging to Cucurbitaceae family. Ridge gourd can be grown in all kinds of soil, loam, clay loam and silt soils throughout the year and are used as an important vegetable in the south and east India. Many crop pests and pathogen attack this crop. Among them virus diseases cause severe yield loss. Begomoviruses transmitted by whitefly *Bemisia tabaci* (Gennadius) dominante tropical and subtropical regions of the world and attack more dicot plants including tomato, pepper, cassava, beans, cotton and cucurbits. A detailed survey conducted in and around thuraiyur and kannanur regions recorded the occurrence of Whitefly-Transmitted Gemini Virus (WTG). Collection of various plants and weed species infected by WTGs during the study revealed that the ribbed gourd plants expressing Yellow Vein Clearing and Mosaic symptoms were found to be new and severe vein clearing in ribbed gourd lead to serious yield loss. Bhendi *(Abelmoschus esculentus)* and three weed species *viz., Impatiens balsamina* (garden balsam) and *Salvia saplendus* (sage weed) and *Hibiscus tetraphyllus* respectively were found to be weed hosts for Yellow Vein Mosaic Virus on Ribbed gourd. Insect vector *Bemesia tabaci* was more prevalent and transmitted the virus persistently. Vector control was the only possible way to manage the new virus. Hence integrated disease management was followed. Hand weeding, insecticides like Dimethoate, Nimbicidin and biocontrol agents like *Pseudomonas* were tried to control whiteflies transmitting the Yellow Vein Mosaic Virus in ribbed gourd.

IDM-PP 27. Evaluation of Management Strategies of Iris Yellow Spot Virus (IYSV) of Onion Crop

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Onion (*Allium cepa*) is an economically important crop in India. Iris yellow spot virus (IYSV), genus Tospovirus, family Bunyaviridae, causes large economic losses in a wide variety of plant hosts. It has typical tospovirus genome organization with three single-stranded RNA segments of negative or ambisense polarity. IYSV is transmitted by *Thrips tabaci.* The virus causes important problems in a number of monocot hosts, and among these, the disease caused to onions is the most severe. The leaf symptoms of disease were observed as irregularly shaped, chlorotic or necrotic lesions on onion plants (*Allium cepa*). The experiment was conducted to find out suitable management strategy for the management of Iris Yellow Spot Virus disease on onion crop. Among the different treatments, four spray of cypermethrin (10E.C @ 0.1% at 10 days interval controlled the disease most efficiently having disease incidence 10.8% only in comparison to control (DI 38.0%). Sprays of castor oil @ 5ml L^{-1} water at 10 days interval were also found effective which restrained the disease at 13%. Twenty germplasms $lines^{-1}$ were screened against the disease but no entry had resistance against IYSV. In all germplasms $lines^{-1}$ disease incidence was in the range of 20-30 per cent.

IDM-PP28. An Approach for the Management Root (Wilt) Disease in Coconut

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Coconut root (wilt) disease, caused by phytoplasma is a serious disease of coconut in worldwide. Currently, evaluation of the various treatments adopted is mainly based on the symptoms of root (wilt) disease management. However, various methods only provide visual estimation rather than accurate measurement of phytoplasma inoculum in coconut palms. In field trial, all the cultural practices along with root feeding of oxytetracycline hydrochloride @ 1000 ppm at two monthly intervals up to 20 months observed the remission of root (wilt) disease symptoms. Using quantitative PCR, the concentration of phytoplasma ranged from 4.6×10^5 to 8.8×10^5 and the concentration was found to be minimum in trees with root feeding of oxytetracycline hydrochloride @ 1000 ppm $tree^{-1}$ followed by soil application of mixtures of bioagents (Pf1 + EPC5 + Tv) in field trial. In this study, DNA- based quantitative polymerase chain reaction (qPCR) analyses were evaluated to quantify phytoplasma concentration in different treatments were imposed in coconut palms. However quantification purpose of phytoplasma, the qPCR approach was much faster, versatile, more convenient, sensitive and accurate in most cases. Therefore, it is an excellent tool for in planta quantification of phytoplasma and can be used for reliable assessment of epidemiology and host resistance.

IDM-PP30. Identification of Sugarcane Clones for Resistance to Sugarcane Red Rot caused by *Colletotrichum falcatum* Went.

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Red rot of sugarcane caused by *Colletotricum falcatum* Went. is the most important disease of sugarcane and major constraints in

the profitable cultivation of sugarcane particularly in India. Many high yielding and high sugared varieties *viz*., CoC 671, CoC 90063, CoC 8001, CoC 85061, CoC 92061 are susceptible to red rot and have gone out of cultivation (Kalaimani and Natarajan, 1994). Because of the deep seated nature of the pathogen, hard nature of the cane rind and growth characters of the crop, biological and chemical methods of diseases management were found to be ineffective. The use of resistant varieties is the practical as well as cheap method of disease control, commonly applied as major component of integrated disease management strategy. The clones developed in Sugarcane Research Stations located at Cuddalore, Sirugamani and Melalathur were evaluated for red rot resistance during 2013-14 and 2013-15 at Sugarcane Research Station, Cuddalore. Totally 122 clones along with standards were screened for red rot resistance by using the composite isolates of *Colletotricum falcatum.* Twenty canes in each clones/standard (7 month old) were inoculated by plug method (Srinivasan and Bhat, 1961). After the incubation of two months, the inoculated canes were split open longitudinally along the point of inoculation and graded as per 0-9 score. Among the clones tested, four clones *viz*., Co 86249, Si 2010-105, C 31075 and 11G003 exhibited resistant reaction to red rot by registering less than 2.0 grade. Twenty one clones registered moderately resistant reaction (2.1 to 4.0 grade), 14 clones recorded moderately susceptible reaction (4.1 to 6.0 grade), 19 clones exhibited susceptible reaction (6.1 to 8.0 grade) and 60 clones were highly susceptible to red rot disease (more than 8.1 grade).

IDM-PP31. Evaluation of Sugarcane Clones for Resistance to Smut caused by *Ustilago scitaminea* Sydow

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Smut disease caused by *Ustilago scitaminea* Sydow is one of the major disease in sugarcane. The characteristic symptoms of the smut disease are the emergence of a long, elongated whip like structure. Infected plants produce profuse tillering. The disease causes loss in yield and cane quality. Since the pathogen is systemic and deep seated in nature management is difficult. Hence, host resistance can be exploited for development of disease resistant variety. Fourty six sugarcane clones including the standards were screened for resistance to smut disease at Sugarcane Research Station, Cuddalore during 2014. Two budded setts of each clone were steeped in freshly prepared smut spore suspension (spore with more than 90 % viability) with spore load of one million spore per milliliter for 30 minutes and incubated under shade for 24 h and planted in plot of 3 m × 0.8 m × 2 rows replicated twice in a randomized block design . The incidence of smut was observed at 15 days interval from 35 days after planting upto harvesting. Affected clumps were uprooted after recording the incidence during each observation to avoid the chances of secondary spread. The cumulative incidence of smut was used for calculating the disease reaction. Among the 36 sugarcane clones screened 15 clones *viz.,* C31072, C31075, C31078, C31093, C31097, C31098, C31100, C31127, C31131, C31136, C31223, Co86249, CoA11322, Co7219 and CoC11336 recorded resistant reaction (0% infection). Twelve clones exhibited moderately resistant reaction (>0 to 10 % infection), five clones registered moderately susceptible reaction (10.1 - 20 % infection), one clone was susceptible (20.1 - 30 % infection), and three clone clones recorded highly susceptible reaction (above 30.1%).

IDM-PP33. Management of Powdery Mildew of Black gram (*Vigna mungo*) caused by *Erysiphe polygoni*

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Powdery mildew caused by *Erysiphe polygoni is* one of the economically important disease in blackgram causing an yield loss of 20 per cent. Field trials were conducted during *Rabi* 2012 – 13 and 2013 – 14 at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam, to evaluate the bioefficiency of plant products, biocontrol agents and fungicides on powdery mildew disease of blackgram. The trials were laid out with twelve treatments including untreated control replicated thrice with a plot size of 4x3m^2 in RBD by using the VBN (Bg) 4 variety. Sowing was taken up during second fortnight of December at a spacing of 30 × 10 cm. The crop was grown under rainfed conditions by adopting all the agronomic practices as per the recommendation of crop production guide, Tamil Nadu except fungicides applications. The first spraying was given after the initial appearance of the disease and further spray was given at 10 days interval. The results showed that all the tested plant products and biocontrol agents were effective against powdery mildew disease. The application of wettable sulphur (0.25%) and carbendazim (0.1%) recorded the lowest per cent disease incidence (PDI) of 15.80 and 19.60 per cent and exerted 66.88 and 58.91 per cent reduction over control respectively. However application of plant product castor oil 1% and after 10 days interval by *Ampelomyces quisqualis* found to be effective on controlling the disease (24.55 PDI). Maximum grain yield (624 kg ha^{-1}) was recorded in the wettable sulphur treatment followed by carbendazim 0.1% treatment (607 kg ha^{-1}) and castor oil with *A. quisqualis* treatment (599 kg ha^{-1}). However highest benefit cost ratio of 2.01:1 was recorded in the castor oil with *A. quisqualis* treatment. The efficacy of the plant product oil and biocontrol agents used in the study is quite effective when applied singly but improved when applied alternatively.

IDM-PP38. Genetic Inheritance of Resistance to Mungbean Yellow Mosaic Virus in Urdbean (*Vigna mungo* (L.) Hepper)

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An investigation was conducted to unravel the inheritance pattern of mungbean yellow mosaic virus (MYMV) in six genetic populations *i.e.* P_1, P_2, F_1, F_2, B_1 and B_2 of five selected cross combinations of urdbean involving three highly resistant donors *viz.,* PU 31, VBN (Bg)4 and VBN (Bg)6 and two susceptible cultigens *viz.,* Co 5 and LBG 623 under field conditions at NPRC, Vamban, a hot spot area for MYMV. The highly susceptible cultivar for MYMV, Co 5 was used as indicator-infector and was also sown all around in the field to increase the MYMV incidence. No insecticide was sprayed in order to maintain the natural white fly population in experimental field. MYMV incidence was recorded on all the plants based on the visual scores on 50th day. It was found in the crosses Co 5 × PU 31 and Co 5 × VBN (Bg)6, the F_2 segregation was governed by digenic duplicate interaction while it was digenic complementary interaction in the cross Co 5 × VBN (Bg)4. In contrast, in the crosses LBG 623 × VBN (Bg)4 and LBG 623 × VBN (Bg)6 the MYMV incidence was governed by digenic

inhibitory interaction. Based on the results of F_2 segregation pattern and backcross ratios in the five selected crosses, it is inferred that a digenic dominant gene was involved in resistance against the MYMV disease.

IDM-PP39. Screening of Chilli Genotypes Against the Fruit Rot Disease caused by *Colletotrichum capsici* (Syd.) Butler & Bisby

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Chilli is one of the important vegetable as well as spice crop of India. It has its unique role in the world diet in its ripe dried form as spice crop because of its astonishing pungency and colour. The fungal pathogen, *Colletotrichum capsici* (Syd.) Butler & Bisby is major constraint in chilli production in tropics and subtropics which causes anthracnose, die back and fruit rot. The fruit rot stage of the disease is most destructive which not only reduces yield but also the quality of the fruit. A study was conducted during *kharif* 2013-14 at Horticulture Research Station Devihosur Haveri (Karnataka) where in 250 genotypes of chilli were screened to know their field resistance against the fruit rot disease at red stage. Out of 250 genotypes, none of the genotypes was found immune to fruit rot in the field. Forty three genotypes *viz,* DCA-102, 102-2, 108, 109-1, 111, 114, 119, 120, 122-1, 122-2, 123, 125-1, 129, 132, 132-1, 134, 134-1, 141, 144, 145, 149-1, 149-2, 161, 170-2, 174, 179-1, 181, 181-1, 184, 185, 192-2, 193-1, 196, 196-1, 198-1, 206, 208, 208-1, 209, 220, Tiwan-1, 13 and 19 were found resistant. One hundred and ten were moderately resistant, sixty-five were moderately susceptible, twenty were susceptible and twelve were highly susceptible.

IDM-PP40. Management of Fruit Rot of Chilli During Drying Using Solar Tunnel Drier

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Red chillies is one of the important spice crops of India. The fruit rot of chilli caused by *Colletotrichum capsici* (Syd.) Butler & Bisby is one of the major constraints in the red chilli production in tropics and subtropics. The fruit rot stage of the disease is most destructive which not only reduces yield but also the quality of the fruit. If the infection to the fruits starts in the field at the time of harvesting, it will be carried to storage. During drying the fruit rot turns severe and deteriorate the quality of the fruits to a greater extent. In this context a study was conducted during *kharif* 2013-14 at Horticulture Research Station Devihosur Haveri (Karnataka) where in chilli fruits after harvest were dried in solar drier, open sun and shade with various treatment combinations and sequences. The results indicated lowest fruit rot (24.2 PDI) in treatment having drying chillies 96 hrs in solar tunnel drier followed by 24 hours of shade. Drying in shade (56.5 PDI) and heap drying (62.4 PDI) recorded highest incidence. Drying chillies 96 hrs in solar tunnel drier followed by 24 hours shade also recorded highest capsaicin (2.46%) among all the treatments.

IDM-PP41. Effect of Micronutrients and Premixture Fungicidal Spray on Powdery Mildew and Leaf Spot Diseases of Pigeonpea

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Pigeonpea (*Cajanus cajan* L. Millsp) is one of the primary grain legume crops grown in India. It serves as the low cost protein for the large section of the people in our country. These crops enrich the soil fertility by fixing atmospheric nitrogen through root nodules and improve the soil structure. Pigeonpea is affected by many diseases. Among these, foliar diseases *viz.,* leaf spot caused by *Cercospora cajani* and powdery mildew caused by *Leveillula taurica* are the important diseases which showed wide spread occurrence in almost all the pigeonpea growing areas of Indian sub-continent. Early infection of these diseases causes premature defoliation which in turn reduces pod setting and grain filling. Therefore an attempt was made to investigate the effect of micronutrient and premixture fungicidal spray on the incidence of powdery mildew and leaf spot. Field experiments were conducted during kharif 2011-2012 and 2012-2013 with seven treatments and three replicationsin RBD at Pulse Breeding Station TNAU, Coimbatore. The treatments comprised of T_1 - $ZnSO_4$ @ 0.5 %, T_2- $FeSO_4$ @ 0.5 %T_3 - $MnSO_4$ @ 0.5 %,T_4 -$CuSO_4$ @ 0.2 %, T_5- Borax @ 0.2%, T_6- $NaMO_3$ @ 0.1% and T_7 – Control. Foliar spraying with different micronutrients was done on 30 days after sowing. Fifteen days after spraying of micronutrients one pre mixture fungicidal spray was given with Carbendazim + Mancozeb@ 1g lit^{-1}. The observations were recorded on the incidence of leaf spot and powdery mildew diseases. The data was recorded on grain yield also. The experimental results revealed that foliar spraying of $MnSO_4$ @ 0.5 % on 30 DAS + Carbendazim + Mancozeb@ 1g lit^{-1} on 45 DAS recorded the lowest leaf spot incidence (8.0PDI) and the highest disease reduction (75.0%). In the control plot, leaf spot incidence of 32 PDI was observed. Foliar spraying of $ZnSO_4$ @ 0.5 % + Carbendazim + Mancozeb@ 1g lit^{-1} on 45 DAS ranked next in reducing the leaf spot incidence by recording 11.8 PDI. The incidence of powdery mildew was found to reduce to 78.0 per cent by foliar spraying of $FeSO_4$ @ 0.5 % + Carbendazim + Mancozeb @ 1g lit^{-1}. This was followed by $ZnSO_4$ and Carbendazim + Mancozeb spray which reduced the powdery mildew incidence by 72 per cent. Significantly higher grain yield were also recorded by $MnSO_4$, $ZnSO_4$ and $FeSO_4$ foliar spray @ 0.5 % along with Carbendazim + Mancozeb@ 1g lit^{-1} as compared to control.

IDM-PP42. Zincated Coir pith for the Management of Dry Root Rot of Pulses

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The pulse crops *viz.,* blackgram, greengram, chickpea and redgram are highly susceptible to soil borne diseases. Experiments were conducted with the bio inoculant *Trichoderma viride* and composted zincated coir piths 5 t ha^{-1} to manage the dry root rot of pulses. The coir pith was zincated individually with 25, 20, 15 and 10 kg of zinc sulphate ha^{-1} and was basally applied to the soil. The coir pith compost zincated at 25, 20 and 15 kg ha^{-1} were on par in managing the root rot disease of greengram, blackgram and chickpea .Hence the minimum dose of 15 kg zinc sulphate along with 5 t composted coir pith has been recommended for the effective management of root rot. The cost of transporting and composting of coir pith adds on to the cost of zincated coirpith. Hence the CB ratio is comparatively less but the zincated coirpith chelates the zinc and increased the availability of zinc to the plants and hence the dose of zinc in the composted coir pith has been reduced for the management of root rot disease. This technology is feasible in the coconut growing areas where coir pith is freely

available More over by applying the zincated coirpith the texture of the soil and the water holding capacity is improved which is a beneficial effect to the rainfed crops**.** Zincated coir pith significantly increased defense related protein *viz.,* peroxidase, polyphenoloxidase phenols, unoxidised auxin content and also increased the seed protein content .The cation exchange capacity was also estimated as it plays an important role in the absorption of nutrients which helps in increasing the vigour of plants. There was increase in the CEC level from 19.00 (control) to 22.67 m.e 100 g^{-1} in the zinc sulphate applied roots of blackgram. The intricate relationship of the plant's nutritional status with plant pathogens, the abiotic environment and organisms in the environment is dynamic and the severity of most diseases can be greatly decreased by proper nutrient management. Knowledge of the relationship of plant nutrition to disease provides a basis for reducing disease severity in intense as well as integrated crop production systems.

IDM-PP46. Integrated Management of Turmeric Rhizome Rot in Salem districts of Tamil Nadu

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Turmeric (*Curcuma longa*) an important rhizomatous spice crop being cultivated in Salem district, in an area of nearly 13684 ha. It is affected by some diseases of which rhizome rot disease caused by *Pythium* sp. is most important. Rhizome rot incited by *Pythium aphanidermatum* is the destructive disease causing considerable damage and reduces yield and quality of rhizomes. Use of antagonistic microbes to manage the diseases replaces the chemicals and protects the environment from toxic hazards. A field trial was conducted to test the efficacy of biocontrol agents against rhizome rot of turmeric during kharif 2013-2014. The treatments imposed were TO1 - Farmers practice (Application of Farmyard manure and Carbendazim drenching @ 0.3%),TO2 -1. Rhizome treatment with *Trichoderma harzianum* IISR-P26 + *Pseudomonas fluorescens* IISR-6 @ 10 g kg^{-1} of rhizome. 2. Soil application of *Trichoderma harzianum* IISR-P26 + *Pseudomonas fluorescens* IISR-6 @ 10 g kg^{-1} of FYM at first earthing up operation (IISR, Calicut), TO3 - 1. Rhizome treatment with metalaxyl @ 2gm lt^{-1} + *Pseudomonas fluorescens* @ 10 g lt^{-1} (30 min. dipping). 2. Soil application with 0.2% Pseudomonas (90 DAP) 3. Foliar spray with mancozeb + carbendazim @2gm lt^{-1} (120 DAP), 4. Tebuconazole @ 0.1 % on 150 DAP (TNAU(SWC),2011). The results revealed that the combination of biocontrol agents application and fungicides reduced the disease incidence compared to control. He saved 2 sprayings of fungicides for the crop and got yield about 24 tonnes of rhizomes on an average with net income of Rs. 3,00,000 ha^{-1}, gross cost of Rs. 1,40,000, gross return of Rs. 4,40,000 and BC ratio of 3.14 in one hectare of area. Rhizome treatment with metalaxyl and soil application with biocontrol agents and application of fungicides like mancozeb, tebuconazole at 150 DAP

IDM-PP-57. Integrated Management of Turcicum Leaf Blight of Maize (*Zea mays* L.)

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Maize is an important staple food crop of the world and turcicum leaf blight is one of the most important disease in maize growing areas. Integrated approach is the novel idea to manage crop diseases as it involve minimum fungicidal load in nature. The present study was undertaken to evaluate the efficacy of IDM module against turcicum leaf blight. The experiment was conducted under irrigated, black soil conditions. Kohinoor Variety was sown. Seven treatments including control were imposed, Seed treatment with carboxin 200 FF 2 ml kg^{-1} seed and 2 sprays of 0.25% mancozeb at 40 and 50 days after sowing, Seed treatment with carboxin 200 FF 2 ml kg^{-1} seed and 2 sprays of 3% nimbicidin at 40 and 50 DAS, Seed treatment with *Trichoderma harzianum* 6g kg^{-1} seed and 2 sprays 0.25% mancozeb at 40 and 50 DAS, Seed treatment with *T. harzianum* 6g kg^{-1} seed and 2 sprays of 3% nimbicidin at 40 and 50 DAS, Seed treatment with thiram @ 2g kg^{-1} seed and 2 sprays of 0.25% mancozeb at 40 to 50 DAS, Seed treatment with thiram @ 2 g kg^{-1} seed and 2 sprays of 3% nimbicidin at 40 and 50 DAS and control. Significantly the lowest PDI (25.66%) and the maximum grain yield (65.48 q ha^{-1}) was recorded in treatment Seed treatment with carboxin (2 ml kg^{-1}) and two sprays of mancozeb (0.25%) at 40 and 50 DAS which is statistically on par with the treatment Seed treatment with *T. harzianum* (6 g kg^{-1}) and two spray of mancozeb (0.25%) as compared control where in it recorded the highest PDI (61.88%) and the lowest grain yield (54.88 q ha^{-1}).

Session 8. Regulatory and Policy Issues

RPI-PP1. New Record of Grain smut (*Ustilago panici-frumentacei)* of Indian Barnyard millet of Tamil Nadu in India

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Grains of Indian Barnyard millet (*Echinochloa frumentacea* (Roxb.) Link) has 10.5% protein, 3.6% fat, 68.8% carbohydrate and 398 kcal 100 g^{-1} energy. The total dietary fibre content is high (12.6%) including soluble (4.2%) and insoluble (8.4%) fractions. Low glycemic index in the grains both dehulled (50.0) and dehulled and heat treated (41.7) is recorded. The feeding intervention of 28 days revealed a significant reduction in glucose (139.2 to 131.1 mg dl^{-1}), LDL-C (from 167.7 to 162.9 mg dl^{-1}), VLDL-C (from 24.0 to 23.2 mg dl^{-1}), ratio of TC: HDL (from 4.7 to 4.6) and LDL and has emerged as very important dual purpose food and fodder crop (Roopashree Ugare et al., 2014). It is grown in many countries like, India, China, Japan, Malaysia, East Indies, Africa and United States of America. In India, the crop is grown in Madhya Pradesh, Uttarakhand, Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra and Bihar. It is grown in diverse soils, varying rainfall regimes and in areas widely differing in thermo and photoperiods. Barnyard millet is grown under organic agriculture and quite indispensable to rainfed, tribal and hill agriculture where crop substitution is difficult. To cope up with the demand for this crop to ensure food and nutritional security it is necessary to enhance production and productivity of this crop not only for people living in harsh and difficult terrains, but also in other areas. Currently the Government of India is interested in promoting this millet under Millet Mission and farmers are encouraged to grow barnyard millet. During Khrif and Rabi seasons 2013-14 the crop was raised at Dryland Agricultural Research Station, Chettinad and was heavily infected with smuts for the first time. Symptoms appeared on the ears of barnyard millet but not all the grains are attacked. The affected ones are double the size of the healthy grains and they are filled with pulveralent spore masses lead to heavy yield loss and quality. The sori enlarge the ovaries into 2-3 fold of their normal size covered by the seed coat, opening at maturity by an apical pore, seed coat

rendered hairy, spore masses pulverulent, deep black brown epispore, thick, minutely echinulated. Spores are spherical, sub spherical, buck thorn brown 6-10µ diam. The morphological characteristic fit/match the descriptions of the smut fungus of *Ustilago panici -frumentacei* (Bredford 1975). A herbarium sample was deposited at the Herbarium cryptogamae Indiae Orientalis (HCIO),Division of Plant Pathology, IARI New Delhi, India (HCIO/2013/7) and thus the new disease of grain smut of Indian barnyard millet is noticed in TamilNadu and reported for the first time.

RPI-PP2. Root (wilt) Disease of Coconut – A Preliminary Survey in Tamil Nadu

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Root (wilt) disease (RWD) caused by phytoplasma is one of the most serious problems in coconut plantations. The major symptoms of this disease are leaves showing wilting, drooping and flaccidity; ribbing, paling/yellowing and necrosis of leaflets. The disease was transmitted by plant hoppers (*Proutista moesta*) and lace wing bug (*Stephanitis typica*). Leaf rot disease is also associated with RWD and the unopened pale yellow leaflets of spindle leaves are more susceptible to leaf rot causing pathogens. The intensity of disease was very severe in southern parts of Kerala and spreads to the adjoining district of Tamil Nadu state. In Tamil Nadu, root (wilt) disease incidence was reported in Theni, Tirunelveli, Kanyakumari, Dindigul and Coimbatore districts. A preliminary survey was undertaken by CRS, (AICRP on Palms) to know the level of root (wilt) disease incidence in different coconut growing districts of Tamil Nadu. Maximum disease incidence was observed in the Cumbum (Theni), Thenkasi (Tirunelveli), Thiruvattar (Kanyakumari) and Pollachi (Coimbatore) blocks. Due to root (wilt) disease several farmers are replacing coconut plantation with banana and grapes in Theni and rubber and banana in Kanyakumari districts. Since, RWD is a non-lethal debilitating disease; integrated strategies for the management of disease affected palms suggested by CPCRI, Regional Station, Kayamkulam are being recommended. In order to prevent further spread of the disease, several awareness campaigns were conducted in the disease prevalent locations and nearby areas and the farmers are periodically advised to remove severely affected palms with replanting of disease resistant/tolerant varieties/hybrids developed at CPCRI, Kasaragod.

Session 9: Food Mycology

FML-PP4. Effect of Botanicals on Pathogens Infecting Spawn of *Pleurotussajor-caju*

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Usually spawn of mushroom are infected by several fungal pathogens. Here botanicals were tested against pathogens infecting *Pleurotussajor-caju* under *in vitro* condition. Common contaminants such as *Trichoderma harzianum*, *Aspergillus niger* and *Aspergillus flavus* were encountered on spawn production. Six different botanicals namely neem (*Azadirachta indica*), garlic (*Allium sativum*), datura (*Datura stramonium*), ginger (*Zingiber officinalis*), turmeric (*Curcuma longa*) and tulsi (*Ocimum sanctum*) were tested at 5 and 10 per cent concentrations to test their efficacy against grain spawn infecting pathogens. Neem extract showed highest inhibition efficacy against all three pathogens with 43.33%, 55% and 45.5% per cent inhibition respectively and it also showed lowest inhibition 21.85% against *P. sajor-caju.* But it could be seen that the least inhibition was exhibited by tulsi with 23.33%, 19.26% and 19.45% mean inhibition of mycelial growth of pathogens *A. niger*, *T. harzianum* and *A. flavus* respectively. The least inhibition of mycelial growth of *P. sajor-caju* was exhibited by tulsi 18.15%.

FML-PP5. Hypolipidemic Effect of Oyster Mushroom

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Mushrooms have been used as food supplement from times immemorial not only for their flavour, aroma and nutritive values but also for their medicinal properties. Oyster mushroom is extremely delicious as well as conferring various health giving properties and benefits. Among the Oyster mushroom varieties, *Pleurotus ostreatus* as health promoter and environmental restorer is gaining more importance as compared to other medicinal mushrooms. The chemical nature of the bioactive compounds present in this mushroom includes: polysaccharides, lipopolysaccharides, proteins, peptides, glycoproteins, nucleosides, triterpenoids, lectins, lipids and their derivatives. Mevnolin (monacolin K, Lovastatin) the lead compound for the statin detected in this species which may involved in decreasing the activity of 3-hydroxy-3-methylglutarly coenzyme A (HMG-CoA) reductase enzyme which is the rate-limiting enzyme of cholesterol biosynthesis. It also contain water-soluble gel-forming substances, including β-1,3-D-glucan and pectin, which bind to bile acids, thereby inhibiting cholesterol-bile micelle formation and cholesterol absorption. Hence feeding oyster mushrooms may involve suppression of endogenous cholesterol biosynthesis by inhibiting HMG-CoA reductase activity and it could be recommended as a natural cholesterol lowering substance.

FML-PP8. Evaluation of High Yielding Varieties / Strains of Oyster Mushroom (*Pleurotus species)* under Haryana Conditions

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The six varieties / strains of *Pleurotus* species were cultivated under natural mushroom house conditions during Sept.-Oct., 2012 (temp > 20 C) and Jan.– Feb. 2013 (temp < 20 C) using chemically treated wheat straw as substrate. During Sept.-Oct., 2012, the P-04 strain of oyster mushroom gave significantly higher yield (650.0 g kg^{-1} substrate) followed by P-02, P-05, P-03, P- 06 and P-01. No significant differences were observed among the six varieties / strains of *Pleurotus* species regarding spawn run, pin head appearance and harvesting period. During Jan.–Feb. 2013, the strains evaluated differed significantly among themselves regarding the time taken for spawn run, 2nd, 3rd flush and yield. On the other hand differences were observed for pinhead formation and time taken for 1st flush but these were not significant. The P-02 variety of oyster mushroom gave the highest yield (679.3 g kg^{-1} substrate) followed by P-04, P-01, P-05, P-03 and P-06. Spawn

growth was earliest in case of P-03 and P-01 strain while it was slowest in case of P-04 strains. Incidence of green mould, inky caps and mushroom flies were recorded in all the evaluated strains.

FML-PP9. Studies on Oyster Mushroom (*Pleurotus-citrinopileatus*) Cultivation under Different Substrates

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Mushroom cultivation is becoming a popular and profitable enterprise. The Socio economics status of small and marginal farmer can be improved by cultivation of mushroom and marketing locally. The various agricultural waste are accumulating and pose environmental pollutions. In order to utilize the locally available agricultural waste material, mushroom cultivation would be an alternative. So that the waste material could be effectively recycled. Therefore an experiment was conducted to evaluate different agricultural wastes namely corn cob, sugarcane bagasse, sugarcane trash, hariyali leaves, broken groundnut shell, banana leaves including paddy straw. The results revealed that paddy straw is the best substrate for the cultivation of edible mushroom (*Pleurotus citrinopileatus)* and recorded 118% biological efficiency. Among the other sources broken groundnut shell, sugarcane bagasse, corn cob and sugarcane trash and banana leaves showed 109.2, 101.5, 99.7, 97.3 and 42.3 % (Biological efficiency). However it was seen that banana leaves could not support fruiting of the mushroom probably the banana leaves could not have enough cellulose nor might the water adsorption capacity have been very low for the growth of the fungus. Hence, it is concluded that paddy straw followed by broken groundnut shell are the best sources to the support mushroom cultivation.

FML-PP11. The Mycelium as Food

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The hope that microbes could provide a mean of solving the world food shortage and fungi are an ideal food because they have a fairly high content of protein (20-30%) which contain all the amino acids which are essential to human and animal nutrition. Fungal biomass is easily digested, the chitinous wall provides a source of dietary fibre and also contain B-Vitamins in addition characteristically low in fat. An extremely important attributes of all fungal food is that it is virtually free of cholesterol. Consequently, fungal protein food competes successfully with animal protein foods on health grounds. In principle, fungal food can be produced readily using waste products as substrate; fungal food should also be able to compete successfully on grounds of primary cost. Yeasts play a dominant role where biotechnology is applied to food industry being essential in brewing and bread making and important sources of single cell protein and dietary supplement. Judging from archaeological and similar finds, mushroom, toad tools and bracket fungi have been used since before recorded history for both food and medicinal purpose. European and Asian ancestors held fungal products in such high esteem that they were necessary accessories for daily life. Today, alcohol and citric acid are the world's most important fungal metabolites in terms of production volume, although, pennicillin can still lay claim to be the most important in social and medical terms. So antibiotics obtained from fungi have high clinical use like *penicillium cephalosporin* and fusidic and griseofulvin. Today, the emphasis has moved towards the use of wastes as substrate for microbial biomass production for animal feed and towards production of novel 'health' food for sale in advance economics. So keeping in view of the growing population increased demand on food grains for quantity and quality and deaths due to hunger in countries like Africa etc., the fungal mycelium can show as viable alternative path for food security of the world.

FML-PP12. Evaluation of Bioactive Compounds of *Ophiocordyceps sinensis* [Berk.] Sacc. Against *Fusarium* spp.

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Chinese caterpillar fungus *Ophiocordyceps sinensis* [Berk.] Sacc., is an entomopathogenic fungus, parasitizing the larvae of himalayan bat moth, *Hepialis armoricanus*. Several bioactive molecules and alkaloids of this fungus and its products are known to have greater stakehold with health care industry worldwide. Studies were undertaken to extract and evaluate the bioactive compounds of *O. sinensis* against *Fusarium* spp. Secondary metabolite composite obtained on 15d old culture at 500ppm showed significant level of inhibition of *F. o.* f. sp. *cubense* and *F. o.* f. sp. *lycopersici* (45.55 per cent and 49.63 per cent as against control) in a well diffusion assay. Different solvents *viz.*, methanol, ethanol, hexane, butanol, ethyl acetate, petroleum ether, acetone, acetonitrile, chloroform and aqueous phase have been used for the extraction of bioactive compounds from *O. sinensis*. Ethyl acetate fraction of the culture filtrate condensate showed the maximum mycelial inhibition of *F. o.* f. sp. cubense and *F. o.* f. sp. *lycopersici* (49.00 and 51.48 per cent respectively). GC-MS analysis of ethyl acetate fraction of cell free culture filtrate (CFC) indicated the presence of thirteen different compounds *viz.,* Ethyne; 2-tert-Butyl-4-isopropyl-5-methylphenol; 1-Heptadecanol; 1,2-Benzenedicarboxylic acid,bis (2-methylpropyl) ester; 1,4-diaza-2,5-dioxo-3-isobutyl bicyclo [4.3.0] nonane; (R)-(-)-2-(N-Cyclohexyl-N-methylamino)-2'-(trifluoromethanesulfonyloxy)-1, 1'-binaphthyl; 1H-Imidazole-4-carbonitrile; 3, 5-Dimethyl-1, 2 ,4 thiadiazole; Ergotamine; Pyrrolo [1, 2-a] pyrazine-1, 4-dione; Phthalic acid, di (2-propylpentyl) ester; N-Methyl-2-Propyl-5-Butylpiperidine; Cycloheptadecanone and 1-Propyl-1-[(tertbutyldimethylsilyl)oxy] perfloroheptene. Out of these, 1H-Imidazole-4-carbonitrile; 3,5- Dimethyl- 1, 2, 4-thiadiazole are reported to have antifungal activities.

FML-PP16. Empowerment of Women through Mushroom Cultivation and Value Addition of Mushrooms

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Mushrooms are the richest source of protein and are suitable for human consumption. They are fleshy fruiting bodies of higher fungi. Mushrooms are also used in medicine traditionally, which may help to prevent heart diseases, diabetes, cancer and obesity. Mushroom cultivation is a growing agro based industry with an annual increase of 7 % in production and productivity. Agricultural waste *viz.*, paddy straw, maize cob waste, cumbu stalks and

sugarcane trashes are used to cultivate oyster and milky mushrooms. Paddy crop is the main crop of Madurai district, after harvesting paddy straw is utilized for cultivating oyster and milky mushrooms. Farm women are interested in venturing into mushroom cultivating both during off and cropping seasons. Mushrooms have more than 90 per cent moisture. Since it is highly perishable it should be sold within 24 hours of harvest. Because of its perishable nature, mushroom production faces the problem of glut during surplus period thereby fetching a low price. For women who enter into this venture knowledge on both mushroom cultivation and postharvest technologies are required. Hence in this project, oyster and milky mushroom cultivation techniques, postharvest technology, and value addition of mushrooms were given to women groups in the villages of Vadipatti and Thirumangalam blocks of Madurai district of Tamil Nadu during 2011 to 2013. Awareness on mushroom cultivation and postharvest technology of mushrooms were given to 800 women from Vadipatti and 800 women from Thirumangalam blocks. Training and demonstration on oyster and milky mushroom cultivation techniques were given to 80 participants from Vadipatti and Thirumangalam blocks. Hands on training and value addition of mushrooms were conducted to the 80 women from Vadipatti and Thirumangalam blocks. Fifteen women beneficiaries from Vadipattiblock and twelve women from Thirumangalam block were started mushroom cultivation on commercial basis by learning the technologies of mushroom cultivation and postharvest technologies the problem faced by mushroom growers is eliminated. Eventually the growers can get good market price for their mushroom. Mushrooms can be preserved for long term and short term period and mushroom industry can be done in more profitably. Standard of living of women can be improved and they will have job and additional income during off season. Above all, the women beneficiaries from Vadipatti and Thirumangalam blocks were empowered to earn their bread and keep their family sufficient.

FML-PP17. Medicinal Value of Mushrooms

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Mushrooms, the present day's best known Nutraceuticals. They are called so because of their culinary values which possess high quality proteins, vitamins, fibers and many medicinal properties. *Ganoderma* has been considered as king of medicinal mushroom producing filamentous fungi followed by *Lentinula* and others including *Pleurotus*. Extracts of Ganoderma species have been very useful in the treatment of human ailments right from microbial infections to viral infections including HIV due to its immunopotentiation and immunomodulatory properties; treatment of malignancies such as lung cancer, cardiac failure etc. *Lentinula edodes*, a sub-tropical mushroom of Asian origin is useful in the treatment of various human ailments such as cancer, high cholesterol level, high blood pressure, blood sugar etc. Fruiting bodies as well as active mycelia of *Pleurotus* species also possess a number of therapeutic properties like anti-inflammatory, immunostimulatory and immunomodulatory anticancer. Hot water extracted glucans of *Agaricus bisporus* were effective ROS generators when associated with polyphenolic compounds. The chemical nature of the bioactive compounds present in this mushroom includes: polysaccharides, lipopolysaccharides, proteins, peptides, glycoproteins, nucleosides, triterpenoids, lectins, lipids and their derivatives. Discarded mushroom bed can be utilized for production of various bioactive compounds like Carboxy Methyl Cellulose (CMC) and industrial enzymes such as *Schizophyllum commune, Fomitopsis feei, Trametes gibbosa,* and *Trametes elegans.*

Session 10. Extension Plant Pathology

EPP-PP4. Effect of Spent Mushroom Substrate (SMS) on the Multiplication of *Trichoderma viride*

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Trichoderma viride, a contaminant in substrates and compost used for mushroom growing is a promising biocontrol organism used for the management of several of the soil borne plant pathogens. In one of the study which involved in an outdoor system of paddy straw mushroom cultivation showed that artificial inoculation of spent mushroom substrate with *T. viride* at the rate of 5.8×10^8 cfu ml^{-1} was found to increase the total cfu of *T. viride* upto 129.96×10^6 over a period of 30 days as compared to untreated control. Similarly, biodegraded maize stalks and wheat straw previously used for the cultivation of paddy straw mushroom also encouraged the multiplication of *T. viride*. In field trials application of paddy straw spent mushroom substrate fortified with *T. viride* at the rate of 500 ml 20 kg^{-1} of substrate has helped in reduction of both pre emergence (38.5%) and post emergence (39.3%) damping off in tomato respectively. This treatment was also found to increase the seedling growth and biomass production as compared to control. Having been degraded by the mushroom fungus the nutrient for the succeeding biocontrol organism *Viz*., *T. viride* would have present in a more readily available form. Hence, it is clear that partially cellulose rich paddy straw mushroom spent compost could be used as on effective carrier material for the delivering of *T. viride.* More over even the contaminated mushroom bed recycled more effectively.

EPP-PP5. Role of Plant Physician in Food Security

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A Plant pathologist is a professional who specialized in plant health much like a physician specializes in human health in order to maintain plant healthy. It gives the credit to plant pathologists that there has been no famine after the great Irish famine 1845 and Bengal famine 1942. Plant pathologist has great role in green revolution and going to perform better role in next green revolution also. Diagnose disease rapidly, strengthen the host by genetic modifications, suggests suitable management practices apart from providing required known-how to the need about plant disease. Plant pathologist play vital role for research and teaching at universities, extension activities to farmers for agriculture and horticulture departments. Plant pathologist also show new path for future food security by introducing beneficial edible fungi like mushrooms as nutritional alternative to hunger, medicine. His role in quarantine, ecofriendly approaches for disease management adding a lot for increased food production and sustainability. Plan pathologists integrate and use information from many branches of science to develop insights in disease development and disease control. Plant pathologists are walking around the world to develop new, more efficient and environmentally safe/suitable strategies to

manage plant health. The scope of future plant physician in reality lies in solving not only the emerging problems of plant disease and increase food production, but also to benefit mankind.

Award Session-2014: PP Singhal Memorial Pesticides Industries Award

PSMPIA-1 (Winner). Synthesis and antifungal efficacy of pH regulated Cu-chitosan based biocompatible nanoparticles against pathogenic fungi

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The pH regulated Cu-chitosan nanoparticles were synthesized and evaluated for their growth promotory and antifungal efficacy in tomato (*Solanum lycopersicum* Mill). Physico-chemical characterizations of the developed Cu-chitosan nanoparticles were carried out by DLS, FTIR, TEM, SEM-EDS, and AAS. The study highlighted the stability and porous nature of Cu-chitosan nanoparticles. Laboratory synthesized nanoparticles showed substantial growth promotory effect on tomato seed germination, seedling length, fresh and dry weight at 0.08, 0.10, and 0.12% level. At 0.12% concentration, these nanoparticles caused 70.5 and 73.5% inhibition of mycelia growth and 61.5 and 83.0% inhibition of spore germination in *A. Solani* and *F. oxysporum*, respectively in an *in-vitro* model. In pot experiments, 0.12% concentration of Cu-chitosan nanoparticles was found most effective in percentage efficacy of disease control (PEDC) in tomato plants with the values of 87.7% in early blight and 61.1% in Fusarium wilt. The overall results confirm the significant growth promotory as well as antifungal capabilities of Cu-chitosan nanoparticles. Our model demonstrated the synthesis of pH regulated Cu-chitosan nanoparticles and open up the possibility to use against fungal disease at field level for other important crops. We also demonstrated that upon infection of fungi Cu ions releases from nanomaterials and act on fungi and increase the antifungal efficacy of developed biocompatible nanomaterials. Further, developed porous nanomaterials could be exploited as smart delivery system for other antifungal compounds to enhance the efficacy of fungicides.

PPSMPIA-02 (Runner). Role of Seed in the Epiphytology of MYMV in Mungbean

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Yellow Mosaic Disease of the mungbean is caused by a variant MYMV-Vig: IN: NVS: Mg: 2012 in the South Gujarat. The disease spread through its insect vector whitefly (*Bemisia tabaci*, Gennadius) and appeared with the emergence of first trifoliate leaf which rapidly covers the entire field under the suitable environmental condition. In Navsari district, 08-12 per cent incidence of MYMV at the first trifoliate leaf, 16-20 per cent incidence at the second trifoliate leaf stage, 41-55 per cent incidence at the flowering stage and 65-76 per cent incidence at the maturity has been observed. Though, none of the whitefly transmitted begomovirus have been reported to be the seed transmitted, the spreading pattern of the disease was almost found similar to the diseases caused by seed and vector borne pathogens in the congenial environmental conditions. During the present investigation typical yellowing could be observed on all the green coloured aerial parts of the plants including the pod and seeds. PCR of the yellow coloured pod and seeds by using the begomovirus specific primer showed the presence of virus. Presence of the virus from the whole seed after the drying could also be detected. Seed coat, cotyledon and embryonic axis of such yellow coloured seed after the drying were separated carefully without causing injury and presence of virus could be confirmed by the PCR in the seed coat and cotyledon. Virus could not be detected in the embryonic axis. Callus from the infected cotyledon was developed on the MS media which also showed the presence of virus. Since the virus was not present in the embryo, it was not seed transmitted. During the field experimentation it was observed that the germination of the mungbean was epigeal and the entire seed came out of the soil rupturing the crust of the soil. Cotyledon became succulent after imbibitions of water and could be penetrated by the stylet of the whitefly. Whiteflies in some cases fed on the seed coat and acquired the virus. When these viruliferous whiteflies fed on the cotyledonary or other leaves, it releases the virus in the leaf infecting the plant. The result indicated that the virus present in the seed served as a source of primary inoculum for the initiation of the disease in the population which rapidly spread in the entire field depending upon the vector population. Since the virus does not transfer from seeds to the plants, it is not a seed transmitted virus, however, seed found play significant role in the epiphytology of the disease. Whiteflies could be seen in the field throughout the crop period. Maximum numbers of whiteflies (148) were trapped at North East direction. Whereas 128, 123 and 123 whiteflies were observed in North West, South East, South West direction respectively during crop period in the summer 2010. Average number of whitefly on 10 plants ranged from 0 to 2.5. Maximum temperature and morning relative humidity has revealed significantly effect on development of whitefly population on plant. Epiphytological studies indicated positive correlation between maximum temperature, average temperature, relative humidity and whitefly population and also minimum temperature, average temperature, afternoon relative humidity, average relative humidity, wind velocity and MYMV incidence. Positive correlation has also been observed between whitefly population and MYMV incidence. Field experimentation with the different combination of chemicals for the management of whiteflies showed that the seed treatment with the Thiomethoxam 30 % FS @ 10ml 5 kg^{-1} could also be significantly manage the disease. However, the best treatment was seed treatment with the Thiomethoxam 30 % FS @ 10ml 5 kg^{-1} seeds before sowing followed by application of Acetamaprid 20 % SP at 20 days after sowing (DAS), Trizophos 40 % EC at 35 DAS, Acephate 75 % SP 1.0 g lit^{-1} at 50 DAS gave maximum yield over control.

PPSMPIA-03. Integrated Approach to Management of Brown Root Rot Disease of Tea (*Camellia sinensis* (L) O. Kuntze)

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Tea is a long duration perennial crop and is prone to attacks by several pathogens. Diseases lead to 10-15% crop loss annually. Brown root rot disease caused, by *Fomes lamoensis* (Murr.) Sacc. and Trott, has been identified as the primary disease of tea roots. Indiscriminate uses of chemicals have adverse effect on the environment. An integrated approach, therefore, is required to control this disease for sustainability in tea cultivation. The present study involves use of five systemic fungicides, which tested against the pathogen. Propiconazole and hexaconazole, out of five fungicides used, inhibited 98.51 % and 100% growth of the pathogen at 100 mg L^{-1} concentration. Bavistin, roko and ektino, however, respectively resulted in 12.58%, 5.18 %, and 1.48 % inhibition. *Bacillus cereus* and *Trichoderma harzianum* evaluated and efficiently inhibited *F. lamoensis in vitro.* The zone of inhibition varied from 10 to 15 mm in case of *B. cereus* and 10 to 16 mm in case of *T. harzianum.* The nursery experiment exhibited that tea plants at 120 days after the treatment with the pathogen showed 76.66% disease incidence. The reduction in disease incidence (23.33% and 13.25% respectively) observed when the plants treated with biocontrol agents i.e. *B. cereus* and *T. harzianum*. In case of chemically treated plants, only 10% disease incidence observed. The results of the nursery experiment showed that both the chemicals and biocontrol agents significantly affected incidence of disease and promoted growth measured in terms of shoot height, root length, number of new leaves, lateral branches, biomass of shoot and root over the control.

PPSMPIA-04. Screening of New Fungicide SAAF (Carbendazim 12% + Mancozeb 63%) for its Bioefficacy Against Chilli Leaf Spot Incited by *Cercospora capsici*

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Chilli (*Capsicum annuum* L.) belongs to the family solanaceae and is a variable red pepper species comprising of cultivated and wild accessions that differ in many yield and characters such as fruit shape, fruit weight, fruit colour, pungency, plant height, and maturity. Chilli leaf spot *Cercospora capsici* is the most destructive and explosive diseases of chilli and incur heavy losses. In the event of identifying new fungicide molecules for the management of this disease, SAAF tried in the farmers' filed at Coimbatore district of Tamil Nadu. All the treatments were more effective in comparison to untreated control. However, after 10th day of 2nd application the foliar spraying of SAAF @ 1000 g ha^{-1} provided the maximum control (PDI 3.52) of the leaf spot disease which was on par with SAAF at the rate of 750 g ha^{-1} (PDI 3.87). Both these treatments were significantly superior as compared to rest. The spraying of the Carbendazim 50% WP @ 300 g ha^{-1}, Mancozeb 75% WP @ 2000 g ha^{-1} and SAAF chemical @ 500 g ha^{-1} proved next best effective treatments differing insignificantly to each other with PDI of 5.57, 6.31 and 6.76 respectively. Hexaconazole 2% SC @ 3000 ml ha^{-1} provided least control of leaf spot disease (PDI 9.45). The data on terminal disease severity index (TDI) also gave the same trend and controlled the disease up to the extent of 76.50 – 75.90 % by two superior dosages of SAAF @ 1000 and 750 g ha^{-1}. The highest Cost benefit ratio of 1:5.04 and 1:5.03 was obtained in the treatments of SAAF@ 1000g ha^{-1} and SAAF @ 750 g ha^{-1}, respectively. The ratio of 1: 2.84 observed in untreated control.

PPSMPIA-05. Proteome Analysis in Rice Plants Treated with Fungicide Premixture (Fenoxanil 5% and Isoprothiolane 30% EC) Against Blast Disease and Assessing their Bioefficacy and Phytotoxicity

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Rice blast is the most serious disease in major rice-growing regions of the world. Currently, this disease was managed mostly by application of systemic fungicides. In this connection, a field experiment was conducted for two seasons in the year 2012 and 2013 to evaluate the newer premixture fungicide (Fenoxanil 5% and Isoprothiolane 30% EC), Fenoxil 20% SC, Isoprothiolane 40% SC and Tricylazole 75% WP with different concentrations against rice blast disease. Among these fungicides, application of premixture molecule 35 % EC at the concentration of 1000 ml ha^{-1} significantly reduced blast incidence and increased the grain yield followed by the treatments tricylazole under glass house and field conditions. Analysis of defense molecules revealed that more accumulation of phenylalanine ammonia-lyase (PAL), Peroxidase (PO) and Poly Phenol Oxidase (PPO) were observed in premixture fungicide 35% EC (Fenoxanil 5% and Isoprothiolane 30% EC) treated rice plants challenged with blast pathogen. Two-dimensional polyacrylamide gel electrophoresis strategy was adopted to identify the fungicide mediated differentially expressed proteins and elucidate the molecular responses in three way interaction of fungicide-host-*M. oryzae* through protein profiling. The result revealed that totally 25 proteins spots were differentially expressed in rice plants under various treatments. Among the 25 proteins, eleven proteins were altered by the pathogen for successful disease development but it was arrested upon treatment with interaction of fungicide premixture + pathogen treatments. In additions 14 proteins were up regulated in fungicide treated rice plants. However three proteins were newly expressed in fungicide alone applied plants. These results suggest that application of fungicide premixture significantly expressed the proteins in rice plants there by induction the resistance were occurred against blast disease. Analysis of phytotoxicity in fungicide premixture treated rice plants showed that there was no phytotoxic symptoms *viz.,* leaf tip injury, leaf surface injury, vein clearing, necrosis, epinasty and hyponasty were observed in all the concentration. Hence this study revealed that the performance of fungicide premixture 35 % EC (Fenoxanil 5% and Isoprothiolane 30% EC) were highly effective against blast diseases and enhanced rice grain yield. From this study, proteomic strategy unravels the fungicide mediated mechanism of resistance against rice blast disease.

PPSMPIA-06. Occurrence of Weather Factors for Diseases of Major Rainfed Crops and Management with Fungicides

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The dry land crop diseases mainly affected by environmental changes during crop periods for 2011-2014. The extent of disease development, however, depends on the combination of weather conditions during the growing season. Whether a plant disease causes significant losses often depends on how local or seasonal

climatic conditions match the requirements for development, dispersion, and infection by the pathogen. The environment viz., Temperature, Relative humidity and Rainfall in rainfed farming community and management with different fungicidal application in dry land crops to minimize the yield loses. Epidemiological factors for in dry conditions 1) Maximum and Minimum Temperature, 2) Relative humidity and Heavy rainfall and 3) Diseases incidence and Diseases severity of rainfed crops followed by application of fungicides with effective management of Rainfed rice, Groundnut, Ragi, Black gram, Kudiraivali and Tenai in dry land conditions of Sivagangai District

Smt Guman Devi Verma Memorial Best Woman Scientist Award

SGDVMBWSA-1 (Winner). The Influence of Arbuscular Mycorrhizal Fungi on the Growth of *Psidium guajava* and *Pongamia pinnata*

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Psidium guajava L. and *Pongamia pinnata (*L.) Pierre. are two important plants in the field of traditional medicine. Besides its food and nutritional values, *P.guajava* is known for its medicinal properties like it is used in epilepsy, nephritis, jaundice etc. The *P.pinnata* is used in rheumatism, child birth etc. During our study on diversity of AM Fungi in Kaziranga National Park, Assam, *Glomus deserticola*, *Acaulospora scrobiculata* and *Scutellospora pellucida* were found to be the most dominant AMF species and *P.guajava* and *P.pinnata* were two commonly occurring plants there in. The present study, therefore, was conducted to assess the effect of these AMF species on growth of these two economically important plants i.e. *P.guajava* and *P.pinnata* under pot culture experiments. The selected AM fungal spores were mass multiplied by single spore cultures on *Allium cepa*. The plants of *P.guajava* and *P.pinnata* were grown in pots containing sterilized soil and then inocula containing AM fungal spores were applied to them. Different levels of inocula (1/2, 1 and 2N) were used along with a control. The various growth parameters such as height, number of leaves, root length, leaf area and chlorophyll content of leaves and dry biomass of the seedlings were studied. After 12 weeks the mycorrhizal plants had better growth than the controls. Improvement in growth of mycorrhizal plants as compared to control indicated the positive influence of mycorrhization of plants. It was also observed that the plants inoculated with mycorrhizal consortium showed better results than those inoculated with spores from of single species. The findings of this study showed that AMF helps in plant growth, especially, if a combination of AMF species were applied. Hence, we can conclude that the growth of economically important plants can be accentuated by applying a combination of AMF inocula.

SGDVMBWSA-02 (Runner). "Plant Diagnostics" - A Simple Computer Based Interactive Software for Identification and Management of plant diseases

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Diseases of crop plants contribute greatly to yield loss. Some of the diseases are so serious that it wipes out the entire crop within a few days if they are not identified and controlled in time. Hence an early identification and working out of precise recommendations for effective control of the disease is necessary, so that control measures can be quickly communicated for timely action as well as for judicious use of inputs. However, with the availability of computers and the Internet this requirement can be easily met provided suitable software tools are available. One such tool is the "PLANT DIAGNOSTICS" which is a simple PC based interactive software developed using Microsoft Access as back end and Visual Basic (VB) as front end, in order to identify the diseases as well as to give appropriate recommendations for its control. The hierarchical arrangement makes the tool very simple to develop and use and at the same time gives precise recommendations. The user after ascertaining which part of his plant is affected selects a photograph resembling the symptoms of that seen in his field, which is confirmed through confirmatory photographs contained in the second and third level. The recommendations for control based on stage of the crop are found in the fourth level of the hierarchy. Two important inference methods used in this software are forward chaining and backward chaining methods. The flexible design of the system permits several types of knowledge to be easily included at any time. The uniqueness of this software is that it can be developed in any language and also it has voice recording at every step so that even illiterate farmers can use it by just listening to the audio. Hence no subject expertise is needed for using "PLANT DIAGNOSTICS"

SGDVMBWSA-03. Integrated Disease Management Package for Vascular Wilt of Cowpea in Central Travancore Tract of Kerala

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Vascular wilt of cowpea caused by *Fusarium oxysporum* f. sp. *tracheiphilum* identified as the most important disease of the crop resulting in considerable crop loss in Central Travancore Tract of Pathanamthitta district of Kerala. The present study undertaken as part of "State Food Security project" to develop an integrated disease management package with minimal environmental toxicity and residual effect for the management of vascular wilt disease of cowpea in the tract. A survey conducted throughout the district also revealed that vascular wilt is the most important disease of the cowpea in the district. The wilt causing fungus was isolated from infected plants. *In vitro* studies revealed that oats agar medium favoured the maximum growth of the fungus. *Trichoderma viride* (KAU isolate) was efficient in reducing the mycelial growth of *the fungus* by 77.8% *in vitro* whereas *Pseudomonas fluorescence* resulted in 51.1% mycelial growth inhibition of the fungus. Analysis of soil of the region revealed its extremely acidic nature, which reveals the absolute necessity of lime application. Pots and field trialsrevealed that the integrated package includes crop rotation, burning pits 3 weeks before planting, lime application during pit preparation, drenching copper oxy chloride 2 weeks before planting @ 2.5 to 3.0 g litre^{-1} water @ 3 litre pit^{-1}, seed treatment using *Trichoderma* @ 4 g per Kg seed at planting, soil application of *Trichoderma* multiplied in cow dung & neem cake @ 250g per pit, foliar spray/drenching *Pseudomonas* @ 20g per litre water from one month after planting onwards and need based drenching of copper oxy chloride alternated with carbendazim if disease reappears was found to be effective in combating the vascular wilt disease of cowpea**.** Studies conducted to analyse the compatibility of copper oxy chloride and *T. viride* revealed that a concentration of copper oxy chloride @ 2.5 to 3.0 g would not be inhibitory to the growth of the bio control agent, *viz., T. viride*. A

benefit cost ratio of 1.74:1 proves the feasibility of the application of the integrated management package derived because of this study. During the study, two new fungi, *Sclerotium rolfsii* and *Pythium aphanidermatum* infecting cowpea for the first time in the region in a severe form were isolated and identified. In vitro studies prove that *T. viride* was efficient in reducing the mycelial growth of both the fungi appreciably.

SGDVMBWSA-04. A Proteomic Approach to identify *Bacillus subtilis* Induced Defense Related Proteins in Noni Challenged with *Meloidogyne incognita*

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Biopesticidal formulations of naturally occurring beneficial microorganisms are the most promising methods for more rational and safe crop management practices. *Bacillus subtilis* strains are important groups of natural antagonists that produce a broad spectrum of bioactive peptides with great potential for biocontrol of phytopathogens. Surfactin, an exceptional biosurfactant imparts biocidal activity by direct suppression of plant parasitic nematodes. Root knot nematode, *Meloidogyne incognita* is an economically important pathogen of noni, a herbal medicine gaining popularity in India. In this investigation, endophytic strains of *B. subtilis* were isolated from noni plants and tested for their nematicidal activity against root knot nematode, *in vitro*. The genomic DNA of the *Bacillus* strains isolated and amplified by PCR to identify antibiotic genes *surfactin* and *iturin.* The strain Bs 5, with high surfactin and iturin activity found to suppress egg hatching and caused juvenile mortality. Using the 'omic' approaches effort were taken to understand pathogenicity and defence-related genes and proteins expressed during the three way interaction of host, pathogen and biocontrol agent during disease development. Protein profiling done using (2-DE) two-dimensional polyacrylamide gel electrophoresis and the differentially expressed proteins analyzed by mass spectrometry. Up and down regulated protein, spots excised and analyzed by MALDI-TOF MS/MS, followed by cross-species protein identification. A total of 15 different proteins were found to be differentially expressed. Proteomic investigations revealed that certain functionally important defense related proteins *viz.,* Putative late blight resistance protein homolog, Toll-interleukin resistance domain containing protein, Translation Initiation factor IF1, Disease resistance protein putative Kalata- B1 and β-1, 3-glucanase were induced by *B. subtilis* which are involved in the induction of defense response of host against the pathogen, *M. incognita.*

SGDVMBWSA-05. Temporal and Spatial Epidemic Development of Early Blight (*Alternaria solani* Ell. and Mart) in Tomato as a Function of Different Fungicides Treatments

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Field experiment was conducted at university In-check farm, Kalyani under Bidhan Chandra Krishi Viswavidyalaya in the year 2009-10 and 2010-11 to study the temporal and spatial development of early blight (*Alternaria solani* Ell. and Mart) on tomato under different chemical treatments to identify nature of progression of the disease in all fungicides treatment and also to evaluate the minimum apparent infection rate that restrict disease development at low level. One susceptible tomato variety "Patharkuchi" (indeterminate type) was taken and natural epiphytotic condition was permitted. Disease severity recorded at 10 days interval and the infection rate (r or k) was calculated after logistic and gompertz transformation of the realized observed value of the disease severity (expressed as AUDPC). Among the six chemicals tested *i.e.*, Mancozeb, Propiconazole, Hexaconazole, Carbendazim, Cholothalonil and Difenconazole, Mancozeb showed minimum disease severity (AUDPC: 98.44 and 96.84) followed by Hexaconazole (AUDPC : 98.69) and Carbendazim (AUDPC: 97.68) respectively for the year 2009-10 and 2010-11. Maximum disease severity was observed in Propiconazole treatment (AUDPC: 102.89 and 102.06) for both the two experimental year. Here, AUDPC is used to quantify the disease over different point of time and two growth models logistic and gompertz tested, through which disease progress curve move over time. Results revealed that the two models were not equally fit for depicting disease progress in every treatment but for linearization of area under disease progress curve (AUDPC) following the two models (logit and gompit) revealed that gompit fit better than logit for the spread of early blight disease severity over time and this was confirmed by the low standard error estimate (MSE) value of gompertz in all the treatments.

SGDVMBWSA-06. Is South American Leaf Blight (SALB) a Threat to Major Rubber Producing Countries? – An Analysis in the Light of Key Climatic Parameters

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South American leaf blight (SALB) of rubber tree caused by the plant pathogenic fungus *Microcyclusulei*is recognized as the most serious threat to the natural rubber industry worldwide. A warm humid weather during refoliation is reported to be congenial for the growth and spread of SALB disease. The climatic condition prevalent in most of the rubber growing countries in India, South East Asia, Sri Lanka, Africa, and China, which contribute to over 98% of world's natural rubber production, is similar to that of the American tropics and the introduction of this pathogen could be disastrous for global rubber production. The present study assesses climate suitability for the occurrence of SALB in different parts of the world based on the available literature for *M. Ulei pathogen establishment* and SALB disease occurrence. The three major environmental factors for disease development namely, temperature, relative humidity and precipitation were considered and threshold parameters were set based on available knowledge of the pathogen biology. It is known that young leaves are most susceptible to *M. ulei infection* and mature leaves are resistant to the pathogen. Existence of a plant disease caused by a biotic agent requires the interaction of a susceptible host, a virulent pathogen and an environment favorable for disease development. Maps were constructed with the three key environmental factors namely temperature, precipitation and RH known to be suitable for disease occurrence during the refoliation period. The study provides some indication of the likely threat of SALB in different rubber growing areas of the world, but it is limited by our knowledge of the pathogen biology, its diversity, and environmental tolerance. It was observed that refoliation period in India, China, Thailand, Vietnam, Cambodia, and Laos does not coincide with the favourable climatic conditions for M. ulei infection, and therefore, these countries are at present safe from SALB infection. However, a few regions

within Africa, Sri Lanka, Malaysia, Philippines and Indonesia seem to have partially favourable climatic condition during the refoliation period, which is a matter of concern for these regions. The paper attempts to identify risk zones for rubber cultivation based on climate suitable for SALB infection and crop growth parameters.

SGDVMBWSA-07. Infectivity of Cowpea Isolate of *Mungbean yellow mosaic India virus* by Agroinoculation

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Mungbean yellow mosaic India virus (MYMIV) transmitted by the whitefly *Bemisia tabaci* causes serious economic losses in various parts of the world. Agroinoculation with the cloned components DNA A and DNA B of a non-sap transmissible isolate MYMIV-[IN: Ana: CpMBKA25:04] has been demonstrated here. The cloned components are introduced into the legumes using sprouted seed inoculation method in French bean, Mungbean (cv. K.851, GM-2-12-24, GM -9907, GM-9908, GM-9922, GM-02-01 and local Delhi cultivar), black gram and cowpea. Seedling inoculation was carried out in tobacco plants. Cent per cent symptom had seen in French bean cv.Sel.9 from seventh day onwards. Average infection on 7th, 14th and 21 day is 40%, 60% and 100% in mungbean cv. K.851respectively. Flecking symptom developed in mungbean cv. GM-2-12-24 and local Delhi cultivar from fourteen day onwards with 40% and 20 % infectivity. The plants remained free from infection in mungbean cv. GM -9907, GM-9908, GM-9922, GM-02-01 and cowpea. The seedling inoculated tobacco plants also remained free from infection. Agroinoculated plants with DNA AN alone could not produce symptom on any of the plants.

SGDVMBWSA-08. Sodium Alginate Entrapped Biocontrol Agents for the Control of Most Virulent Isolate of *S. rolfsii*

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Most virulent isolate of *S. rolfsii,* SrSB3 was selected out of ten isolates based on its virulence on sugar beet plants, tubers, and leaf petioles. Among different isolates, SrSB3 caused wilting symptoms even at lesser population of sclerotia, recorded more lesion length on inoculated leaf petiole and more mycelial diam on inoculated tubers. Hence SrSB3 was considered as a most virulent isolate and for which management practices were carried out. The sensitivity of sclerotia to culture filtrates of different bio-control agents was studied by poisoned food technique. Results clearly indicated the lethal effectiveness of different culture filtrates at different levels on sclerotia of *S. rolfsii.* The effective bio-control agents were entrapped inside the sodium alginate beads and tested individually and in combination against the most virulent isolate of *S. rolfsii* (SrSB3) under pot culture and field conditions. The result from pot culture experiment revealed that next to chemical treatment, least root rot incidence (33.3 %) was observed for the combination treatment of Pf1 + TTH1 which was comparable with Pf1 + EPCO16 (36 %) as against control (83.3 %) and individual treatments. Similarly, minimum root rot incidence was observed for the same combination treatments than individual and control treatments under field conditions. The present study suggested that alginate beads based bio-formulations could control root rot of sugar beet by the slow and continuous release of bio-control agents in to the soil in an eco-friendly manner.

SGDVMBWSA-09. Polyphasic Detection of Atoxigenic *Aspergillus flavus* Isolates for the Biocontrol of Groundnut Aflatoxin Contamination

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Aflatoxin contamination by *Aspergillus* section *Flavi* is a major pre-and post-harvest problem in groundnut, causing significant trade losses globally. These secondary metabolites have carcinogenic, hepatotoxic and teratogenic effects on human and animal health. For sustainable management of pre-harvest contamination in groundnut, biological control using atoxigenic *A. flavus* strain is one of the viable options. However, selection of an appropriate atoxigenic strain can be cumbersome, costly and also erroneous in view of the frequent false positives and negatives in detection methods. In our present studies, we have adopted a polyphasic approach for precise detection of an atoxigenic *A. flavus* strain through certain cultural, analytical and molecular methods. Detection by growth of *A. flavus* (58 isolates of groundnut) and standard color reaction on coconut cream agar (CCA); yeast extract sucrose (YES) agar and exposure to ammonium hydroxide vapors was adopted in cultural methods. Further, the atoxigenic strains obtained based on cultural methods are screened for aflatoxin production by enzyme linked immunosorbent assay (ELISA) and thin layer chromatography (TLC). Later, the atoxigenic strains are screened for the absence of major structural and regulatory genes by amplifying them with gene specific primers using polymerase chain reaction (PCR). The obtained atoxigenic strain was also screened for its α-amylase activity, gene for amylase production, and for production of anthraquinone pigments. Our results yielded a promising atoxigenic strain, *A. flavus* (AF-334), that has shown negative reaction to the cultural and analytical screening methods. Further, the AF-334 has only five out of 23 structural genes and no regulatory genes responsible for aflatoxin biosynthesis. Further, the AF-334 strain has no α-amylase activity and gene responsible for amylase production. Also, the major anthraquinone pigments that are intermediates in aflatoxin biosynthesis are also not produced by AF-334. Our results confirmed the atoxigenicity of AF-334 by application of a polyphasic approach. These results will be useful in further studies on pre-harvest aflatoxin management in groundnut through field application of atoxigenic *A. flavus* strains. However, prior screening of this AF-334 is mandatory for its biocontrol potentialities, absence of toxigenic secondary metabolites other than *aflatoxins* before its recommendation as a candidate bioagent.

SGDVMBWSA-10. Management of Sugarcane Red Rot by Mechanized Means of Sett Treatment

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To manage primary sources of red rot inoculum (*Colletotrichum falcatum*), efficacy of new systemic fungicides viz., azoles and strobilurins in comparison with thiophanate methyl and carbendazim were evaluated under *in vitro*, green house and field conditions by different sett treatment methods. Two different methods *viz.,* conventional-overnight soaking (~18h) and

mechanized-vacuum infiltration (<30min) have been evaluated for selecting fungicidal dosage, duration of sett treatment, compatibility among the fungicides, application of inducers, biocontrol agents, biofertilizer microbes, their efficacy and phytotoxic effect on sugarcane growth. Although tissue bioassay, green house and field experimental results indicated that the efficacy of fungicides was found to be on par for both the methods of treatment, the mechanized treatment has certain advantages such as rapidity, effectiveness, less cumbersome in handling material, amenable for large scale application, capable of delivering more than one agrochemical/microbes, uniform treatment with evenly dispersed chemical, economical as it consumes less chemical and suitability for large scale application under farmer's field condition. Among the fungicides tested, thiophanate methyl was found to be highly suitable under mechanized treatment, while azole fungicides were phytotoxic at elevated concentrations. However combination of fungicides, integration with biocontrol agents and biofertilizer microbes had added advantage than the individual use of fungicides. All these results confirm that the mechanized means of treatment was found to be feasible and practically applicable in delivering more than one agrochemical and microbes for managing red rot and improving sugarcane productivity.

PR Verma M Sc students Award

PRV-MSc-01 (Winner). Hydrolytic Enzyme Producing genes of *Trichoderma asperellum* in the Management of Stem Rot of Carnation

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Carnations are the most wanted cut flower verities of the world next to rose. Stem rot caused by *Sclerotinia sclerotiorum* (Lib.) de Bary was found predominant in all varieties. The survey results indicated that maximum per cent disease index calculated for stem rot ranged from 25-30% in the susceptible variety charmant light pink. The study on mode of infection indicated that the primary mode of infection is through soil borne mycelium and the secondary mode of infection through airborne ascospores. Sclerotium residing in soil plays a major role in the establishment of infection through myceliogenous and carpogenous germinations. Diverse strains of *Trichoderma* were isolated from the Nilgiri biosphere and their efficacy was tested *in vitro* against *S. sclerotiorum*. The *Trichoderma* strains were subjected to molecular characterization of the ITS 1 and 4 regions. They were sequenced for the identification up to species level and submitted in NCBI. Molecular screening for the presence of hydrolytic enzyme producing genes through PCR techniques revealed that *T. asperellum* strain NVTA2 possessed 3 hydrolytic enzymes producing genes *viz.*, cbh1, ech42, eg14 pertaining to cellobiohydrolase, endochitinase and endoglucanase activity respectively. The genes were detected using specific primer pairs and also confirmed by sequencing. The per cent inhibition of mycelial growth of the pathogen by *T. asperellum* (NVTA2) was 53.70 under *in vitro*. The biocontrol agent also inhibited sclerotial formation, colonized sclerotia and apothecium of *S. sclerotiorum* under *in vitro* conditions.

PRV-M Sc-02 (Runner). Molecular Characterization of Plant Quarantine Pathogen *Xanthomonas axonopodis* pv. *dieffenbachiae* causing Bacterial Blight in Anthurium and its Management

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Detection of harmful bacteria in plant material is essential to ensure safe and sustainable agriculture. Various techniques have evolved in last few years to achieve reliable and rapid detection of pathogens. Anthurium (*Anthirum andreanum* Linden ex Andre) is an important export oriented cut flower crop. Bacterial blight of anthurium was caused by *Xanthomonas axonopodis* pv. *dieffenbachiae*, a plant quarantine pathogen. Pathogen causing bacterial blight was identified by polymerized chain reaction using specific primers. Housekeeping genes like ATP synthase subunit (*atpD*), molecular chaperone dnak (*DnaK*), elongation factor (*efp*), Ton-B dependent receptor (*fyuA*), Glutamine synthetase type 1 (*glnA*) and DNA dyrase subunit B(*gyrB*) of *Xanthomonas axonopodis* pv. *dieffenbachiae* also confirmed the identity of plant quarantine pathogen. *In vitro* screening of different *Bacillus* spp., revealed that the antagonistic bacteria *B. mojavensis* (KA3) inhibited the growth of *X. axonopodis* pv. *dieffenbachiae* over an area of 3730mm2 compared to other antagonistic isolates. *In vitro* screening of extra cellular proteins from different *Bacillus* spp., revealed that the antagonistic bacteria *B. mojavensis* (KA3) inhibited the growth of *X. axonopodis* pv. *dieffenbachiae* over an area of 83 mm^2 compared to other antagonistic isolates. The crude antibiotics of *B. mojavensis* (KA3) inhibited the growth of *X. axonopodis* pv. *dieffenbachiae* over an area of 1320mm^2. It was succeeded by *B. subtilis* (BSD4). Studies on the management of bacterial blight with antagonistic bacteria revealed that, foliar spray with liquid formulations of *B. mojavensis* (KA3) @ 0.5% (5 ml $litre^{-1}$) at 15 days interval after symptom initiation for four times was effective in reducing bacterial blight to an extent of 78.84% over control. Similarly, foliar spray with 0.1% streptomycin sulphate (9% Streptomycin sulphate + 1% Tetracycline hydrochloride) along with 0.1% COC and 0.1% fosetyl aluminum was effective in reducing the severity of bacterial blight of anthurium up to 85.33% over control.

PRV-M Sc-03. A Rapid Screening Technique for Evaluation of Maize Genotypes against Stalk Rot Complex caused by *Macrophomina phaseolina* and *Fusarium verticilloides* and *Molecular Characterization* of the Inbred Lines

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Post flowering stalk rot (PFSR) complex of maize caused by *Macrophomina phaseolina* (Tassi) Goid and *Fusarium verticilloides* (Sacc) Nirenberg. In order to screen maize genotypes under field condition for resistance to PFSR disease, toothpick method used for creating artificial epiphytotics. In this study, thirty-four maize inbred lines were screened in field by toothpick method of inoculation. Under laboratory condition, twenty maize genotypes were screened by two new methods of inoculation of the cut stems. Split stems were inoculated in the first method and un-split stems were inoculated by toothpick method in the second. The split method produced recordable data within fifteen days of post inoculation (DPI) where as the un-split stem inoculation method produced the result at 20 DPI. Both the new techniques employed in the laboratory were faster in producing results as compared to the field screening of maize genotypes by the standard toothpick

method. Split open method was better than the un-split method of cut stem inoculation *in vitro*. A new scale ranging from 1 to 16 cm was developed based on the existing 1-9 scale of PFSR for rating of the disease severity *in vitro*. Molecular characterization of twenty-four maize inbreeds was done for the resistance to Fusarium stalk rot disease using thirty-four Simple Sequence Repeats (SSR) primers. Among these SSR primers, two primers *viz.,* SSRZ 135 and SSRZ 319 showed polymorphism for stalk rot resistance. The marker SSRZ 319 located on chromosome 1, distinguished the resistant lines H 109, P 503, P 408 and E 618 from the susceptible lines H-8, P 320, P 373 and 18834. The second marker SSRZ135 was inefficient in distinguishing the resistant and susceptible maize inbred lines although it showed polymorphisms. Resistant genotypes identified in the study would serve as potential donors in the stalk rot resistance-breeding programme. Further, QTL *qRfg2* with most likely presence in the Indian maize inbred lines can transferred to elite inbreeds using marker-assisted selection.

PRV-MSc-04. Phenotypic and Molecular Characterization of Chrysanthemum White Rust *Puccinia horiana* (Henn) and its Management under Protected Cultivation

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Chrysanthemum varieties surveyed for the incidence of white rust (P. horiana (Henn) in Yercaud of Salem district and Kothagiri of Nilgiris district in Tamil Nadu, India during 2012-2013. The white rust incidence ranged between 62.72% and 65.81 in variety Saffin pink. Symptoms become visible 7 to 10 days after initial infection under favorable conditions followed by the production of telia. Historically, identification protocols for white rust relied upon macroscopic symptom development free hand under a stereoscopic binocular microscope and histopathological studies by microtome. White rust were detected in symptomatic leaves of two varieties using PCR with P. horiana genus specific primer (Ph-F1 and Ph-R1; Ph-F2 and Ph-R1) amplified a fragment of 240bp and 340 bp approximately corresponding to the region of the 16S-23S rDNA intervening sequence, specific for P. horiana. Detection of crude antibiotics analyzed through GC/MS to detect the antimicrobial compounds produced by the most effective isolates like STR15 and BS2. Evaluating the bio-efficacy of fungicide modules indicated that, module II was most effective in reducing the incidence of white rust. Foliar application of B. subtilis isolate BS2 and B. subtilis isolate STR15 at fortnightly intervals were effective in controlling chrysanthemum white rust at 0.5% concentration. Besides, it increased plant height, marketable stems, and flower diameter.

PRV-MSc-05. Studies to Exploit the Antimicrobial Activity of *Aloe vera* for the Management of Important Postharvest Disease of Mango

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Anthracnose caused by *Colletotrichum gloeosporioides* Penz. is considered to be the important diseases in fruit crops in the humid tropics that contribute significantly to pre harvest and postharvest losses in mango. The objective of this study is to manage the disease using potential antagonists and chemicals under *in vitro* and *in vivo* conditions. Anthracnose disease affected fruits of mango were collected from fruit markets of Madurai, Tamil Nadu. The pathogens *viz., C. gloeosporioides* were isolated from the infected fruits of mango respectively. The antifungal activity of *Aloe vera* combined with sodium bicarbonate was tested against *C. gloeosporioides.* The effect of different combination of Aloe vera, sodium bicarbonate, bio agents and hot water treatment after 24 hours and 48 hours of spore inoculation against the against the anthracnose of mango were tested. Among these treatments tested after 24 hours of spore inoculation, the treatment T7 which comprising hot water treatment (49 C) for 20 minutes plus Sodium bicarbonate 2% amended with *Aloe vera* (20 %) for 15 minutes was found to be more effective in completely inhibiting the disease development. It recorded 100 per cent and 98.88 disease reduction over control at 8 DAI in mango and treatment T8 comprising, *P. fluorescens* (0.2%) for 15 minutes alone were found to record the less disease reduction of 80.70, 53.33 and 60.00 per cent over control at 8 DAI. Among the treatments tested after 48 hours of spore inoculation, treatment T7 comprising hot water treatment (49 C) for 20 minutes plus Sodium bicarbonate 2% amended with *Aloe vera* (20 %) for 15 minutes was found to inhibit the disease development at 8 DAI by recording 98.88, 90.00 and 90.00 per cent disease reduction over control at 8 DAI. *In vivo* evaluation of fruit treatment with different fungicides at two different concentrations (1.0 and 1.5%), among the different fungicides treatment tested, carbendazim and mancozeb each separately recorded cent per cent inhibition of disease development in mango.

PR Verma Ph D Students Award

PRV-PhD-01 (Winner). PCR Assay for Rapid and Accurate Detection of *Magnaporthe oryzae* in Rice (*Oryza sativa*) using Primers Specific to PWL Gene Family

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Magnaporthe oryzae is a destructive pathogen of rice and other economically important crops and causes huge losses both qualitatively and quantitatively. The pathogen can infect all the above ground parts of the rice plants including seeds. Association of this pathogen with the seeds contributes as the source of primary inoculum for development of epidemics in the field. Likewise, infected seeds may introduce the pathogen to un-invaded areas. Therefore, seed health testing of rice for blast should be the essential component of an integrated disease management. Routinely used seed health testing methods are tedious, time consuming and difficult to interpret. Therefore, an attempt was made to develop a polymerase chain reaction-based assay for specific, sensitive and economical detection of the pathogen from seeds. *PWL* gene family specific primer was designed using NCBI-Primer designing tool, and a PCR assay was standardized. The primer produced an amplicon of 200 bp with the genomic DNA of *Magnaporthe*. The sensitivity of the PCR assay was found to be 50 pg μl^{-1} with genomic DNA of *M. oryzae*. The primer was found to be very specific, as with other fungal and bacterial pathogens tested, it did not produce 200 bp amplicon. Seed assay was developed with infected seeds of five different rice varieties. Sensitivity of the seed assay was found to be 5% though after enrichment of seeds in potato dextrose broth the sensitivity of the assay increased by 1%. The assay was found to be specific with seeds also, as only 200 bp amplicon was observed in every PCR. Further, on comparison of the PCR assay with the conventional

methods used in the detection procedures, it was found that it is more specific and has high positive predictive value, indicating its usefulness in detection protocols. Results obtained in this study indicate that *PWL* gene specific primer could be utilized for sensitive and specific detection of *M. oryzae*. The assay will be useful in determining the rice seed health and thus will help in effective and economic management of the disease by adopting judicious management program.

PRV-PhD-02 (Runner). Development of Coat Protein Mediated Resistance in Peanut Plants against *Peanut bud necrosis virus*

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Bud necrosis, caused by *Peanut bud necrosis virus* (PBNV), is a devastating disease of many crops including peanut (*Arachis hypogaea*). The coat protein gene of 831 bp was amplified and cloned. The coat protein gene was sub cloned into a plant transformation vector pCAMBIA1305.1 to get a plant expression cassette under the control of CaMV 35S promoter and *nos* terminator. The resulting vector was mobilized into the *Agrobacterium tumefaciens* LBA 4404 strain by triparental mating. Coat protein gene was transferred to peanut (cv. GPBD 4) by *Agrobacterium*-mediated in planta transformation of embryo axis. Of the 200 embryo axis infected with *Agrobacterium*, 140 developed into plants (T_0), and thirteen plants (6.5%) showed the presence of coat protein gene when checked with PCR and GUS assay. Of the 52 T_1 transgenic plants from thirteen (T_0) events, 37 showed stable integration of the coat protein gene. Expression of the coat protein gene was confirmed using DAC-ELISA. The challenge inoculated plants were resistant to PBNV. Absence of virus was confirmed in PCR positive T_1 transgenic plants by negative amplification for movement protein gene of PBNV.

PRV-PhD-03. Diversity of Endophytic Fungi Isolated from Mangrove Plants of Maravakadu and their Antagonistic Activity Against *Fusarium oxysporum* f.sp. *lycopersisici*

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Three mangrove plant species such as *Avicennia marina, Suaeda monica* and *Rhizophora mucronata* in Muthupet mangroves selected for the study on diversity of fungal endophytes. Among these, *Avicennia marina* seems to be the dominant mangrove plant species recorded 95% of the vegetation cover. The width of *Avicennia* forest varies between 30-100m and the average height is between 20-22 feet. Because of the Grey colour of its bark, it also called as Grey Mangrove. Pneumatophores the unique feature of *Avicennia* species. Two hundred segments of leave sample from each mangrove plant species taken into account to isolate endophytic fungi pertinent to four seasons between October 2012 and September 2013. Similar to this rhizosphere soil sampling of the above three mangrove plant species collected to isolate mangrove soil fungi. Moist chamber incubation technique and serial dilution technique were adapted. Totally, forty-four soil fungi and twenty-seven endophytic fungi were isolated and enumerated. Of all these *Aspergilli*, *Penicillium* and *Trichoderma* were the predominant genera. *Trichoderma harzianum* present in marine soil as well as endophytic fungi of studied three plants. The antagonistic fungus *Trichoderma harzianum* was very effective in inhibiting the mycelial growth of the pathogen *Fusarium oxysporum* f.sp. *lycopersisici* in Dual culture. The antagonistic fungus produced lytic enzyme (Chitinase) which found to inhibit the growth of the pathogen *in vitro*. In green house experiments, the antagonist *Trichoderma harzianum* was effective in the suppression of the pathogen *Fusarium* causing wilt in Tomato plants. Seed treatment with *Trichoderma harzianum* broth recorded an increase in the seed vigour index by 69.02 % over the control also promoting the Plant Growth (PGPF).

PRV-PhD-04. Conserved Sequence of Replicase Gene Mediated Resistance to *Tobacco streak virus* through RNA Silencing

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The transgenic tobacco (*Nicotiana tabacum* L.) cv Abirami plants expressing hairpin RNA transcript (hpRNA) targeting replicase gene of *Tobacco streak virus* (TSV) were generated and analyzed at the molecular and phenotypic levels. The replicase (*Rep*) genes of three samples of TSV were sequenced with view to develop transgenic resistance to *Tobacco streak virus* (TSV). The sequence analysis showed that they had a sequence identity of around 99 per cent at nucleotide level. The hairpin construct was generated using pHANNIBAL vector with the conserved sequences of replicase gene of TSV isolates. The *Rep* hairpin construct cloned into pART27 and mobilized into *Agrobacterium tumefaciens* LBA4404. The hpRNA constructs corresponding to replicase gene of TSV introduced into tobacco by *Agrobacterium* mediated transformation. The T_0 plants obtained screened by PCR and Southern blot analysis using the genomic DNA from the transformed tobacco plants. The transformants produced ~299 bp and 340 bp amplicons corresponding to *nptII* gene and *Rep* gene respectively. Southern blot analysis confirmed the integration of transgenes into the tobacco genome. Both single and multiple-copy integration of the transgenes detected. The transgenic T_0 tobacco plants showed resistance against TSV upon mechanical inoculation of TSV without producing any symptoms, which also confirmed by DAC-ELISA. These results showed successful generation of TSV resistant transgenic tobacco plants through *Agrobacterium*-mediated transformation with inverted repeat corresponding to replicase gene.

PRV-PhD-05. Understanding Biocontrol Mediated Defense Response in Host-pathogen Biocontrol Agent Interactions for Effective Management of *Pythium aphanidermatum* in Hot Pepper

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Chaetomium globosum TNAU-Cg6 is studied as an effective biocontrol agent for the management of plant diseases besides a good plant growth promoter. In the current study, the biocontrol

efficacy of *C. globosum* was evaluated against damping-off disease caused by *Pythium aphanidermatum* in chillies under *in-vivo* and field conditions. The results showed the greater efficacy of *C. globosum* in reducing damping off disease under glass house and field conditions. *But C. globosum* induced defense related proteins against plant pathogens were studied by Proteomic approach nothing will perform best in all the regions. Nevertheless, the molecular study on tripartite interactions between plant-pathogen-biocontrol agents is further warranted to understand the expression of proteins. Thus, the differential protein expression studies were carried out to understand the molecular responses of chilli seedlings primed with *C. globosum against P. aphanidermatum.* The differentially expressed proteins were identified using two-dimensional polyacrylamide gel electrophoresis and analyzed by mass spectrometry. The study showed the differential expression of 28 proteins in chilli seedlings treated with *C. globosum* and challenge inoculated with *P. aphanidermatum*. The differentially expressed proteins were identified as Defensin like protein, WRKY6 transcription factor, Peroxidase, Endoglucanase 3 precursor, cytochrome P450, Ethylene-responsive transcription factor, UDP-glucose dehydrogenase, annexin-like protein, nodule-specific cysteine-rich peptide, oxidoreductase, 2OG-Fe(II) oxygenase family protein, putative NBS-LRR disease resistance protein, CASP-like protein, Ribulose-bisphosphate carboxylase large chain precursor and hypothetical protein. The MATRIX analysis of proteins revealed that the differentially expressed proteins have greater role in growth promotion and enhancing defense responses in chilli plants against *P. aphanidermatum*. The biocontrol potential of *C. globosum* is further evidenced from the present study through the characterization of growth and defense related proteins.

PRV-PhD-06. Biological Management of Major Post-harvest Pathogens of Mango

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Anthracnose caused by *Colletotrichum gloeosporioides* (Penz.) (Penz. and Sacc) and stem end rot, caused by *Lasiodiplodia theobromae* (Pat.) (Griffon and Maubl) are the major diseases of post-harvest significance in mango. Twenty isolates of *C. gloeosporioides* and sixteen isolates of *L. theobromae* collected from the major mango growing regions of Tamil Nadu. The pathogens were isolated on PDA medium and based on the morphological characters, they identified as C. *gloeosporioides* and *L. theobromae.* Pathogenicity of the isolates proved using pinpricking of mango fruits followed by mycelial disc inoculation. Simultaneously, the virulence nature of the isolates was observed, which revealed that *Cg* 4 of *C. gloeosporioides* and *L*t 14 of *L. theobromae* were the most virulent as evidenced by the maximum PDI of 83.33 and 75.00 respectively. Morphological characterization of the isolates revealed a wide variation among the isolates of both the pathogens, with respect to colony colour, topography, margin, pigmentation, and zonation. The isolates also varied in the level of pathogenicity, while come were highly virulent, some were moderately virulent and few isolates were less virulent. The ITS regions of the isolates of the two pathogens amplified using the universal primers, ITS-1 and ITS-4, which generated amplicons of size 560 bp for *C. gloeosporioides* and 550 bp for *L. theobromae*. The *C. gloeosporioides* isolates amplified with the specific primer, *Cg*Int coupled with ITS-4, which generated a uniform amplicon of size 450 bp for all the isolates, confirming their identity as *C. gloeosporioides*. Further, the ITS regions of all the twenty isolates of *C. gloeosporioides* and fourteen isolates of *L. theobromae* were partially sequenced, submitted to GenBank and accession numbers were obtained. Genetic diversity among the isolates determined using RAPD-PCR technique. Twenty-one random primers used for the amplifications. The primers generated bands that were variable among the isolates. Using the RAPD data, a dendogram constructed for each pathogen and the genetic distance among the isolates obtained. Results revealed wide variation among some of the isolates while some closely related. However, isolates obtained from the same cultivar or locations were not necessarily in the same group as revealed by the dendogram. The efficacy of hexanal evaluated against *C. gloeosporioides* and *L. theobromae in vitro.* Among the different concentration of hexanal tested, 0.06 per cent showed complete inhibition in mycelial growth of both *C. gloeosporioides* and *L. theobromae.* Further, the minimum inhibitory concentration of hexanal confirmed as 0.06 per cent against both the pathogens by poisoned food technique. Hexanal also effectively reduced the germination of spores of *C. gloeosporioides* and *L. theobromae* after 24 h of incubation. Scanning Electron Microscopic analysis revealed that hexanal caused distortions and breakages of mycelial strands of both the pathogens and caused deformation of spores. Two field trials conducted in different locations in the main seasons of 2013 and 2014. In the first trial, the treatments comprised of hexanal sprays in two different concentrations, *viz.,* 0.02 and 0.04%, given as pre-harvest sprays 30 and 15 days before harvest. In the second trial, six treatments were imposed, namely, 0.04% hexanal, 0.5% Pf-1, 0.5% EPCO-16, combination of hexanal and biocontrol agents, 0.1% carbendazim given as pre-harvest sprays and control.

PRV-PhD-07. Genetic Engineering of Tomato Leaf Curl Virus Resistance in Tomato Using Viral Replication Genes

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Tomato leaf curl disease (ToLCD) is caused by a group of geminivirus that belong to *Tomato leaf curl virus* (ToLCV) complex and are transmitted by the whitefly (*Bemisia tabaci* Genn.). The disease causes great yield losses in many countries throughout the globe. In this work, we have developed transgenic tomato plants, transformed with an intron–hairpin genetic construction to induce post- transcriptional gene silencing against the ToLCV genome. Coding conserved regions from the genome of ToLCV, *Tomato leaf curl virus* were selected and used to design a construct that can trigger broad resistance against different viruses that cause tomato leaf curl disease. In order to generate engineered resistance to this disease, an intron-hairpin RNA construct harboring a *Tomato leaf curl virus* truncated replication-associated protein (Rep), transcriptional activator protein (TrAP) and Replication Enhancer protein (REn) genes were used to transform genotype of tomato plants. The silencing construct was cloned into a pHANNIBAL vector and sub cloned into Agrobacterium-binary vector with the sense and antisense orientation and used in transient assay to infiltrate tomato plant. A high level of resistance was obtained when plants were challenge inoculated with ToLCV using whitefly-mediated transmission 16-20 days post infiltration with the silencing construct. The polymerase chain reaction showed that the resistance was effective against the virus. The infected transgenic plants were divided into 3 different groups according to their specific symptoms. These strategies involve that ToLCV rep-driven RNAi, targeting AC1, AC2 and AC4 and conserved viral sequences, provides a promising approach to suppress a wide spectrum ToLCV infection in the tomato.