

## Abstracts presented during ISMPP 38<sup>th</sup> Annual Conference & National Symposium–2016 on “Challenges towards Plants Health under Changing Climate Scenario for Sustainable Agriculture” at Farmers Academy and Convention Centre (FACC, Lake Hall), Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, WB from November 24-26, 2016

### Technical Session-I : Biology of Plant Pathogen : Microbial biodiversity and taxonomy

#### Lead Lecture

##### S-1/L-1

#### Positive influence of beneficial rhizospheric bacteria with multi-functional traits on growth and disease suppression of crop plants

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Use of natural resources for crop improvement is the basis of sustainable agriculture whereas conventional agriculture relies on the use of chemical fertilizers and pesticides. Natural occurrence of pests and pathogens in the field seriously hampers crop productivity leading to reduction in yield. While chemicals have been used extensively for control of pests and pathogens, they have been shown to have several consequent harmful effects due to their residues which tend to be toxic. On the other hand, the last few decades have revealed the benefits of controlling diseases and achieving crop improvement through the use of biological resources which are eco-friendly without any damaging qualities. North Bengal region, with its forests, rivers and hilly terrain, a biodiversity hot-spot, is a virgin territory for isolation of microorganisms which can be potential resources in sustainable agriculture. In line with this approach, a large number of beneficial bacteria have been isolated from different forests, river basins, rhizosphere of agricultural and plantation crops of six districts of North Bengal, and, following molecular characterization and analysis of functional diversity, used for crop improvement studies. Sequencing of 16S rDNA region was done for identification and their diversity analysis was done by RAPD-PCR. Their diversity was also analysed using Denature Gradient Gel Electrophoresis (DGGE). The bacterial isolates were found to possess several beneficial traits. Some of the bacteria which included *Bacillus megaterium*, *B. pumilus*, *B. altitudinus*, *B. amyloliquefaciens*, *B. cereus*, *B. safensis*, *Serratia marcescens*, *Paenibacillus polymyxa*, *Ochrobactrum anthropi*, *O. pseudogregnonense*, *Streptomyces griseolus* and *S. griseus* showed plant growth promoting traits *in vitro* such as phosphate solubilization, siderophore production, IAA secretion and antagonism against fungal pathogens. Further, some of the bacteria were found to be tolerant to water stress as well high concentration of salt. Plant growth promoting activities of the selected microorganisms *in vivo* were observed in cereals (*Oryza sativa* and *Triticum aestivum*), plantation

crops (*Camellia sinensis* and *Citrus reticulata*) and pulses (*Glycine max*, *Vigna radiata* and *Cicer arietinum*). Either seed bacterization or soil drench significantly promoted growth of the test plants as evidenced by increased height, number of leaves, number of branches and biomass. These bacteria could also reduce root diseases which were determined to be either by direct antagonism in the soil or induction of systemic resistance in the host as evidenced by enhanced activities of defense enzymes as well as increased accumulation of phenolics. Salt and drought tolerant isolates which could promote growth were also successful in alleviation of salinity and drought. Sustainability of the applied bacteria in soil was done immunologically using PABs raised against the bacteria. Results indicate that wide range of soil microorganisms in different soils can be utilized as eco-friendly biological resources for crop improvement.

##### S-1/L-2

#### Molecular identification and phylogenetic analysis of *Fusarium* spp. - using Cellobiohydrolase-C and Topoisomerase II genes

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A phylogenetic approach based on comparison of stable 28S rDNA, a functional gene cellobiohydrolase-C and a house keeping gene topoisomerase II was employed to distinguish eleven different species and forma specialies of *Fusarium*. PCR amplification of 28S rRNA, Cellobiohydrolase-C and Topoisomerase II genes produced a fragment of 1123-1150, 720 and 350 bp respectively. The result of 28S rRNA-RFLP analysis was not conclusive to differentiate among the eleven different species. One representative strain of each species was sequenced except *F. oxysporum* for which two strains were selected for sequencing of the selected three genes and a phylogenetic tree was constructed using MEGA4. The parsimonious tree obtained with the combined data set clearly defined the positions of *Fusarium oxysporum* species complex and *Gibberellafujikuroi* species complex supported with higher bootstrap values than the trees obtained with individual data sets of 28S rDNA, cellobiohydrolase-C and topoisomerase II gene. We hypothesized based on our findings that the protein-encoding genes proved to be phylogenetically more informative for parsimony than the nuclear large subunit 28S rDNA.

## Oral Presentation

### S-1/O-1

#### Scope and limitations of *in vitro* cultures of arbuscular mycorrhizal (AM) fungi

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AM fungi are integrated components of terrestrial ecosystems and are ecologically important for growth and survival of plants. About 93 per cent of flowering plant families and 92 per cent of land plant families are estimated to have mycorrhizal associations. AM fungi are obligate biotrophs and live in symbiotic association with their host plants. Colonization by AM fungi provides several benefits to their host plants such as improved mineral nutrition by the capture and the transport of mineral nutrients, essentially of phosphorus (P), improved soil aggregation, soil water relation, biotic and abiotic stress tolerance. In return the plant provides the fungus with photosynthetically derived carbon. Different methods have been developed for mass multiplication of AM fungi. *In vitro* culture system is one such valuable tool developed for the study of AM fungi. The fungi are grown in *in vitro* along with *Agrobacterium rhizogenes*-transformed roots on a sterile artificial medium. Efficient production systems and the ability to concentrate very large numbers of AM fungal propagules into a small volume of sterile Petri plate make the product/inoculum easy to transport, free of unwanted microorganisms and potentially economically viable for large-scale application to important crops. However, the diversity of AM fungi that have been grown *in vitro* and produced many thousands of propagules is lower than in pot cultivation, and could be seen as a disadvantage. In the present study, the scope and limitations of *in vitro* cultures of AM fungi have been discussed.

## Poster Presentation

### S-1/P-1

#### Effect of age of inoculum of *Exserohilum turcicum* on disease development in maize variety Harita

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Turcicum leaf blight disease of maize caused by the fungus *Exserohilum turcicum* is one of the important foliar diseases causing severe reduction in grain and fodder yield. A study was carried out to test the virulence of the fungus in relation to the age of inoculum on maize variety Harita in plant growth chamber under optimum condition of disease development. Three plants were planted in each pot with five replications for studying the effect of 7 days, 10 days, 14 days and 21 days inoculum age. Five pots each were sprayed with the suspension of *Exserohilum turcicum* when the plants attained the age of 28 days. The significant highest PDI (percent disease index) was

recorded at 46.66 per cent when 14 days old inoculum was inoculated in 28 days old plant followed by 42.85 per cent when 10 days old inoculum was sprayed. The study revealed that 14 days old inoculum was most pathogenic and the virulence of the fungus was significantly reduced in 21 days old inoculum where PDI was observed at 30.47 per cent.

### S-1/P-2

#### Isolation of mycoflora from discoloured rice grains

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A lab experiment was conducted at Agricultural college, Bapatla, Andhra Pradesh. In order to assess the portion of the grain colonized by the mycoflora, component plating method was followed. Fungal genera of *Alternaria* sp., *Aspergillus* sp., *Curvularia* sp., *Bipolaris* sp. and *Rhizopus* sp. were isolated from discoloured glumes, endosperm and embryo of discoloured grains. The frequency of *Aspergillus* spp. occurrence was the most predominant in all parts viz., glumes, endosperm and embryo followed by *Alternaria* sp., *Bipolaris* sp., *Curvularia* sp. and *Rhizopus* sp. in the descending order of prevalence. Among the mycoflora isolated from glumes the individual interactions between *Bipolaris* sp. and other genera i.e., *Aspergillus* sp., *Alternaria* sp., *Curvularia* sp. and *Rhizopus* sp. was found to have significant effect on the grain discolouration. However the mycoflora isolated from endosperm the association of *Bipolaris* sp. with *Aspergillus* sp., *Alternaria* sp., *Curvularia* sp. and *Rhizopus* sp. in different combinations was found to be highly significant in causing grain discolouration. *Aspergillus* spp. had significant synergistic impact on grain discolouration when *Alternaria* sp., *Bipolaris* sp., *Curvularia* sp. and *Rhizopus* sp. are associated in the embryo. It was also observed that glumes acted as the primary source for the fungal association as all the pathogens had more or less equally affected glumes followed by endosperm and embryo region.

### S-1/P-3

#### Variation in *Bipolaris* isolate collected from the wheat germplasms

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Wheat is one of the most important cereal crops of the world, which constitutes a very important source of food to a vast population. In India it contributes nearly 31.50 per cent of the total food grain basket. The investigation included screening of 600 genotypes with broad genetic base. A symptom of different variant was collected and the pathogen was isolated from different genotypes from different plant parts, variations in the isolates were documented along with *in-vitro* pathogenicity testing. The morphological study of both culture and conidia was made on half strength PDA and water agar respectively. Singles spore cultures were made from all those isolates for the studies for pathogenicity. The results of the morphological study comes with the findings that the UBS-1 (Septation:

9.1±1.3, Length: 92.2 ± 25.7, Width:49.3± 37.8) and UBS-2 (Septation: 7.6±1.7,Length:85.3±19.1,Width:33.6±19.2 ) has higher in average septation. UBS-7, UBS-9, UBS-11, UBS-12 has triangular shape conidia. USB -9 and USB-14 has two different types of septation i.e euseptate and distoseptate. The result of the pathogenicity shows that out of 14 isolates UBS -1 and UBS-2 is the most virulent isolates in *in-vitro* condition and the remaining are moderately virulent and avirulent isolates. The finding comes with the variability of the pathogen depends on host factor and environmental factor. Different degrees of host resistance lead to evolve new character in the pathogen to adjust with the respective genotype and environment. From the cluster of different isolate, it was found that the potential virulent pathogen remain consistent *in-vivo* where as avirulent or moderately virulent isolate shows different degree of virulence based on morphological and physiological characters in different environment.

#### S-1/P-4

### Studies on leaf spot of Bach caused by *Nigrospora oryzae*

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Bach (*Acorus calamus*) is one of the most important medicinal plants in West Bengal and suffers from foliar disease caused by *Nigrospora oryzae*. In this paper, fixed plot survey of leaf spot of bach, isolation of pathogen, pathogenicity test of isolated pathogen for confirmation of disease, colony characters and growth of pathogen in different semi solid and liquid media were made. The results revealed that the severity of the leaf spot disease of *Acorus calamus* caused by *Nigrospora oryzae* were more during the period from November to February and maximum disease incidence was recorded in the month of November, thereafter the incidence was decreased slowly and reached minimum during July - August. From September onward the incidence was gradually increasing and reached to the peak during November–February. Symptoms of leaf spot of Bach showed that minute brown to black spots appeared at the leaf tip, later it spread from leaf tip to lower part of the leaves. Spots coalesced with each other and appeared as a large spot. Blight symptom was shown from tip and drying of the leaves occurred from leaf margin. In severe infection whole leaf is blighted were recorded. The pathogen was established through pathogenicity test. Visual observations of the colony characters were made after re-isolation from the inoculated plants with the pathogens revealed that the colony of the pathogen was deep black in colour with white cottony mass present on the growth. The highest growth of *Nigrospora oryzae* was recorded in Oat meal agar and Richards media and lowest in PDA media where as in liquid media highest dry weight was recorded in Richards media (1.54g) and lowest in Oat meal agar media (0.14g). Micrometric measurement of the pathogen were made after growing in PDA media and observed under the high power microscope. *Nigrospora oryzae* produce smaller size spores (6.12 - 13.60 µm x 5.06 - 12.14 µm). The colony character of the pathogen in different media revealed that in different media the colony character of the pathogen were different.

#### S-1/P-5

### Morphological and cultural characterization of *Colletotrichum musae* of Banana the Causal agent of anthracnose

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Anthracnose of banana caused by *Colletotrichum musae* is a serious post-harvest problem of banana in Assam. Fifty samples of fruits showing typical symptoms of anthracnose were collected from different banana growing areas of Assam and the pathogen involved were identified as *Colletotrichum musae*. Based on the cultural characteristic in PDA all the fifty isolates were categorized under 4 groups as group I, fast growing mycelia with white to salmon orange, group II fast growing mycelia with pinkish to light orange mycelia, group III sparse, slow growing, suppressed, light orange mycelia and group IV dense, fast growing, orange mycelia. Characters to conidiophores and cylindrical conidia were found but without any setae. Study revealed variation of *C.musae* with in the state of Assam which needs further studies for characterization at molecular level.

#### S-1/P-6

### Isolation of rhizosphere mycoflora and Fluorescent pseudomonads from different sources and evaluating it's efficacy against *Rhizoctonia solani*

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Tomato crop is attacked by several soilborne fungal pathogens among which *Rhizoctonia solani* is the most important soilborne pathogen causing symptoms of damping off, crown rot and root rot. In addition to these, blight symptoms on stems at early flowering to fruiting stage were observed in farmers' fields of Ranga Reddy district of Andhra Pradesh. To provide bioefficacy against casual agent, the population of rhizosphere mycoflora and fluorescent pseudomonads was estimated from the soil samples collected from diseased, healthy and luxuriously growing weed plants as colony forming units (cfu) on different culture media and were tested for their antagonistic potential against *R. solani* under *in vitro* condition. Among the sources of rhizosphere soil collected, significantly highest mean cfu count of mycoflora (27.70) and fluorescent pseudomonads (40.75) was observed in case of samples collected from weed plants followed by healthy tomato plants. The least mean cfu count of mycoflora (20.20) and fluorescent pseudomonads (21.31) was observed in samples collected from diseased plants. All the antagonistic isolates were tested for their efficacy against *R. solani* under *in vitro* condition. Among



the mycoflora, the isolate M10 was found to be the potential antagonist and was identified as *Trichoderma viride*, whereas the effective pseudomonad isolate P1 was identified as *Pseudomonas fluorescens*.

#### S-1/P-7

### Cultural characterization of *Trichoderma* spp. isolated from Rayalaseema region of Andhra Pradesh

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The cultural characteristics of 20 isolates of *Trichoderma* were studied in three media, viz., potato dextrose agar (PDA), oat meal agar (OMA), Czapek Dox Agar (CZA) and malt extract agar (MEA). The growth pattern of isolates of *Trichoderma* was observed daily and all the distinguishing characters were recorded. In general, there was dense mycelial growth of *Trichoderma* spp. in MEA followed by OMA, relatively less dense growth in PDA and lesser granular growth of antagonists in CZA. The sporulation was first observed in MEA, followed by OMA and PDA and sporulation not observed in CZA but differences in their sporulation is very short period of time span. *Tharziaenum* as fast growing colonies, aerial mycelium floccose, white to greyish or yellowish. Flat pustule surface appearing granular or powdery owing to dense conidiation, colourless to dull yellowish, ochraceous buff, pale drab shades, exudates amber to colourless or greenish yellow, odour indistinct and hyphae hyaline. While, *T. viride* as rapidly growing fungus, aerial mycelium usually limited, floccose to arachnoid, reverse side of the growth was colourless to dull yellowish, some isolates with distinctive aromatic odour resembling coconut, conidiation effuse, loosely tufted, or in some isolates forming compact pustules, white at first, eventually green or brown. *T. asperelluma* colonies are fast growing, watery white to green colour mycelium with cottony compact growth. Aerial mycelium was rarely produced. Conidiation was dispersed through the colony in the form of small green grass to cushion shaped tufts. The isolates not produced any odour. Similarly, *T. longibrachiatum* fast growth, light green to dark green fluffy granular growth, mottled with white flecks and often with inconspicuous wefts of yellow hyphae. Raised granular pustules, few isolates produced coconut like aroma. Radial growth rate of potential *Trichoderma* isolates on OMA, MEA, PDA and CZA medium were used and growth rate recorded at different intervals of time viz., 24, 48 and 72 hrs. Out of 20 isolates, MEA and OMA medium supported faster growth rate of 89.0 mm after 72 hr compared to other media. Isolates ATPU1, KNN4, KNPG 3, ATPP 6 and KNO 9 recorded more growth rate in four types of media. CZA medium supported slow growth, sparse and less sporulation.

#### S-1/P-8

### Assesment of the incidence and percent of Anthracnose (*Collectotrichum capsici*) in dry Chilli fruit samples

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Anthracnose of chilli caused by *Colletotrichum capsici* (Sydow) Butler and Bisby is an economically important disease of chilli affecting both fruit and seed quality. To determine the per cent seed infection, germination and per cent microflora associated with seed twelve dry chilli cultivar fruit samples were collected from various locations belonging to seven states of India viz., Rajasthan, Himachal Pradesh, Assam, Karnataka, Gujarat, Madhya Pradesh and Andhra Pradesh during 2015. Seed samples were subjected to assess the incidence of anthracnose 500 gram chilli samples were rated on 1-9 disease rating scale. The data of results revealed that anthracnose severity or incidence in these samples were ranged from 4.1 to 34.0 per cent with maximum 34.0 per cent incidence in chilli cv. Pusa Jwala and minimum in cv. Guntur Teja. To test the germination and per cent microflora associated with these seed samples experiment was carried out in the laboratory by growing on blotter paper. The maximum seed germination per cent 85.0 was recorded in Guntur-Teja, while minimum germination (52.5%) was found in cultivar Pusa Jwala and Fatki Chilli respectively. Different five fungi viz., *Colletotrichum capsici* (30.0%), *Aspergillus* (6.46%), *Alternaria* (4.17%), *Cercospora* (5.0%), *Penicillium* (3.96%) were recovered with mean per cent association from these samples. The maximum 45.0 per cent mean infection across all fungi was recorded by *C. capsici* in cv. Pusa Jwala.

#### S-1/P-9

### Effect of rice fungal endophytes on seed germination and seedling growth of Rice

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An investigation was carried out to study the effect of rice fungal endophytes on the seed germination and seedling growth of rice. Culture filtrates of fourteen fungal endophytes viz., *Cladosporium cladosporioides*, *Penicillium citrinum*, *Fusarium moniliforme*, *Trichoderma asperellum*, *Penicillium pinophilum*, *Aspergillus niger*, *Aspergillus flavus*, *Drechslera specifera*, *Penicillium oxalicum*, *Geotrichum candidum*, *Curvularia lunata*, *Aspergillus amstelodami*, *Talaromyces* sp.,

and *Chaetomium ochraceum* were tested at different concentration (25, 50 and 100%) at different dipping periods (15, 30 and 60 minutes). The culture filtrates of the endophytes were prepared by growing the endophytes in potato dextrose broth. Blotter method was used for testing the germination of seeds. The maximum per cent germination of rice seeds was recorded with the endophyte *P. citrinum* (96.65) when dipped for 15 and 60 minutes at 50 and 25 per cent concentration respectively. The maximum shoot length was recorded with seeds treated with *C. cladosporioides* (13.74 mm) when dipped for 30 minutes at 100% concentration as compared to 6.74 mm shoot length recorded in control experiments. The maximum root length was recorded with seeds treated with *A. amstelodami* (42.59 mm) when dipped for 60 minutes at 100 per cent concentration of culture filtrate as compared to control (41.19 mm).

### S-1/P-10

#### Effect of *Pseudomonas aeruginosa* and *Glomus mosseae* on the plant growth promotion of Nizer (*Guizotia Abyssinica* Cass.)

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Nizer (*Guizotia abyssinica* Cass.), a member of the family Compositae is an oil seed crop mostly grown under rain fed conditions in India. Application of bio fertilizers like plant growth promoting rhizobacteria and arbuscularmycorrhizal fungi is known to improve by supplementing the chemical fertilizers. The combination effect of *Pseudomonas aeruginosa* and *Glomus mosseae* application on the Ootacamund and IGP – 76 cultivars of niger was assessed in pot and field trials in this study. *P. Aeruginosa* alone and along with *G. Mosseae* increased plant length, fresh and dry weights and biomass. If soil was treated with mycorrhizal fungi alone, there was a significant change in the improvement of crop. But combination treatment performed better than their individual treatments.

### S-1/P-11

#### Chayote (*Sechium edule*), a new host of *Sclerotinia sclerotiorum* from Sikkim, India

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Chayote (*Sechium edule*), a minor Cucurbitaceous crop, mainly cultivated in hilly tropical and subtropical regions of India (Mizoram, Madurai and Nilgiri district of Tamil Nadu, Karnataka, West Bengal etc.). The fruits, stems, tender leaves and tuberous parts of the adventitious roots are used as food and also have cardio-vascular and anti-inflammatory properties and can be used for ailments such as arteriosclerosis, hypertension and kidney disorders. In the month of February

2016, *Sclerotinia sclerotium* have been recorded from Chayote (*Sechium edule*) at South Sikkim. All the aerial parts of the plant were attacked by the pathogen and in due course of time, infected plant parts became covered with white mycelial growth of the pathogen. The plants became rotten and withered. Black, irregular, broad mass of sclerotia were produced on the diseased tissue and mostly on the fruits. Mycelium with hyaline, branched and septate hyphae were produced by the pathogen. Near spherical, elongated and irregular shaped black sclerotia were formed towards the periphery of the medium (PDA) in Petridish. Initially the sclerotia appeared shiny black in colour with secretion of drops of exudates which dried off with increasing age of the culture and surface of the sclerotia became pitted and rough. Cultural and morphological studies confirmed the isolate to be *Sclerotinia sclerotiorum*. The mycelia disc of the pathogen was inoculated on Chayote stem and water-soaked lesion appeared after 60 hrs of inoculation and rotted portion elongated with the progression of time and white cottony growth of the mycelium was also observed. This *S. sclerotiorum* isolate did not have host specificity and neither compatible with other isolates (eastern India) of the pathogen. The scanning of literature suggested that this is the first report of *Sclerotinia sclerotiorum* on Chayote in India.

### S-1/P-12

#### Characterization of a naturally occurring DNA-beta satellite associated yellow vein mosaic disease in *Neolamarckia cadamba* in India

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The kadam tree (*Neolamarckia cadamba* (Roxb.) Bosser) under family of Rubiaceae is a beautiful fast growing large sized ornamental and shade giving pyramidal tree that bears striking pom-pom like apricot-gold coloured flowers with a delightful fragrance. The wood is used for manufacturing plywood and light construction/furniture work and paper making. Traditional medicine uses infusions of leaves and bark as mouthwash, for throat infections as a gargle, while the fruits are considered aphrodisiac. Leaves, bark, seeds are medicinal, being anti-inflammatory and liver protective and all these usages are currently the subject of medical research. During the survey in the summer seasons of 2013 - 2015, in Barasat, West Bengal, India, the *N. cadamba* exhibited typical symptoms for a begomovirus infection, including vein clearing, leaf curling, leaf yellowing and stunted growth. The symptomatic plants were tested for the presence of Geminivirus using Geminivirus specific degenerate primers and Rolling circle PCR. The PCR product gave a fragment of 760 bp and it was sequenced. On sequence analysis it shares 95% identity with *Mesta yellow vein mosaic virus* (MeYVMV). The viral infection was further confirmed by symptomology, Southern Blot Analysis, polymerase chain reaction (PCR). Full genome organization of the virus was characterized by rolling circle amplification (RCA) PCR. Full nucleotide sequence was analyzed as 1358 bp. Sequence analysis showed that the virus showed 84-88 per cent identity with other available beta-

satellite sequences of *Tomato yellow leaf curl virus*, *Tobacco leaf curl virus* and *Tomato leaf curl virus* with query cover 35-63 per cent. We have tentatively proposed the viral name as *Kadam yellow vein mosaic virus* beta- satellite. To the best of our knowledge, this is the first molecular evidence of beta satellite DNA associated with yellow mosaic disease in *N. cadamba* in West Bengal, India.

### S-1/P-13

#### **Natural occurrence of *Papaya ring spot virus* and *Tomato leaf curl delhi virus* mixed infection in *Coccinia grandis* in India**

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Natural mixed infections of plant viruses are frequent, leading to unpredictable variations in symptoms, infectivity, accumulation and or vector transmissibility. Mixed infections with potyvirus and geminivirus have been reported in several hosts over a wide geographic area. Ivy gourd (*Coccinia grandis* (L.) Voigt) is a weed, belonging to the family *Cucurbitaceae*. In Southeast Asia, ivy gourd is grown for its edible young shoots and edible fruits. Symptomatic plant samples were tested for the presence of potyvirus by ACP-ELISA (antibody coated plate- Enzyme linked immunosorbent assay) using potyvirus specific polyclonal antibody (Agdia, USA) according to the instruction of manufacturer. Samples tested positive in ELISA were used for the extraction of total RNA and total DNA. Total RNA was extracted from infected leaf samples of *C. grandis* plants showing symptoms were carried out using Potyvirus group specific primers, amplifying 327 bp, encoding the core region of the coat protein gene. Total DNA was extracted and tested for the presence of geminiviruses by PCR using a pair of degenerate geminivirus-specific primers, of resulting in an amplicon approximately 760 bp of sequence partially overlapping the putative AV1, AC3 and AC2 genes. PCR products were eluted and sent for sequencing. Sequencing and BLAST analysis of the RT-PCR product showed 92% identity at the nucleotide level with *Papaya ringpot virus* (PRSV) isolate and amplified DNA showed 98% identity at the nucleotide level with *Tomato leaf curl New Delhi virus* isolate (ToLCNDV-IN). These results indicate that the plant acts as the reservoir of both potyvirus and geminivirus and further full genome characterization and its threat to other crops has to be studied and it is also necessary to investigate the presence of other viruses in this plant.

### S-1/P-14

#### **Induction of defense responses in cereal crops against foliar fungal pathogens using bioinoculants**

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Three PGPR- *Bacillus altitudinus*, *B. methylotropicus* and

*B. megaterium*, as well as a PGPF- *Trichoderma asperellum* were tested to determine their efficacy in promoting growth and induction of resistance in selected cereals (rice, wheat and sorghum). PGPR were applied both as seed treatment and foliar application, while wheat bran based formulation of *T. asperellum* was used a soil application. Growth promotion in different cereal crops was measured in terms of average height and number of leaves. After 2 months of sowing, differences in growth rates between treated and untreated plants were evident. *In vitro* antagonistic tests of these PGPR and PGPF against two foliar pathogens, *Drechslera oryzae* and *Bipolaris sorokiniana* showed suppression of pathogen growth. Increased accumulations of chitinase,  $\beta$ -1,3 glucanase, phenyl alanine ammonia lyase and peroxidase were observed in plants treated with the bioinoculants and challenge inoculated with pathogens when compared to untreated healthy plants. Accumulation of antifungal phenolics in rice, wheat and sorghum following bioinoculant treatment and challenge inoculation with pathogen was analysed using HPLC. Infections by *D. oryzae* and *B. sorokiniana* were confirmed by dot immunobinding assay using leaf antigens of untreated healthy and untreated inoculated samples as well as by FITC labeling in leaves using PABs of *D. oryzae* and *B. sorokiniana*. Cellular localization of PR-2 and PR-3 in bioinoculant treated leaves of wheat and sorghum was further confirmed using PABs of chitinase and  $\beta$ -1,3 glucanase following Transmission Electron Microscopy. Expression of defense genes encoding chitinase,  $\beta$ -1,3 glucanase, peroxidase and phenyl alanine ammonia lyase following induced immunity in wheat genotype using bioinoculants, were analysed by microarray and the gene expression levels were compared in scatter plot. A total number of 461 genes were differentially expressed in wheat genotype treated with bioinoculants and challenge inoculated with *B. sorokiniana* in comparison to control, out of which 284 genes were up regulated and 177 genes were down regulated. Most significant up-regulated genes were those of pathogenesis related protein 4 and 10, phenylalanine ammonia lyase, glucan endo-1,3-beta-D-glucosidase, 5-enolpyruvylshikimate 3-phosphate synthase,  $\beta$ -1,3 glucanase and peroxidase.

### S-1/P-15

#### **Addition of new leaf spot disease caused by *Lasiodiplodia* sp. to the spectrum of *Dieffenbachia* [*Dieffenbachia daguensis* Engl.] diseases from West Bengal**

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*Dieffenbachia* [*Dieffenbachia daguensis* Engl.] belonged to the family Araceae is attacked by 4 fungal (*Phyllosticta* leaf spot caused by *Phyllosticta dieffenbachiae*, root and stem rot by *Phytophthora nicotianae*, anthracnose by *Colletotrichum gloeosporioides* and *Myrothecium* leaf spot caused by *M. roridum*), 3 bacterial (*Pseudomonas* leaf spot and blight caused by *Pseudomonas marginalis* pv. *marginalis*, *Erwinia* stem rot by *Erwinia carotovora* pv. *carotovora* and *Xanthomonas* leaf



blight by *Xanthomonas axonopodis* pv. *dieffenbachiae*), 6 viral (Potato virus Y, Arabis mosaic virus, Konjac mosaic virus, Impatiens necrotic spot virus, Tobamovirus and Tospo virus) and 2 nematode (root knot caused by *Meloidogyne incognita* and root gall by *Rotylenchulus reniformis*) diseases as reported from different parts of the world. Recently, it is found to attack by leaf spot disease, the symptoms of which appears as ashy colored, circular- oval, and water-soaked medium to large sized spots, mostly surrounded by light brown to dark margin followed by yellow halos confined near about tip and margin of upper leaf surface. Numerous light brown to black, minute dot like, concentrically arranged, pycnidial structures are observed on greyish or ashy coloured dead region of leaf. On potato dextrose medium (PDA) medium, pathogen appears thin, whitish, fluffy from the top but greyish to black at its maturity, covers 90 mm diameter of Petri plate within four days, produces pycnidia at both upper and lower surface of Petri plate in aggregated manner. Hyphae of the fungus are hyaline, thin, septate and 6.5 – 14.7 (av. 11.3)  $\mu$  wide. On dead tissue, pycnidia are erumpent, sub-epidermal, solitary or confluent, ostiolate [ostiol diameter 31.3 - 52.1 $\mu$  (av.41.7 $\mu$ )], 226.4 – 502.2  $\mu$  (av. 420.4 $\mu$ ) in size, brown to black with pseudo-parenchymatous wall and mostly covered by mycelial remnants. Conidia are ellipsoidal, apex and base rounded, widest at the middle, thick-walled, initially hyaline and aseptate but on maturity they become light to dark-brown with typical striate formation, equally 2-celled, oblong, bilamellate with 28.6 - 33.2 $\mu$  (av. 31.9 $\mu$ ) x 18.6 – 23.7 $\mu$  (av. 22.8 $\mu$ ) in size. Potato dextrose agar medium is good for both pycnidia and pycnidiospores production as compared to oat meal agar, peptone salt agar and V8 media. Pathogenicity test of the isolated fungus has been established in the laboratory with detached leaf. Based on pycnidial and conidial characteristics the pathogen has been identified as *Lasiodiplodia* sp. which is a new record on this crop from West Bengal.

#### S-1/P-16

### Fruit Rot disease : A major threat to Chilli (*Capsicum annuum* L.) in Kharif season of West Bengal

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Chilli, *Capsicum annuum* L. cultivation has existed for several hundred years as a sustainable form of agriculture in India and in many other countries. It is an annual herbaceous vegetable and spice grown in both tropical and sub-tropical regions of the world and belongs to family Solanaceae. Fruit rot (Anthracnose) disease caused by *Colletotrichum* spp. is the most serious and destructive disease of chilli. Chilli anthracnose usually develops under high humid conditions when rain occurs after the fruits have started to ripen. The disease causes both pre- and post-harvest fruit decay. Investigations were carried out at Department of Plant Pathology, B.C.K.V, and Nadia and in farmers' field at Haringhata, Nadia, on the symptomatology of disease, morphology of causal organism, cultural studies in nutrient

media, progress of disease under field condition, and role of weather in disease development. Fruit rot disease of chilli is caused by *Colletotrichum capsici* and symptoms appeared as small circular, watersoaked spots on ripening chilli fruit. As the spots develop, they become sunken, turned brown or black. The conidia were falcate, hyaline, and singlecelled. Chilli crop was grown during kharif season from June to October 2012. Onset of fruit rot disease at the field was on mid-August, and at the time of onset the severity of disease was 3.55% and it reached maximum i.e; 43.11% at the end of growing season. The weather condition during the development of the disease was congenial and rapid development of the fruit rot disease took place in a very short span of time. The mean temperature during disease development varied from 25.19C to 32.47C, mean relative humidity from 80.58 to 95.94 per cent and mean rainfall was 6.45 mm. The two fungicides namely, Cabrio (Pyraclostrobin 5% +Metiram 55% W.G), and Tilt (Propiconazole 25% EC) proved to be most superior to manage the *in vitro* vegetative growth of mycelia and reproductive growth of conidia.

### Technical Session-II : Ecology, Epidemiology : Climate change and pest risk analysis, disease forecasting and modeling

#### Lead Lecture

#### S-2/L-1

### Likely impacts of climate change (including elevated CO<sub>2</sub>) on arthropod species and their management in plant-based production systems, with particular reference to Australia

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Predicted climatic conditions in Australia are for annual average temperatures to increase 0.6-5.1C above the 1986-2005 baseline by 2030 (depending on emissions scenarios) with movement of hot/warm climates southwards and inland; substantially lower rainfall (especially in winter-spring) in southern Australia with associated lower humidity and higher evapotranspiration and increased drought frequency; as well as increased frequency of heavy rainfall events across all regions. While many field crops in Australia are rain-dependant, most horticultural crops are irrigated. Under the predicted climate change scenario, field cropping and some horticulture is expected to move from southern to northern Australia; alternatively, a number of horticultural crops will be increasingly grown under intensive, protected cropping. The three major groups of arthropods of economic and biological significance are: potential pests, natural enemies (biological control agents) and pollinators. The recognised methodology for pest control in Australian crops is integrated pest management, where biological control plays a significant role in suppression of phytophagous pests. While the impacts of

increased temperature and changes in rainfall patterns (in particular relative humidity) can directly impact growth and development of arthropods and their population dynamics, the impacts of elevated CO<sub>2</sub> are indirect, via changes to their plant host physiology, chemistry, growth and morphology. The most obvious impact of elevated CO<sub>2</sub> is increased photosynthesis and the resultant change in the C:N ratio; however, even so, it is not always possible to predict the responses of specific phytophagous species. Furthermore, changes in plant chemistry, especially levels of secondary compounds, and changes in plant morphology or architecture can impact phytophagous arthropod growth and development, their gut microorganisms and behaviour and transmission of diseases, as well as their natural enemies. Research from Western Sydney University, including from FACE facilities, has elucidated that in addition to arboreal species, soil arthropod pests may be impacted by elevated CO<sub>2</sub>. Furthermore, crop pollinators, similar to many biological control agents, require access to non-crop floral and nesting resources, particularly during crop dearth. Climate change impacts on these non-crop resources may be even more severe than their impacts on populations within crops.

### S-2/L-2

#### **Prediction of downy mildew disease risk of cucurbits in new alluvial agroclimatic zones of West Bengal by using weather and biological data**

**Indrabrata Bhattacharya**

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The cucurbits are of tremendous economic importance and are cultivated throughout the world from tropical to subtropical and temperate zones in an area of 8.5 million hectares in the world with production of 17.9 million ton (FAO, 2004). Biotic stresses are of paramount importance in causing economic losses in cucurbits. Among them, downy mildew is the most destructive climate sensitive foliar disease caused by the Oomycetes fungus, *Pseudoperonospora cubensis* (Berk. & Curt.) Rostow. especially in humid conditions. The time of initial infection will depend on the availability of inoculum and the favorableness of weather conditions. Heavy dews, fogs, frequent rains, and high humidity favor infection and rapid multiplication of the pathogen. When a film of moisture is present on a leaf surface, the asexual spores called sporangia germinate and give rise to motile spores (zoospores) which swim about for a while before they encyst and produce germ tubes that penetrate cucurbit leaves. Therefore, leaf wetness is critical for infection and spread of the disease under wide range of temperature 5-30 degree centigrade. Downy mildew disease of cucurbits epidemiology depends on the time of inoculum arrival i.e onset of disease and frequency of favorable weather conditions for further spread of disease in the field. Risk refers to the potential spread and development of disease in the cucurbits growing areas. By using 7-day recording Burkard spore trap near crop field, population build up of cucurbits

downy mildew pathogen has been assessed. Quantification of inoculum threshold level requires for the onset of the disease and epiphytotic development employing statistical relationship it is possible to quantify the pathogen load significant with respect to a particular set of weather condition and assessing the disease risk period. Crop-Weather-Disease relationship has been established in field condition by cultivating three different Cucurbits namely Cucumber Ridge gourd Bitter gourd in autumn-winter&spring-summer season which exposed them under variable weather regime. To understand the behavior of pathogen *Pseudoperonospora cubensis* an experiment was set up under controlled environmental condition with variable temperature and moisture regime in growth chamber. An attempt has been made to develop a model to predict the onset and assessment of the spread of the Downy Mildew disease under new alluvial agroclimatic zone of West Bengal.

### S-2/L-3

#### **Agrochemicals global perspective and fungicide market scenario in India**

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Globally the Population & nutritional requirement is increasing, but per capita farm land availability is reducing year by year. Technological innovations in agriculture have played & further going to play key role to meet the Quantity & Quality of the agriculture produce. Technological advances like Mechanization , fertilizer, crop protection & breeding & Plant biotechnology are playing very important role in increasing the production and productivity of agricultural crops. Among them Crop protection also have key role to play under the challenging environment conditions of Agriculture. In last 50 years the Global cropped area has increased in some developed countries, but the overall increase was insignificant. Approximately threefold increase in agricultural production is attributed to increase in productivity through adoption of modern technologies in mechanization, fertilizers, agrochemicals-crop protection, and bio technology In India, the demand for food will continue to rise significantly in the future as the population grows. Overall demand for food grains to increase from 192 million MT (2010) to 345 million MT (2030).To meet this demand, production of food grains needs to increase by 5.5 million tons annually . Constant increasing yield is required to meet production demands. Global CPC Industry has grown @ CAGR of 8.2 per cent (2010-14) while growth over last year is 4.5 per cent. Increasing awareness in Herbicides coupled with number of new introductions on Rice, Cotton & Soybean; Sucking pest segment of Insecticides make up larger share ; Strobilurins are the growing segment in fungicides. Emerging trend is towards environmentally safer & user friendly formulations Ex WG, SC, EW, FS etc. Disease complexes on various crops like Bakane & false smut, sheath rot and grain discoloration in rice & Rust, leaf spots & boll/pod rot in Soybean and Cotton are emerging new segments. Various Game Changers like mobile networking & Banking, Micro Banking, Use of Apps, Progressive farmers communities,



Internet etc are changing the Indian Agriculture as well as Agrochemical Industry.

## Oral Presentation

### S-2/O-1

#### Impact of elevated CO<sub>2</sub> on *Fusarium* wilt in chickpea investigated with real-time PCR analysis

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Chickpea (*Cicerarietinum* L.) is the second most important legume crop throughout the world. *Fusarium* wilt [*Fusariumoxysporum* f. sp. *ciceris* (Foc)] is one of the major constraints for chickpea production causing an estimated 10-15% yield loss annually can be 100% under favourable conditions. With the irreversible changes in climatic factors, such as increasing temperature and elevated CO<sub>2</sub>, the disease/pathogen behaviour may change. Drastic increase of atmospheric CO<sub>2</sub> has reached to 400 ppm in 2013 from 280 ppm in 1750, and projected concentration to be increased more than three times (~1200 ppm) by 2095. Therefore, present study was aimed to study the effect of elevated CO<sub>2</sub> on *Fusarium* wilt disease development as well as colonization of Foc in resistant and susceptible cultivars. Using real time PCR, we estimated the Foc biomass in roots of infected chickpea seedlings cv. JG 62 (susceptible) and WR 315 (resistant) grown in Open Top Chamber adjusted with 700 ppmCO<sub>2</sub> concentration. The results showed that the incubation period is advanced under elevated CO<sub>2</sub>. The higher accumulation of Foc biomass in roots of chickpea seedling was found at 700 ppm than ambient. The expression pattern of some *Avr* gene(s) of Foc and pathogenicity related (PR) genes of chickpea during chickpea-Foc interaction showed that the *Avr* genes e.g. SIX 5, 8, 11, 13 and 14 were highly up-regulated in JG 62 in early stage of infection irrespective to CO<sub>2</sub> concentration, whereas PR genes e.g. β 1,3-glucanase, defensin, thaumatin and chalcone synthase were up-regulated in wilt resistant cv. WR 315. Moreover, we are studying in detail to determine the expected change in chickpea wilt disease dynamics during chickpea-Foc interaction under elevated CO<sub>2</sub> in near future.

### S-2/O-2

#### Effect of climatic parameters on persistence of *Metarhizium anisopliae*

Himadri Kaushik<sup>1</sup>, Pranab Dutta<sup>1</sup>, RP Bhuyan<sup>2</sup> and Harikesh Singh<sup>3</sup>

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*Metarhizium anisopliae* is a potential entomopathogen but its knowledge on biology outside the insect host is very little. To find an answer of this question, we performed a study in

organic and inorganic tea ecosystem of Assam. The fungus was sprayed thrice and its presence in the air, soil and vegetation was subsequently monitored. Result indicated that *M. anisopliae* persisted and remain viable for one year and a month in both soil and air in inorganic tea ecosystem. While it was detectable for one year and a month in soil and for approximately 12 months in air in organic tea ecosystem with negative periods in between. *M. anisopliae* did not persisted as epiphyte in the vegetative cover of the tea bushes of both the tea ecosystem. The cfu of the isolated colonies were further correlated with climatic parameters and found both positive and negative correlation with the same.

### S-2/O-3

#### Integrated management of apple diseases in the present climatic changing scenario

JN Sharma

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Incidence of diseases is one of the most important factor in lowering the fruit production and they can cause as much as 30-50 percent loss under favourable conditions, if suitable package of practices are not followed. Apart from the lowered fruit quality and yield, certain plant pathogens infecting roots and stems of the trees may cause premature decline of the orchards and death of the bearing trees resulting in total loss. Disease scenario has been changing all through the last century. White root rot (*Dematophora necatrix*) and collar rot (*Phytophthora cactorum*) are important soil borne diseases which were first found to cause damage in the Indian orchards in the early part of 20<sup>th</sup> century when apple cultivation was undertaken on a commercial scale in different agro-climatic conditions and are favoured by clayey soil with poor drainage of the orchards; whereas seedling blight affects the nursery stock and young trees and is particularly severe in well aerated sandy loam soils. Apart from better drainage and resistant root stock, soil drenching with carbendazim (against the white root rot), metalaxyl (against collar rot) and thiram (against seedling blight) is effective in controlling these diseases. More than 13 canker causing fungi affecting tree trunks of apple have been isolated and found responsible for production various cankers. Major among them are smoky blight (*Botryosphaeria obtusa*), pink canker (*Corticium salmonicolor*), stem brown (*Botryosphaeria dothidea*), stem black (*Coniothecium chomatosporum*), nail head (*Numularia discreta*), and silver leaf canker (*Chondrostereum purpureum*). Pruning wounds and other unavoidable mechanical injuries should be treated with fungicide based pastes and paints immediately. Affected portion should be scarified and cauterized with blow lamp, followed by copper based or cow dung paste for hastening the healing of the wounds. Sprays of carbendazim (0.05%), benomyl (0.05%) and copper oxychloride (0.3%) in the fall and late dormancy and are effective in controlling pink canker and others in the field. Attempts have also been made to use biocontrol agents such as *Trichoderma koeningii* and *Bacillus subtilis* for the control of *Nectria galligena*, and *Trichoderma viride* against silver leaf and Valsa canker. First recorded in 1935 in Kashmir, scab is the foremost disease and it is

prevalent almost in all the apple producing states of India affecting both leaves and fruits. It appeared in epidemic form in 1973 and 1983 in Jammu & Kashmir and Himachal Pradesh, respectively. Presently, its incidence is quite high in JK, Uttarakhand and Arunachal Pradesh. In Himachal Pradesh, extensive work has been done on its epidemiology and management. Computerized automated electronic device Reuter Stokes Predictor has been used effectively for predicting infection periods in monitored scab control. A protective spray schedule involving different fungicides like dithiocarbamates, benzimidazoles, captan, dodine and dithianon is recommended for the fruit growers. Sterol-inhibiting fungicides bitertanol, fenarimol, myclobutanil, haxaconazole, penconazole and difenoconazole have exhibited excellent curative and eradicated activity against *Venturia inaequalis* which has been successfully used in monitored disease control especially in epidemic situations. Marssonina blotch appeared in Himachal Pradesh early in 1990s and affected the apple plantation through out the state covering more than 90 per cent area by 1995 when it caused widespread premature defoliation of the trees. The author is credited with successful diagnosis of 'premature leaf fall' to be caused by *Marssonina coronaria*, a hitherto little known fungal pathogen in India. Its incidence has also been recorded from JK, Uttarakhand and Arunachal Pradesh. A protective spray schedule, involving application of mancozeb, carbendazim, dodine and mancozeb flowable from walnut to preharvest stages of apple at 21 days intervals is recommended to control it. As both the above apple pathogens perpetuate in the infected leaf litter, its destruction by raking, collection followed by burning, and urea (5%) spray in the autumn is effective in reducing the disease incidence. Sooty blotch (*Gloeodes pomigena*) and fly speck (*Schizothyrium pomi*) cause black superficial blemishes on apple and pear fruits thereby reducing quality and ultimately the market price of the fruit produce. They can be avoided by application of dithiocarbamates, benzimidazole and captan in rainy season at regular intervals. An integrated spray schedule is also recommended to the orchardists for controlling all these diseases effectively.

#### S-2/O-4

### Environment friendly management practice leads to sustainable development of agriculture resource of East Kolkata wetland, India

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Anthropogenic activities as well as ecological process contribute the eastern part of Kolkata. This largest urban wetland, the East Kolkata Wetlands, covering around 12,500 ha, which has been declared a RAMSAR site. This includes 286 wastewater-fed fishponds spread over 3,832.27 ha. Over the years this ecosystem has been experiencing tumultuous changes like unabated reclamation pollution industrial activities and dumping of industrial activities, atmospheric deposition, urban effluents, traffic emission and long term use of waste water in agriculture land. Wetlands are considered low-cost alternatives for treating industrial, municipal

effluents. Apart from the natural amelioration processes, this wetland produces nearly 150 tons of fresh vegetables daily and 11,000 metric tons of fish annually by the agricultural practices utilizing of city's wastewater (about 68 million liters/day) regularly. In relation to the prevailing environmental parameters like pH temperature, dissolved oxygen, organic carbon and heavy metal concentration of water and soil are examined. Food is one of the major important factors promoting growth and enriching the biochemical Composition of our Body. Hence it is essential to have an understanding of the relationship between the food chain and food web. The importances of the seasonal changes are also equally important for sustainable development. During the study the effect of seasonal changes at different types of heavy metal distribution, bioaccumulation load, and bioconcentration factor are recorded. From the ANOVA Analysis it was found that P value in Pb (.037) & Cd (.025), Cr(0.000) P<0.05 significance so average Bioconcentration of heavy metal in maize is different significantly in both the season (premonsoon and monsoon) But in case of Ni & Hg Average Bioconcentration of heavy metal in maize is same in both the season (premonsoon and monsoon). So the seasonal changes are the major factor influencing the abundance of heavy metal distribution and accumulation in maize one of the selected agricultural resources. It is also strongly affected by the socio economic factor such as land policies, property rights, population migration, urbanization, resource availability, other commercial activities and market for the resources. Environmentally sound management practices of wetland agriculture can only minimize destruction of resource base on which sustainable development depends.

### Poster Presentation

#### S-2/P-1

### Rhizospheric potassium solubilising bacteria and potassium nutrition of wheat

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Rhizospheric microorganisms contribute significantly in solubilization of fixed forms of soil minerals potassium (K). Inoculation of potassium solubilising bacteria (KSB) in soil improve solubilization of insoluble mineral K to plant available form resulting in higher crop performances. In this context, we tried to establish the relationship between wheat growth and solubilisation of insoluble K bearing mineral with inoculation of potassium solubilizers in a pot culture experiment. Three most efficient potassium solubilizer (*viz.*, KM1, KM3 and KM7) out of ten isolates taken from different rhizospheric soils were chosen for the present study. Out of four treatments, three were inoculated with three different KSB strains and one was

control (no inoculation). All four treatments received organic manure, chemical fertilizers (only N & P) and mica powder (containing insoluble form of K). Plant growth parameters at 65 DAS and at harvest were recorded. It was observed that all the treatments with inoculated bacteria gave better plant growth, nutrient uptake (K) and yield component of wheat plants over absolute control. Inoculation of KSB strains also increased the population of KSB in the rhizosphere of wheat plant. The highest KSB population was recorded in treatment receiving the strain KM1. However, the KSB population of treatment inoculated with isolate KM7 was found to be at par with absolute control. Treatment inoculated with KM1 showed high available K content in soil at 65 DAS compared to other treatments. Among all the three strains KM1 and KM3 performed very well. Therefore, it was concluded that both the strains KM1 and KM3 can be tested on the field to rate its performance as a biofertilizer.

### S-2/P-2

#### Assessment of yield loss due to leaf curl virus in tomato

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Tomato (*Lycopersicon esculentum* L.) is the world's largest vegetable crop and also known as protective food for its special nutritive value and wide spread cultivation. In India it is one of the most important vegetable crops grown almost all the states. In West Bengal the crops is widely grown in every district during the rabi season. Every season its production is threatened by different biotic stresses including fungal, bacterial and viral agents. Among the different viral diseases, tomato leaf curl virus is most destructive one and known to cause even up to 100 per cent yield loss if infection occurs at early stage. It is a whitefly transmitted Gemini virus belongs to the family Geminiviridae, genus Begomovirus. No definite information is available regarding actual loss due to this disease under West Bengal condition. Therefore, an attempt was made to assess the yield loss following direct approach by calculating the losses in yield in total (q/ha) under protected (spraying of insecticide) and unprotected (control) conditions, in all the plots Metalaxyl + Mancozeb @ 1.5g/lit of water was applied (four sprays at 10 days interval starting from twenty five days after transplanting) to check the blights diseases. The formula used to assess the yield loss was  $AYL = [(YP - YU) / YP] \times 100$  where YP = Yield under protected condition, YU = Yield under unprotected condition. Experiment was conducted at the University Instructional Farm Jaguli, Bidhan Chandra Krishi Viswavidyalaya, Nadia under Gangetic plains of West Bengal during 2012-13 and 2013-14. Four promising genotypes viz., Patharkuchi (susceptible), BSS 575 (susceptible), AJEET 11 (moderately susceptible) and ARTH 2104 (tolerant) were sown during rabi season in 5m x 5 m plots which were divided into two parts as protected and unprotected and laid out in a factorial design with three replications. Treatments of protected plots were sprayed with imidacloprid @ 1ml per 5 lit of water starting from 15 days after transplanting and subsequently three

more sprays at 15 days intervals were applied to keep the plot free from tomato leaf curl virus disease. The severity of the disease was measured on the basis of scale by Fridmann *et al*, 1998 and yield data (qha<sup>-1</sup>) were recorded from each plot. The result revealed maximum disease severity in Patharkuchi (49.41% and 45.61%) for the two consecutive years under unprotected condition. Significantly lowest disease severity was recorded in ARTH 2104 (6.61% and 4.73%) under protected condition in comparison to unprotected condition (31.45% and 29.19%) during two experimental years. The highest fruit yield (871.00 qha<sup>-1</sup> and 789.19 qha<sup>-1</sup>) was observed in ARTH 2104 under protected condition for the two respective years. Lowest fruit yield under protected condition was noted in BSS 575 (691.20 qha<sup>-1</sup> and 681.25 qha<sup>-1</sup>) for the two experimental years respectively. Yield loss was highest in AJEET 11 (44.63%) followed by ARTH 2104 (43.57%) and BSS 575 (37.74%) and lowest yield loss was recorded in the variety Patharkuchi (33.61%) in case of two years pooled mean.

### S-2/P-3

#### Efficacy of *Metarhizium anisopliae* against termite in tea ecosystem

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Termite is an important pest of tea gardens of Assam causing a huge havoc. An experiment was carried out to study the efficacy of a native isolate of *Metarhizium anisopliae*, an entomopathogenic fungus, against the infestation of termite in two different tea ecosystems of Assam viz. Inorganic (Experimental Garden for Plantation Crops (EGPC), AAU) and organic (Banaspati Tea Garden, Sarupathar, Assam) tea ecosystem. Prior to the field application of bioformulation of *M. anisopliae*, the whole experimental area was cleaned properly and sprinkled with water for 30-45 min. Three applications of the solid and liquid bioformulation of the entomopathogen (@1X10<sup>6</sup> spore/ml of water) were done at an interval of 30 days @800 litre of water per ha. A control plot sprayed with water was maintained to compare its efficacy. Observations on the development of new termitorium built up and termite infestation in the soil and/or on the propagating materials, seedlings, new infestation within the treated area were taken from 60 days of final spraying till six months of the final spray. We observed liquid formulation was effective upto 9 months of its application as no new termitorium and new infestation was observed within the treated area. Nylon net was used as a trap for recording adult termite population for Banaspati Tea Garden. From both the experimental plots it was recorded that *M. anisopliae* can effectively reduce the termite population as well as mortality of termite infested propagating materials. In addition to this it was seen that the application of bioformulation showed early bud breaking resulting in increase in tea yield of the new flushes. So it was conferred that the



management of termites in tea ecosystem by the use of *M. anisopliae* bioformulations gave potent results.

#### S-2/P-4

### Epidemiology and management of pomegranate fruit rot

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Pomegranate fruit rot caused by *Aspergillus niger* was found to be predominantly associated in orchard as well as after harvest and storage. The comprehensive surveys were carried out during August 2013 to February 2014 for occurrence of fruit rot in market of Udaipur, Chittorgarh and Bhilwara district of Rajasthan (India). The diseases was observed in moderate to severe level and the maximum incidence of 20 to 24 per cent found during August to September 2013 and minimum incidence of 5 to 10 per cent observed during January to February 2014 in markets. *Aspergillus niger* cause infection during flowering time and where the fungus becomes latent 3 to 4 months and at ripening time the fungus start growing and invades the arils as well as insect and mechanical injury also helpful in rotting of fruits. *In vitro* epidemiological studies on inoculated fruits showed the maximum rotting were found at 30C to 35C and relative humidity up to 90 per cent and play a vital role in the development and spread of fruit rot pathogen. To develop effective management strategies for this menacing disease, three systemic and non systemic fungicides, two anti microbial agents and three botanicals were evaluated against *A. niger*, first *in vitro* and then giving fruit dip treatment. In fruit dip treatment, mancozeb at 0.5, 1.0 and 1.5 per cent, chlorine water, neem oil and ginger extract at 4 and 6% concentrations were found to be most effective against fruit rot while boric acid, garlic extract at same concentration were least effective as compare to others. Hence, the results indicate that mancozeb, chlorine water, neem oil and ginger extract posses antifungal activity that can be exploited as an ideal treatment for future fruit rot disease management.

#### S-2/P-5

### Seasonal occurrence of prevalent diseases of bitter melon during rabi 2015-16 in raipur condition

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Bitter melon, *Momordica charantia* L. is one of the most popular vegetable in the tropical and subtropical countries. Bitter melon is commonly attacked by number of diseases such as downy mildew, powdery mildew, gummosis, *Phytophthora* blight, anthracnose, *Cercospora* leaf spot, phoma blight, collar rot, *Fusarium* wilt, white rot, damping-off of seedlings and fungal root rots, root knot nematode, bacterial wilt, bacterial leaf spot, mosaic, watermelon bud necrosis, leaf curl and leaf

distortion virus. These diseases are of national importance and cause important economic losses in cucurbits. Seasonal occurrence of prevalent diseases of bitter melon was recorded from first December 2015 to end of February 2016. Four diseases viz., downy mildew, leaf curl, mosaic and powdery mildew were appeared during the course of investigation. The occurrence of downy mildew and leaf curl were first observed from second fortnight of December 2015 and appeared up to end of February 2016. The occurrence of mosaic was observed from first fortnight of January 2016 to end of February 2016. However the occurrence of powdery mildew was recorded from second fortnight of January to end of February 2016. Disease severity and incidence reached at maximum in the month of February 2016.

#### S-2/P-6

### Influence of time of planting on disease severity, infection rate and yield of cowpea due to leaf spot causing pathogens

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The experiment was conducted in the Jaguli Instructional Farm of BCKV during Pre-kharif, Kharif & Rabi season of 2013, 2014 & 2015 to investigate the effect of planting time on the severity, apparent infection rate and maximum yield of widely cultivated cowpea varieties under West Bengal condition. The varieties were kashi kanchan, Mani kanchan, KSP-170, Triguna and Arka garima. Four time of planting were done at 10 days interval starting from 1<sup>st</sup> March to 30<sup>th</sup> March (Pre-kharif season), 1<sup>st</sup> June to 30<sup>th</sup> June (Kharif season) and 1<sup>st</sup> November to 30<sup>th</sup> November (Rabi season) of each year. The observations of above mentioned diseases were recorded at 7 days interval starting from the 1<sup>st</sup> appearance of the lesion on the infected plant parts. The Randomized Block Design with three replications was followed for statistical calculation. For all the three years, 1<sup>st</sup> week of March during Pre kharif and 1<sup>st</sup> week of June during Kharif season i. e. early sowing cowpea had less disease severity, apparent infection rate and higher yield than all other late sown crops. In case of Rabi season, three varieties (kashi kanchan, Mani kanchan & KSP-170) were found to be most profitable when they were planted at 4<sup>th</sup> week of November. On the contrary, for the other two varieties (Triguna & Arka garima), they were found to be most profitable during 2<sup>nd</sup> week of November. The present investigation reveals that among the five cultivars Kashi kanchan proved to be most susceptible variety whereas, Arka garima was found to be tolerant to all the three leaf spot diseases. During Pre kharif & Kharif season early sowing of cowpea can avoid *Alternaria* and *Colletotrichum* leaf spot disease whereas, late sown of cowpea during Rabi season was found to be most profitable against *Corynespora* leaf spot disease.

**S-2/P-7****Studies on survey of *Sclerotinia* rot of crucifer in Northern Madhya Pradesh****Pramod Fatehpuria, Veerendra Gupta, Devashish Chobe, Bhagyashree Singh and Rajni Sasode***Department of Plant Pathology, RVSKVV, Gwalior (M.P.) 474002; E-mail : pramodfatehpuria@gmail.com*

Mustard is cultivated in 53 countries spreading over the six continents across the globe-covered area. Madhya Pradesh contributed in mustard crop production in area about 08.00 lakh hectares with production and productivity of 11.40 lakh tonnes and 1425 kg/ ha respectively. Present investigation was carried out at six villages from each district were randomly selected and from each village five fields were randomly selected. Survey was conducted in area of Gwalior, Bhind and Morena districts. Systemic survey was carried out in the month of January and February (2014-15) among eighteen locations from Gwalior, Bhind and Morena districts (six locations from each districts) were randomly selected in Gird zone to assess the incidence of stem rot. Findings reveal that incidence of *Sclerotinia* rots in Morena, Bhind and Gwalior districts were 14.21, 5.03 and 2.25 percent respectively. Percent incidence of *Sclerotinia* rot was recorded in northern Madhya Pradesh comprising Morena, Bhind and Gwalior districts. Disease incidence was higher in Morena district and it varies from 18.72 to 9.36 per cent and maximum incidence was recorded in Dimni (18.72%) followed by Jeegni (17.68%), Morena (15.60%), and Ambah (13.52%). One location of Bhind viz, Mihona was diseased free, while its maximum incidence (11.44%) was recorded in Gauhad and Mehgoan 7.28%, followed by Bhind (6.24%) in Raun (3.12%). Maharajpura and Badagoan locations of Gwalior district are diseased free while its maximum incidence was recorded in Mohanpur (5.20%) followed by Jalalpura (3.12%). Hotspot recognized in survey for maximum disease incidence, can use as screening locations for germplasms and the disease free areas like Mihona, Maharajpura and Badagoan could be use for seed production.

**S-2/P-8****Status of major diseases of jute and assessment of weather parameters of stem and root rot diseases in eastern region of Bihar****Santosh Kumar<sup>1</sup>, Md Nadeem Akhtar<sup>2</sup> and Daya Ram<sup>3</sup>***<sup>1</sup>Department of Plant Pathology, - Bihar Agricultural University, Sabour, Bhagalpur 813210, Bihar, India; <sup>2</sup>Krishi Vigyan Kendra, Agwanpur, Saharsa, Bihar Agricultural University, Sabour-854105, India; <sup>3</sup>Department of Plant Pathology, Dr. Rajendra Prasad Central Agriculture University, Samastipur, Pusa, Bihar 848125; E-mail: santosh35433@gmail.com*

Jute is an important bast fibre crop next to cotton extensively cultivated in North-East and Eastern part of India. Bihar is the second largest producing state after West Bengal. Survey was conducted at three tehsil of district Katihar (Katihar, Hasanganj and Korha) during May and August, 2012. Maximum stem and

root rot incidence (15.25 %) was recorded during last week of August at Katihar tehsil. Anthracnose incidence was found in 2-3 % cases only. However mosaic was recorded at Hasanganj and Korha with very low extent. Survey results that *Macrophomina phaseolina*, a soil borne pathogen, causing stem and root rot, appears every year with varying intensity and causes heavy reduction in fiber's yield. A field experiment was conducted at Jute farm, Jute Research Station, Katihar during 2013-14 and 2014-15 with references to weather parameters, to know its effect on stem and root rot disease development. High temperature (33° C) and high relative humidity (> 85%) were correlated with higher incidence of stem and root rot disease. Effect of rainfall on the development of disease was also observed and congenial conditions were revealed. On the basis of congenial mean temperature, mean relative humidity and average rainfall we have developed geopathological model.

**S-2/P-9****Prevalence and symptomatology of major potato viruses in Punjab, India****Ankit Kumar Ghorai, Santokh Singh Kang, Abhishek Sharma and Shikha Sharma***Department of Plant Pathology, Punjab Agricultural University, Ludhiana 141004; E-mail : akghorairresearch@gmail.com*

Survey was conducted over six major potato growing districts of Punjab during November to December of 2015. The per cent viral disease incidence recorded was correlated with aphid populations observed on potato grown in these districts and different weather parameters. The highest viral disease incidence on potato was observed in Hoshiarpur district (21.07 %), which may be due to relatively more abundance of aphid population in this district among the others. Leaf samples of 95 potato plants showing various virus disease like symptoms were collected from the survey. These leaf samples were crushed in extraction buffer and tested with antisera of seven major potato viruses viz. PVY<sup>n</sup>, PVY<sup>oc</sup>, PVX, PVA, PVM, PVS and PAMV in DAS/TAS-ELISA. Study on various symptoms produced by these viruses on potato was done. Among the potato viruses, the highest incidence was recorded for PVX (89.47 %) followed by PVY<sup>n</sup> (75.79 %), PVS (24.21 %), PVM (17.89 %), PVA (10.53 %), PVY<sup>oc</sup> (13.68 %), and PAMV (5.26 %) on potato. Maximum collection of infected potato plants were found to be co-infected with PVX and PVY (73.68 %) which exhibited rugose mosaic type symptoms. Potato plants infected simultaneously with multiple potato viruses (44.21 %) were accompanied with malformation of leaves, rosetting and severe stunting. PVY<sup>n</sup> and PVY<sup>oc</sup> mostly produced blistering, curling and mosaic type of symptoms. Infection by PVM showed mosaic, puckering, blistering and leaf rolling in young stages of potato. PAMV incidence on potato was very rare and induced mosaic type of symptoms. PVS always occurred in association with PVX and PVY inducing mosaic, wavy leaf and rugosity type of symptoms on potato. Titre of PVA was generally low in the infected potato samples and was mainly found to infect together with PVY and PVX.

**S-2/P-10****Studies on different traits of wheat related with resistance to spot blotch disease caused by *Bipolaris sorokiniana*****Sukram Thapa and Prateek Madhav Bhattacharya***Department of Plant Pathology, Uttarbanga Krishi Viswavidyalaya, Pundibari, Coochbehar; E-mail : sukramthapa22@gmail.com*

An investigation was carried out with fifty five genotypes with three replication in rows (in 1 mtr length) which includes eight susceptible checks to evaluate the different traits related with resistance against spot blotch disease of wheat caused by *Bipolaris sorokiniana*. Different traits were observed as phenological traits were days to heading, flowering and days to physiological maturity. Symptomatological traits were lesion number, lesion size, lesion mimic. Morphological traits were plant height, spike length, leaf angle and glaucoseness index. Physiological traits were stay green property, canopy temperature. The phenological traits shows that the resistant genotypes and susceptible checks were late maturing and early maturing types respectively and days to maturity varied from 108.85 to 117.3 days. A strong correlation was observed in symptomatological traits that the lesion number was negatively and the lesion size were positively correlated with disease severity. Among the morphological traits plant height showed very weak correlation with spot blotch severity. Erect types of leaves were resistant than the drooping types of leaves. Higher glaucoseness *i.e.* waxy covering of leaves showed lower AUDPC. Among the physiological traits the SPAD value was found to have negative correlation with AUDPC. Lowest SPAD value was observed in susceptible check the entry number 1 (337.9) and 55 (342.3) in comparison to resistant genotype the entry number 47 (392.9). Canopy Temperature Depression (CTD) varied from 49.26 to 60.3 in entry number 8 and 21 respectively showed highly resistant. The highest AUDPC was observed in the genotype TILILA/TUKURU/4/SERI.1B\*2/3/KAUZ\*2/BOW//KAUZ (454.49) and the lowest was observed in the genotype CNDO/R143//ENTE/MEXI\_2/3/AEGILOPS SQUARROSA (TAUS)/4/WEAVER/5/2\*KAUZ (96.92) (entry number 23). Therefore above traits can be used for selecting wheat genotypes that are resistance against spot blotch disease. It can be concluded that the physiological, phenological and morphological traits also plays an important role in spot blotch disease resistance.

**S-2/P-11****Spore dynamics of fungal endophytes in different rice growth stages resulting severe outbreak on cultivar lalswarna****Vikas Kumar Ravat\*, Amitava Basu\*\*, Veera Suresh and Jayashree Bhattacharjee***Department of Plant Pathology, B.C.K.V., Mohanpur-741 252, Nadia; E-mail : vikasraavat@gmail.com / basuamitava1961@hotmail.com*

Rice represents one of the India's most common staple food and cultivated in most of the states in India, each rice cultivar harbours multiple fungal species which can behave as

endophytes. An experiment was conducted on lalswarna cv of rice to detect the spore load in the air and its impact in further disease development, with special reference to meteorological parameters and growth stages of the crop under west Bengal condition for 2014 and 2015 Kharif season. The spore traps were placed in four different height (30cm, 60cm, 90cm and 120 cm) and five different locations (E, W, N, S, C) for recording the spore load and its subsequent role in severe development of disease. Trapped spores were identified through microscopic observation of different slides. The endophytic fungi identified during observation were *Aspergillus* sp., *Alternaria* sp., *Curvularia* sp., *Choanephora* sp., *Sarocladium* sp., *Penicillium* sp., *Nigrospora oryzae* and *Lasioidiplodia theobromae*. The spore percentage and disease severity were remarkably differing in different rice growth stages (Germination, Seedling, Tillering, Stem elongation, Booting, Heading, Milk stage, Dough stage and Mature grain). During quantification of primary inoculum in the field it was found that *Alternaria* (50% and 41%) and *Sarocladium* (19% and 23.12%) were dominant in both kharif 2014 and 2015 but, during severity study *Sarocladium* (43.24% and 42.43%) and *Curvularia* (41.55 and 35.11) were most dominant during kharif 2014 and 2015 respectively. The incidence level of most of the trapped spore were specific to the particular growth stages *i.e.* the favourable growth stage for *Alternaria* is Germination/Seedling stage while for *Sarocladium* booting stage is more favourable for initiation of disease. Direct observation under field condition indicates that saprobic colonization and sporulation of non-systemic rice endophytes could become unrestrained when their host plant tissue dies. Subsequently, when appropriate environmental conditions favour sporulation on grass host surfaces, the natural cycle for airborne conidia initiates and large numbers of these conidia disperse as inoculum for new endophytic infections. Therefore, the cycle of endophytism may be an important link between climate and plant biology.

**S-2/P-12****Incidence of bacterial wilt (c.o.: *Ralstonia solanacearum*) in Sundarban region of West Bengal, India****Saktipada Mandal and Bholanath Mandal***Department of Plant Protection, Palli-Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Srinikatan 731 236, West Bengal; E-mail : bholanath.ppvb@gmail.com*

Experiment was conducted in nineteen blocks of North and South 24 Parganas under Sundarban region of West Bengal for three consecutive years (2012-2014) to record the incidence of bacterial wilt caused by *Ralstonia* (= *Pseudomonas*) *solanacearum* (Smith) Yabuuchi *et al.* in crop plants. Fifteen numbers of plots per block selected randomly were considered for collecting data. Bacterial nature of the disease was confirmed in the field condition directly by ooze test. Selective medium was used for isolation of the bacterium. Important morphological and biochemical characters were recorded for its identification. Host range of the pathogen studied through pathogenicity test employing stem injection method. Soil



samples were collected from each plot for determination of pH, EC and organic carbon making a sharp relationship with the disease incidence. Bacterial wilt is prevalent in 19 blocks under Sundarban region of West Bengal infecting brinjal, tomato, potato, chilli, elephant foot yam, ginger, bitter gourd and *Amaranthus viridis*. Incidence of the disease on these crops was recorded throughout the region except bitter gourd that was recorded from Jaynagar I, Jaynagar II, Kultali and Mathurapur-II block under the district South 24 Parganas. The average range of disease incidence was recorded 14.13-64.67 per cent (brinjal), 9.84-63.63 per cent (tomato), 1.99-15.48 per cent (potato) and 1.33-9.23 per cent (chilli) for six blocks under North 24 Parganas, while that was 11.07-61.22 per cent (brinjal), 9.73-58.35 per cent (tomato), 1.49-11.49 per cent (potato) and 2.53-16.91 per cent (chilli) for thirteen blocks under South 24 Parganas. No much variation observed on disease incidence with average soil P<sup>ii</sup> (4.9-8.05), EC (0.31-0.98 dsm<sup>-1</sup>) and organic carbon (0.39-0.70%), while a reverse relationship was recorded between soil EC and disease incidence. Disease incidence recorded lower in the field proximity to river side. On pathogenicity test existence of variation in relation to host specificity and virulence was prominent.

#### S-2/P-13

### Occurrence of diseases on sweet flag (*Acorus calamus* L.) in West Bengal

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Sweet flag (*Acorus calamus* L.), commonly known as *Bach*, is one of the most important plant in the Asia for its beneficial and medicinal value. It is cultivated commercially in India since long time. The word 'acorus' is originated from the Greek word 'acoron' used by the Dioscorids which in turn derived from the 'coreon' word means 'pupil' because it is used in the treatment of eyes diseases and its inflammation. It is one of the most valuable plants in the medical sciences as well as *Ayurvedic* science throughout India as it is effective against wide varieties of illnesses. This plant showed anti-spasmodic, carminative and anthelmintic properties. The rhizomes of this plant is widely used in the numbers of ailments like epilepsy, mental ailments, chronic diarrhea, dysentery, bronchial catarrh, intermittent fevers and glandular, abdominal tumors, kidney and liver troubles, rheumatism, sinusitis and eczema. However, the plant was found to vulnerable to plant pathogen attack. The occurrence of four diseases namely, basal rot caused by *Sclerotium rolfsii*, leaf spot (*Colletotrichum* sp.), leaf tip rot (*Cercospora* sp.) and rust caused by *Uromyces acori* was identified on *bach* (*Acorus calamus*) in a field at Kalyani, Nadia, West Bengal. In case basal rot, the pathogen attacked in the base of the leaves resulting gradual dried of total leaves. In severe infection, white mat of mycelia and occasionally sclerotia of the pathogen were found to cover the base of

leaves. The leaf spot disease was characterized by dark brown to black necrotic lesions surrounded by yellow hallow with lighter grey centre covered with white mycelia of the pathogen. Gradually, the lesions became enlarged and coalesced to form blighted areas. Severely blighted leaves turned withered and dry. In leaf tip rot disease, the affected leaves were gradually withered from the leaf tip. The *Bach* rust was appeared as brown colour pustules and covered on all over the leaves.

#### S-2/P-14

### In vitro efficacy of plant growth promoting rhizobacteria (PGPR) from salinity affected rhizosphere of mungbean

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For the survey and isolation of potent PGPR, fourteen representative samples were collected from different saline areas of Navsari. All the soil samples were characterized for physico-chemical as well as microbiological parameters and data revealed that all the samples were saline-sodic (EC: 3.88-5.42 dS/m; pH: 7.53-8.43) as well as possessed variable organic carbon content (0.25-0.87%). Microbiological data suggested that increase in soil EC and pH reduced total bacterial population whereas, increased ACC deaminase producing bacterial population. Total 41 isolates were obtained from all the collected soil samples with distinct colony morphology and were tested in in vitro conditions for their efficacy of Plant Growth Promoting (PGP) characteristics like ACC deaminase activity, phosphate and zinc solubilization, potash mobilization, nitrogen fixation, antagonistic potential etc. Two most potent PGPR isolates were screened and identified as *Bacillus subtilis* and *Serratia liquefaciens* by biochemical and molecular identification methods. Native strain of *Rhizobium phaseoli* was also isolated from mungbean growing under saline conditions. All the three bioagents were found to improve per cent seed germination, seedling length and weight over alone inoculation and control treatment by paper boat method.

#### S-2/P-15

### Temporal and spatial changes in defence enzyme molecules in response to *Fusarium* wilt in chickpea and pigeonpea

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*Fusarium* wilt is a serious and wide spread disease of chickpea and pigeonpea in India, Iran, Pakistan, Nepal, Burma, Spain, Mexico, Peru, Syria and the USA. Various host molecules have been discovered that seem to confer resistance to plants against this disease. Consequently, there is a considerable interest in understanding how plants recognize pathogen attack and

control expression of defence mechanisms. Induction of plant defence against pathogen attack is regulated by a complex network of different signals. In this study, compounds have been identified which impart resistance or tolerance to the donors in chickpea and pigeonpea. An attempt was made to correlate and analyse the biochemical basis of disease resistance, by measuring levels of PO, PPO, PAL, catalase, chitinase,  $\beta$ -1,3-glucanase and phenolics in root, stem and leaf tissues of wilt resistant and wilt susceptible cultivars of chickpea and pigeonpea inoculated with *F. oxysporum* f. sp. *ciceri* and *F. udum*, respectively. The results indicate that all these enzyme activities increased in chickpea and pigeonpea tissues after inoculation with Foc and Fud. In comparison to susceptible cultivars, activities were higher in the resistant cultivars at disease initiation stage. This establishes the fact that enzymes are induced at high amount only after pathogen infection and disease initiation in resistant cultivars. The identification and characterization of novel bio-molecules involved in plant defence will contribute to our understanding of the complex regulation of expression of the corresponding genes and will be helpful in the elucidation of the transduction pathways that connect perception of the inducing signal to activation of gene expression. Much work is presently concentrated on these topics and will undoubtedly yield exciting new insights in this field of research.

#### S-2/P-16

### Development of disease prediction model for Collar rot disease of Chickpea incited by *S. rolfisii* under West Bengal condition

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Chickpea (*Cicer arietinum* L.) is an important pulse crop, which belongs to leguminous family, ranking third after dry beans (*Phaseolus vulgaris* L.) and dry peas (*Pisum sativum* L.) Production of chickpea has either remained static or declined over the past decade due to biotic and abiotic constraints. Among the biotic stresses diseases are one of the most important constraints in pulse production. More than 50 pathogens of chickpea are identified in the world but a few of them have the potential to devastate the crop. Collar rot of chickpea incited by *Sclerotium rolfisii* is one of the most important soil-borne diseases of chickpea under gangetic alluvial region of West Bengal, India. The objective of the present research work was to identify major important weather indices and soil abiotic factors associated with *Sclerotium rolfisii* induced disease progression in chickpea. Correlation coefficient between all weekly average of soil and weather parameters (Soil T max, Soil T min., Soil T avg., Soil Moist., Atm. T max., Atm. T min., Atm. T avg., R.H. max., R.H. min., R.H. avg., Avg. Rainfall) and sclerotial population with disease incidence percentage indicated that disease incidence was found to be significantly positively correlated with sclerotial population even at 1% level of significance. Even some of the soil and weather parameters showed high correlation within

themselves. So, regression in backward step was performed to eliminate the parameters having interdependence to find the most important soil and weather parameters contributing to the disease incidence of *S. rolfisii*. Sclerotial population, soil T max and soil T avg were considered to be the important predictor and could able to predict the variation of disease incidence of *S. rolfisii* up to eighty two percent. The regression model developed was found to be of goodness of fit with the observed and model driven cumulative disease incidence.

### Technical Session–III: Molecular Plant Pathology : Detection, diagnosis, host-pathogen interaction and nano technology

#### Lead Lecture

#### S-3/L-1

### Chemical and molecular basis of plant health during adaptation to biotic challenges and the role of small RNAs

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Plants encounter a plethora of biotic stresses, several of which, such as attack from pathogens, dominate their biological niche. We investigate how plants reconfigure their signaling and metabolic networks to defend themselves when they are attacked by pathogens and herbivores. Reconfiguration of plant metabolism to confer reliable resistance to invading organisms comprise a complex chain of events involving an intricate phytohormone response involving jasmonic acid [JA], ethylene and salicylic acid [SA] signaling networks. These complex signaling networks may regulate complicated large-scale metabolomic reconfigurations that arm plants with chemical arsenals for defense, including phenolics, phenolamides, polyamines, diterpenoids, and volatiles. How these complex, adaptive chemical responses are regulated molecularly, remains a daunting question. In this talk we will try to answer this question by exploring how the regulatory small-RNAs [smRNAs; such as miRNAs and siRNAs] may be master regulators of plant defenses. We propose involvement of a novel smRNA machinery that has been specifically tailored for modulating the sophisticated plant-biotic interactions. We also attempt to gain insights into understanding the basis of molecular evolution and diversification of pathways that synthesize the regulatory smRNAs.

#### S-3/L-2

### Nanocentric plant health management with special reference to Silver

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The term 'nano' (Greek word) mean dwarf. Nanometre (nm) is

one-billionth of a metre, or approximately one hundred thousandth of the width of a human hair. Nanotechnology, the fascinating science refers to the technology of rearranging and processing of atoms and molecules to fabricate materials to nano specifications such as a nanometre (1-100 nm). A key requirement in the area of nanotechnology is the growth of reliable and environment friendly process for synthesis of metallic nanoparticles. Synthesis and characterization of noble metal nanoparticle like silver with unique electronics, optical, magnetic and chemical properties, which differ considerably from those of the corresponding bulk material is a challenge and are technological importance. In our study we synthesized silver nanoparticle from different potential biological sources, which were characterized by UV-VIS spectrophotometer, DLS, XRD, TEM and Zeta potential. The green synthesized silver nanoparticle when tested against different plant pathogens like, *Rhizoctonia solani*, *Sclerotium rolfsii*, *Fusarium* spp., *Sclerotinia sclerotiorum*, and *Colletotrichum capsici*, we found silver nanoparticle at 100 ppm have higher antifungal efficacy as compared to the recommended chemical. In our laboratory, works on green synthesis of nanoparticle like zinc oxide, copper, gold and chitosan, their efficacy against different plant pathogens and preparation of nanobioformulation is in progress. If these are found effective it will pave way of using plant disease management and also reduce the pressure of pesticide load in the environment to the extent of many fold. Scientists have developed interest towards exploring new applications of nanotechnology in agriculture and the food industry too- if these discoveries applied wisely, the environment, the agricultural sector and the food industry will indeed see remarkable change for the superior in the forth coming years.

### S-3/L-3

#### Genome-wide analysis of *Alternaria* stress-responsive microRNAs and their targets in tomato

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MicroRNAs are crucial regulator of reprogramming of gene expression cascade during plant-pathogen interaction. We have used tomato (*Solanum lycopersicum*) cultivar Pusa Ruby and early blight pathogen *Alternaria solani*, for the analysis of miRNA and mRNA transcriptome expression profiles in a compatible interaction. Next generation sequencing (NGS) technique based whole transcriptome analysis revealed that, 67 miRNAs belonging to both conserved and Solanaceae specific miRNA families were differentially expressed, and 5450 genes' expression was varied. Most of the miRNAs were down-regulated, and 13 miRNAs were highly differentially regulated ( $\log_2FC \geq \pm 3$ ). Furthermore, using stringent selection criteria we could detect 74 putative novel miRNAs. GO terms enrichment and KEGG pathway analyses of predicted targets of differentially expressed miRNAs, as well as mRNA

transcriptomics, indicated that genes of plant-pathogen interaction, plant hormone signal transduction pathways and secondary metabolite biosynthesis were mostly affected by these miRNAs. We have also found that five different miRNAs target ~37% of tomato NB-LRR genes. These studies were further extended to investigate the mechanism of regulation of miRNA expression. Analysis of the promoter region of the miR167 gene, one of the highly expressed miRNAs, indicated that biotic stress related cis-elements have an important role in transcriptional regulation. Individual miRNA and target interaction are being analyzed to understand the importance of this interaction in the disease biology.

### S-3/L-4

#### Antimicrobial biomolecules of higher fungi against phytopathogens (Concept to Commercialization)

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Innovative ideas and novel products are the most wanted dynamic tools for advancements in plant protection industry. A global estimate shows that, approximately 400 registered active ingredients and 1250 commercial products are already available in the market and several others are in pipeline (NAAS, 2013). Biopesticides assumed a strong growth rate with the total market share of 3.3 billion USD during 2014 (BCC Research, 2015). Live formulations or extracted molecules represent 4.2 per cent of the overall pesticide market in India and the expected annual growth rate would be more than 10 per cent (FICCI, 2013). The versatile utility and effectiveness of recently introduced triazoles and strobilurins make them prime among all other contemporary molecules used in agrochemical and health care industries. Strobilurins and oudemansins are a group of natural products produced by wood inhabiting fungi, *Strobilurus tenacellus* and *Oudemansiella mucida*. These natural products formed the base for the synthesis of more than 1400 compounds for the use in agrochemical and pharmaceutical industries (Bartlett et al 2002). The secretomes of several mushrooms and toadstool possess inhibitory effect on plant pathogenic fungi, bacteria and viruses (Janssens et al 1992; Breheret et al 1997 and Marumoto et al 1997). A peptide called eryngin and a polypeptide called alveolarin obtained from *Pleurotus eryngii* and *Polyporus alveolaris*, respectively possessed antifungal activity against *Aspergillus flavus*, *Aspergillus fumigatus* and *Penicillium chrysogenum* (Wang et al 2004). A kind of lectin obtained from *Ganoderma lucidum* exhibited antifungal activity against *Fusarium oxysporium*, *Penicillium chrysogenum*, *Aspergillus niger*, *Colletotrichum musae* and *Botrytis cinerea* (Girja et al 2011). Hypsin and lyophyllin extracted from the fruiting bodies of the edible mushrooms like *Hypsizigus marmoreus* and *Lyophyllum shimeji* inhibited the growth of *Mycosphaerella arachidicola*, *Physalospora piricola*, *Botrytis cinerea* and *Fusarium* sp. (Lam and Ng, 2001). The phenolic compounds and water extracts of *Lentinula edodes*, *Boletus edulis*, *Pleurotus ostreatus* and



*Agaricus bisporus* have been known to possess antimicrobial and nematocidal properties (Luo et al 2007 and Susana, et al 2009). Aslam and Saifullah (2013) reported that button mushroom and oyster mushroom spent substrate extracts had exhibited antinematic activity against root-knot nematodes. *Ophiocordyceps sinensis* (= *Cordyceps sinensis* (Berk.) Sacc.), the “Chinese caterpillar fungus” (Family: *Ophiocordycepiaceae*, Phylum: Ascomycota), is one of the most valued mushroom fungus by pharmaceutical industry (Sung et al 2007). The erstwhile known anamorphic state(s) of the genus *Cordyceps* viz., *Beauveria*, *Metarhizium* and *Paecilomyces* have been reported to kill nematodes and insect pests by direct parasitism or lysis (Jatala et al 1980; St. Leger et al 1992; Gillespie et al 1998; De-faria and Wraight, 2007; Sangeetha et al 2015). *Cordyceps* species are parasitic rather specifically on insects, nematodes, sclerotia of *Claviceps*, or hypogeous ascocarps (Jeffries and young, 1994). *Ophiocordyceps* spp are known to produce several novel bioactive compounds like cordycepin, adenosine, ergosterol and myriocin (Isaka et al 2000; Varshney et al 2011; Kumar and Spandana, 2013; Sangeetha et al 2015).

In addition, the fungus is also known to produce several volatile compounds (Yu et al 2012; Sangeetha, 2015 and Sangeetha et al 2016) including aldehydes (benzaldehyde, benzene acetaldehyde, nonanal and decanal); aromatics alcohols (phenylethyl alcohol, 2-(methylthio)-3-pyridinol, 7-octadien-1-ol, azulene, 2-6, dimethylnaphthalene and 1, 6-dimethyl-naphthalene) and phenols (2-methyl-phenol, butylated hydroxytoluene). Exploration of such volatiles will have more promises in the management of soil borne plant pathogens, nematodes and harmful soil insects. At this juncture, formulating novel active ingredients, prototype fungicides and consortia of biomolecules having multiple advantages are highly demanding. Obviously, it would be great, if one time delivery of such formulation addresses plant pathogens, parasitic nematodes, insect pests and plant growth promotion.

## Oral Presentation

### S-3/O-1

#### Molecular characterization of Yellow Mosaic Virus (s) causing yellow mosaic diseases of pulses in north-east Indian state of Meghalaya

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Four species of yellow mosaic viruses namely *Mungbean yellow mosaic India virus* (MYMIV), *Mungbean yellow mosaic virus* (MYMV), *Horsegram yellow mosaic virus* (HgYMV) and *Dolichos yellow mosaic virus* (DoYMV) are identified as

causal agent of yellow mosaic disease (YMD) worldwide. An investigation was performed to identify the actual causal agent responsible for YMD in legumes of mid-hill Meghalaya. Overall, 19 genotypes of mungbean, two of blackgram, 120 of rice bean and 28 of soybean were evaluated for YMD under natural field condition. The disease incidence varied from 1 to >50% among different genotypes of various leguminous crops. Resistant to moderately resistant genotypes of mungbean (11 and 5), rice bean (6 and 59) and soybean (5 and 6) has been identified while few showed moderate to highly susceptible reaction. None of the crop showed immune responses. Detection was done through rolling circle amplification and polymerase chain reaction (RCA-PCR) using species specific primers. It confirmed the presence of MYMIV DNA A (~1000bp), MYMIV DNA B (~900bp) and MYMV DNA B (~900bp). None of the sample was positive for HgYMV and DoYMV. The full genome characterization was achieved following RCA and restriction digestion of total DNA extracted from a symptomatic mungbean genotype (Sm13-23). Full length DNA A (digested by restriction enzyme *EcoRV*) and DNA B (digested with *BglI*) had expected size of ~2.7 kb. [NCBI accession no. KU95030 and KU95031, respectively]. Sequence analysis showed Meghalaya isolate had characteristic features of begomoviruses. DNA A and DNA B shared a common region (CR) with 90.4 per cent similarity. Sequence comparison of DNA A component of Meghalaya isolate showed maximum (97%) nucleotide (nt) identity with MYMIV isolate (HF922628) reported from West Bengal, India and DNA B showed ~96% nt identity with MYMV isolates (KP319016 and KP319017) having variant DNA B. Phylogenetic tree of DNA A of Meghalaya isolate also revealed it to be MYMIV as it clustered within MYMIV cluster. However, the DNA B of Meghalaya isolate grouped with variant MYMV positioning in between MYMIV and MYMV. Recombination analysis also confirmed, one recombination event in the CR of DNA B of Meghalaya for which MYMV: India: clone PB1 was identified as major parent and MYMIV: India: clone MBB-B31 as minor parent. The results indicated that YMD of legumes under mid-hill condition of Meghalaya, India was caused by a distinct strain of MYMIV with a recombinant DNA B.

### S-3/O-2

#### Green synthesis and characterization of silver nanoparticles and their efficacy against certain lepidopteran pests

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Each year, in agriculture, billions of dollars are spent worldwide in controlling insect pests. Lepidoptera is the second largest order of insects, with more than 150, 000 species worldwide, which causes yield loss of 30-35% from sowing up to storage condition. Until recently, broad spectrum chemical insecticides have been the primary control agent for agricultural pests, with about 40% targeted to the control of lepidopteran pests. Synthesis of silver nanoparticles from plant

extracts is a pioneer technique. Preparation of plant extracts is very easy, cheap method and eco friendly in nature. Biological approaches using plant extracts for metal nanoparticles synthesis is a valuable alternative over chemical methods. So the present studies was carried out with synthesis of silver nanoparticles from *Mimosops elengi*, *Ocimum sanctum*, *Nerium oleander*, *Datura metel* and its efficacy against *Leucinodes orbonalis* and *Corcyra cephalonica*. The production of silver nanoparticles synthesized using plant extract like, *Mimosops elengi*, *Ocimum sanctum*, *Nerium oleander* and *Datura metel* was confirmed through UV-Vis spectrophotometer in wavelength range of 200-700 nm. This revealed a peak at 423nm, 302nm, 303nm and 410 nm for *Nerium oleander*, *Mimosops elengi*, *Ocimum sanctum* and *Datura metel* which confirmed the production of silver nanoparticles. To determine silver nanoparticles efficacy against *Leucinodes orbonalis* and *Corcyra cephalonica* dilution viz, 200, 300, 400 and 500 ppm were prepared and sprayed it against selected pest larvae. A control with untreated larvae was also maintained. In case of *Leucinodes orbonalis*, 80 per cent of larval mortality obtained from *Nerium* and *Datura* AgNPs between conc. 200-400ppm upto five days after treatment. For *Corcyra cephalonica*, 85 per cent larval mortality observed from *Mimosops* and *Nerium* AgNPs conc.300-500ppm upto three days after Treatment. As the concentration and days after treatment increased, larval mortality also increased. The application of nanotechnology as a supplement for existing strategies for insect pest management.

### S-3/O-3

#### Rapid detection of Mesta Yellow Vein Mosaic Virus by Loop-Mediated Isothermal Amplification Reaction

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The primary step for efficient management of viral diseases is the development of a simple, rapid, and sensitive virus detection technique. Therefore, a loop-mediated isothermal amplification (LAMP) assay was optimized for the detection of *Mesta yellow vein mosaic virus* (MeYVMV) in diseased plants of mesta (*Hibiscus sabdariffa* L. and *Hibiscus cannabinus* L.). The LAMP assay optimized in the present study involved a set of six primers targeting MeYVMV and could be completed in 30 – 60 min under isothermal temperature of 63 °C. The LAMP amplification results were visualized by adding 1 µl of Hydroxy Naphthol Blue (HNB) dye in 25 µl LAMP reaction mixture prior to amplification as well as by electrophoresis. The visibility in HNB dye was similar to that of the visibility in electrophoresis. The sensitivities of both LAMP and polymerase chain reaction (PCR) assays were comparable at low virus titer concentrations. The LAMP assay was more sensitive, by a 10<sup>-5</sup> fold dilution factor, than the PCR assay (10<sup>-4</sup> fold dilution factor) for the detection of MeYVMV in diseased plants. No positive reactions were detected in the tissues of healthy plants either by LAMP or by PCR. The LAMP assay

optimized in this study was capable of detecting MeYVMV in different parts of kenaf and roselle plant. Similarly, the optimized PCR assay was also capable of detecting MeYVMV in different parts of kenaf but failed to detect MeYVMV in stem and flower buds of roselle. The LAMP assay optimized in this study will provide a simple, efficient and highly specific tool for the detection of MeYVMV in virus quarantine programs. This is the first report in India for detection of MeYVMV in kenaf and roselle using LAMP.

#### Technical Session–IV: Plant Disease Management: Chemical, biological, cultural, plant quarantine, IDM.

##### Lead Lecture

##### S-4/L-1

#### Migration and immigration of plant pathogens into cut flower industry and their management

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Floriculture is a fast growing industry in with an average area of 2,33,000 ha in India. Cut flowers, being a low volume and a high valued crop, most of the entrepreneurs venture into the cultivation of cutflowers like carnation, orchids, anthurium, gerbera, lillium, alstomeria, bird of paradise, chrysanthemum and rose. Besides, loose flowers like jasmine, crossandra, tuberose, ixora, marigold, chrysanthemum and nerium are also cultivated under open field conditions. The propagative materials for the cultivation of high valued cut flowers are imported from other countries. The import of the propagative materials results in immigration and migration of unknown plant pathogens of National significance, which are to be quarantined and regulated. Based on our experience with various cut flower growers, we came to detect the entry of quarantine pathogens like tomato spotted wilt virus from cut chrysanthemum, which is not known to exist earlier. The TSWV was introduced through chrysanthemum stem cuttings (*Dendranthema grandiflora* Tzvelev). Symptom expression were noticed only after 30 days of planting. Infected plants showed veinal necrosis and necrotic spots on leaves, browning of flower petals, malformed flowers and stem necrosis. In severe cases, excessive necrosis, complete drying and death of the plants were also observed. RT-PCR was performed using the tospovirus degenerate primers gl 3617/ F-5'CCTTTAACAGTDGAAACAT 3'; gl4435c/R- 5'CAT DGCRCAAGARTGRTARACAGA3') (Stankovic, et al, 2013) corresponding to the RNA-dependent RNA polymerase (RdRp) gene of tospoviruses. An amplicon of approximately 750 bp (KJ013534) was amplified from the symptomatic samples and had 98% identity with the RdRp gene of *Tomato spotted wilt virus* (TSWV) (GenBank Accession numbers, KC261950, KC261956, KC261959, KC261962). Further it was confirmed with two sets of primer pairs specific to the TSWV

nucleocapsid gene (GK TSWV CP F-5'CAAGCAATAAAGA TAAAGAAAGC3';GKTSWV CPR- 5'AGCATATAACAAC TTCTACGATC 3'), and movement protein (MP) gene (GK TSWV MP F 5'ACCTATTATACACTTTGCTAAGAA3'; GK TSWV MPR 5'AATGCAAAATWRACAGAAATT 3') of TSWV (GeneBank Accession numbers for N gene-KJ494928; MP gene - KJ494927) exhibited the highest nucleotide identity of 98% with corresponding regions of TSWV isolates from different hosts and countries (GenBank accession numbers: for N gene- FR693048, KC494481, KC494495 and for MP gene- HQ830188, HQ830185, HM 015511). Subsequently, it was further confirmed using DAS ELISA and TSWV-specific antiserum. While there are several tospoviruses known to infect economically important crops in India (Pappu et al., 2009), TSWV is not known to occur in India (Mandal et al., 2012). Chrysanthemum was also infected by white rust, the quarantine pathogen *Puccinia horiana*. The *P. horiana* species specific primer (Ph-F1 5'- TGCATGAATTTTGGAAAGGT-3' and Ph-R1-5'-CAAAAATTATTTTGTGAGAGGG-3') amplified a fragment of approximately 240bp. Yet another, *P. horiana* species specific primer for the region of 18S to 28S rDNA intervening sequence (Ph-F2 5' CCCCTTTTATTATA TAACACAAG-3' and Ph-R1-5'-CAAAAATTATTTTGTGAGAGGG-3') amplified a fragment of approximately 340 bp. DNA fragments amplified with species specific primer pairs of *P. horiana* were cloned and sequenced for the K5 rust isolate from the variety (punch white) and the isolate HP2 from the variety (Saffin Pink). In the BLAST analysis sequences of K5 and HP2 isolates (Accession no: KC291657, KC291658, KC291659 and KC291660 respectively) had a nucleotide sequence identity of 100% with the *P. horiana* (Accession no: EU816916.1, HQ201326.1 EU816916.1 and EU816924.1) isolates. Apart from the same, we also encountered crown gall pathogen *Rhizobium tumefaciens* in the nursery and main field. Survey of anthurium revealed the presence of bacterial blight. The pathogen causing bacterial blight was identified up to genus level through MALDI TOF-MS as *Xanthomonas*. It was further confirmed as *Xanthomonas axonopodis* pv. *dieffenbachiae* through FAME analysis, BIOLOG and by polymerized chain reaction using pathogen specific primers. DNA sequence of *X. axonopodis* pv. *dieffenbachiae* isolates designated as XAD1 and XAD2 were submitted in the NCBI Gen Bank bearing the accession numbers KJ603434 and KJ637328 respectively. House keeping genes also confirmed the identity of *X. axonopodis* pv. *dieffenbachiae* (KJ603435, KJ603436, KJ603437, KJ603438, KJ637329 and KJ637330). Survey was conducted in carnation growing areas of Tamil Nadu revealed the occurrence of stem rot of carnation seedlings in the susceptible variety, Charmant pink. Initial symptoms include paleness of the plant and drooping of leaves. When the pale drooping plants were examined, cottony white mycelial growth was observed in the root zone as well as in the collar region of the plant. Under severe infestation, dark black irregular sclerotial bodies of various sizes, were noticed in the split opened stem. The disease incidence was estimated to be 38.5%. The pathogen was confirmed as *Sclerotinia sclerotiorum* through morphogenetic and molecular means. The genomic DNA was extracted from the fungus by CTAB method and the region between ITS 1 and ITS 4 primers were amplified with the primer pairs, ITS 1 (5'-TCTGTAGGTGA

ACCTGCGG-3') and ITS 4 (5'-TCCTCCGCTTAT TGATATGC-3'). The amplicon of ~ 600bp obtained were sequenced. The nucleotide sequence (GenBank accession number KP676452) had maximum identity of 99% with *S. sclerotiorum* (KM272350). Survey of oriental and asiatic lillium in Nilgiris revealed the presence of *Botrytis cinerea* and devastated the entire crop within 48h after infection during the favourable environmental conditions including low night temperature below 15C coupled with increased hours of leaf wetness and relative humidity of >90%. The asiatic variety beausoliel, brindhisi and nashville were highly susceptible for *Botrytis* blight. Oriental lillium leaf samples showing characteristic symptoms of virus infection were collected from Nilgiris district of Tamil Nadu and indexed using ELISA and reverse transcription polymerase chain reaction (RT-PCR). The coat protein (CP) gene of PIAMV was amplified with an amplicon size of 722 bp and sequence analysis confirmed the viruses as PIAMV. They were 99 to 100 % nucleotide and 99.5 to 100% amino acid homology with other PIAMV isolates. Multiple sequence alignment comparison analyses confirmed the close relationship between PIAMV and *Tulip virus X* (TVX) which had sequence identity of nearly 70 %. Phylogenetic analysis of the nucleotide confirms that our PIAMV isolates forms a single subgroup with other PIAMV isolates. *Plantago asiatica mosaic virus* (PIAMV) was identified in oriental lily showing symptoms of chlorotic and necrotic streaks on the leaves, a syndrome of wide occurrence and possible multiple etiology. This study provides important clues about spread of the virus and to the best of our knowledge it is the first detailed study of PIAMV infecting lily in India *Plantago asiatica mosaic virus*. There is no doubt that, cut flower cultivation is a lucrative business. But, the legal and illegal imports of the cut flowers has to be monitored to prevent the new introductions and after the introductions, it has to be regulated on a war foot, by sensitizing the growers and by empowering the growers, quarantine authorities, extension functionaries and scientists to prevent the immigration and further spread of the pathogens to other food crops and to rescue the cut flower industry. The migrated pathogen into the country can be very well managed by exploring endomicrobiomes such as *Bacillus amyloliquefaciens*, *B. pumilis*, *B. licheniformis* and *Ochrobactrum* spp., through biohardening of the propagative materials coupled with the drenching of growing media and through foliar spray. Intensification of research in these areas will open new avenues for the management of plant diseases.

#### S-4/L-2

### Management of millet diseases- challenges and way forward

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Milletts are small-grained, annual grasses of taxonomically different genera. They have the largest area among the cereals after rice, wheat and maize. Of the cultivated millets, sorghum,



pearl millet, finger millet and foxtail millet are widely grown in India. Millet cultivation is mostly concentrated in central, southern and western parts of the country and in a few states in north India. These crops have an advantage of growing in the harshest environments, where there is limited scope for growing other crops. Millets are indispensable as food crops in the rainfed agro-ecosystems. Millets are sources of high-energy and nutritious food, rich in fibers, minerals and B-vitamins, hence called nutri-cereals. Several regions in the semi-arid tropics are expected to experience scanty rainfall, long dry spells and warmer temperature due to climate change. A change in rainfall pattern makes it difficult to decide on the sowing and harvesting timings. There is also a chance of occurrence of new pests and diseases due to changes in temperature and humidity regime. Under such conditions, climate resilient crops that yield near normal productivity under changing climate are required and millets are the most prospective group of crops than any other crops under this situation. Millets are infected by many diseases, which cause considerable economic loss. Management of millet diseases is a real challenge because of the nature of the low-input production system, which does not allow input-intensive management practices to recommend and supplement the host resistance. Sole dependant of on host-plant resistance makes the management efforts tough. This paper discusses the significance of millet diseases in changing climatic situations and all aspects of disease resistance including sources, molecular mechanisms, genetics, and utilization of resistance for management and profitability of the crop.

S-4/L-3

### Management of plant diseases under organic farming system

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To meet the projected demand of the world's population, global food production must increase 50 per cent by 2050 while the cropland for non-food production sector viz. land degradation, urban expansion is likely to reduce the total global cropping area by 8–20 per cent. Climate change is likely to affect 25 per cent of world cereal production in Asia by influencing water availability. Pest and disease management has played its role in doubling food production in the last 40 years, but pathogens still claim 10–16 per cent of the global harvest. In financial terms, disease losses cost Rs 22,000 crores. The use of pesticides has helped in increasing agricultural production but also has led to the development of resistance in pests, contamination of the environment and resurgence of many new pests. Indian crop protection chemical industry is worth 4.25US\$ this year and with expected 12-12 per cent growth it will reach 7.5 billion US\$ by financial year 2019. At present, Indian consumption is about 90,000 tonnes of plant protection chemicals. It comes to about 500 grams per ha compared to 10-12 kg/ha in Japan and 5 kg/ha in Europe. There are about 1000 agrochemicals in use in the world over. India accounts for about 3.7 per cent of the total world consumption. It is also of interest to know that in spite of increased consumption of plant

protection chemicals, the produce loss due to insects and pests increased by 5 times during the period from 1988 to 1995. In addition, many other disadvantages of the pesticides have been recorded including the contamination of water sources, food and shift in biodiversity. Nearly seventy per cent of the healthy looking vegetables and fruits have high levels of residual pesticides. Organic farming is the globally accepted movement in respect of sustainable agricultural production, health safety, eco friendly, socio viable and on-farm based organic inputs & its management without disturbing the natural ecosystem. Many techniques used in organic farming like inter-cropping, mulching, botanicals, and integration of crops and livestock have been used in the traditional agriculture. However, involvement of modern developments in agricultural sciences like selection of areas, crops/varieties, composting methods, biofertilizers, bioagents, parasites, predators, traps etc. have provided strong scientific base for organic farming which capacitates to get higher and quality yields in various crops and also helps in maintenance and improvement of soil, water and environmental properties. Disease Management in Organic Farming is based on basic principles such as--avoidance, exclusion, eradication, resistance etc (no chemicals); Clean cultivation; selection of varieties: timely planting; companion planting; trapping or picking v ectors from the crop; using crop rotations, ITK based organic inputs and biopesticides etc. Many of them have been tested and found effective against a number of diseases of cereals and vegetable crops. Organic inputs have been used by organic practitioners based on ITKs for the management of various diseases. Many of them have been tested against a number of diseases of cereals and vegetable crops and found effective; Beejamrit---Cowdung + lime (Extracts); Jeevamrit—Cowdung + cowurine + Gram powder + jaggery; Panchgavya –CU + CD + Milk + curd + ghee; Amritpani - CD + ghee + honey; Horn manures (BD500, BD507); Matka khad –CD + CU + Jaggery + water; Vermiwash; Biosol etc. In a detailed study on organic management of buckeye rot of tomato caused by *Phytophthora nicotianae* var *parasitica*, integration of cultural practices with cow urine, *Trichoderma koningii* (DMA-8), aqueous extract of marigold leaves, soil drenching with Panchgavya, Neemastra, Jeevamrit, Amritpani, Ghniri extract or Akshwan @10% conc. was found to manage the disease most effectively.

### Oral Presentation

S-4/O-1

#### Proteomic analysis of *Capsicum annuum* to N-acyl homoserine lactone, a bacterial quorum sensing molecule

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The growth of *Ralstonia solanacearum* in plant tissues, particularly during disease development, leads to colonization, that can be linked to the formation of biofilms. Biofilms have a characteristic structure consisting of microcolonies enclosed in a hydrated matrix of microbially produced proteins, nucleic

acids, and polysaccharides. In this complex biofilm network, the cells act less as individual entities and more as a collective living system, often with channels to deliver water and nutrients to the cells at the inner portion of the biofilm. Biofilm formation is a trait closely related to pathogenicity/virulence. Bacteria form multicellular biofilm communities on most surfaces. Formation of these sessile communities and their inherent resistance to antimicrobial agents are at the root of many persistent and chronic bacterial infections. Biofilms represent microbial societies with their own defense and communication systems. Acyl homoserine lactone (AHL) mediated quorum sensing is widely prevalent in Gram negative bacteria. The Quorum Sensing (QS) mechanism enables bacteria to make collective decisions with respect to the expression of a specific set of genes involved in biofilm formation and virulence. Very little is known about the factors required for biofilm formation in *R. solanacearum*, a bacterial wilt causing pathogen in Solanaceous crops. Isolates were tested for biofilm formation using a microtiter plate method. These AHL molecules were used as elicitor to study the defense expression in chilli plants (*Capsicum annum* L.). Proteomic approach was employed to identify the differentially expressed defense related proteins between the *R. solanacearum* treated and AHL treated chilli seedlings. Proteins were extracted from leaves of 3-week-old seedlings of the different treatments and separated by 2-DE (Two dimensional electrophoresis). Our results indicated that a total of 400 protein spots are successfully identified under treatment conditions (by PDQuest software analysis), out of this the 24 differentially expressed protein spots are successfully identified by LC-MS/MS. Majority of proteins belongs to stress and defense, metabolism and energy related categories.

#### S-4/O-2

### Rhizosphere fluorescent pseudomonads induced systemic resistance in Mulberry (*Morus* spp.) against powdery mildew

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Studies were conducted to assess induced systemic resistance by native fluorescent pseudomonas against powdery mildew in mulberry. Native fluorescent pseudomonas bacteria were isolated from rhizosphere soil of mulberry and were evaluated against powdery mildew. *In vitro* conidial germination study showed significant ( $P < 0.05$ ) variation in conidial germination due to treatment with bacterial isolates Pf1 and Pf3. Mildew incidence was significantly varied due to treatment with various pseudomonas isolates *in vivo*. Significantly ( $P < 0.05$ ) low mildew incidence was observed in plants treated with Pf1 (9.113%) followed by Pf3 (13.48%) against untreated control (29.79%). Similarly, mildew severity was less in case of Pf1 (1.507%) followed by Pf3 (2.727%) and Pf5 (2.233%). The

bacterial isolates significantly influenced biochemical constituents such as chlorophyll-*a*, chlorophyll-*b*, protein and soluble sugar content of the leaf. Similarly the phenol content and peroxidase activity were found higher due to treatment with Pseudomonas strains Pf1, Pf3 and Pf5 where the disease severity was less. Significant ( $P < 0.01$ ) negative correlation was found between powdery mildew severity with phenol content as well as with peroxidase activity, thus confirms induction of systemic resistance in mulberry by pseudomonas bacteria. The study shows scope for exploration of rhizosphere fluorescent pseudomonas bacteria for induction of systemic resistance in mulberry to contain powdery mildew disease.

#### S-4/O-3

### Development of mapping population of bread wheat for karnal bunt disease resistance and validation with microsatellite marker

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Karnal bunt (KB) disease in wheat is caused by the fungus *Tilletia indica* (Syn. *Neovossia indica*). It is a hindrance to the grain industry, owing not to drastic yield loss but for the quarantine regulations that restrict free movement of the affected grain in the international trade. Several sources of resistance to KB have been reported. Understanding the genetics of resistance will facilitate the introgression of resistance into new wheat cultivars. Also, identification of PCR-based markers linked to KB resistance offers the prospect of using marker-assisted selection schemes in developing resistant wheat cultivars. In this study, initially recombinant inbred line (RIL) populations were derived from crosses of the susceptible cultivars HD 2009 and WL 711 with resistant parents HD 29 and HD 30. F4 and F5 populations evaluated for resistance against the KB pathogen was carried out under artificial epiphytotic conditions in the green house. The purpose of present study is to exploit the advantage of simple sequence repeat (SSR) primers to identify DNA markers closely linked to KB resistance gene(s) in bread wheat. Four SSR primers such as Xgwm88-6B, Xgwm337-1D, Xgwm637-4A and Xgwm538-4B specific for KB resistance gene were utilized for screening various crossing population of wheat taken from three crosses *viz.*, HD 30 x WL 711, HD 30x HD 2009 and HD 29x HD 2009. Each primer showed one resolvable bands. Primers Xgwm88-6B, Xgwm637-4A and Xgwm538-4B gave rise to single band of 350bp, 180bp and 150bp, respectively. Two alleles were amplified by the fourth primer Xgwm337-1D by giving rise to two amplicons of 50bp and 200bp size. The study demonstrated the efficiency of SSR technology and confirmed the existence of KB resistance gene in the newly developed RIL populations of bread wheat.

## S-4/O-4

**Bio-formulation of antagonistic *Pseudomonas aeruginosa* strains of PRS3 and PRP5**

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Antagonistic strains of pseudomonads PRS3 & PRP5 isolated from the rhizosphere of paddy seedlings from acidic soil of Kuttanad, Kerala. The bacterial strains selected antagonistically were identified using morphologically, biochemical characterization as well as sequence of 16S ribosomal RNA confirmed their identity as *pseudomonas aeruginosa*. The present study shows the bio formulation of strains (PRS3 & PRP5) shows antagonistic as well as plant growth promotion of rice in green house and field condition. The different combinations are (rice seeds coated with bacterial strains), (rice seeds coated with bacterial strains + fungal inoculum), (rice seeds without bacterial strains + fungal inoculum) tested with control (rice seeds without bacterial strains). The gnotobiotic study reveals the antagonistic effect of bio-formulate strains of (PRS3 & PRP5). The rice seeds coated with strains + fungal inoculums have great antagonistic effect compared with uncoated seeds having fungal inoculums. In all combinations the rice seeds coated with pseudomonas strains have great effect of antagonistic as well as plant growth compared with the untreated seeds. Infield studies, the bio-formulation of strains (PRS3 & PRP5) in paddy plant shows great shoot, root, leaf and yield compared with control. The present study the bio-formulation of pseudomonas aeruginosa strains PRS3 & PRP5 show great percentage of plant growth and antifungal activity in gnotobiotic, green house and field condition against in sheath blight by *Rhizoctonia solani*.

## S-4/O-5

**Management of *Fusarium* wilt of tomato caused by *Fusarium oxysporum* f. sp. *lycopersici***

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*Fusarium* wilt of tomato (*Lycopersicon esculentum* Miller) caused by *Fusarium oxysporum* f. sp. *lycopersici* is one of the most destructive diseases in tomato throughout the world. Effective and efficient management of the crop disease is generally achieved by the use of synthetic pesticides. These pesticides cause deleterious effects on human health and biosphere. Amendments (Neem cake, oil cake, cow dung, rabbit manure and chicken manure) were used in tomato seedlings to observe growth promotion increase in healthy and treated tomato seedlings of two varieties, Shrijana and Param. Results revealed that growth of the tomato seedlings was significantly increased following amendment with neem cake and oil cake in the treated *Fusarium oxysporum* f. sp. *lycopersici* inoculated plants than in untreated uninoculated plants as recorded. Oil cake had better effect than neem cake manure. It has been observed that the growth of tomato

seedlings increased in treated uninoculated than treated inoculated tomato seedlings. Among cow dung, rabbit manure and chicken manure, chicken manure gave better growth of tomato seedlings than that of rabbit manure and cow dung. Similarly effective integrated management practices against *Fusarium oxysporum* f. sp. *lycopersici* were also developed using neem cake, oil cake, aqueous bulb extract of *Allium sativum*, bio-control agent like *Trichoderma harzianum* and calixin (0.1%) in vivo. Combination with cow dung, neem cake, oil cake, chicken manure and rabbit manure, disease reduction were insignificant. However, combination with neem cake and oil cake showed 64.4 per cent disease incidence, whereas in oil cake, neem cake and *Allium sativum* in combination disease incidence were recorded 10.1 per cent. Under pot culture conditions *T. harzianum* alone and in combination with neem cake, oil cake and *Allium sativum* provided best effective management practices of *Fusarium* wilt in all the three modes of application viz ., simultaneous, repeated and post infection.

**Poster Presentation**

## S-4/P-1

**Biological control of sunflower rust disease caused by *Puccinia helianthi***

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This investigation was designed to explore the potential of microbial antagonism in the control of Sunflower (*Helianthus annuus*) rust disease caused by *Puccinia helianthi*. *Trichoderma harzianum* and *Pseudomonas fluorescens* were tested for biological efficacy in vivo as percent disease control and disease incidence. Field experiments were conducted and the results obtained indicated that *Trichoderma harzianum* treated plants showed reduced disease severity (least disease incidence) and highest percent disease control. The soil treatment method was effective in controlling the pathogen even at 65 days after sowing. This was significantly different from the control and *Pseudomonas* treated plants. Soil treatment with *Trichoderma* and *Pseudomonas* enhanced the growth parameters. Shoot, root length from treatment with *Trichoderma* (74.4 cm and 14.07 cm) were significantly longer compared to the control (50.8 cm and 9.60 cm) and plants treated with *Pseudomonas* (59.2 cm and 11.19 cm). Other parameters like leaf area, test weight, seed yield and oil analysis etc., were recorded. Thus the results showed that *Trichoderma* was very effective bio-control agent on *Helianthus annuus*.

## S-4/P-2

**Investigation on early blight (*Alternaria* sp.) of Tomato (*Solanum lycopersicum* L.) under South Gujarat condition**CV Chaudhary<sup>1</sup> and JR Pandya<sup>2</sup>

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Tomato (*Solanum lycopersicum* L.) is a crop of immense value



in olericulture. Tomato is one of the most widely cultivated solanaceous fruit vegetable crop in the world believed to have its origin in Tropical America (Thompson and Kelly, 1957). It is known as Love apple, Tomate, Tomat, Tomatar, Rangam, and Tomati in different parts of the world it is also popularly called as 'Poormen's orange'. It is grown extensively and marketed throughout the world. It ranks third largest vegetable crop after potato and sweet potato. It is a traditional vegetable crop commercially cultivated with a large area and higher production and productivity in India. The major tomato producing states are Gujarat, Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh, and West Bengal. In Gujarat, average of five years it is extensively cultivated in the area 44.57 ('000 ha) with production of 1259.01 ('000 Tons) and productivity of 28.2 MT/ha (Anon., 2014-15). In India, tomato crop is heavily affected by early blight disease, resulting severe yield losses in Gujarat. Early blight produces a wide range of symptoms at all stages of plant growth. The leaf blight phase usually begins on the lower, older leaves and progresses up to the plant. Infected leaves eventually wither, die and fall from the plant. Due to huge variability in the pathogen population and wider environmental adaptability, *Alternaria solani* is becoming a serious problem, now-a-day. Along with that intensification in agro-ecosystem like monoculturing of tomato and other Solanaceous crops and modernization in agronomic practices like sprinkler irrigation system provide a suitable environment for these pathogens. This ultimately leads higher incidence of disease. On the other hand extensive use of high risk fungicides increases the chance of development of fungicide resistant isolates. Therefore, their management is becoming a serious problem. The symptoms were observed through frequent field visit and subjected to slide preparation and tissue isolation. The pathogen was isolated confirmed and identified as *Alternaria solani* by isolating and after proving pathogenicity test. The systemic fungicides viz., propiconazole at 500, 750, and 1000 ppm proved very effective fungicide in inhibitory against *A. solani* which was followed by carbendazim and difenconazole at same concentrations, respectively. Among non-systemic fungicides, mancozeb, copper oxychloride, chlorothalonil, zineb, iprodion and propineb at different concentrations were found inhibitory against fungal growth of *A. solani*. The significant growth inhibition was recorded in mancozeb at 2000, 2500 and 3000 ppm concentration and found significantly superior over rest of the fungicides tested which was followed by copper oxychloride and propineb at same concentrations, respectively. Among combinations of systemic and non-systemic fungicides at different concentrations, the significant growth inhibition was recorded in metalaxyl 8% + mancozeb 64% at 1500, 2000 and 2500 ppm concentration, followed by carbendazim 12% + mancozeb 63% at same concentration. Six different known antagonists were screened *in vitro* for their *A. solani* by dual culture method. Among the antagonists tested, *T. viride* appeared as potential antagonist, which showed significant inhibition of mycelial growth of *A. solani* *in vitro*, followed by *T. harzianum*. The extracts of garlic (*allium sativum*) bulb showed significantly maximum growth inhibition 58.15 per cent of *A. solani*. The next best in order of merit was datura (*datura stramonium*) leaves 52.63 per cent. Screening done against natural infection of early blight disease during crop

#### S-4/P-3

### Soil-pest relationship: effect of soil physico-chemical properties on pest and disease development

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Soil is essential for the production of healthy nursery stock. It provides physical support for roots and supplies mineral nutrients and water necessary for growth. The soil is also the environment in which plant roots interact with soilborne insects and pathogens. Therefore, an understanding of how soil properties affect both plant and pest health is critical for making effective pest management decisions. Healthy soils occur when their biological, chemical, and physical conditions are all optimal, enabling high yields of crops. When this occurs, roots are able to proliferate easily, plentiful water enters and is stored in the soil, the plant has a sufficient nutrient supply, there are no harmful chemicals in the soil, and beneficial organisms are very active and able to keep potentially harmful ones in check as well as stimulate plant growth. Fine-textured soils are more prone to compaction and susceptible to poor drainage. Both conditions inhibit root growth and result in plant stress that can increase susceptibility to root pathogens. Damping-off and root rot are frequently more severe in clay soils because of these conditions. Fine-textured soils may slow seedling emergence, thereby increasing the amount of time that seedlings are in contact with pathogenic fungi. Coarse-textured soils, on the other hand, are more favorable for nematodes, which require larger pore spaces to move easily. Soil moisture conditions may also need to be managed for effective pest control. Fumigant efficacy is dependent on soil moisture during and after fumigation, and excess water can lead to pesticide leaching or uneven pesticide distribution in nursery fields. Warm soil temperatures are favorable for the development of a number of diseases including charcoal root rot and *Fusarium* root rot. The severity of several diseases may be significantly reduced by soil acidification.

#### S-4/P-4

### Potentiality of native *Pseudomonas* spp. in promoting Sugarcane seedling growth and red rot (*Colletotrichum falcatum* Went.) management

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Sugarcane is an important cash crop of India earning a lot of revenue. Sugarcane productivity is majorly hampered by several diseases of which red rot (*Colletotrichum falcatum* Went) is a major havoc. This disease is responsible for phasing

out of several ruling cultivars previously. Our present research is aimed at identifying a potential Plant Growth-Promoting Rhizobacteria (PGPR) strain that promotes cane growth, yield besides managing red rot disease effectively. Eight native strains of *Pseudomonas* were isolated from rhizosphere of sugarcane clones on Pseudomonas Agar using standard protocols. Further, these strains were characterized for antagonistic traits on red rot pathogen and Plant growth-promoting (PGP) activities in greenhouse up to 30 days from single node setts in portrays as sett treatment ( $10^9$  CFU ml<sup>-1</sup>). Two promising isolates were characterized up to species level by PCR amplification of 16S rDNA region using specific primers. Our results indicated that, *Pseudomonas* strains were inhibitory to *C. falcatum* (1.4 to 69.2% inhibition). Majority of isolates produced protease; however, only two strains were phosphate solubilizers. None of the isolates have produced the antibiotic pyocanin. Elite strains were identified as *P. putida* (AKP-1 and AKP-2). In Greenhouse, all the isolates were found to enhance sugarcane seedling growth, however, the strains, AKP-1 and AKP-2 were found superior over others. Our future studies are directed in establishing the endophytic nature, if any, of these elite strains in sugarcane and in confirming the antagonistic activity on *C. falcatum* in GH and field besides PGP activities.

#### S-4/P-5

### Screening of glutinous rice (Bora) against sheath rot disease of rice and to study the fungicidal efficacy against the disease in field condition

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An experiment on screening and reaction of Sheath rot of rice against glutinous or Bora rice was conducted at Regional Agriculture Research Station (RARS) Titabar, Assam, under field conditions during kharif 2015. The disease is one of the emerging major disease of rice which subsequently reduce the rice yield up to 86 per cent. The aim of the present study was screening of different genotypes and to access the potential of certain new molecules of fungicides to embit pathogen, *Sarocladium oryzae* the causal organism of Sheath rot of rice. Twenty numbers of rice genotypes of Bora were screened against Sheath rot, and the outcome of the experiment revealed that among the different genotypes less disease incidence were recorded Viz, Bokul Bora, Malbhog Bora (1), Chakua Bora, Aghoni Bora, Bhogali Bora and higher disease incidence were recorded viz, Jota Bora, Ikora Bora, Mon Bora, Ropahi Bora(2), Pokhori Bora, Poita Bora. For management of Sheath rot of Bora rice, the fungicides formulation were tested, among them ICF-110 (Tricyclazole 45% + Hexaconazole 10% WG) was found to be more efficient amongst all the other fungicides with reducing the disease severity by 87.81 per cent followed by Companion and Carbendazim 50% WP.

#### S-4/P-6

### Study of antagonistic activity of biocontrol agents against some important plant pathogenic fungi under *in vitro* condition

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Biological control refers to the purposeful utilization of introduced or resident living organisms, other than disease resistant host plants, to suppress the activities and populations of one or more plant pathogens or reproduction of one organism using another organism. Bio-control methods are successful as non-chemical and eco-friendly approach in the sustainable agricultural production. The study was conducted to judge the biocontrol potential of *Trichoderma harzianum*, *T. viride* and yeast under *in vitro* conditions against some fungal plant pathogens namely- *Alternaria alternata*, *Curvularia lunata*, *Corynesporacassicola*, *Fusariumciceri*, *Sclerotium rolfsii*, *Colletotrichum capsici*, *Rhizoctonia solani*, *Sclerotium hydrophyllum*, *Nigrospora oryzae* and *Rhizopus oryzae*. Percentage inhibition was calculated using standard formula. Antagonistic potential of *Trichoderma* was rated on Bell's scale. It was observed that *Trichoderma harzianum* showed maximum efficiency against *S. hydrophyllum* (77.1%) followed by *N. oryzae* (68%), *S. rolfsii* (64.4%), *C. capsici* (59.5%), *R. solani* (55.5%), *F. ciceri* (55.4%) etc. *T. viride* was maximum effective against *C. capsici* (60.9%) followed by *S. rolfsii* (59.6%), *S. hydrophyllum* (51.1%), *A. alternate* (48%) etc. Mycelial growth of the pathogens was restricted by mycoparasitic activity of *Trichoderma*. Coiling of hyphae of the pathogens by *Trichoderma* was seen under microscope. The yeast isolate was moderately effective against *S. rolfsii* (57%), *C. lunata* (45%), *N. oryzae* (42.2%), *C. cassicola* (40%), *C. capsici* (35.7%), *R. oryzae* (32.5%), *R. solani*-rice (31.3%) etc. Inhibition zone was recorded in case of *C. Cassicola* only. In rest of the cases it was found that the mycelial growth stopped immediately after touching the streak. At the vicinity of the streak, the mycelial density was gradually thinner. Significantly colony colour of *Colletotrichum capsici* differed in the dual culture plates from that of control.

#### S-4/P-7

### *In vivo* testing of different *Pseudomonas fluorescens* (PF) isolates and defense inducing chemicals for management and their role in induction of resistance in wheat plants against spot blotch pathogen

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Wheat is a very important crop specially in Northern Parts of India as most people take bread there. The crop is now

spreading very fast in West Bengal also. The crop is affected by number of diseases. Among them, spot blotch disease caused by *Bipolaris sorokiniana* is most important in West Bengal and Eastern UP. 9 different isolates of *Pseudomonas fluorescens* (PF) were collected from different rhizospheric soil of West Bengal and they were named UBPF 1 to UBPF 9. Those 9 PF isolates and 3 different defense inducing chemicals like salicylic acid, cupric chloride and nickel chloride were tested in field condition in wheat to know their effectiveness against spot blotch pathogen and induction of resistance was worked out by different biochemical tests. In the field condition, UBPF 9 produced lowest AUDPC of 107.00 which was closely followed by UBPF 6 (115.23) with a highest yield of 4.20 t/ha in UBPF 6. UBPF 9 recorded second highest yield of 4.13 t/ha. Among the 3 chemicals tested here, application of salicylic acid produced the lowest AUDPC (181.07) and highest yield of 3.67 t/ha over 2 years of study. In biochemical analysis, highest amount of phenol (3.37 mg/g), OD phenol (2.13 mg/g), PPO activity (2.40 per minute per g fresh weight) and PAL activity (69.69 mg/ml) was recorded by UBPF 6 treatment. Among the chemicals, salicylic acid induced most of the biochemical parameters better than the other chemicals. Significant negative correlation for protein, phenol, peroxidase and PAL was noticed with respect to AUDPC for all the treatments. So, it can be concluded that these chemicals got induced as a result of incorporation of these bio agents and defense inducing chemicals. They induced defence reaction in the host which ultimately minimized spot blotch disease incidence in wheat plants.

#### S-4/P-8

### Management of foliar diseases and fruit spot in bottle gourd

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Most cucurbit crops play an important role in human nutrition. A large number of diseases affect the cucurbits at different stages of crop growth. One of the major constraints in the cultivation of bottle gourd (*Lagenaria siceraria*) in kharif season is that the leaves and fruits of the crop are attacked by various diseases viz., downy mildew, powdery mildew, cercospora spot, anthracnose, Alternaria leaf spot etc. at different stages of the crop growth and reducing yield and quality of the fruits. Bottle gourd is often suffered from foliar diseases and fruit spot disease in saurashtra region and also other part of Gujarat so for management of foliar and fruit spot diseases of bottle gourd grown in Kharif season applications of four sprays of difenconazole @ a.i. 0.025 % (1 ml/lt.) and hexaconazole a.i. 0.07 % (1 ml/lt.) at 10 days interval after appearance of the disease are effective and economical.

#### S-4/P-9

### Compatibility of *Beauveria bassiana* (Bals.) Vuill. with other fungal bio control agents

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Fungal bio control agents have different mechanisms of disease suppression in the host. In most of the studies on biological control of plant pathogens, deal with single bio control agent as antagonist to a single pathogen. But there may be the fact that there is some degree of host-specificity in bio control agents found even at subspecies level which may partially account for the reported inconsistent performance of bio control agent preparations. In the present investigation *Beauveria bassiana* was tested against five different fungal biocontrol agents viz., *Metarhizium anisopliae*, *Trichoderma asperellum*, *Trichoderma harzianum*, *Paecilomyces lilacinus* and *Gliocladium virens* with an aim to find out compatible biocontrol agents for the management two or more problem at a time with synergistic effect amongst the bioagents. A total of twenty three treatment combinations were tried and arranged in completely randomized block design. Radial growth of the bio control agents and inhibition zone produced were recorded at an interval of 24 hrs till full growth appears in the control plate. The results of the isolates exhibited differential antagonistic activity among themselves. Based on the mycelia growth inhibition (MGI) the reaction was grouped as compatible (<30%), moderately compatible (30-49%), less compatible (50-79%) and incompatible (>80%). We found compatible reaction (MGI) amongst *B. bassiana* (entomopathogens) *T. asperellum* (phytopathogenic biocontrol agents) and *P. lilacinus* (nematopathogenic fungus). This present shows encouraging results of using all the three compatible biocontrol agents for preparation consortia bioformulation for the management of insects pests, fungal pathogen and nematode disease of a particular crop.

#### S-4/P-10

### Effectiveness of *Trichoderma harzianum* (THCh-1) against Chickpea Wilt

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The results of pot experiment revealed that seed treatment @10 g/kg + soil application @ 100 or 200 g/kg soil of *T. harzianum* found significantly superior for germination of chickpea seeds (78.81 to 70.78%) but these were statistically at par with seed treatment @5 g/kg + soil application @ 100 or 200 g/kg soil.



Seed treatment alone with *T. harzianum* @5 g/kg (60.00%) was also good. Soil application alone proved poor. Minimum wilt incidence was recorded in seed treatment of *T. harzianum* @ 10 g/kg + soil application @ 100 or 200 g/kg soil (11.18%) followed by seed treatment of *T. harzianum* @ 5 g/kg + soil application @ 100 (19.21%) or 200 (16.78%) g/kg soil. Seed treatments alone (5 or 10 g/kg seeds) also proved good but soil application alone poor in wilt management. For more confirmation of the efficacy of *T. harzianum* against chickpea wilt a multilocal trials were also carried out for two years. The trends of the results of all locations were more or less similar. All the treatments proved effective in managing the wilt but seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. harzianum* found significantly superior (28.39%) as compared to the rest but statistically was at par with seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. fasciculatum* (30.02%). Yield was also significantly higher in all the treatments compared to the check. Higher yield (12.50 q/ha) was recorded in seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. harzianum* followed by seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. fasciculatum* (11.88 q/ha). The results of the two year experiments conducted at PRS, Navsari revealed that all the treatments proved very effective in wilt management with higher yield. Minimum wilt was recorded (28.55%) in seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. harzianum* but was statistically at par with seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. fasciculatum* (30.56%) and seed treatment alone with *T. harzianum* (30.83%). The yield results indicated that highest yield was recorded in seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. harzianum* (12.50 q/ha) followed by seed treatment + soil application @ 5g/kg of seeds + 100 g/m<sup>2</sup> of *T. fasciculatum* (12.33 q/ha) and seed treatment alone with *T. harzianum* (11.57 q/ha).

#### S-4/P-11

### Antagonistic behaviour of few fungal and bacterial microflora of tea ecosystem against *Poria hypobrunnea*

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Seven microbial agents isolated and purified from the tea ecosystem of Assam viz., *Beauveria bassiana*, *Metarhizium anisopliae*, *Trichoderma pseudokoningii*, *Paecilomyces lilacinus*, *Trichoderma asperellum*, *Trichoderma harzianum* and *Pseudomonas fluorescens* were tested *in vitro*, against *Poria hypobrunnea*, the causal agent of branch canker and root rot of tea. Five of the tested microflora show promising result in inhibiting the mycelial growth of the pathogen. Amongst the

tested microflora, maximum mycelial inhibition was observed in *T. harzianum* (52.66%) followed by *T. asperellum* (39%) and *B. bassiana* (33.77%) respectively. The antagonistic behaviour is found to be absent in the isolates *P. fluorescens* and *M. anisopliae*. Results of the present investigation indicate that *T. harzianum*, *T. asperellum* and *B. bassiana* can be suggested for an ecofriendly and cost-effective management of the devastating problem caused by *P. hypobrunnea*.

#### S-4/P-12

### Fungicidal management of Stemphylium blight (*Stemphylium botryosum* Wallr.) of Lentil (*Lens culinaris* Medik.)

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Lentil is a valuable human food and one of the oldest known protein rich food legumes which is also known as poor men's meat. Owing to biotic and abiotic stresses, the crop yield is below attainable levels which are mainly attributed to pathological factors especially Stemphylium blight caused by *Stemphylium botryosum* Wallr. A field experiment was carried out during rabi season of 2015-16 at the District Seed Farm (AB Block), Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal to evaluate the efficacy of fungicides in controlling Stemphylium blight of lentil (*Lens culinaris* Medik.). Six fungicides were evaluated under high disease pressure of Stemphylium blight. Two times foliar spray with Captan 70 % + Hexaconazole 5% WP @ 1 g/litre of water at 10 days interval reduced 63.89% disease severity and increased yield of lentil by 32.86 % with highest net incremental cost-benefit ratio (1:9.8). The fungicide may be recommended to control of Stemphylium blight of lentil.

#### S-4/P-13

### Management of Flacherie disease of Muga silkworm, *Antheraea assama* Ww. using botanicals, microbial antagonists and antibiotics

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Flacherie is a deadly bacterial disease causing extensive losses in cocoon crop harvest of Muga silkworm. Diseased cadavers of Muga silkworm showing typical symptoms of Flacherie were collected and the causal organism of the disease was identified as *Bacillus amyloliquefaciens* subsp. *plantarum*. For controlling the disease, the present study was conducted wherein botanicals, microbial antagonists and antibiotics were used as an integrated control measure. *In vitro* studies revealed that botanical, *Mikania micrantha* HBK causes maximum growth inhibition (27.37%) and hence found most effective in

suppressing the growth of the pathogenic bacterium. Similarly, *Trichoderma asperallum* was found the best antagonist in inhibiting the growth of the pathogen. Two antibiotics viz, Streptomycin and Tetracycline (at 50 ppm and 100 ppm) were tested *in vitro* and Streptomycin 100 ppm was found best in controlling the growth of the pathogen. The best treatments in different combinations with each other were tested in controlled conditions against *B. amyloliquifaciens* subsp. *plantarum*, the combined application of the four treatments (*M. micrantha*, *A. barbadensis*, *T. asperallum* and Streptomycin 100 ppm) was found to reduce 87.50 per cent larval mortality of silkworm with significantly better larval weight and cocoon characters.

#### S-4/P-14

### Assessment of yield losses due to major diseases in improved varieties of Rapeseed-Mustard and their economical fungicidal management

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Downy mildew, Alternaria blight, White rust are the major diseases which causes major yield losses in rapeseed-mustard. Field experiments were conducted to estimate the yield losses due to major diseases in improved varieties of rapeseed-mustard and to search for the most economical and effective way to reduce the losses. All the investigated varieties of Toria, Yellow sarson and Rai were found susceptible to Downy mildew at cotyledon stage. DM index was found maximum in variety PTE-2008-6 (12.97 %), PYS-2008-5 (12.70 %) and NDRE-4 (12.01 %) of Toria, Yellow sarson and Rai respectively. All the varieties of Toria and Yellow sarson were found resistant to White rust disease. Rai varieties PR-2006-14 and NDRE-4 found susceptible to white rust while varieties PRB-2008-5, PRE-2009-12, and PRB-2004-3-4 found slightly tolerant to White rust disease. All the varieties of Toria, Yellow sarson and Rai found susceptible to Alternaria blight disease except Divya which was found slightly tolerant. Yield loss ranges from 9.62 to 32 % in Toria, 9.94 to 23.37 % in Yellow sarso and 3.16 to 31.87 % in Mustard. In Toria, yield loss was found maximum in variety Uttara (14.38%) followed by PTE-2008-2 (13.47%) and PT-2006-2 (13.26%) during 2011-12. During 2012-13 maximum yield loss was found in variety PTE-2008-2 (30.64%) followed by PT-2006-4 (26.54%). In Yellow sarson, yield loss was found maximum in variety FTPYS-Local (23.37%) and (21.43%) during 2011-12 and 2012-13 respectively. In Rai, yield loss was found maximum in variety PRB-2004-3-4 (25.10%) and (25.83%) during 2011-12 and 2012-13 respectively. Seed treatment with Apron SD @ 6g/Kg and 5-6 alternate sprays of Ridomil MZ and Mancozeb is found most economical and highly effective for the management of White rust, Downy mildew and Alternaria blight diseases to the extent of 30 % which ultimately reduces the yield loss at greater extent in all the varieties of Toria, Yellow Sarson and Rai.

#### S-4/P-15

### Fungicides use strategies and rotational program for management of late blight of potato

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A field experiment was conducted with potato to evaluate the efficacy of chemical and bio-fungicides having different inherent potentialities and mode of action when applied singly or in tank mixed combination against late blight of potato caused by *Phytophthora infestans*. Foliar application of Mandipropamid @ 0.8 ml/l and Mancozeb @ 2.5g/l (T<sub>1</sub>) in alternate weeks caused very low disease severity followed by spraying of Mandipropamid @ 0.8ml/l alternated with *Bacillus subtilis* formulation @ 370g/ha (T<sub>2</sub>) at weekly intervals as compared to other treatments. The area under disease progress curve and apparent infection rate were checked by foliar application of Mandipropamid @ 0.8 ml/l and Mancozeb @ 2.5g/l (T<sub>2</sub>) in alternate weeks. However, fluctuation in apparent infection rate among the treatment was found due to seasonal variation in corresponding year.

#### S-4/P-16

### Field efficacy of some new fungicide molecules against stem rot in olitorius jute (*Corchorus olitorius* L.) caused by *Macrophomina phaseolina* Tassi Goid

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Jute (*Corchorus* sp.) is one of the most widely used natural fibres in various textile industries and hence called as “Golden Fibre”. Jute is in great demand because of cheapness, softness, strength, length, lustre and uniformity of its fibre. In India jute is grown in different states like West Bengal, Bihar, Orissa, Assam and Andhra Pradesh. Among various biotic constraints *Macrophomina* disease complex comprising of pre- and post emergence damping off, seedling blight, collar rot, stem rot and root rot is the most commonly occurring problems in all jute growing areas. Stem rot and root rot which appear during active vegetative growth phase of the crop result in quantitative as well as qualitative loss in production. Due to the wide host range of the pathogen and with changing climatic condition management of this disease is becoming tough. In course of time the pathogen also develops resistance against various fungicides which were previously recommended against it. Therefore, evaluation of new fungicidal molecules should be a continuous process to avoid development of resistant biotypes. In recent times many Triazole and Strobilurin based combined fungicides are coming into market and their field potential

needs to be validated multi-locationally before final recommendation. Three years (2014 to 2016 Pre-kharif) field experiment was conducted in Terai zone of West Bengal for assessment of seven new fungicide molecules for making comparison with recommended fungicide (Carbendazim) against stem rot. Although the disease severity in control plots varied in different years due to climatological variation but the trend in performance of the test fungicides were almost similar over time. Seed treatment with Azoxystrobin + Difenconazole @ 1.0 ml/kg seed + spraying of Azoxystrobin + Difenconazole @ 0.075% at 40-45 DAS of crop stage was found most effective for chemical management of the disease where the percent reduction in disease severity was ranged between 60-67%. Application of Tebuconazole as seed treatment @ 1.5ml/kg of seed followed by spraying of same @ 0.15% at 40-45 DAS of crop stage was emerged as second best chemical management option exhibiting 55-62% reduction of the disease. The recommended fungicide Carbendazim as seed treatment followed by spraying of it @ 0.2% at 40-45 days after sowing showed 46-50% reduction of disease severity. The least effective fungicides were propineb and cyproconazole. The efficacy of different fungicides was also reflected in the fibre yield of the crop. Application of Azoxystrobin + Difenconazole resulted 43-74% increase in fibre yield, whereas, by application of Tebuconazole it was in the range of 32-57%. The fungicides may be recommended since Carbendazim as most widely used fungicide against the disease showed 26.5-50% increase in fibre yield.

#### S-4/P-17

### Use of biocontrol agents for the management of jute stem and root rot disease under sustainable integrated approach

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Jute is a commercial bast fibre crop next to cotton, and it is extensively grown as a cash crop. India ranks first in area and production of jute accounting for 62% of the world's production. Stem and root rot of jute caused by *Macrophomina phaseolina* is economically the most important dreadful diseases of jute affecting both the cultivated species *Corchorus olitorius* L. and *Corchorus capsularis* L. resulting in yield loss and reduce fibre quality. This disease causes average yield loss of 10%, but in case of severe infection it might go up to 35-40%. An integrated disease management approach was applied in a field experiment with seven sustainable treatments during 2013-2014 and 2014-2015. The treatment (T3: 50% NPK + ST with *Azotobacter* and PSB @ 5g/Kg+ *Trichoderma viride* (ST @ 5g/Kg of seed and soil application @ 2Kg/ha at 21DAS) + spray with PF @ 0.2% at 55 DAS was found highly significant

in terms of stem rot and root rot diseases incidence and these were only 3.25 and 2.55 respectively with respect to control (12.35 and 8.75%). Moreover, there was also found in terms of yield components viz., plant height, basal diameter and fibre yield.

#### S-4/P-18

### Effect of different levels of NPK on foliar diseases of potato under different fertility gradient of soil in field

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A field study was conducted to find out the effect of different combinations of three nitrogen, two phosphorus and two potassium levels against the severity of three foliar diseases viz. late blight, early blight, leaf blotch and their combinations and their effect on yield of potato grown in four different fertility gradient soils. The four fertility gradients were as (S<sub>1</sub>) low = 278.3: 9.9:80.3; (S<sub>2</sub>) medium = 290.1: 22.9: 97.0; (S<sub>3</sub>) moderate= 296.0: 26.6: 213.5 and (S<sub>4</sub>) high =301.8: 37.1: 282.8 kg ha<sup>-1</sup> NPK respectively. Whereas, three nitrogen doses were applied @ 150, 200 & 250 kg ha<sup>-1</sup>, two phosphorus and potassium @ 100, 125 kg ha<sup>-1</sup>. Four fertility gradients were assigned as main plot and each of the main plot were divided into 16 sub plots cover each area of 25 m<sup>2</sup> (5X5 m<sup>2</sup>) of gross total area 2000 m<sup>2</sup> consisting of 64 plots. The crop variety was Kufri Jyoti planted on 30<sup>th</sup> November for three consecutive years (2012-2014). The result showed that three nitrogen, two phosphorus and potassium levels in different combinations under four fertility gradient soils produced different levels of disease severity of late blight, early blight, leaf blotch and their multiple complex and their effect on the tuber yield of potato. Maximum tuber yield and minimum disease severity of three foliar diseases were obtained in different NPK combinations in different fertility gradient soil were as in low (S<sub>1</sub>) N<sub>150</sub>P<sub>125</sub>K<sub>100</sub> kg ha<sup>-1</sup> (2.94, 1.47, 3.98 & 8.39 AUDPC for late blight, early blight, leaf blotch and multiple disease complex); in medium (S<sub>2</sub>) N<sub>250</sub>P<sub>125</sub>K<sub>125</sub> kg ha<sup>-1</sup> (1.85, 2.12, 3.07 & 7.03 for late blight, early blight, leaf blotch and multiple complex respectively); moderate (S<sub>3</sub>) N<sub>250</sub>P<sub>125</sub>K<sub>100</sub> kg ha<sup>-1</sup> (1.05, 2.83, 3.70 & 6.73 respectively) and high (S<sub>4</sub>) N<sub>250</sub>P<sub>125</sub>K<sub>125</sub> kg ha<sup>-1</sup> (0.60, 0.94, 1.55 & 3.08 for late blight, early blight, leaf blotch and multiple complex respectively) where as yield character like number of tuber per plant, weight of tuber per plant (g) and tuber yield (t ha<sup>-1</sup>) were also found highest in N<sub>150</sub>P<sub>125</sub>K<sub>100</sub> in low S<sub>1</sub> (8.00, 441.67 g & 19.60 t ha<sup>-1</sup>) in medium S<sub>2</sub> N<sub>250</sub>P<sub>125</sub>K<sub>125</sub> ( 8.00, 491.67 g & 25.40 t ha<sup>-1</sup>) in moderate S<sub>3</sub> N<sub>250</sub>P<sub>125</sub>K<sub>100</sub> ( 7.00, 525.00 g & 18.80 t ha<sup>-1</sup>) and in high S<sub>4</sub> N<sub>250</sub>P<sub>125</sub>K<sub>125</sub> (10.67, 661.67 g & 25.07 t ha<sup>-1</sup> respectively) fertility soils condition, where all the foliar diseases were reduced. So, testing of soils and application of fertilizers in soil may play an important role in eco-friendly management of plant protection in potato.



**S-4/P-19****Effect of different levels of NPK on rust disease of groundnut under different fertility gradient of soil in field****<sup>1</sup>Ayana Chakraborty and <sup>2</sup>Srikanta Das**<sup>1</sup>Basirhat college, Basirhat; <sup>2</sup>Dept of Plant Pathology, BCKV, Mohanpur, Nadia, W.B; E-mail : ayana98361@gmail.com

A field study was conducted to find out the effect of different combinations of three nitrogen, two phosphorus and two potassium levels against the severity of rust disease of groundnut and their combinations and their effect on yield of groundnut grown in four different fertility gradient soils. The four fertility gradients were as (S<sub>1</sub>) low = 278.3: 9.9:80.3; (S<sub>2</sub>) medium = 290.1: 22.9: 97.0; (S<sub>3</sub>) moderate= 296.0: 26.6: 213.5 and (S<sub>4</sub>) high =301.8: 37.1: 282.8 kg ha<sup>-1</sup> NPK respectively. Whereas, three nitrogen doses were applied @ 150, 200 & 250 kg ha<sup>-1</sup>, two phosphorus and potassium @ 100, 125 kg ha<sup>-1</sup>. Four fertility gradients were assigned as main plot and each of the main plot were divided into 16 sub plots cover each area of 25 m<sup>2</sup> (5X5 m<sup>2</sup>) of gross total area 2000 m<sup>2</sup> consisting of 64 plots. Groundnut crop was TAG17 and sowing was done on 28<sup>th</sup> January 2010, 19<sup>th</sup> February 2011 and 6<sup>th</sup> February 2012 for three consecutive years (2010- 2012). The result showed that three nitrogen, two phosphorus and potassium levels in different combinations under four fertility gradient soils produced different levels of disease severity of rust of groundnut and their effect on the kernel yield of groundnut. Maximum kernel yield and minimum disease severity of rust disease was obtained in different NPK combinations in different fertility gradient soil were as in low (S<sub>1</sub>) kg ha<sup>-1</sup> (7.49 AUDPC); in medium (S<sub>2</sub>) N<sub>40</sub>P<sub>40</sub>K<sub>20</sub> kg ha<sup>-1</sup> (8.59 AUDPC); moderate (S<sub>3</sub>) N<sub>40</sub>P<sub>40</sub>K<sub>40</sub> kg ha<sup>-1</sup> (13.13 AUDPC) and high (S<sub>4</sub>) N<sub>20</sub>P<sub>40</sub>K<sub>20</sub> kg ha<sup>-1</sup> (13.99 AUDPC) where as yield character like number of kernel per plant, weight of kernel per plant (g) and kernel yield (q ha<sup>-1</sup>) were also found highest in N<sub>20</sub>P<sub>20</sub>K<sub>40</sub> in low S<sub>1</sub> (23.58 qha<sup>-1</sup>) in medium S<sub>2</sub> N<sub>40</sub>P<sub>40</sub>K<sub>20</sub> (21.77qha<sup>-1</sup>) in moderate S<sub>3</sub> N<sub>40</sub>P<sub>40</sub>K<sub>40</sub> ( 24.0 q ha<sup>-1</sup>) and in high S<sub>4</sub> N<sub>20</sub>P<sub>40</sub>K<sub>20</sub> (26.4 q ha<sup>-1</sup> respectively) fertility soils condition, where rust disease was reduced. So, testing of soils and application of fertilizers in soil may play an important role in eco-friendly management of plant protection in groundnut.

**S-4/P-20****Effect of different levels of nitrogen and potassium against tikka disease of groundnut in different fertility gradient soil in field****Trina Sandham, Sunita Mahapatra and Srikanta Das**

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The field experiment was conducted to find out the effect of two different nitrogen (20; 40 kg ha<sup>-1</sup>) and potassium (20; 40 kg

ha<sup>-1</sup>) combinations with recommended dose of phosphorus under four different fertility gradient soil against tikka disease of groundnut. Nitrogen and potassium were applied @ 20 and 40 kg/ha in different combinations with recommended dose phosphorus(40 kg ha<sup>-1</sup>) in four fertility gradient soil where NPK were tested before fertilizer application and divided in four fertility status as low (S<sub>1</sub>)= 278.3: 9.9:80.3; medium (S<sub>2</sub>)= 290.1: 22.9: 97.0; moderate (S<sub>3</sub>)= 296.0:26.6: 213.5 and high (S<sub>4</sub>)= 301.8: 37.1: 282.8 kg ha<sup>-1</sup> NPK respectively. The plot size was 5×5m<sup>2</sup> with four replications of total 64 plots in a split split design. Groundnut crop was TAG17 and sowing was done on 28<sup>th</sup> January 2013, 19<sup>th</sup> February 2014 and 6<sup>th</sup> February 2015 for three consecutive years (2013- 2015).The result showed that two different doses of Nitrogen and Potassium produced different tikka disease severity caused *Cercosporaacra-chidicola* and *Phaeoisariopsispersonata* and kernel yield on four different fertility gradient soil in field in three different years. In the three years pooled mean, it was observed that with increase in fertility gradient of soil there was a significance decrease in tikka disease severity irrespective of NK combinations. Maximum reduction and minimum disease severity in different NK combinations in different fertility gradient soil were as in low (S<sub>1</sub>) N<sub>40</sub>K<sub>20</sub> (AUDPC-34.48 & 16.06% reduction); in medium (S<sub>2</sub>) N<sub>40</sub>K<sub>40</sub> (AUDPC- 32.88 & 13.68% reduction ) moderate (S<sub>3</sub>) N<sub>20</sub>K<sub>40</sub> (AUDPC- 31.51 & 11.44% reduction) and high (S<sub>4</sub>) N<sub>20</sub>K<sub>20</sub> (AUDPC-25.40 & 11.58% reduction). The yield attributes like kernel number per plant, kernel weight per plant (g) and kernel yield (qha<sup>-1</sup>) were also high in above N and K combinations in different fertility gradient soil as in low (S<sub>1</sub>) (30.75; 38.02 g & 22.19 qha<sup>-1</sup>); medium (S<sub>2</sub>)(26.28; 33.24 g & 21.91 qha<sup>-1</sup>); moderate (S<sub>3</sub>) (33.74; 40.11g & 22.35 qha<sup>-1</sup>) and high (S<sub>4</sub>) (30.04; 33.44 g & 24.92 qha<sup>-1</sup>) respectively. So, it can be concluded that before fertilizer application, testing of soil is necessary for proper fertilizer use in minimizing the disease of tikka and maximizing the yield in eco-friendly crop protection.

**S-4/P-21****Biological control of coriander root rot incited by *Fusarium solani* with rhizosphere microflora****CM Bhaliya, KB Jadeja and LF Akbari**

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Coriander (*Coriandrum sativum* L.) is an important spice crop of India. The root rot disease of coriander incited by *Fusarium solani* cause considerable crop loss in Saurashtra region of Gujarat state. The fungal and bacterial isolates of coriander rhizosphere were evaluated for their biocontrol potential against *F. solani* under *in vitro* study (dual culture method) and sick soil (pot) condition. Under *in vitro* study, fungal isolates *Trichoderma viride*- II and bacterial isolates *Pseudomonas*

## S-4/P-22

**Studies on effect of different nitrogen and phosphorus combinations on potato early blight**Ashis Chakraborty<sup>1</sup>, Subham Dey<sup>2\*</sup> and NK Gawande<sup>2</sup>

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A field trial was conducted during Rabi season of 2011-12 and 2012-13 to study the effect of different nutritional (nitrogen and phosphorus) level on potato early blight to find out the optimum dose of fertilizer application to keep severity of the disease under check as a prophylactic measure. In this investigation the potato variety KufriJawahar was planted with ten different combinations of nitrogen and phosphorus keeping the potassium level constant and one untreated control. The disease incidence and intensity per cent were recorded at seven days interval from the first appearance of visual symptom. Minimum per cent incidence (23.96%) and intensity (10.31%) of the disease was observed in treatment T<sub>5</sub> i.e. (N<sub>250</sub>P<sub>150</sub>K<sub>150</sub>) at the time of final observation. Per cent disease decrease over control in terms of incidence and intensity were 54.60% and 62.38% respectively. From the experiment it was observed that higher doses of nitrogen and phosphorus had ability to reduce the incidence and intensity of the disease and increase the tuber yield of potato.

## S-4/P-23

**Adequacy of native antagonistic bacterial and fungal isolates in biological control of root rot disease of moth bean**

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Growth of a root through soil causes marked shift in the microbiological equilibrium, both quantitatively and qualitatively known as rhizosphere. Rhizosphere play an important role by affecting the associative or antagonistic microorganisms present in the rhizosphere of host resulting in reducing the soil borne diseases. Moth bean (*Vigna aconitifolia*), which is attacked by large number of pathogens resulting in varying degree of losses in terms of production, is an important crop of arid zone. *Macrophomina phaseolina*, has been reported as the most devastating pathogen found invariably associated with bean seeds. So, these studies were carried out to throw light particularly in relation to soil microbes responsible for their associative and antagonistic effect on the pathogen in the vicinity of host plants roots. Different species of fungi, bacteria and actinomycetes were isolated from rhizosphere of moth bean crop, screened *invitro* in order to check their antagonistic properties against *M. phaseolina*. So that, soil borne diseases and their related pathogens can be managed by making changes in the dense and dynamic community of microbes in rhizosphere.

## S-4/P-24

**Antifungal activity of plant extracts against *Pestalotiopsis mangiferae* *in vitro***Moirangthem Indira Devi<sup>1</sup> and RK Tombisana Devi<sup>2</sup>

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An experiment was carried out in the laboratory of Plant Pathology Department, College of Agriculture, Central Agricultural University, Imphal in the year 2013-14. Seven locally available extracts (garlic, ginger, chinese chasetree, Indian woodworm, sweet flag, derek and turmeric) were evaluated against *Pestalotiopsis mangiferae*. The plant extracts were evaluated at three different levels of concentrations. Among seven plant extracts tested against mycelial growth of *P. mangiferae*, garlic extract could inhibit 57.44, 77.77 and 89.22 per cent at 2, 4 and 6 per cent concentrations. However, it was observed that turmeric, chase tree, ginger, sweet flag and Indian wood worm could inhibit less than 50 per cent of the mycelial growth. Derek could inhibit 10-15 per cent of mycelial growth. No sporulation of the fungus was observed upto 7 days of incubation. Some of the aqueous plant extracts under *in vitro* revealed that higher doses were relatively more efficient than the lower. Among the seven plant extracts garlic clove extract @ 6 per cent gave maximum inhibition (89.22%) followed by turmeric rhizome extract @10% (51.11%) whereas minimum inhibition in derek leaf extract @ 10% (18.88%).

## S-4/P-25

**Survival and population distribution pattern of foliar nematode, *Aphelenchoides besseyi* causing floral malady symptom in tuberose in West Bengal**Suvash Chandra Bala\* and Anirban Sarkar<sup>1</sup>

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Tuberose (*Polianthes tuberosa* L.) is one of the most important bulbous ornamental crops, commercially cultivated in West Bengal for its traditional uses and export purposes. The crop is severely damaged by the foliar nematode, *Aphelenchoides besseyi* in most of the tuberose growing areas of West Bengal and inflicting appreciable quantitative and qualitative yield losses. The nematode disseminates through infested bulbs and survives on the infected plant parts and transplantable bulbs. Investigation was carried out to estimate the relative numbers and distribution of nematodes in the clump of tuberose. More numbers of *A. besseyi* was recovered from the central bulb than obcentral and peripheral bulbs. Further, outer scaly leaves and neck region of individual bulb showed maximum number of nematodes. The survival and movement of *A. besseyi* on plant surface depends on moisture availability which is mostly

provided through dew deposition, rainfall and relative humidity. Survey on infestation of foliar nematode (*A. besseyi*) on tuberose was carried out in different districts of West Bengal. Samples (170) were collected from 32 locations distributed in six blocks of four districts (Nadia, North 24 Parganas, South 24 Parganas, and East Midnapore). Results from the 170 flower samples showed that *A. besseyi* were present in all the samples but with varying densities. The density of nematode varied between 513.6 to 3,27,800.3 per 50 g flowers and percent of infestation varied from 14 to 82 per cent. The highest mean infestation (51.48%) was found in Ranaghat-II block followed by Ranaghat-I (47.28%) and Haringhata (28.43%) blocks of Nadia district.

#### S-4/P-26

### Lure and kill technique, an eco-friendly approach against melon fruit fly, *Bactrocera cucurbitae* coq. through mass trapping by using different coloured pheromone traps and poison baits in new alluvial zone of west bengal, india

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India is the second largest producer of vegetables in the world after China, accounting for about 10 per cent of the world's production. One of the major constraints in increasing vegetable production is loss caused due to insect pests. The melon fruit fly, *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae) is a major key pest of cucurbitaceous vegetables in West Bengal as well as in India. The fruits of cucurbits are picked up at short intervals for marketing and self-consumption. The farmers show little concern for the residual effect of chemicals, being more concerned about profit. It is very difficult to rely on insecticides as a means of controlling this pest due to the cryptic nature of the damaging stage *i.e.* maggot. Therefore, there is a need to explore alternative methods of control to the seasonal abundance and effective management of this pest through mass trapping with pheromone traps and poison baits. Lure and kill technique against this pest is essential as one of the procedures in the IPM concept. The study aimed to investigate eco-friendly and effective innovative approach through attraction of male fruit flies to different coloured pheromone traps and poison baits during 2012 and 2013 in cucurbitaceous vegetable fields. The experiments with different coloured trap were conducted at two locations of each of Nadia and North 24 Parganas district and experiment with poison baits were conducted at three locations of Nadia district, West Bengal, India. It was observed that melon fruit fly was more prone to attract by yellow (0.85/day) and transparent (3.93/day) coloured traps and cue-lure + malathion (8.98 catch/trap/day) and methyl eugenol + cue-lure + malathion (17.17 catch/trap/day) baited traps than other coloured traps and poison baits during respective years. As cue-lure is a specific para-pheromone for attracting male cucurbit fruit fly, this also helps to create an imbalance on male: female ratio in the environment and causes comparatively low infestation due to the production of unfertilized eggs by female.

To curb this devastating menace and increase the yield of cucurbitaceous vegetables, this is an eco-friendly innovative approach which is environmentally safe.

#### S-4/P-27

### Diseases management in vegetable crops through eco-friendly approach

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India is the second largest producer of vegetables just after China. Even though, the importance of growing vegetable crops has not been fully realized and hardly about 5 per cent area of the total cultivated crop is occupied by vegetables. The role of vegetables as an essential food in our daily and balanced diet is great indeed they do not only adorn the table but also enrich the health of human being. Thus, vegetable play a vital role in the balanced diet of human being. But diseases limit the production of vegetable crops. The consumer expectation of vegetable produce, for internal and export markets, is of high quality products, which are residue free, safe to handle and fit for fresh consumption. This brings into focus the importance of managing pests with minimal hazard to the environment and absolute safety to humans. Pesticides when used heavily have led to undesirable side effects. Eco-friendly disease management (EFDM) involves with minimum use of pesticides and maximum use of biocontrol agents and nonchemical methods. Thus, EFDM ensures ecologically and economically viable strategies to manage disease sustainably.

#### S-4/P-28

### Evaluation of chilli genotypes against anthracnose disease (*Colletotrichum capsici*) under field condition by artificial inoculation in Gwalior district of MP

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Chilli (*Capsicum annum*) is an important spice as well as vegetable crop that are grown throughout the world especially in tropical and subtropical regions. It is valued for its diverse commercial uses. India is a major producer, exporter and consumer of chilli. Chilli is grown in almost all states. Anthracnose of Chilli caused by *Colletotrichum capsici* (Sydow) Butler and Bisby, is an economically important disease which affects chilli production. Anthracnose disease can occur on leaves, stems, and both pre- and post-harvest fruits. On the leaves, small, circular spots appear. Severely infected leaves fall off leading to defoliation and on fruits displays small, circular brown spot with concentric rings of acervuli. It is one of the major and devastating diseases of chilli causes severe losses (10-60%) both in yield and quality of the



chilli depending upon the varieties. For successful cultivation of chilli, it is important to identify resistant varieties against anthracnose diseases. Therefore, an experiment was conducted in the Krishi Vigyan Kendra Research farm, RVSKVV Gwalior (M.P.) during 2015-16 for Screening of 25 varieties & genotypes of chilli received from ICAR/National institutes were evaluated against anthracnose (*Colletotricum capsici*) under field condition. Semi-ripe chilli fruits (25 days old) were chosen for field experiment. A purified and pathogenic local isolate was used for spray inoculation. Spray inoculation was done by spraying suspension of conidia ( $5 \times 10^5$  conidia ml<sup>-1</sup> water) separately in respective plots using hand sprayer. Uninoculated plots served as control. The canopy of all plants was watered from next day morning up to 1 week period by spraying water, two times per day to stimulate conidial germination. The disease reaction was recorded by rating scale 0-5 on leaves. The PDI was calculated. Data was analyzed by ANOVA through randomized blocked design. The mean observations recorded after first spray and second spray of conidial suspension. Out of twenty five, none of genotype showed immune reaction. The 3 genotypes (Arka Harita, Classica-152 and Madhurima-148) showed resistant reaction while six cultivars (EC-341075, Pusa Jwala, Pant C-1, LAC-434, Arka Meghna, Divya Jyoti) exhibited moderately resistant reaction. Whereas 4 cultivars (EC-566320, Arka Khyati, Arka Lohit, Divya Jyoti) showed susceptible reaction and twelve cultivars have been found to show highly susceptible reaction (Kashi Anmol, Kashi Gaurav, Punjab Lal, Pusa Sadabahar, AKC 89-38, Jayanti, P-1649, LAC-422, Phule Jyoti, Jawahar Mirch-218, Jawahar Mirch-283 and Natasha -727).

#### S-4/P-29

### Evaluation of fungicides against the *Alternaria brassicae* (Berk.) Sacc. infecting different *Brassica* host crops

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*Alternaria* blight caused by *Alternaria brassicae* (Berk.) Sacc. has been reported from all the continents of the world and affects most brassicaceous crops. It causes considerable reduction in quality and quantity of *Brassica* crops. The present investigation was carried out *in vitro* to find out the efficacy of one non-systemic fungicide *viz.*, Mancozeb and three systemic fungicides *viz.*, Thiophanate methyl, Propiconazole and Ridomil MZ against *A. brassicae* isolates collected from different *Brassica* host crops *i.e.* mustard, cauliflower, cabbage and radish. Three different concentrations of each fungicides *i.e.* 50, 200 and 500 ppm were used. Four different isolates were designated on the basis of their host as Acae M, Acae Cf, Acae Ca and Acae R from mustard, cauliflower, cabbage and radish, respectively. All these isolates exhibited significant variation in response of their radial growth to the different concentration of systemic and non-systemic fungicides. All fungicides significantly inhibited radial growth of the pathogen at their highest concentrations *i.e.* 500 ppm, however Propiconazole was found to be most effective against all four

isolate at their all concentrations resulting 100% inhibition of radial growth. Mancozeb was also effective at all concentrations against all isolates, whereas cent percent inhibition of radial growth was observed in only one isolate *i.e.*, Acae Ca at 500 ppm. Ridomil MZ was found to be effective against all isolates only at their highest concentration *i.e.* 500 ppm. Thiophanate methyl was least effective in this study.

#### S-4/P-30

### Efficacy of fungicides and bio agents against the *Sclerotinia sclerotiorum* (Lib.) de Bary causing *Sclerotinia* rot of rapeseed-mustard

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*Sclerotinia* stem rot (SSR) caused by *Sclerotinia sclerotiorum* (Lib.) de Bary is a major disease of rapeseed-mustard and it is considered next to *Alternaria* blight in causing yield losses as much as 70 per cent in susceptible crop. The pathogen survives in the form of sclerotia on plant debris or in soil for more than 4 years, which makes it very difficult to manage with conventional approaches. Therefore, its management with fungicides and bio-control agents remains an effective approach. The present study was undertaken *in-vitro*, using four fungicides *viz.*, vitavax, propiconazole, mancozeb and azoxystrobin at three different concentrations *i.e.* 0.05, 0.1 and 0.2% and three species of *Trichoderma viz.*, *T. harzianum*, *T. viride*, *T. koningii*, to find out their relative efficacy in inhibiting mycelial growth of the pathogen. It is evident from the observations that all four fungicides and three *Trichoderma spp.* resulted a significant effect on growth inhibition of *S. sclerotiorum*. Among all fungicides vitavax and propiconazole were most effective at all three concentrations (0.05, 0.1 and 0.2 %) and inhibited cent percent radial growth of the pathogen, whereas mancozeb and azoxystrobin were least effective. Among the bioagents, *T. viride* was noted to be most effective antagonist followed by *T. koningii* resulting 78.50 per cent and 72.21 per cent growth inhibition, respectively. Whereas *T. harzianum* showed minimum radial growth inhibition (49.25%) of *S. sclerotiorum* in this study.

### Technical Session-V : Post-harvest Technology : Management : Field and horticultural Crops.

#### Lead Lecture

#### S-5/L-1

### Combination of seed polymers, fungicides, biocontrol agents for seed health management in oil seed crops

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The loss of seed viability is due to the several biotic and abiotic stresses in storage and seed germination stages. Quality of seed is the basis for profitable production of any crop. Research findings of work that lead to development of a seed coating combination using seed coat polymers, fungicide and biocontrol agents for management of soil/seed borne pathogens apart from promotion of plant growth are presented in this paper. Seed coating polymers provides protection from the stresses, improves seed germination, promote plant growth and reduce fungal invasion. Oil seed crops like groundnut (*Arachis hypogaea* L.), soybean (*Glycine max* [L.] Merr.) and castor (*Ricinus communis* L.) are affected by various stresses in storage and also during seed germination and seedling growth. Effect of synthetic and a biopolymer in separate combinations with three *Trichoderma* strains and fungicides (carbendazim and carboxin + thiram) on the germination and vigour of groundnut, soybean and castor under the influence of various biotic and abiotic stresses is studied. Two combinations viz., synthetic polymer @ 0.3% along with *Trichoderma harzianum* Th4d WP (10g/kg) and synthetic polymer @ 0.3% along with carboxin + thiram @0.2% gave significant improvement of seed germination and seedling vigour apart from reduction in incidence of seed pathogens like *Aspergillus niger*, *Fusarium* and *Alternaria* in soybean. In castor, seed treatment with combination of biopolymer chitosan@ 0.25%, carboxin + thiram @0.2% and *Trichoderma harzianum* Th4d WP is very effective in seedling health improvement. In groundnut, chitosan @0.25% along with *T. asperellum* Ta DOR 7316 treatment improved seed germination and vigour index and recorded low collar/root rot incidence. In castor, seed coating with biopolymer chitosan in combination with *Trichoderma harzianum* Th4d WP resulted in improvement in germination, vigour index with low *Fusarium* wilt incidence. The effective combinations will be further evaluated under field conditions.

### S-5/L-2

## Present status on molecular diagnosis, characterization and management of citrus greening disease (Huanglongbin) in India

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Citrus greening disease (HLB) caused by '*Candidatus Liberibacter asiaticus*', a Gram negative alpha Proteobacterium is considered as the most important disease and principal cause of citrus decline in India. Extensive surveys revealed its presence in major citrus growing states like Maharashtra, Punjab, Andhra Pradesh, North-Eastern states etc. Among commercially important citrus cultivars, incidence of greening was more on sweet orange and mandarin varieties compared to other cultivars like acid lime and lemon. The disease was diagnosed through symptom expression, biological indexing and PCR based molecular diagnostic tools. Different sets of greening bacterium-specific primers were designed and synthesized for amplification of 16S rDNA, 16S/23S intergenic regions, ribosomal protein genes and *omp* genes. All the infected samples yielded specific amplification products, sizes of which were found similar to that amplified from '*Ca.*

*Liberibacter asiaticus*' as was confirmed by sequencing of the amplified DNA fragments and phylogenetic analyses. Again, duplex-PCR, real time PCR and LAMP based diagnostic tools has been standardized to detect the pathogen in both plant and citrus psyllid collected from infected plants. Variability studies based on the tandem repeats at hyper variable genomic locus CLIBASIA\_01645 reveals that the Indian populations of '*Ca. L. asiaticus*' is more diverse than other reported populations. Production of disease-free nursery plants and other novel approaches of disease management will be discussed.

### S-5/L-3

## XopL T3SS-effector suppresses ROS accumulation and subsequent PTI events to support the growth of *Xanthomonas axonopodis* pv. *punicae* during blight pathogenesis in pomegranate

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Bacterial blight caused by *Xanthomonas axonopodis* pv. *punicae* (Xap) is a major disease of pomegranate. Xap secretes effector proteins via type III secretion system (T3SS) to suppress pathogen-associated molecular pattern (PAMP)-triggered plant immunity (PTI). Previously we reported that XopN, one of the conserved effectors of Xap, modulates *in planta* bacterial growth, and blight disease. Here we report another T3SS-effector, XopL from Xap that suppresses accumulation of reactive oxygen species (ROS) including H<sub>2</sub>O<sub>2</sub> and O<sub>2</sub><sup>-</sup> and subsequent downstream cell-wall associated immune responses including callose deposition. We quantitatively assessed the higher accumulation of H<sub>2</sub>O<sub>2</sub> in pomegranate leaves infiltrated with Xap XopL compared to Xap wild-type. We analysed significant increase in transcript expression of ROS and flg22-inducible genes, namely *FRK1*, *GST1*, *WRKY29*, *PR1*, *PR2* and *PR5* in *Arabidopsis* when challenged with Xap XopL; contrary, the up-regulation of all the genes were compromised when challenged with either Xap wild-type. We determined that XopL favours Xap for its *in planta* growth and virulence. Further, we demonstrated that XopL protein is localized to the plasma-membrane. Altogether, our study suggested that Xap also recruits XopL T3SS-effector that possibly play important role during blight pathogenesis, particularly in the suppression of ROS-mediated early defense responses in pomegranate.

## Oral Presentation

### S-5/O-1

## Effect of irradiation and CA storage on post harvest diseases management of Alphonso mango

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Irradiation has been successfully prevents food poisoning, reduces wastage to contamination and at the same time

preserves the fruits against post harvest diseases or disorders. In this regard the present investigation entitled "Effect of irradiation and CA storage on post harvest diseases management of Alphonso mango" was conducted at Cold Storage and Post Harvest Technology Unit of Navsari Agricultural University, Navsari, Gujarat, India and two years collective mean result submitted in the year 2012. The experiment was laid out in completely randomized block design with factorial concept with three repetitions. There were sixteen treatment combinations of irradiation dose ( $I_1$ -0.00,  $I_2$ -0.20,  $I_3$ -0.40 and  $I_4$ -0.60kGy) and storage temperature in cold room and controlled storage ( $S_1$ -Ambient,  $S_2$ -9°C,  $S_3$ -12°C and  $S_4$ -CA storage at 12°C). Export grade mangoes of cv. Alphonso were harvested from university orchards. The fruits were exposed to gamma radiation from the source of  $^{60}\text{Co}$  at ISOMED, Board of Radiation and Isotope Technology, Bhabha Atomic Research Centre, Mumbai. The fruits were kept at various temperatures *i. e.* at ambient, 9C (90% RH), 12C (90% RH) and at control atmospheric storage (12°C,  $\text{O}_2$  2%,  $\text{CO}_2$  3% and RH 90%). The two years pooled data indicated that the fruits irradiated with 0.40kGy gamma rays recorded significantly minimum rotted fruits as well as in storage temperature it was significantly minimum under 9C storage temperature. Jointly the fruits exposed to 0.40kGy gamma rays and stored at 9C recorded reduced rotting percentage.

### S-5/O-2

#### Development of local based substrate and mass production protocol for (*Pleurotus* spp) spawn of mushroom

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The Bihar is the second most populous state of the country, with a total human population of 103.80 million and population density of 1102 persons/Km<sup>2</sup>, respectively. Considering the poverty ratio in rural population of Eastern India, mushroom cultivation may be taken as one of the technologies to uplift the economic status to earn sustainable income. In Eastern India rice production is highest and Bihar farmers for breaking china record in rice production. In view paddy are very cheaper source and easily available as well as less cost @Rs 8 and compared to wheat @Rs 20/ per kg and also fact that, mushroom cultivation can do everyone in small scale, household system and large scale as a business but it should need good quality, fast growing mushroom spawn. The experiment was carried out to select most suitable locally available cheaper materials and fast growing mycelium for production of mushroom (*Pleurotus* spp.) spawn. Six different substrates were evaluated for growth of early development of mycelium. From the experiments results, revealed that the paddy grain proved to be the most suitable substrate was fully covered with high quality mycelium growth in 12-14 days at temperature 22±2C even after 1 month fruiting bodies were removed from spawn bags, Wheat grain alone was found to be the least preferred substrate and fully covered with mycelium upto 21 days, whereas it took 28 days for full colonization of banana pseudostem. The growth of mycelium on maize

stem+paddy grain and maize stem +banana pseudostem, maize stem+banana pseudostem+ paddy grain were found very slow and poor.

### S-5/O-3

#### Horticultural postharvest management analysis : An overview of the challenging task for india in the globalized era of agricultural trade

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The inevitable postharvest losses have considerable impact on growers, society and national as well as international agricultural trade. After the liberalized economic reforms of the past century, world economic order has elicited the globalized concept of trade including agriculture. Different international regulations already poses problem for traditional agricultural trade and has enlarged and aggravated the arena to meet various challenges for the millions of small and marginal farmers, exporters, policy formulators and scientists. In this globalized era the countries with developing economy in no way is comparable to developed nations in terms of infrastructure, human resources, technology and various socio-economical factors. In india, the investment in the horticulture sectors is manifold resulting the boost in horticultural production yet present scenario of postharvest technology in its entirety has not able to meet the requirement it deserves. Despite the creation of a separate Ministry of Food Processing at Union and Statelevels and claimed sunrise potentialities of the sector much progress is not been evident. Postharvest pathosystems play vital roles in deterioration of the produce and consequent losses either in terms of quantity, quality, monetary and export. Different aspects of pathosystems and their dynamics along with current Indian limitations have been analysed to manage those systems in the context of current globalized scenario. The aspects of biosecurity as well as pest risk analysis efforts particularly in the horticultural domain are lagging behind, however the Indian Quarantine System is under the process of up gradation to meet certain international challenges. The zonal difference of export and import is clearly evident. The co-ordination and academic aspects needs to be looked into in right perspective and these issues have been discussed. The need for co-ordinated and integrated efforts at least for certain exportable produce have also been emphasized.

### Poster Presentation

#### S-5/P-1

#### Evaluation of various bitter gourd varieties against downy mildew disease

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Bitter gourd, *Momordica charantia* L. is one of the most popular vegetable India, China and Nepal, Bangladesh, Myanmar etc. Downy mildew (*Pseudoperonospora cubensis*)



is one of the important foliar disease of bitter gourd. Indiscriminate use of chemicals in agriculture during post green revolution period and their adverse effect on soil health and environment has created an alarming situation. A situation has resulted which urgently demands an environmentally safe, sustainable and simultaneously, economically viable production system. Therefore nineteen varieties of bitter gourd were evaluated against prevalent diseases of the crop at Horticultural Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during 2015-16. Three diseases viz., downy mildew, leaf curl and mosaic were observed during the period of work. Among the nineteen varieties of bitter gourd two (Unnat Kathi Gaurav, Kathi Selection) were highly resistant, three (No. 4003, Bujji, Meghanaa- 2) were moderately resistant, thirteen viz. VNR-28, VNR Kanhaiya, Vivek, Sagar (AG-811), Nanha, Ankur Tillu, Sunil Karela, Indra Karela, Raman, Selection 05, NS-1018, Katahi, Uchha Bolder were moderately susceptible and only one variety i.e. VNR-22 was susceptible against downy mildew disease.

#### S-5/P-2

### Effect of various seed treatments on seedling parameters of bitter gourd

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Bitter gourd, *Momordica charantia* L. is one of the most popular vegetable in the tropical and subtropical countries. It is widely grown in South-east Asian countries including India, China and Nepal, Bangladesh, Myanmar etc. Present study was conducted to find out various seed treatments on seedling attributes viz., germination percentage, root and shoot length, fresh weight, dry weight and vigour index of bitter gourd seedlings were evaluated during 2015-16 at Horticultural Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.). Among all the treatments chemical treatment provided best result in comparison to control (untreated). The highest germination percentage (99.00%), root length (10.77 cm), shoots length (17.97 cm), fresh weight (60.29 mg), dry weight (0.72 mg) and vigour index (1789.30) were observed when seeds were treated with chemical i.e. carbendazim 12% + mancozeb 63% (3 g<sup>-kg</sup> seed). This was followed by bio control (seed pro 25 g<sup>-kg</sup> seed). The lowest germination percentage (96.00%), root length (8.08 cm), shoots length (14.06 cm), fresh weight (48.08 mg), dry weight (0.60 mg) and vigour index (1364.82) were observed in control.

#### S-5/P-3

### Extent of postharvest losses and diseases of potato in cold storages of Bankura, West Bengal

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The food and nutritional security continues to be a priority agenda to developing nations for their burgeoning population, the potato emerged as a hope for future sustain ability to society & agriculture. The enhancing productivity of potato alongwith reduction of enormous losses at postharvest phase remains the other option for sustenance of equitable distribution. In the last two decades Bankura (23° 38' - 22°38'N and 86° 36' -87°46' E 44 - 100 meters amsl) has emerged as a new destination with adequate production potential within Rice & Potato popular cropping sequence. In the *rabi* season approx. 11.42 % of gross cropped area is occupied by potato alone. Potato cultivation along with the growth of cold storages (maintained around 0-4° C) is strongly linked 7nos (1980) to 43nos (2011) alongwith total capacity enhancement from 26596 MT to 705340 MT including modernization yet the cold storages are not uniformly distributed in the district and no cold storage exist in seven blocks. Farmers pay no extra efforts on curing, culling and grading of potato tubers before storage between March to December. Traders dispatched potato tubers after culling and grading to the distant markets of neighbouring states despite the declining demand due to poor tuber qualities and higher postharvest losses. In Bankura district a survey was conducted during October, 2010 in Radhakrishna cold storage, Beliapore (RKCB), M.K. Heemghar, Taldangra (MKHT) and Mondal Ice and cold storage Bishnupur (MICB) to assess the loss and postharvest diseases. The extent of losses (range and average) differed among cold storages RKCB (5-21% & 8.54%); MKHT (8-23% & 12.28 %) and MICB (5-21 % & 10.62 %). There were variations in pathogenic spectra among samples in different cold storages. *Fusarium oxysporum* and *F. solani* are common but *Doratomyces microspores* was only from RKCB. Mixed infection of *Penicillium cyclopium* and *Fusarium oxysporum* was also encountered. The interrelationship of tuber maturity, injury and fungal infections are discussed.

#### S-5/P-4

### Postharvest quality maintenance of guava

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Guava (*Psidium guajava* L.) is highly perishable fruits, and it is susceptible to chilling injury, mechanical damage and has a limited postharvest shelf life. Fruits are rich in high-profile nutrients. With its unique flavor, taste, and health-promoting qualities, the fruit easily fits in the new functional foods category, often called "Super-fruits". Guava fruit contain, Vitamin-C 228 mg, Vitamin-A 624 IU, Lycopene 5204µg, Energy 68 Kcal, and anti-oxidant property 496 mg/100 gram fruit. Harvesting stage of fruits are depends on the purpose of use of consumer. Guava fruits are picked at the mature-green stage (color change from dark- to light-green) in some countries where consumers eat them at that stage. In countries

where consumers prefer ripe guava, the fruits are picked at the firm-yellow to half-ripe (softer) stage for long-distance transport or at the fully-ripe (yellow and soft) stage for local markets. Fruits are store at 8-10°C (46-50°F) at 95% RH for mature-green and partially-ripe guavas for 2-3 weeks. Ethylene at 100ppm for 1-2 days can accelerate ripening of mature-green guavas to full-yellow stage at 15-20°C with 90-95% relative humidity. Fully-ripe guavas are less sensitive to chilling injury than mature-green guavas and may be kept for up to a week at 5°C without exhibiting chilling injury symptoms. Most of the postharvest disease problems like anthracnose, aspergillus rot, mucor rot, phomopsis rot, and rhizopus rot. Effective preharvest management to reduce infection, careful handling to reduce physical damage, prompt cooling to 10°C and subsequent maintenance of that temperature throughout the handling system. Postharvest treatment for extension of fresh guava shelf-life and to determine these effects on the phytochemical content, antioxidant capacity, and overall quality of guava fruits.

#### S-5/P-5

### Botanicals and Bio-control agents against Anthracnose and Crown rot diseases of Banana

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Anthracnose and Crown rot have been considered as major diseases of Banana in almost all the banana producing countries. Anthracnose caused by *Collectotrichum musae* and Crown rot caused by a number of pathogens viz. *Collectotrichum musae*, *Fusarium solani*, *Lasioidiplodia theobromae* etc. can cause considerable losses. In Assam the post harvest loss of Banana has been estimated to be about 22%. The losses due to post harvest diseases are greater than generally realized because the value of fresh fruits and vegetables increases several folds while passing from field to consumers. To combat the post harvest losses in Banana, an attempt was made to evaluate the efficacy of different botanicals and bio-control agents for the management of post harvest diseases of Banana. Two bio control agents viz. *Trichoderma viride* (@30g/l), *Pseudomonas virideflava* (@30g/l) and leaf extract of *Solanum torvum* (50%) were tested singly and in combinations as pre- and post harvest applications, while carbendazim (0.1%) was used as the chemical check. Results revealed that combination of pre harvest spray and post harvest dip with leaf extract of *Solanum torvum* (50%) was best amongst the treatments, other than chemicals in managing anthracnose (50.5%) and crown rot (32.4%) compared to control (74.5 and 72 % respectively). The total shelf life, green life and yellow life were also found to be highest with 14.6, 7.4 and 7.2 days respectively with compared to control (9.4, 5.2 and 4.2 days respectively).

#### S-5/P-6

### Efficacy of plant extracts and bio-inoculants in managing leaf spot diseases of banana

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Leaf spot disease of banana causes considerable yield loss in every year and in some cases it may goes up to 50% or more. Moreover, it hinders the commercial cultivation and export of banana while considering the detrimental effect of residual chemicals both in human health and agro-ecosystems. To reduce the use of chemical fungicide and to investigate the bio-efficacy of some indigenous plant extracts and bio-inoculants, an effort has been made to combat the foliar diseases of the crop in a trial in the provenance of lower Gangetic zone of West Bengal on a susceptible banana cultivar Martaman (AAB) during 2012-2014. Six botanical oils have been tested viz. Neem oil (0.2%), Palmarosa oil (0.2%), Lemon grass oil (0.2%), Castor oil (0.2%), Citronella oil (0.2%) and Karanj oil (0.2%) along with two bacterial bio inoculants namely *Pseudomonas fluorescens* and *Bacillus subtilis* @ 5g formulation (10<sup>8</sup> cfu/g) per liter using a standard check (propiconazole, 0.1%) for comparison. Severity of leaf spot was measured with per cent disease index (PDI). Out of eight treatments, performance of Neem oil was found to be the best to reduce the disease severity. Per cent disease index (PDI) was estimated 19.50 as compared to 31.25 in control. However, maximum disease reduction was calculated in the propiconazole treated plots. Yield of the crop was also recorded highest with propiconazole (30.82 t/ha). Yield of the Neem treated plot and *P. fluorescens* plot were recorded 27.12 t and 23.80 t respectively, where as yield of the control was recorded in the tune of 21.66 t/ha. Yield increase over control was calculated as 42.88%, 25.20% and 13.64% from propiconazole, Neem oil and *Pseudomonas fluorescens* treated plot respectively. Although the efficacy of the Neem oil is not at par with standard, however, it has a great ability to reduce development and spread of the disease leading to environment friendly commercial cultivation of banana with minimal residual toxicity.

#### S-5/P-7

### Analysis of defence metabolites production in brinjal infected by the bacterial pathogen *Ralstonia solanarum* L.

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Phytopathogen infection leads to changes in primary metabolism as well as secondary metabolism based on the modification in the metabolites levels leads to change in the growth and development of the plant. Therefore, pathogen attack causes crop yield losses even in interactions, which do

not end up with disease or death of the plant. While the regulation of defense responses has been intensively studied for decades, less is known about the effects of pathogen infection on primary metabolism. Qualitative changes in the amino acid, Phenolic acids, phytohormones, polyamines and organic acid contents of the Eggplant (*Solanum melongena*) during pathogenesis caused by *Ralstonia Solanaceum* were investigated chromatographically. There was remarkable alteration in the level of various metabolites during interaction. Total in all nine different amino acids namely, Aspartic acid, Glutamic acid, Histidine, Glycine, Cysteine, Arginine, Serine, Leucine, and Phenylalanine, were detected in the Arka Nidhi and Pusa Purple Long during different time intervals after infection. Lysine, Isoleucine, Tyrosine, Threonine, Alanine, Methionine, and Valine were not found in the susceptible, as well as resistant plant, on the other hand, Proline was found only in the susceptible plant but not in resistant plant. Similarly, Arginine and leucine were not in any time point found in resistant plant. The organic acids, which detected in both the plant, were Fumaric acid, Malonic acid, Malic acid, Succinic acid and Citric acid, during the given incubation period, in all the given incubation periods. There were no remarkable changes in the concentration and composition of detected organic acids in diseased and control plant during various incubation periods. The concentration of Malic acid was the only factor that could be considered here in Eggplant (*Solanum melongena*)- *Ralstonia Solanaceum* interaction. Polyamines are implicated in the regulation of many processes in the plant cell, including functioning of ion channels, DNA replication, gene transcription, mRNA translation, cell proliferation and programmed cell death. Plant polyamines occur either in free form, covalently bound to proteins, or conjugated to hydroxycinnamic acids forming phenol amides. Our data revealed a striking increase in brinjal polyamine putrescine and spermidine in susceptible Pusa Purple Long than resistant Arka Nidhi. In this addendum, we describe that changes in polyamine metabolism take place even in earlier stages of brinjal plant infection with *Ralstonia Solanaceum*. However, after 24 hpi the levels of both hormones goes in opposite direction in susceptible plant. Phenolic compounds were measured in roots of brinjal in control and inoculated plants. phenolics were analyzed by high performance liquid chromatography. 4-dihydroxybenzoic acid, Vanilic acid and Ferulic acid was not found in the resistant; while Vanilic acid was absent in the susceptible plant at all the time point of study. Gallic acid, 3, 4-dihydroxybenzoic acid, Catechol, ferulic and *p*-coumaric were very much higher in susceptible control plant than resistant plants. However, there was gradual decline in the all the phenolic acid after pathogen inoculation in susceptible plant. The plant hormone abscisic acid (ABA) is involved in a wide variety of plant processes, including the initiation of stress adaptive responses to various environmental cues. In our study, ABA, IAA and GA3 emerged as a central factor in the regulation and integration of plant immune responses, although little is known about the underlying mechanisms. Aiming to advance our understanding of cross talk of these hormone during disease resistance/susceptibility, we have analyzed the quantity of SA, JA, ABA, IAA and GA3 during infection process of *Ralstonia Solanaceum* and defence

process by plants. In addition, As in our case, we have detected increase concentration of these phytohormones in susceptible plant than resistant plant during pathogenesis. Our results clearly indicate that, there was suppression of SA mediated defence pathway. There was reduction of JA in susceptible inoculated plant than resistant inoculated plant, indicated their role in imparting susceptibility towards disease at higher concentration.

### S-5/P-8

## Genetic variability for panicle characters in rice

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A wide range of variability was observed for thirteen panicle characters in 42 indigenous rice genotypes. The high magnitude of both phenotypic and genotypic coefficients of variation was recorded for panicle number plant<sup>-1</sup>, secondary branches panicle<sup>-1</sup>, spikelet number panicle<sup>-1</sup>, grain number panicle<sup>-1</sup>, test weight, yield panicle<sup>-1</sup> and grain yield plant<sup>-1</sup>. High heritability accompanied with high genetic advance as percent of mean was observed for all the panicle characters studied except days to flowering and primary branches panicle<sup>-1</sup> indicating preponderance of additive gene action for these characters and hence selection to be effective. Very close values of genotypic and phenotypic correlation were observed between most of the characters. Panicle weight exhibited highest positive and significant correlation with grain yield plant<sup>-1</sup> followed by yield panicle<sup>-1</sup>, test weight, panicle bearing height of plant and primary branches panicle<sup>-1</sup> at genotypic and phenotypic level. Panicle weight showed the highest positive direct effect on grain yield plant<sup>-1</sup>. This indicates that panicle weight is very important component of grain yield. Another important character with high direct effect on grain yield is spikelet number panicle<sup>-1</sup> which showed positive direct effect on grain yield. Hence, panicle weight and spikelet number should be given more attention in rice improvement program. Presence of wide variability for different panicle characters in this population may be helpful in selecting climate proofing genotypes under growing drivers of climate change.

## Technical Session–VI: Agricultural Chemical Industry : Agricultural chemicals, bio-formulation and soil health.

### Lead Lecture

### S-6/L-1

## New molecules of fungicides: profile and development

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Fungicide use is the most important component of pest and disease management programmes in agro-production systems.



Most fungal diseases are difficult to eradicate as, despite attempts at eradication, disease outbreaks can continue to occur across several growing seasons. The devastating impact of fungal diseases have goaded the use of fungicides and resulted in it being considered best practice to avoid colossal economic losses. The past few decades have been the witness of several changes in the paradigm of plant disease control through fungicides. The discovery of Bordeaux mixture in 1885 was the corner-stone for fungicide development and the advent of fungicides like dithiocarbamates, quinones, benzimidazoles, phenylamides, morpholines, azoles etc. ushered in a new era of plant disease management. The farming world is now visualizing the emergence of new generation, highly specific fungicides which has a multi-prong effect on the disease triangle. Not only the fungicides are capable of curative effect, but also have the attributes of altering the carbohydrate levels of the host or simulate the host defense system. Boscalid, Metconazole Fluxapyroxad, Mefenoxam and Penflufen are some of the fungicides which possesses the above mentioned characteristics and are expected to be in the global market within 2020. After 2020, fungicides like Triflumizole, Amisulbrom, Cyflufenamid, Silthiofam, Ethaboxam, Valifenalate etc. are expected to come to the fore because of their low doses and ability to mitigate resistance risk. In the present scenario, however, triazoles and QoI fungicides like strobilurins are predominant in the global market but carboxylic acid amides like Dimethomorph, Mandipropamid etc. are also gaining a steady importance. Research into the potential environmental risks posed by fungicide use is needed so that evidence-based policy decisions can be made on the future management of fungicide use in agriculture. This need is driven by an increasing community expectation for governments and industry to implement measures to protect environmental assets. In addition, from marketing perspectives, there is increasing pressure on agricultural industries to demonstrate their 'clean and green' credentials to address concerns from consumers and to maintain market access.

## Oral Presentation

### S-6/O-1

#### Green synthesis of silver nanoparticles and its effect against soil borne pathogens

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Nanotechnology has emerged as an important branch of science and it will play an important role in agricultural science in the coming years. An attempt was made for green synthesis of silver nanoparticles from *Trichoderma asperillum*, a potential indigenous biocontrol agent. Silver nitrate was added as precursor for the synthesis of silver nanoparticles. The biosynthesized silver nanoparticles was characterized by UV-

Vis spectrophotometer, Dynamic Light Scattering (DLS), X-ray diffraction (XRD), Zeta Sizer and Transmission Electron Microscope (TEM). UV Vis spectrum of aqueous medium containing silver ion showed peak at a wavelength of 420 nm corresponding Plasmon Absorption of silver nanoparticle. DLS study showed that the biosynthesized silver nanoparticles have a size of 27.64 nm with polydispersity index (PDI) of 0.409. This indicates that the biosynthesized nanoparticle were polydispersed in nature. The charge of silver nanoparticles was determined by zeta sizer and found to have negative potential value of -1.34 and indicated as stable on dispersion. TEM study revealed the formation well dispersed silver nanoparticles in the range of 9-41 nm with roughly spherical in shape. Antifungal activity of silver nanoparticle at different concentration (100 ppm, 50 ppm, 30 ppm, and 10 ppm) was tested against four soil borne plant pathogens viz., *Rhizoctonia solani*, *Fusarium* spp., *Sclerotinia sclerotiorum*, and *Sclerotium rolfsii* and comparison was made with Carbendazim @3000 ppm. The result showed that the silver nanoparticles at 100 ppm significantly inhibit the mycelia growth of the pathogens as compared to the Carbendazim at 3000 ppm.

### S-6/O-2

#### Better together: plant growth promoting microbial consortium for acid soils

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The use of microbial resources in improving habitat-adaptive fitness of crops and their production in acid soil is very much pertinent. To develop a microbial consortium (MC) with multifaceted plant growth promoting (PGP) traits relevant to acid soils, this study was formulated for screening of bacteria for PGP traits, assessment of compatibility among PGPB isolates for formulation of MC and to test the suitable carrier materials. From a repository of 300 pure culture bacteria (inhabitants of root and rhizosphere soils of rice species) maintained in the Microbial Ecology Laboratory, CPGS (CAU-Imphal), five PGPB isolates from each of the four functional groups viz. cellulose decomposing bacteria (C-group), nitrogen fixing bacteria (N-group), IAA producing bacteria (I-group), and phosphorus solubilising bacteria (P-group) and one bio-control agent (B-group) from Plant Pathology Laboratory, CPGS were screened for quantitative determination of IAA-like substances, dissolution of insoluble inorganic (AlPO<sub>4</sub> and FePO<sub>4</sub>) and organic (Na-phytate) phosphates, phosphatase activity, exopolysaccharides secretion and ACC-deaminase activity. The highest scorers based on PGP traits were C4(25), I3(24), N3(22), P5(24) and B1(24) for C-, I-, N-, P- and B-groups, respectively and found compatible to each other through dual cross streaking and mixed culture broth assays. The taxonomic identities of 21 isolates belong to genera *Pseudomonas*, *Klebsiella*, *Pantoea*, *Serratia*, *Lysinibacillus*, Uncultured *Rhizobium*, *Bacillus* and *Enterobacter*. The test for shelf-life of 5 consortium isolates indicated that MC-compost supported higher viable counts during storage compared to MC-biochar. In micro-plot field experiment using rice (var.

CAUR3) as test crop, the harvest index, grain yield and grain nutrient (N and P) uptake of rice was found to be higher in MC-compost than RDF and MC-biochar. This study has generated a compost based MC having multifaceted PGP traits that needs to be validated through multi-locational trials in farmers' fields.

## Poster Presentation

### S-6/P-1

#### Eutrophication and soil phosphorus: a study on the feasible mitigation technologies

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The need to reduce anthropogenic nutrient inputs to aquatic ecosystems in order to protect drinking-water supplies and to reduce eutrophication, including the proliferation of harmful algal blooms and "dead zones" in coastal marine ecosystems has been widely recognized. However, the costs of doing this are substantial; hence, developing the appropriate nutrient management strategy is very important. Phosphorus is an essential component of nucleic acids and many intermediary metabolites, such as sugar phosphates and adenosine phosphates, which are an integral part of the metabolism of all life forms. Phosphorus only occurs in the pentavalent form in aquatic systems. Phosphorus is delivered to aquatic systems as a mixture of dissolved and particulate inputs, each of which is a complex mixture of these different molecular forms of pentavalent P. P levels have also significantly increased because of fertilizer use, as well as from municipal and industrial wastewater. Phosphorus in runoff from agricultural land is an important component of nonpoint-source pollution and can accelerate eutrophication of lakes and streams. Problems with soils high in P are often aggravated by the proximity of many of these areas to P-sensitive water bodies; however, P is a very dynamic, biologically active element. After these P inputs arrive in receiving water, the particulates may release phosphate and organic phosphates to solution in the water column and various P compounds may be chemically or enzymatically hydrolyzed to orthophosphate, which is the only form of P that can be assimilated by bacteria, algae, and plants. This type of eutrophication is not reversible unless there are substantial changes in soil management. So, technologies for rapidly reducing phosphorus content of overenriched soils, or reducing erosion rates, are studied to improve water quality.

### S-6/P-2

#### Evaluation of phyto extract and bio-control agent against fruit rot of Tomato caused by *Fusarium* spp.

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Tomato (*Solanum lycopersicum* L) fruit is attacked by fruit rot disease caused by *Fusarium oxysporum* f.sp. *lycopersici* causing yield loss up to 80 per-cent. An attempt was made to

evaluate the efficacy of phyto extract and antagonist on reduction on radial growth of *F. oxysporum* f.sp. *lycopersici*. In *in vitro* evaluation, aqueous extract of neem, garlic and tulsi significantly reduced the radial growth of *F. oxysporum* f. sp. *lycopersici* at all the concentrations viz., 5, 10 and 20 per cent as compared to control. However, neem extract found most effective (85.00% of growth inhibition) against *F. oxysporum* followed by garlic extract and tulsi extract, while extract of tulsi was found least effective. Amongst the three antagonists' viz., *Trichoderma harzianum*, *Gliocladium virens* and *Trichoderma koningii*, maximum radial growth inhibition (82.51%) of *F. oxysporum* f.sp. *lycopersici* was recorded by *T. harzianum* as compared to others. In the compatibility test, neem extracts showed slightly antagonistic activity on *T. harzianum* at 5 and 10 per-cent but showed moderate antagonistic activity on *T. harzianum* at 20 per-cent while moderate antagonistic effect was shown against *T. koningii* by neem extracts at 5, 10 and 20 per-cent but highly antagonistic effect was shown on both the antagonists of garlic extracts at 5, 10 and 20 per-cent.

### S-6/P-3

#### *In vitro* efficacy of antimicrobial peptides against citrus canker

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Citrus canker caused by *Xanthomonas axonopodis* pv.citri (Xac), is one of the most devastating disease which is endemic throughout Asia. A considerable expenditure has to be incurred for bactericidal sprays, which adversely influences the environment and the bacterium also developed resistance to different commonly sprayed antibiotics. *In vitro* attempt using the filter paper disc method was made to find out the eco-friendly solution by comparing the efficacies of nine antimicrobial peptides (AMPs) viz. PEP11, D4E1, ESF1, ESF4, ESF5, ESF6, ESF12, ESF13 and ESF17 at a concentrations of 500 ppm, 1000 ppm, 2000 ppm and 5000 ppm with eleven antibiotics and chemicals viz. Streptocycline, Bactrinashak, Ambistryn-S\*, Resteclin\*500, Blitox, Bordeaux mixture, Captan, NanoCopper, PSEUDO- FL, Power plant grow<sup>®</sup> and Power plant<sup>™</sup> at concentrations of 250 ppm, 500 ppm, 750 ppm and 1000 ppm. In addition to it, micro-dilution broth method was used for testing the *in vitro* efficacy amongst the AMPs at a concentration of 500 ppm. Among the various antibiotics and chemicals tested, Resteclin\*500 and Bactrinashak showed the highest and least efficacy respectively where the efficacies were found to be the most significant at a highest concentrations of each chemical tested, while Power plant grow<sup>®</sup> and Power plant<sup>™</sup> were not effective. Amongst the AMPs, D4E1 was the most effective while ESF4, ESF6 and ESF13 were not effective at all. D4E1, PEP11, ESF1 and ESF17 are the potential AMPs which can be used effectively for further crop improvement and for further studies that can substitute the commonly used chemicals and antibiotics.

## S-6/P-4

**Biopesticides : Investigation on present status, future prospects and challenges in agriculture****Madhurima Banik\***, Anandkumar Naorem, Gyanendra Kumar and Shiva Kumar Udayana*Department of Agricultural Chemistry and Soil Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal; E-mail : madhurimab791@gmail.com*

Biopesticides include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs. Biopesticides are receiving increased exposure in scientific annals and the lay press, as alternatives to chemical pesticides and as key components of integrated pest management (IPM) systems. The science of biopesticide is still considered to be young and evolving. In-depth research is needed in many areas such as production, formulation, delivery and commercialization of the products. Some of the biopesticides, currently under development, may prove to be excellent alternatives to the chemical pesticides. Presently, biopesticides cover only 2 per cent of the plant protectants used globally; however its growth rate shows an increasing trend in past two decades. Global production of biopesticides has been estimated to be over 3,000 tons per year, which is increasing rapidly. Globally, the use of biopesticides is increasing steadily by 10 per cent every year. About 90 per cent of the microbial biopesticides are derived from just one entomopathogenic bacterium, *Bacillus thuringiensis*. Biopesticides are attracting global attention as safer strategy to manage pest populations such as weeds, plant pathogens and insects while posing less risk to human being and the environment. Research in production, formulation and delivery may greatly assist in commercialization of biopesticides. More research is needed towards integrating biological agents into production system, improving capability of developing countries to manufacture and use biopesticides. At the same time, it is also required to encourage public funded programmes, commercial investors and pesticide companies to take up biopesticide enterprises.

## S-6/P-5

**In vitro evaluation of certain fungicides, botanicals and bio control agents against *Lasiodiplodia theobromae*****V Suresh<sup>1</sup>, B Vidya Sagar<sup>2</sup>, P Kishore Varma<sup>3</sup>, N Sumalatha<sup>4</sup> and M Rajendra Prasad<sup>5</sup>***<sup>1,2,4,5</sup> College of Agriculture, Rajendranagar, Prof. Jayashankar Telangana State Agricultural university, Hyderabad-500030, Telangana, India, <sup>3</sup> scientist, RARS, Anakapalle, ANGRAU, A.P.; E-mail : v.sureshagrigo@gmail.com*

Mango (*Mangifera indica* L.) being an important tropical and subtropical fruit crop, is being affected by several fungal diseases among which gummosis caused by *Lasiodiplodia theobromae* (Pat.) Griffon & Moube [synonym: *Botryodiplodia*

*theobromae*] is becoming a serious problem in India on many popular varieties of mango particularly during monsoon and post-monsoon periods. An investigation to in vitro evaluates the different effective fungicides, botanicals and bio control agents were conducted to manage the gummosis disease of mango. Among the 10 fungicides tested at different two concentrations (250 and 500 ppm) carbendazim, carbendazim+ mancozeb and propiconazole, completely inhibited the growth of *L. theobromae* concentrations whereas pyraclostrobin was least effective. Among the different botanicals, extract of Garlic bulb at 10 per cent found to be superior (35.93%) followed by Neem at 10 per cent (8.15%). Among Trichoderma isolates T9, T6, T3 and T2 were found effective against *L. theobromae*.

## S-6/P-6

**Efficacy of different plant extracts for inhibiting the growth of *Colletotrichum gloeosporioides* (Penz.) Penz. and Sacc.****KN Koshale and MK Mishra***Department of Plant Pathology, College of Agriculture, IGKV, Raipur (Chhattisgarh) 492012; E-mail: koshalekamaalnarayan@gmail.com*

*Colletotrichum gloeosporioides* Penz. and Sacc. is considered as the most important pathogen of mango that causes a serious pre and postharvest disease anthracnose that limits the production and productivity of mango and causes severe economic losses to the growers. Anthracnose disease of mango is being controlled by many synthetic fungicides, which increase cost of production, cause environmental hazards and are toxic to the living beings. Therefore twelve botanical extracts were evaluated by poison food technique at three different level of concentration (5, 10 and 15%) to find out their antagonistic efficacy against *Colletotrichum gloeosporioides*. The highest percent of inhibition was achieved by leaf extracts of *Mentha cordifolia* 29.33% and 42.78% followed by *Piper betle* (22.85%) and *Datura stramonium* (40.96%) at 5 and 10 per cent concentration respectively. The best growth inhibition was obtained when test pathogen was incubated with 15 per cent leaf extract of *Eucalyptus spp.* (63.48%) which was statistically superior over leaf extract of *Mentha cordifolia* (61.96%) at the same concentration. The leaf extract of Fenugreek (*Trigonella foenumgraecum*) recorded lowest mean per cent growth inhibition i.e. 4.41, 10.74 and 11.52 per cent at 5, 10 and 15% concentration respectively.

## S-6/P-7

**Bio-efficacy of Fluopicolide 6.25% + Propamocarb Hydrochloride 62.5% SC (Infinito 68.75% SC) (w/v) against downy mildew (*Pseudoperonospora cubensis*) of Cucumber****RN Bunker and Rajendra Sony***Department of Plant Pathology, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture & Technology, Udaipur 313 001, Rajasthan; E-mail : rnbunker@yahoo.co.in*

Cucurbits are members of the gourd family or cucurbitaceae and include the popular crops of cantaloupe, cucumber, pumpkin, squash and watermelon. Downy mildew is an important and widespread disease in all these crops under



greenhouse and field-grown plants and cause significant yield loss in areas with high humidity and rainfall. To manage downy mildew of cucumber bio-efficacy of the Infinito 68.75% SC (Fluopicolide 6.25% + Propamocarb Hydrochloride 62.5% SC) a new compound was evaluated at different concentration and compared with its individual molecules Fluopicolide 48% SC, and Propamocarb Hydrochloride 72.2% SL along with Curzate M (Cymoxanil 8% + Mancozeb 64% - 72 WP. The field experiment was conducted for two consecutive years 2013-14 and 2014-15 on a moderately susceptible variety Poinset. The randomized block design was followed with three replication maintaining 5.0 m x 4.0 m size micro plots having 16 plants per plot at 60 cm distance on 5m length of ridge on both sides. Pooled results of two years revealed that Infinito 68.75% SC @1500 ml/ha was significantly reduced the disease 89.96 percent with minimum downy mildew intensity 8.0 percent after 3 spray at 7 days intervals. This was reflected in increased yield 161.6 q/ha, that was significantly superior all over the other treatments. Compare to this Curzate M @1500 ml/ha was found less effective with 11.5 percent disease intensity (PDI) and 81.1 (PEDC) percent disease control with 137.31 q/ha yield. In control plots the disease intensity was 60.8 percent with minimum fruit yield 83.26 q/ha was recorded. Hence, a new molecule mixture Infinito 68.75% SC @1500 may be more effective to manage the downy mildew of cucumber.

#### S-6/P-8

### Efficacy of SAR molecule, Nano particles and Reactive Oxygen Species (ROS) towards management of Phytopathogens under *in vitro* condition

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Phytopathogens are one of the major limiting factors in profitable crop production. Now a days, the emerging threats from plant pathogen are pesticidal resistance as well as the environmental pollution due to injudicious application of pesticide. Hence an ecofriendly approach through applying SAR molecule, nanoparticles and ROS molecule at a very lower concentration have developed the resistance in the host to withstand the attack by invading pathogens due to their antimicrobial property. Effective concentration of SAR molecule *i.e.* salicylic acid@ (< 20 ppm), Nano particles namely AgNO<sub>3</sub>, Chitosan and silver@ (<20ppm) and ROS molecule *i.e.* H<sub>2</sub>O<sub>2</sub> @(<20PPM) against *Alternaria* Sp, *Curvularia* Sp, *Corynospora* Sp and *Diplodia* Sp have given effective inhibition and suppression of growth and further development under *in vitro* condition. The field application of above mentioned molecules is undergoing and results are yet to be obtained. The *in vitro* observations of these molecules have

opened up a new hope among plant pathologies with special reference to crop protection practices. The residual toxicity study of the treated host under field condition is also to be carried out as per our programme.

#### S-6/P-9

### Evaluation of some new fungicides for better management of stem rot and root rot disease of *Olitorius Jute (Corchorus olitorius L.)*

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Jute, the golden fibre is one of the most important fibre crops of Orissa. The soil borne diseases, stem rot and root rot caused by the fungus *Macrophomina phaseolina* is the most devastating and affects the yield & fibre quality of *Olitorius* Jute. Because of its soil borne nature, it is very much difficult to manage. An experiment was conducted at Jute Research Station, Kendrapara, Orissa University of Agriculture and Technology, Bhubaneswar for two consecutive years, 2014 and 2015 with an objective to evaluate some new chemicals for minimizing the harmful effect of the disease on *Olitorius* Jute (cv.JRO-204). The treatments were T<sub>1</sub> - Seed treatment with Carbendazim @ 2gm/kg seed + spraying of Carbendazim @ 0.2% at 40-45 days of crop age T<sub>2</sub> - Seed treatment with Propineb @2gm/kg seed + spraying of Propineb @0.2% at 40-45 days of crop age T<sub>3</sub> - Seed treatment with Tebuconazole @ 1.5 ml/kg seed + spraying of Tebuconazole @ 0.15% at 40-45 days of crop age T<sub>4</sub> - Seed treatment with Difenconazole @ 1.5ml/kg seed + spraying of Difenconazole @ 0.15% at 40-45 days of crop age T<sub>5</sub> - Seed treatment with Cyproconazole @1.0 ml/kg seed + spraying of Cyproconazole @ 0.08% at 40-45 days of crop age T<sub>6</sub> - Seed treatment with Tricyclazole + Propiconazole @ 1.0 ml/kg seed + spraying of Tricyclazole + Propiconazole @ 0.1% at 40-45 days of crop age T<sub>7</sub> - Seed treatment with Azoxystrobin + Difenconazole @ 1.0 ml/kg seed + spraying of Azoxystrobin + Difenconazole @0.075% at 40-45 days of crop age. T<sub>8</sub> - Absolute check with no fungicide application. The design of experiment was RBD with three replications. The pooled analysis of the result revealed that disease incidence of both stem rot and root rot was found lowest under T<sub>7</sub> treatment. In case of stem rot T<sub>7</sub> is followed by T<sub>6</sub> and in root rot T<sub>7</sub> is followed by T<sub>4</sub>. Highest yield was obtained in T<sub>7</sub>. Hence, based on disease infestation & fibre yield application of Seed treatment with Azoxystrobin + Difenconazole @ 1.0 ml/kg seed + spraying of Azoxystrobin + Difenconazole @0.075% at 40-45 days of crop age was found best management for stem rot and root rot disease of Jute.

**S-6/P-10****Effect of selected chemical and biological fungicides on the pollen physiology of four vegetable crops****S Raha<sup>1</sup> and M Paramanik<sup>2</sup>**<sup>1</sup>Associate Professor and H.O.D in Botany, S.K.B University, Purulia. 723104; <sup>2</sup> P G student, Department of Botany and Forestry, Vidyasagar University, Midnapore; E-mail : mail2subrataraha@gmail.com

The present investigation was carried out to observe the role of chemical and biological fungicides on the pollen physiology of four vegetable crops belongs to four different families viz. Brinjal (*Solanum melongena* L.) of solanaceae, Bottle gourd (*Lagenaria siceraria*(Molina) Standl.) of cucurbitaceae, Vegetable cowpea (*Vigna unguiculata* (L) Walp.) of Fabaceae and Ladies finger (*Abelmoschus esculentus* (L) Moench) of malvaceae. Fungicides are widely used today to control fungal diseases of crops. It is well known that these chemicals repels and harms the friendly pollinators, contaminate soil and water as well as responsible for human health hazards. The present investigation revealed that the fungicides like, Vitavax (Carboxin, 75% W.P.) and Hilzim (Carbendazim, 50% W.P.) reduces the rate of *in vitro* germination of the test pollen grains. It was also observed that the growth of the pollen tubes were arrested or deformed when exposed to such chemicals. On the other hand, interestingly, the bio-fungicide like Trichostar (*Trichoderma viride* - 1% WP) and Sudobact (*Pseudomonas fluorescens* - 2X10<sup>9</sup> CFU cells bacteria/ml) does not affect the pollen germination and tube elongation. This study naturally proves that improper use of fungicide particularly during flowering period hamper pollen physiology and naturally reduces fruit set or productivity. More research and production of eco-friendly bio-fungicides and their wide application is immediately required for a sustainable agriculture.

**S-6/P-11****Tricho Capsule: an approach to encapsulate bio-agent for long term storage and easy delivering at farmer's level****Rahul Singh Rajput<sup>1</sup> and Jyoti Singh<sup>2</sup>**Ph.D Research Scholar, <sup>1</sup>Department of Mycology and Plant Pathology, BHU, Varanasi; <sup>2</sup>Department of Botany, BHU, Varanasi; E-mail : rahulsinghr829@gmail.com

In present scenario, bio control agents are gaining much more attention in agricultural applications due to their potential of replacing chemical agents up to a remarkable level. In addition, they also play a vital role in enhancing the plant growth, soil quality and environment. *Trichoderma* is one of those bio control agents which is being more extensively used for crop disease management. Different formulations of *Trichoderma* sps such as powder, liquid and tablets are available in the market. Success of these formulations depends on the storing facility, easy availability, effective delivery methods and cost. Till date, none of the formulations have been proven perfect as each of them have their own limitations. One of the formulation Tricho capsule contains pure viable culture of

*Trichoderma* having mycelium, resting spores and carrier encapsulated in hollow hard gelatine capsule. The advantages of this preparation are long shelf life as about three years, simple preparation process, improved disease resistant effect and management of wide range of vegetables, fruits, flowers, cereals and crop disease like *Sclerotinia* blight, *Fusarium* wilt, etc. This technique also helps farmers for mass production at field level for soil applications. It also reduces the quantity and cost of applying bio control agent in soil because it requires least quantity as compared to other formulations of *Trichodermasps*. For instance, the normal requirement of any formulation for cereals and vegetable crops seed treatment 4 gm per kg of seed. It replaced with just one capsule per kg of seed where each capsule weight approx 1 gm. Farmers can also be self capable for mass culturing after obtaining some technique knowledge and handling. In this paper our emphasis is on providing better option to the farmers having long storage and easy availability.

**PP Singhal Memorial PI Industries Award Competition for the Year 2016****Current status of cotton leaf curl begomovirus disease in Northwest India: Incidence, spatial distribution, genomic complexity and development of management strategy****Kajal Kumar Biswas**

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Cotton leaf curl disease (CLCuD), caused by monopartite virus particles under the genus *Begomovirus* belonging to the family *Geminiviridae*, and its satellite molecules, is one of the serious constrains in cultivation of cotton in Northwest (NW) India. This disease is transmitted by whitefly (*Bemisia tabaci*) in semi-persistent manner. Surveys were made to study CLCuD incidence in cotton growing areas of Haryana, Punjab and Rajasthan and Indian Agricultural Research Institute (IARI), New Delhi for the last three years from 2013-2015. In Delhi, it was observed that CLCuD has been increased from initial year to recent year and disease incidence was as high as 15.92% in 2013 and moderate of 8.4-9.2% in 2014 and 2015. The survey revealed very high CLCuD incidence of 50.5-95.5% in the year 2013 and lower of 23.5-65.5% in 2014 and again high of 25.3-77.7% in the year 2015. The overall higher boll number reduction of 36.9% was estimated in 2013 compared to 7.6% boll number reduction in 2014 in Haryana. In Rajasthan the boll number reduction was 21.6% in 2013 and 2.9% in 2014. The overall CLCuD incidence and boll number reduction in Punjab were more or less similar for both the years, where incidence was 54.1% with 14.6% boll number reduction in 2013 and 57.8% with 15.9% boll number reduction in 2014. Several Bt-cotton hybrids from the farmer's fields of Sri Ganganagar and Sirsa districts surveyed were highly susceptible to CLCuD in both the years; showing 100% disease with 32.3-82.3% boll number reduction and 49.2-100% with

8.7-17.4% boll number reduction in 2014. Infectivity of CLCuD in NW India was confirmed through whitefly, and infection of CLCuD-begomovirus determined by PCR targeting CP gene of CLCuD-begomovirus. The increased CLCuD incidence with huge yield loss is attributed to occurrence of CLCuD-begomovirus variants and lack of resistance in cotton cultivars that is an alarming for profitable cultivation of cotton in NW India. The complete genome of 18 NW Indian CLCuD-begomovirus isolates collected from different areas of NW India were cloned, sequenced and analyzed. The nucleotide identity matrix showed that they had 80-100% nt identity among them. Of them 11 isolates (Faz-14, Si-17, Rh-4, SG-14, S-9, Uf-1, Ma-14-3, Sa-3, IARI-34, -42 and -50) showed 95-99% nt identity among them and all fell under CLCuMuV-Rajasthan strain. One isolate S-11 was similar to CLCuMuV-Faisalabad strain (97% nt identity) and another isolate Hi-3 was similar to CLCuMuV-Pakistan strain (100% nt identity). Five isolates (Hi-14, Hmg-14, Si-14-1, IARI-30 and -45) fell under CLCuKoV-Burewala isolate (99% nt identity). The present CLCuMuV isolates has genome length of 2739 to 2753nt and CLCuKoV isolates had genome length of 2759-2762nt. The C4 ORF of all the present CLCuMuV isolates had similar length (303nt) positioned at ~2142-2444nt but CLCuKoV isolates had different lengths from 303 to 441nt. In the present study, 8 betasatellites molecules (~1271nt length) obtained from CLCuD-affected cotton plants are member of Cotton leaf curl Multan betasatellite (CLCuMB; AY083590). Nine alphasatellites (~1366-1396nt length) were obtained in the present study; of them six are Cotton leaf curl Burewala-Pak alphasatellites (CLCuBuA-Pak; FR772090), one is Croton yellow vein mosaic alphasatellite (CrYVMoA; KC577541) and two are *Gossypium darwini* symptomless alphasatellites (GDSA; FJ218493). Of 18 NW Indian begomovirus isolates, 13 are recombinant and five (SG14, Uf-1, Ma-14-3, IARI-34 and Hi-3) are non-recombinant. All the betasatellites were detected as recombinants and mostly all the alphasatellite molecule recombinants. The present study demonstrated that recent CLCuD epidemic in NW India is caused by CLCuMuV-Rajasthan isolate predominantly and CLCuMuV-Pakistan and -Faisalabad/ Hissar along with CLCuKoV-Burewala isolate in association with recombinant betasatellite CLCuMB. As use of resistant or tolerant varieties is regarded to be the best method of CLCuD management, effort was made to screen cotton varieties/hybrids in field as well as green house condition. Total 55 cotton varieties screened against CLCuD in field condition in 2013 and 2014, none was found to be resistant. The per cent plant infection varied with the cultivars and ranged from nil to 46.4% in 2013 and nil to 26.4% in 2014. However, based on the field study for both the years, seven varieties, P21-51, P-31, P-1752, P-5616, P-5618, 12-P 4 and P-5628 were identified as tolerant varieties. In greenhouse condition, 130 cotton cultivars including 73 varieties, 48 germplasms and 12 Bt-hybrid cottons were screened through whitefly inoculation. None of the cultivars were found to be resistant rather highly susceptible. Fifteen desi cotton (*G. arboreum*) varieties were tested, and none was infected by CLCuD. Comparative efficacy for management of the CLCuD

as well as whitefly some eco-friendly substances or chemicals was evaluated. Salicylic acid, Cupric chloride and Ferric chloride (seed treatment) for induced resistance and Potassium dehydrogenate phosphate ( $\text{KH}_2\text{PO}_4$ ), Dipotassium hydrogen phosphate ( $\text{K}_2\text{HPO}_4$ ) and Calcium nitrate ( $\text{CaNO}_3$ ) (soil drenching) for plant resistance. Some low toxic chemicals like Imidacloprid (Confider, 17.8% SL), Flonicamide (Ulala, 50% WG) and Clothianidin (Dantotsu, 50% WDG) and organic products like Calf urine (2-5%), butter milk (3-5%) and mustard oil (2-5%) were sprayed management of whiteflies. Biotechnological based management of CLCuD-begomovirus was studied. For transgenic resistance in cotton against this disease, antisense gene constructs (RNAi) of  $\beta\text{C1}$  gene of betasatellite associated with CLCuD-begomovirus pBinAR and pCAMBIA2301 (+GUS) vector were developed. These construct were used for *in planta* cotton transformation. About 500 cotton plants were transformed and 4 plants in  $T_0$  were found to be positive through in GUS Assay and waiting for seeds/bolls to further screen of  $T_1$  generation.

### Combined application of fungicide tolerant *Pseudomonas fluorescens* and reduced dosage of azoxystrobin for the management of Rice blast disease

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Twenty isolates of *P. fluorescens* were isolated and identified based on morphology and amplification of ITS region. Ten foliar fungicides and twenty *P. fluorescens* isolates were evaluated for the inhibitory action against *P. oryzae* and among these azoxystrobin and *P. fluorescens* PF9 exerted maximum inhibition. Further, fungicide azoxystrobin was compatible with *P. fluorescens* PF9. The interaction between azoxystrobin and *P. fluorescens* for arresting the growth and sporulation of *P. oryzae* was found to be synergistic. In addition, Gas Chromatography Mass Spectrum (GCMS) analysis of the effective isolate of *P. fluorescens* PF9 revealed seven antimicrobial biomolecules. Increased activity of the enzymes viz., peroxidase, polyphenol oxidase, catalase, phenylalanine ammonia-lyase,  $\beta$ -1, 3-glucanase and phenol content were observed in the rice seedlings when treated with the azoxystrobin 125 g a.i.  $\text{ha}^{-1}$  in combination of *P. fluorescens* against rice blast disease. Further, native PAGE analysis of the rice seedlings treated with azoxystrobin 125 g a.i.  $\text{ha}^{-1}$  in combination of *P. fluorescens* revealed an additional isoforms. The efficacy of azoxystrobin at different dosages in combination with *P. fluorescens* was tested under field conditions using two most susceptible varieties Co39 and ASD 19 at two locations and was observed that the treatment azoxystrobin 125 g a.i.  $\text{ha}^{-1}$  plus *P. fluorescens* (0.2 %) recorded the least incidence of leaf and neck blast disease. The interaction of azoxystrobin and *P. fluorescens* for suppressing leaf and neck blast was categorised as additive in both the locations. Further, yield was also increased in the above treatment.



## Diversity analysis and antagonistic potentiality of Fluorescent Pseudomonads from different agro-ecological region of West Bengal

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Fluorescent pseudomonads have emerged as the largest and potentially most promising group of plant growth promoting rhizobacteria involved in the bio-control of plant diseases. In the present study a total number of 160 native putative fluorescent Pseudomonads were isolated from rhizospheric soil of tomato plant of different agro ecological regions of West Bengal. Out of them twenty five isolates (15.62%) were found to be potentially antagonistic against three different soil borne plant pathogens viz., *Rhizoctoniasolani*, *Sclerotiumrolfsii*, *Sclerotiniassclerotiorum* and three different air borne plant pathogens viz., *Alternaria* spp., *Colletotricum* spp., *Corynerspora* spp. Different antagonistic traits such as Siderophore production, HCN production, Salicylic acid production, Chitinase production as well as different traits responsible for plant growth promotion viz., IAA production, P-solubilization and different extra cellular enzymes production were evaluated during the study. Numerical taxonomy of the fluorescent pseudomonads isolates based on their carbon source utilization profiles resulted into three major phenons at a 95 per cent similarity coefficient level. The fluorescent pseudomonads isolates showed high degree of genetic variability in BOX and ERIC-PCR studies. Genotypic analyses of the isolates by BOX (bacterial repetitive BOX element) –polymerase chain reaction (PCR) resulted into six distinct major genomic clusters and twelve distinct BOX profiles at a 95 per cent similarity level. Enterobacterial repetitive intergenic consensus (ERIC)- PCR profiling was also performed to elaborate and compare the genetic diversity of the isolates. ERIC profiles also resulted into high genetic diversity of the isolates showing eight numbers of major phenons and fourteen distinct ERIC profiles at a 95 per cent similarity level. On the basis of phylogenetic characterization and 16S r-RNA gene phylogenetic analyses fluorescent Pseudomonad isolates were identified as *P. putida*, *P. plecoglossicida*, *P. monteilii*, *P. mosselii*, *P. aeruginosa*, *P. cepacia*, which resulted into three major clusters. A PCR-DGGE system that specifically described the diversity of *Pseudomonas* spp. in soil was developed. On the basis of this molecular method the diversity of *Pseudomonas* spp. in rhizospheric soil of tomato under different agro-ecological regimes was studied. Clustering of the DGGE patterns by UPGMA for clustering revealed a clear separation of all patterns into three main clusters at a 0.56 similarity coefficient level and five distinct DGGE profiles at a 0.96 similarity coefficient level. Based on the numbers, intensities and positions of the DGGE bands in all eight samples, from different agro-ecological regions, Shannon –Weaver diversity indices and Simpson diversity indices were calculated using the Gel Analyzer 2010 software. Higher diversity index was measured in the Gangetic Old Alluvial region soil (Shannon: 1.48; Simpson: 0.76), followed by Terai region soil (Shannon: 1.35; Simpson: 0.73), whereas, lowest diversity index was recorded in the Gangetic New Alluvial region soil (Shannon: 1.07; Simpson: 0.65). The result obtained

in this study strongly indicated that, high degree of genetic diversity was revealed among the antagonistic fluorescent pseudomonad strains and different agricultural regimes, due to difference in soil properties, soil micro environment, highly influenced *Pseudomonas* population in soil.

## Lentil rust-A threat to lentil cultivation in Bihar its management and practical experiences of farmers field- A case study

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Lentil (*Lens culinaris* L. Medikus) is very important pulse crop for rabi in Bihar state particularly famous Mokama Tal is not a single tal area but a group of seven blocks covering an area of 1,062 square kilometer and Tal covers about 1,18,000 ha. land. Lentil grows many decades in single crop covered 80-90 percent as single lentil corps in Mokama tal. Rust (*Uromyces viciae-fabae*) is a major disease of lentil, In 2013-14 also very serious problem of rust in PL406 and observed totally damaged the crop. In experimental plot but in same time other variety not affected by the rust. Recently, rust appeared in epiphytotic form on lentil in whole Mokama Tal area of Bihar during 2014-15 and rust severity ranged from 40-90 per cent in different fields. Some places totally failure was observed during the 2<sup>nd</sup> week of February. The area get submerged under deep water monsoon period and becomes unfit for cultivation of *Kharif* crop and cultivation of *Rabi* crops also suffers in productivity due pests and diseases if water is not receded completely by their sown time i.e. 15 October. The late (after II<sup>nd</sup> week of November) sown crop experienced more damage in lentil than early (before 30 October) sown (based on farmers information). Farmers were applying more than one fungicides and insecticides in same spraying tank at a time. In view we have surveyed and recommended only one fungicides and proper methods for sprayings. However farmers are used various pesticides alongwith fungicides bactericides and other growth promoters in attetime for management of this disease. But 70 percent farmers applied minimum 5 fungicides out of Azoxystrobin23%SC was found very effective in 10 days intervals and yield were assessed individual farmers ranging from 2.08 tons to 2.58 t/ha even disease appeared in epiphytotic form.

## Smt Guman Devi Memorial Best Woman Scientist Award Competition for the year 2016

### Targeting disease resistance loci conferring tolerance to major leaf diseases of rubber tree (*Heveabrasiliensis*) through QTL mapping using high density genetic linkage map with DArT markers

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Two major destructive diseases of rubber tree causing

significant loss to rubber production are the abnormal leaf fall disease caused by *Phytophthora meadii* and *Corynespora* leaf disease caused by *Corynesporacassiicola*. Identifying genes conferring tolerance to these diseases is highly desired for resistance breeding. Resistance traits are quantitative in nature and are determined by many genes and gene complexes, which are described as quantitative trait loci (QTL). Construction of a linkage map, densely populated with molecular markers is essential for dissection of QTLs for disease resistance trait. An interspecific cross between *H. brasiliensis* (clone RRII 105) and *H. benthamiana* (clone F4542) was made and a progeny population was raised. RRII 105 is a commercially cultivated high yielding clone with moderate level of susceptibility to *P. meadii* and high level of susceptibility to *C. cassiicola*. F4542 is a low yielder with high level of tolerance to both *P. meadii* and *C. cassiicola*. Genotyping of the 86 mapping population was carried out using SNP and *silico*DArT markers. A consensus linkage map covering 3709 cM with 24004 markers was constructed, which assembled into 18 linkage groups reflecting the haploid chromosome number of rubber ( $n = 18$ ). An average of 1334 markers per chromosome was observed with an inter marker spacing of 0.14 cM. Phenotyping for disease resistance of the progeny population to both these pathogens: *P. meadii* and *C. cassiicola* was carried out through laboratory screening. Frequency distribution of disease resistance among the progeny was continuous indicating their quantitative nature of inheritance. QTL analysis identified six markers for *Phytophthora* disease resistance [five mapped in linkage group (LG) 9 and one in LG 15] and five for *Corynespora* resistance (one each mapped in LG 6, 8, 11, 13 and 16). Application of these potential markers associated with resistance trait will facilitate marker assisted selection, a strategy which is highly relevant in a perennial tree crop like rubber.

### **Development of RNA-based vaccine against *Cucumber mosaic virus* infecting local Chilli BhutJolokia (*Capsicum chinense*) and *Citrus tristeza virus* infecting citrus plantations of Assam**

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Development of RNA based vaccine against *Cucumber mosaic virus* (CMV) infecting local chili BhutJolokia (*Capsicum chinense*) and *Citrus tristeza virus* (CTV) infecting citrus plantations of Assam” were carried out at and Department of Plant Pathology, Assam Agricultural University, Assam, India and Laboratory of Plant Breeding and Biometry, Department of Crop Science, AUA, Athens, Greece. Utilizing virus genome properties enabled the design of novel, safe, and efficacious

vaccines against different viral diseases infecting plants. In this study, it was shown that, dsRNA derived from viral sequences could interfere with cognate virus infection in a sequence-specific manner by delivering dsRNA to plant cells. In dsRNA-mediated protection, a dsRNA homolog of a viral silencing suppressor gene expressed in plants, which interferes with or prevents various stages of the viral life cycle, resulting in attenuated disease symptoms or resistance. It was aimed to produce CMV specific RNA vaccine to manage CMV infecting BhutJolokia crop of Assam. Application of these RNA based vaccines at the seedling stage could effectively reduce CMV infection at the later stage of the crop. These virus-free seedlings of BhutJolokia crop could give rise to a healthy crop growth. Taking it as a model system, it was further aimed to produce CTV specific RNA vaccine and to carry out a proof-of-concept to substantiate the same concept further in management of CTV infecting citrus plantations of Northeast (NE) India. A protocol for the synthesis of dsRNA using T7 RNA polymerase was utilized to produce RNA based vaccine against CMV infecting BhutJolokia and CTV in citrus plantations of Assam. CMV-encoded 2b gene based dsRNA was produced and tested against CMV infecting BhutJolokia. The infection of CMV in BhutJolokia pepper plants was successfully interfered, demonstrating the applicability of RNA-based vaccination. In this study, dsRNA derived from CMV-2b silencing suppressor gene sequence in bacterial cell, *E. coli*, could interfere with cognate virus infection. When dsRNA CMV-2b exogenously applied, along with CMV strain, onto BhutJolokia plants resulted in suppressing CMV infection. DAS-ELISA was used to identify the presence of CMV in the inoculated plants. BhutJolokia infected with CMV became severely stunted, nonproductive with dull light green foliage having a leathery appearance. In contrast, plants that received dsRNA of CMV-2b were less symptomatic and remained healthy as compared to those infected by CMV. Four experiments were conducted where; disease incidence was 15, 5, 29.5 and 0% when dsRNA of CMV-2b molecules were co-applied with CMV, as compared to 55, 55, 92 and 70% when only CMV was infected. As a result of dsRNA mediated resistance crop canopy increased, which is necessary for improved yields of the crop. This study constitutes a non transgenic approach of protection of BhutJolokia against CMV. With the success of CMV specific RNA vaccine, the investigation further aimed towards production of a dsRNA construct coding for the three silencing suppressors of CTV to generate RNA-based resistance and to conduct a proof-of-concept of specific protection against viral infection. It was aimed to get more insight on the role of the CP, p20 and p23 genes all as silencing suppressors of CTV in pathogenesis through topical application of these dsRNA molecules. The CP, p20 and p23 gene sequences of the NE India strain of CTV was folded into a ds RNA. The dsRNA of sufficient quantities

(several micrograms) obtained using in vitro transcription protocols for CP, p20 and p23 genes of the virus. The proof-concept experiment on application of these dsRNA against CTV infected citrus plants revealed that, while applied topically over leaf surface against the cognate virus, all three dsRNA constructs (CTV-CP, CTV-p23 and CTV-p20), could suppress the virus replication. This results successfully interpreted the proof-of-concept about the suppression of viral titre locally up to 10 days of topical application, through RNAi based method in citrus crop infected with CTV-North East India strain. These results support the view that a dsRNA intermediate in virus replication acts as efficient initiator of post transcriptional gene silencing in natural virus infections, triggering the viral RNA for degradation. A dsRNA construct encoding silencing suppressors could be significantly suppressed the replication of viruses and confer potential resistance against the virus.

### **Disease progression: an epidemiological based analysis of *Alternaria* leaf blight in Indian mustard (*Brassica juncea*) to formulate eco-friendly crop management strategy**

**Sunita Mahapatra**

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Rapeseed and mustard (RaM) is the second most important oilseed crop in India after soybean which accounts for nearly 20-22% of the total oilseeds produced and occupies about 71.30 lakh ha area in the country. The cultivation of this crop is mainly concentrated in North-West parts of India, mainly in Rajasthan, UP, MP, Haryana, Gujarat, West Bengal and Assam. However, several biotic and abiotic stresses cause significant reduction in the quality and quantity of RaM seeds and oil. Among several biotic stresses, leaf blight disease caused by *Alternaria brassicae* and *A. brassicicola* damages severely to oil-producing Brassicaspp. not only in India but also worldwide. Due to outstanding research efforts of plant protection scientists, the production of RaM in India has been witnessing an increasing trend in the current decade. But very limited research was conducted on spatial and temporal causes of the disease progression in field condition, and reduction of crop loss due to this disease in eco-friendly manner under integrated nutrient management (INM). Keeping the above gaps in research in view, field experiments were undertaken to determine the effect of INM on the disease progression of *Alternaria* blight of RaM their impact on yield for the two consecutive years 2010-11 and 2011-12. Disease progression as severity of disease in the specified time intervals was measured under 10 different nutrient management treatments (NMT). Among the different NMTs, minimum disease severity upto 13.8 was observed when the plots are treated with Azotobacter @ 250 g/kg seed, Phosphobacteria @ 250 g/kg seed plus FYM @ 7.5 tonnes /ha followed by NPK @ 60.5 : 16.5 : 56 kg ha<sup>-1</sup>

plus green manure @ 10 tonnes /ha, Azotobacter @ 250 g/kg seed and Phosphobacteria @ 250 g/kg seed treatments (19.58%), and their difference was found statistically significant irrespective of the age of the plant when they were applied. In regards to the impact of meteorological factors, av. temperature (13.5 to 19.3°C), relative humidity (>70%) and wind velocity (0.55 - 1.12 km/hr) play important role on disease progression with the high coefficient determination values of 84.4% - 97.7%. Changes in disease severity in different nutrient management system were negatively influenced by average temperature (4.20-10.66 units) and wind velocity (0.75-16.02 units) whereas, av. relative humidity had positive influence (0.40-4.84 units). Seed treatment with Azotobacter @ 250 g/kg seed and Phosphobacteria @ 250 g/kg seed plus FYM @ 7.5 tonnes/ha were found to be the best for less disease severity and higher productivity in mustard (cv. Bhagirathi) in the Gangetic plains when crops were sown on 20<sup>th</sup> October. Linear regression analysis with the seed yield data of two consecutive years 1000 seed weight vs. disease severity and avoidable yield loss of seed yield and 1000 seed weight vs. disease severity showed that the attainable yield of mustard were 1944 - 1980 kg/ha and drop of 12.65- 12.83 kg/ha due to 1% increase in disease severity upto 60%. Similarly attainable 1000 seed weight was 4.30- 4.34 g and a drop of 0.03g for every one percent unit increase in disease severity upto maximum of 60%. In case of avoidable yield loss and 1000 seed weight, 38.90% to 41.19% seed yield loss and 37.04% to 37.17% thousand seed weight could be avoided with every one percent decrease in disease severity. The step down multiple regression analysis (MRA) was carried out to determine the meteorological parameters influencing variation in disease severity of *Alternaria* leaf blight mustard. Disease severity estimates (Y) was considered as dependent variable and other weather parameters like maximum (Tmax) and minimum temperature (Tmin); maximum (RHmax) and minimum relative humidity (RHmin); total rainfall (RT); wind velocity evening (WVE) and morning (WVM); vapour pressure noon (VPN) and morning (VPM); and bright sunshine hour (BSH) were used as independent variables. The weather variables were found to influence the disease severity differently when crops were shown at different five dates of sowing time for the two consecutive years. The Gompertz equation was found to be the best to predict disease progress data followed by the logistic and the untransformed data sets.

### **Occurrence of sooty blotch fly speck complex on mango fruits and its successful post harvest management**

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Sooty blotch and flyspeck (SBFS) fungal complex produces superficial smudgy blemishes on mango fruit surface by



colonizing on the waxy layer of fruit cuticle. Late maturing mango varieties are specifically susceptible primarily due to prevailing congenial climatic conditions during fruit maturity period. Superficial fungal blemishes on fruits cannot be removed easily by simple washing alone. Moreover the blackened appearance of fruits significantly reduce the market acceptability of affected fruits causing huge loss to farmers and traders despite the fact that fruit pulp is unaffected by the fungal colonization. The present study exposed the group of fungi were primarily responsible for blackening and these fungi produced various kinds of typical mycelial types viz., ramose, fuliginous, punctate, discrete speck, compact speck on waxy layer of fruit cuticle. Further it has been established that there was no association of sap sucking insects excreting sugary substances with fruit blackening which clearly differentiate this disease from sooty mould. Various fungi have been found to be associated with this SBFS complex and among them, association of *Zasmidium* sp. and *Pseudocercospora* sp. has been established. These fungi have been identified by morphological keys and ITS-r DNA analysis. Other fungi associated with SBFS are being identified. The present study also documented the prevalence of SBFS from various states of India viz., Odisha, Karnataka, parts of Tamil Nadu, Uttar Pradesh, Bihar, Andaman and Madhya Pradesh. In Odisha, this SBFS complex has also been documented on other fruits like bael, banana, aon, anola and carambola and also on various wild reservoir hosts. As such there was no technology available in India to remove this blemishes on mango fruits. Effective post harvest treatment could allow the growers to get good market value for their produce in local as well as export markets. Hence, detailed study was conducted to devise an effective strategy to remove fungal blackening through various post harvest treatments. After screening of various approved chemicals and series of study, technology for removing this melody has been standardised successfully. Dipping of harvested fruits in a mixture of two solutions in potable water at 1000 ppm conc. having the pH of 6.5 with 15 mins dipping time resulted in removal of 95% of blackening caused by SBFS complex without any tissue damage. No peel injury on mangoes was observed even up to 90 mins of dipping time and up to 3000ppm conc. of solution. Detailed quality parameter viz., fruit firmness, ripening rate, total soluble solids, skin colour, percent weight loss and post harvest rot and shelf life were also studied elaborately to rule out the influence of mango wash on quality of treated fruits compared to untreated fruits. Treated fruits retained the desirable physico-chemical characters and also had significantly extended shelf life as compared to untreated control. This mango wash technology has been successfully validated on more than 100 tonnes of mangoes during the study period at orchards in Odisha, Saharanpur, UP and mango export houses. The composition would be published after registration of "Mango Wash" product.

## **Serological and Molecular characterization of Tobacco streak virus infecting cotton and exploring *Bacillus* species for the management of TSV**

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*Tobacco streak virus*, is a member of *Ilarvirus* under the family *Bromoviridae*. TSV is a (+) ss RNA virus with tripartite nature. The wide host range of TSV covers cash crops, pulses, vegetables, flower crops and also weeds. TSV infection in cotton was first identified and reported by the year 2010 in Tamil Nadu. Infected cotton samples collected from different places, varieties/hybrids subjected to DAC ELISA, confirmed the presence of TSV in cotton. Molecular characterization of TSV was achieved by reverse transcriptase polymerase chain reaction (RT-PCR) using specific upstream and downstream primers. Full length Coat protein, Movement protein and Replicase gene were sequenced and submitted in GenBank. Transmission Electron Microscopic images of purified *Tobacco streak virus* confirmed the presence of spherical isometric particles of size ranging from 27-33nm. Foliar spraying of PGPR viz., *Bacillus amyloliquefaciens*, *B. subtilis*, *B. cereus*, *B. pumilis*, *B. tequilensis*, *B. methylotrophicus*, *B. megaterium*, *Chrobactrum* spp, *Pseudomonas* spp and *Paenibacillus* spp reveals that *B. amyloliquefaciens* strain KA3 was effective in the management of TSV followed by *B. amyloliquefaciens* strain E2 and *B. subtilis* strain B4 in indicator host cowpea (Co7) under *in vitro*. The symptom expression on the bacterized cowpea leaves challenged with TSV delayed the symptom expression by 5-8 DPI (Days Post Inoculation). However, in TSV inoculated control, the symptom expression was noticed after 2-3 DPI indicating the antiviral action of *B. amyloliquefaciens*. Thus, this study shows that, *B. amyloliquefaciens* strain KA3 can be effectively used as a potential biocontrol agent for the management of TSV under controlled and natural conditions.

## **P R Verma Award Competition for Ph.D (Ag.) Students - 2016**

### **Effect of PGPR in mitigation of salt stress in Mungbean (*Vigna radiata* L.)**

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Soil salinity is one of the major abiotic factor affecting crop productivity worldwide. Out of total 6.75 million ha of land is affected by salinity in India, 2.22 million ha comes under Gujarat. Considering the seriousness of the salinity on crop productivity, the present investigation was carried out on various aspects to generate scientific information and technologies pertaining to the mitigation of salt stress by

different Plant Growth Promoting Rhizobacteria (PGPR) in mungbean. For the survey and isolation of potent PGPR, representative samples were collected from different areas of Navsari district where mungbean crop was grown and showed healthy appearance in spite of saline affected soil. All the soil samples were characterized for physico-chemical as well as microbiological parameters and data revealed that all the samples were saline-sodic as well as possessed low to medium organic carbon content. Microbiological data suggested that increase in soil EC and pH reduced total bacterial population whereas, increased ACC deaminase producing bacterial population. Further, total 41 isolates were obtained from all the collected soil samples which distinct colony morphology and were tested in *in vitro* conditions for their efficacy of Plant Growth Promoting (PGP) characteristics like ACC deaminase activity, phosphate and zinc solubilization, potash mobilization, nitrogen fixation, antagonistic potential etc. Two most potent PGPR isolates were screened and identified as *Bacillus subtilis* and *Serratia liquefaciens* by biochemical and molecular identification methods. Native strain of *Rhizobium phaseoli* was also isolated from mungbean growing under salinity condition. All three isolates were tested in field condition at two locations (Navsari and Danti) under salinity stress condition by taking mungbean as a model crop. Treatment combination was tested by inoculating isolates alone or mixed and was compared with recommended dose of chemical fertilizer (RDCF) treatment as a control. Experimental data revealed that all the treatments i.e. single or co-inoculation of any PGPR significantly improved plant characters, yield and yield attributing characters than RDCF. However, combined application of all three PGPR showed significantly highest results than all other treatments. Data pertaining to effect of PGPR on plant stand and structure revealed that application of all three PGPR in combination showed 22.48, 61.57, 31.70, 122.03, 71.76, 153.33 and 100% more seed germination, root length, shoot length, root fresh weight, shoot fresh weight, root dry weight and shoot dry weight respectively than RDCF in average data of both the locations. Similar results were also observed in terms of plant physiological parameters where application of all three bioinoculants in combination showed 46.43, 88.19, 47.80 and 179.86% increased leaf area index (LAI) as well as 33.24, 33.35, 42.45 and 32.60% more chlorophyll content than RDCF in average data at 30, 60, 90 DAS and at harvest respectively. Application of all three bioinoculants in combination showed significant increase in no. of nodules, nodule fresh weight and nodule dry weight in tune of 356.66, 332.43 and 285.71% than RDCF at 30 DAS as well as 283.61, 200.0 and 148.78% than RDCF at 40 DAS respectively in average data of both the locations. Experimental data pertaining to effect of PGPR on yield and yield attributing characteristics in mungbean under salinity stress condition revealed that application of bioinoculants, individual or in combination, significantly improved different yield and yield attributing characteristics over RDCF and RDCF + 8 t/h FYM application. The treatment that received application of all three bioinoculants in combination showed 33.31% more pods and 28.48% more seed weight/plant than RDCF in pooled data. Similarly, 29.62% increased seed and 37.50% straw yield was recorded due to combined application of all three cultures in combination in

average data over RDCF. Effect of different PGPR inoculation on soil health suggested that application of any bioinoculants did not show any effect on soil EC and pH. However, application of organic amendment such as FYM decreased soil EC and pH than RDCF treatment. Application of bacterial cultures as bioinoculants improved total bacterial population in the soil over RDCF treatment.

### **Epidemiology and management of turmeric (*Curcuma longa* L.) leaf blotch caused by *Taphrina* sp** **GB Chopada and KB Rakholiya**

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The investigations on epidemiology and management of the leaf blotch disease of turmeric caused by *Taphrina maculans* Butler, were carried out with the agenda of the set of objectives at College farm, N. M. College of Agriculture, N.A.U., Navsari, South Gujarat during 2013-14 and 2014-15. Few of the experiments were also conducted at farmer's field Tarkani village of Surat district, South Gujarat during 2014-15. Turmeric (*Curcuma longa* L.) is one of the most important spice crops. During the survey, occurrence of leaf blotch disease of turmeric on cv. Sugandham and Local was observed in serious proportion inflicting heavy losses in South Gujarat. Considering the seriousness of the disease, the present investigation was carried out on various aspects to generate scientific information on this important pathological problem and to develop suitable management strategies to prevent the crop losses. The pathogen involved to cause the leaf blotch in turmeric was identified as *Taphrina maculans* Butler, on the basis of symptomatology, microscopic observations and by comparing conidial measurements with previous reports as well as by proving its pathogenicity on turmeric plant. *T. maculans* was isolated on PDA having 4.5 pH and an incubated at 20°C by suspending the infected leaf bits from inside of lid of Petri dish. Symptoms of the leaf blotch disease were observed first on the lower most leaves during the first week of September in 2013-14 and during the last week of August in 2014-15. First symptoms appeared as dot sized (1 to 2 mm diameter) pale yellow specks on the portion of lamina nearer to petiole. The colour of these pale yellow specks turned to dirty yellow and finally to orange brown. The specks or spots coalesced freely as they increased in size, giving the leaf blotched appearance. The infection progressed from the bottom leaves to the top leaves in a successive fashion. Late in the season a month before harvest infection was found to extend in the petiolar canal also. The leaf blotch was found in severe proportion in both the popular varieties viz., Sugandham and Local in Navsari, Surat and Tapi districts of South Gujarat. Navsari district was found more prone to leaf blotch of turmeric as compared to the other districts surveyed. Losses due to the leaf blotch were estimated up to 36.95% and 36.36% at Navsari and Tarkani respectively. Due to leaf blotch of turmeric, losses were found in all the growth parameters which ultimately cause 25.18% reduction of rhizome weight. Young crops (2 to 4 months) were mostly remained free from the infection of the leaf blotch. The infection starts during August

to September months and attained its peak on completion of major rainfall *i.e.* after 36<sup>th</sup> meteorological standard week (MSW). During the major progress of leaf blotch on turmeric (*i.e.* 36<sup>th</sup> to 39<sup>th</sup> MSW), average temperature remains around 26°C and 85 per cent relative humidity with moderate to high rainfall. Correlation coefficient study between weather parameters and disease intensity indicated that all the parameters jointly played an important role in the development of disease. Four weather variables *viz.*, minimum temperature, rain fall, morning and evening relative humidity were found to influence leaf blotch severity by stepwise regression analysis. Total sixteen turmeric genotypes screened against the leaf blotch, out of them genotypes *viz.*, NVST-70, NVST-64, NVST-66, NVST-69 and NVST-79 showed resistant reaction against the disease. Genotypes NVST-72 and NVST-73 were found moderately resistant. Whereas, genotypes NVST-37, NVST-78, RH 9/90, RH 13/90 and Kesar exhibited moderately susceptible reaction while, genotypes NVST-67, NVST-68, NVST-71 and Sugandham were found susceptible to the leaf blotch at both the study areas *i.e.* Navsari and Tarkani. Eight fungicides, one bio agent and one botanical were tested for their efficacy against leaf blotch, among them two foliar sprays of propiconazole (0.025%) and carbendazim (0.025%) proved significantly superior for the management of the leaf blotch disease as well as for getting higher rhizome yield. Neem oil (5.0%) was found least effective in managing disease and recorded with poor yield. However, *Pseudomonas fluorescens* (10%) was found effective against leaf blotch at both the study locations Navsari and Tarkani.

### **Biological and molecular characterization of Tobacco streak virus (TSV) inciting cotton necrosis in major cotton growing states of India and their management**

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Cotton is an important fibre crop grown all over the world. India is a leading producer and exporter of cotton globally. Cotton necrosis caused by *Tobacco streak virus* (TSV) is an emanating problem in the agricultural sector. Among the major cotton growing states in India, Telangna had the highest TSV incidence (25.31%). Symptoms associated with *Tobacco streak virus* (TSV) in cotton is usually disparate, based upon the host pathogen interaction. Chlorotic or necrotic, irregular or circular, purplish or dark brown to black spots were observed on the infected leaves, scattered or confined to a particular area. Presence of TSV in the infected leaves, stem and square samples were serologically detected through DAC-ELISA. Besides, selected isolates were subjected to Reverse Transcription (RT) PCR a amplification of coat protein (CP) gene, pertaining to TSV. They were further confirmed by sequencing the C gene. RT-PCR studies on the cotton seeds, pollen and *Parthenium* pollen revealed the presence of TSV in

the cotyledon and pollen of cotton, as well as in the pollen of *Parthenium* plants. Sodium phosphate buffer – 0.5M (pH 7.2), amended with 0.1% sodium sulphite, 0.01% sodium EDTA, and 0.1% mercaptoethanol was found consistent for mechanical transmission of TSV to suitable indicator hosts. Physico-chemical studies revealed that TSV was thermally inactivated at 53°C. Moreover, cowpea (CO7) produced maximum number lesions (29.33/cm<sup>2</sup>) when incubated at 12 hrs alternate light and dark hours compared to other light and dark conditions. Bioassay studies on various indicator hosts revealed that *Chenopodium quinoa* and *C. amaranticolor* were highly suitable indicator hosts, with highest virus titre. Cotton endophytes, PGPRs (Plant growth Promoting Rhizobacteria), and antiviral principles were screened against TSV in artificially inoculated cowpea plants. Results revealed that, cotton endophyte (M2), *Baillus amyloliquefaciens* (VB7), and root extract of *Mirabilis jalapa* were notably effective in reducing the number of lesion produced by TSV.

### **Immunological and molecular characterization of Tomato spotted wilt virus infecting chrysanthemum (*Dendranthema grandiflora*)**

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*Tomato spotted wilt virus* (TSWV), a Tospovirus, causes high economic losses in several crops worldwide. A typical Tospovirus infection of chrysanthemum (*Dendranthema grandiflora*) was recorded in Tamilnadu, India during 2014. The identity of the virus was confirmed as TSWV using symptomatology, bio assay, Enzyme-Linked Immunosorbent Assay (ELISA) and Reverse Transcriptase-PCR. Genetic diversity of TSWV isolates originating from different regions of Tamilnadu were used investigated. Total plant RNA, isolated from chrysanthemum infected with the TSWV isolates were subjected to reverse-transcription polymerase chain reaction (RT-PCR) using Nucleocapsid (Nc) and Non-Structural movement protein (NSm) gene specific primers of TSWV. The amplicon size of Nc and NSm genes of 900 bp and 950 bp were amplified, cloned and sequenced. Comparison of nucleotide sequence of the Nc and NSm genes revealed the highest similarity of > 97% and > 96 % respectively between study isolates (Nedugula, Yercaud and Kotagiri). Phylogenetic analysis based on the multiple alignments of Nc and NSm genes sequences of the three TSWV isolates along with isolates occurring in different geographical locations in the world revealed the branching of Nc gene of TSWV isolates into three distinct clusters pertained to American, Australian and Indian isolates. It indicated that the immigration of TSWV might be from Australia and America. The three isolates showed high sequence similarity within the Indian TSWV isolates. Nucleocapsid gene sequence of three isolates showed close relation with Poland isolates. Likewise sequences of NSm gene showed high sequence similarity with USA and Serbia isolates. The information generated in this study will be useful



in formulating effective detection kit to prevent the migration of TSWV into India.

### **Efficacy of multifaceted PGPR in amelioration of biotic and abiotic stress in wheat plants**

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Sustainable exploitation of the environment and natural resources are essential issues to maintain a booming population. Wheat makes up the major staple food for many people around the world and it is expected that the world will require a 60 % increase in wheat production by 2020 to fulfill future demands. However, this is a major challenge due to the environmental constraints which limit crop production. Abiotic stress factors such as, heat, cold, salinity and drought and severe plant diseases are the main environmental causes negatively affecting crop growth and productivity worldwide. The aim of this study was to explore the potential of multifaceted beneficial microorganisms isolated from the rhizosphere for inducing tolerance to abiotic (salt and heat) and biotic (spot blotch caused by *Bipolaris sorokiniana*) stresses. Two microorganisms *Bacillus safensis* (W10) and *Ochrobactrum pseudogregnonense* (IP8) isolated from wheat (*Triticum aestivum* L.) and blady grass (*Imperata cylindrica* L.) rhizosphere respectively, showed positive result for PGPR traits *in vitro* such as phosphate solubilization, siderophore production, antagonism to spot blotch causing pathogen *Bipolaris sorokiniana* in addition to tolerance for high temperature and salinity. 16S rDNA sequencing of both the bacteria were done and their phylogenetic relationships established. PBW 343 wheat cultivar was selected for induction of resistance against salinity, high temperature and spot blotch. Talc based formulation of both bacteria were applied as seed treatment as well as foliar application. Both the bacteria promoted growth in terms of increase in root shoot biomass, height of plants and increase in chlorophyll content. Besides, the wheat plants could tolerate abiotic stress more efficiently in presence of the bacteria as indicated by increases in RWC, accumulation of protein, total sugar, delay of appearance of wilting symptoms and elevated antioxidant responses under salinity and high temperature. Enhanced antioxidant responses were evident as increased activities of enzymes such as catalase, peroxidase, ascorbate peroxidase, superoxide dismutase and glutathione reductase as well as increased accumulation of antioxidants such as phenols, carotenoids and ascorbate. Application of the PGPR led to enhancement in activities of defense related enzymes- phenyl alanine ammonia lyase, peroxidase, chitinase and  $\beta$ -1,3glucanase, in disease infected leaves. To obtain a comprehensive view on transcript alteration during the PGPR and plant interaction under stressed condition salinity stress was chosen for further microarray analysis using Affymetrix Genechip probe arrays. The results showed that expression of a large number of genes under salinity stress were either up regulated or down regulated when plants were also inoculated with the PGPR. Those up-regulated included genes were those involved in metabolism, signal

transduction, and stress response. Results clearly indicated that the ability of wheat plants to withstand biotic and abiotic stress was enhanced by application of these plant growth promoting rhizobacteria.

### **PR Verma award competition for M.Sc (Ag.) Students - 2016**

#### **Molecular Detection and Characterization of a Virus Associated with Ringspot Disease of Bell Pepper (*Capsicum annuum* L.)**

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Surveys conducted during investigation revealed the presence of a typical ringspot disease in bell pepper growing areas of Solan district of Himachal Pradesh with disease incidence ranging between 5 to 51 percent during the cropping seasons of 2013 and 2014. Preliminary studies revealed the disease to be of viral etiology. The causal virus was characterized on the basis of symptomatology, host range, serology and molecular studies. Infected bell pepper plants exhibited ringspot symptoms of variable sizes on the leaves as well as on fruits which coalesced later on covering the entire surface rendering fruits unmarketable. Samples collected from different locations when subjected to DAS-ELISA yielded strong positive reaction only against Tospo (I, II, III) antisera. Studies on indicator hosts established *Nicotianatabaccum* var. White Burley and *Nicotianaglutinosato* be the best indicator host for the causal virus. Further studies revealed that members of *Chenopodiaceae*, *Cucurbitaceae*, *Leguminosae* and *Solanaceae* fall within the host range of causal virus. Infected tomato fruits growing in the vicinity of infected bell pepper fields however, yielded no significant positive results in DAS-ELISA but Reverse Transcription –PCR (RT-PCR) based detection revealed clear association of causal virus with tomato. RT-PCR based detection, nucleocapsid (N) gene sequencing, conserved domain search (blastx) for confirmation of encoded protein family and BLASTn analysis of bell pepper virus isolate revealed that the virus associated with ringspot disease of bell pepper in Himachal Pradesh was *Capsicum chlorosis virus*, a member of the genus *Tospovirus*.

#### **Sclerotial production and pathogenicity of *Sclerotium rolfsii* as a function of temperature, moisture and soil microbiological parameters**

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*Sclerotium rolfsii* Sacc. (telomorph : *Athelia rolfsii* (Cruzi) Tu and Kimbrough) is a widespread soil borne pathogen in vegetable production areas. It causes Southern blight, a disease which affects more than 500 plant species in over 100 plant

families. The management of *S. rolfsii* disease is particularly complex because this pathogen forms sclerotia that can survive in soil for long periods, frequently tolerating biological and chemical degradation due to the presence of melanin in the outer membrane. Survival, population build up, successful parasitic relationship and rate of spread of *Sclerotium rolfsii* in soil-plant system depend on different types of crops in sequence, rhizosphere microbial diversities, soil physico-chemical and biological characteristics and abiotic stress factors like soil moisture and temperature. Therefore, the objective of the dissertation work was to identify non-preferred or less preferred hosts of *S. rolfsii* and soil microbiological parameters associated with suppressiveness against *S. rolfsii* and which in future will be the basis in development of crop rotational scheme for ecofriendly management of *S. rolfsii* disease. In this investigation increment of inoculum load and incorporation of crop residues at different levels enhanced the *Sclerotium rolfsii* induced damping off of cowpea. Increased in the rate of saprophytic colonization ability of *S. rolfsii* was observed with decrease in soil moisture content and relatively highest rate of colonization of *S. rolfsii* was observed in clay loam soil under 60% field capacity soil moisture content. Best temperature for saprophytic colonization of *S. rolfsii* was 30 °C followed by 25C and optimum temperature for colonization of *S. rolfsii* was 25-30C. Saprophytic colonization of *S. rolfsii* was highest in sandy loam hilly soil at high level of soil moisture content (FC to 70% FC moisture content of soil) whereas, at comparatively low level of moisture content i.e. 60 % of FC, the saprophytic colonization of *S. rolfsii* was highest in clay loam soil. *Sclerotium rolfsii* proved to be highly pathogenic on peas, bean, palak, jute and sugar beet, moderately pathogenic on cowpea, groundnut, amaranthus and radish and moderate to low pathogenic on cabbage, okra, brinjal and chilli and less pathogenic on maize, cauliflower and broccoli plants in pot experiments. Enhanced microbial activity and microbial population was observed in maize, cauliflower, cabbage and broccoli rhizosphere and FDA activity was found to be highest in maize followed by broccoli and cauliflower. Highest total bacterial population was observed in cauliflower followed by cabbage and maize.

### Augmentation of *Trichoderma viride* for Management of *Rhizoctonia* Root Rot of Soybean (*Glycine max* L.)

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The present study was undertaken on Augmentation of *Trichoderma viride* for Management of *Rhizoctonia* Root Rot of Soybean (*Glycine max* L.). The culture of pathogen inciting the root-rot of soybean was isolated from the diseased plant samples collected from Kolyari, Tehsil Jhadol, Udaipur. The pure culture of *Rhizoctonia* was obtained from these samples. Its pathogenicity was confirmed and identified as *Rhizoctonia solani*. Six agricultural waste materials viz., farm yard manure (FYM), wheat straw, shelled and dried cobs of maize, maize straw, dhaincha and dried on farm weeds were tested for

supporting the sporulation of *T. viride* for mass multiplication. The farm yard manure was found to be most suitable substrate in supporting the sporulation of *T. viride* followed by wheat straw substrate. However, maize straw substrate, maize corn cob, dhaincha straw and dried on farm weeds straw were found to be poor substrates in supporting the multiplication of *T. viride*. Different varieties of soybean were tested for establishment of *T. viride* and *R. solani* in rhizospheric soil. The BCA *T. viride* could successfully be established and resulted in highest population counts in varieties Bragg and JS 93-05 followed by varieties JS 93-52 and 88975 compared to the varieties RKS-45, RKS-24 that responded poor in establishment of *T. viride*. While, the population of *R. solani* was found to be inversely proportional to the population of *T. viride*. The highest suppressed population of *R. solani* was recorded from the rhizosphere soil of the variety Bragg and JS 93-05 followed by JS 93-52 and 88975 as compared to lowest suppression in variety RKS - 24 and JS 335. Two varieties viz., Bragg and JS 93-05 expressed significant suppression of root rot with minimum percent root rot while maximum per cent root rot was recorded in cultivars RKS-24 and JS 335. The combined application of seed treatment with *T. viride* @ 8 g kg<sup>-1</sup> seed + soil application of *T. viride* FYM @ 2.5 per cent resulted minimum per cent root rot with maximum dry weight and percent root rot control over their individual applications as well as over the untreated control. The disease suppression appeared to be due to reduction of the inoculum density of the pathogens.

### Investigation on Early Blight (*Alternaria* sp.) of Tomato (*Solanum lycopersicum* L.) Under South Gujarat condition

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Tomato (*Solanum lycopersicum* L.) is a crop of immense value in olericulture. Tomato is one of the most widely cultivated solanaceous fruit vegetable crop in the world believed to have its origin in Tropical America (Thompson and Kelly, 1957). It is known as Love apple, Tomate, Tomat, Tomatar, Rangam, and Tomati in different parts of the world it is also popularly called as 'Poormen's orange'. It is grown extensively and marketed throughout the world. It ranks third largest vegetable crop after potato and sweet potato. It is a traditional vegetable crop commercially cultivated with a large area and higher production and productivity in India. The major tomato producing states are Gujarat, Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh, and West Bengal. In Gujarat, average of five years it is extensively cultivated in the area 44.57 ('000 ha) with production of 1259.01 ('000 Tons) and productivity of 28.2 MT/ha (Anon., 2014-15). In India, tomato crop is heavily affected by early blight disease, resulting severe yield losses in Gujarat. Early blight produces a wide range of symptoms at all stages of plant growth. The leaf blight phase usually begins on the lower, older

leaves and progresses up to the plant. Infected leaves eventually wither, die and fall from the plant. Due to huge variability in the pathogen population and wider environmental adaptability, *Alternaria solani* is becoming a serious problem, now-a-day. Along with that intensification in agro-ecosystem like monoculturing of tomato and other Solanaceous crops and modernization in agronomic practices like sprinkler irrigation system provide a suitable environment for these pathogen. This ultimately leads higher incidence of disease. On the other hand extensive use of high risk fungicides increases the chance of development of fungicide resistant isolates. Therefore, their management is becoming a serious problem. The symptoms were observed through frequent field visit and subjected to slide preparation and tissue isolation. The pathogen was isolated confirmed and identified as *Alternaria solani* by isolating and after proving pathogenicity test. The systemic fungicides viz., propiconazole at 500, 750, and 1000 ppm proved very effective fungicide in inhibitory against *A. solani* which was followed by carbendazim and difenconazole at same concentrations, respectively. Among non-systemic fungicides, mancozeb, copper oxychloride, chlorothalonil, zineb, iprodion and propineb at different concentrations were found inhibitory against fungal growth of *A. solani*. The significant growth inhibition was recorded in mancozeb at 2000, 2500 and 3000 ppm concentration and found significantly superior over rest of the fungicides tested which was followed by copper oxychloride and propineb at same concentrations, respectively. Among combinations of systemic and non-systemic fungicides at different concentrations, the significant growth inhibition was recorded in metalaxyl 8% + mancozeb 64% at 1500, 2000 and 2500 ppm concentration, followed by carbendazim 12% + mancozeb 63% at same concentration. Six different known antagonists were screened *in vitro* for their *A. solani* by dual culture method. Among the antagonists tested, *T. viride* appeared as potential antagonist, which showed significant inhibition of mycelial growth of *A. solani* *in vitro*, followed by *T. harzianum*. The extracts of garlic (*Allium sativum*) bulb showed significantly maximum growth inhibition 58.15 per cent of *A. solani*. The next best in order of merit was datura (*Datura stramonium*) leaves 52.63 per cent. Screening done against natural infection of early blight disease during crop season. Total thirty three genotype/germplasms

were evaluated. Among them nine were found highly resistant viz, NTL-6, NTL-9, NTL-11, NTL-16, NTL-17, NTL-19, NTL-21, NTL-31 and NTL- 98; fifteen were found resistant viz, GT - 2, NTL- 12, NTL- 20, NTL- 22, NTL-24, NTL- 32, NTL- 33, NTL- 34, NTL- 39 NTL- 71, NTL- 72, NTL- 73, NTL- 74, NTL- 76 and NTL- 97.

### **Molecular detection and characterization of *Puccinia horiana* inciting white rust in cut chrysanthemum and exploring *Bacillus subtilis* (STR15) for the management under protected cultivation**

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Chrysanthemum varieties were surveyed for the incidence of white rust caused by (*P. horiana* (Henn) in Yercaud hills of Salem district and Kothagiri of Nilgiris hills of district in Tamil Nadu, India during 2012-2013. The white rust incidence ranged between 62.72 and 65.81 per cent 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 were made 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) approximately amplified a fragment of 240bp and 340 bp corresponding to the region of the 18s-28s rDNA intervening sequence, specific for *P. horiana*. Detection of crude antibiotics was analyzed through GC/MS to detect the antimicrobial compounds produced by the most effective *Bacillus subtilis* isolates like STR15 and BS2. Evaluating the bioefficacy of antagonistic bacteria indicated that, foliar application of *B. subtilis* isolate BS2 and *B. subtilis* isolate STR15 at fortnightly intervals was most effective in reducing the incidence of white rust at 0.5% concentration. Besides, it increased plant height, marketable stems and flower diameter.