**Mini Review**

Chaetomium globosum: A Potential Biocontrol Agent for the Oomycetes Pathogens

T Raguchander, R Manikandan, K Arunkumar and R Senthil

Department of Plant Pathology, Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India. Email: raguchander@rediffmail.com

---

**Abstract**

Chaetomium globosum Kunze, a saprophytic fungus is widely prevalent in soil and phyllosphere. It has a broad spectrum antagonistic ability against wide range of plant pathogens due to production of diverse metabolites, mycoparasitism and competition. In crop plants, it triggers the phenylpropanoid pathway thereby induces the defense enzymes such as peroxidase (PO), polyphenol oxidase (PPO), β-1, 3 glucanase, catalase and superoxide dismutase against plant pathogens. Chaetomium spp. produces various biologically active substances, such as chaetoglobosin A, B, C, D, Q, R, T, chaetomin, chaetocin, chaetochalasin A, chaetoviridins A and C, chaetoglocins A, C. globosum produces pectinolytic enzymes viz., polygalacturonate trans-eliminase (PGTE), pectin trans-eliminase (PTE), polygalacturonase (PG), pectin methyl esterase (PME), protopectinase (PP), xylanase and cellulolytic (C₁ and C₂) enzymes. It is found to be efficient cellulase producer with the ability to degrade cellulotic and other organic material. Specific strains of Chaetomium have been shown to stimulate plant growth and produce better crop yields both in the greenhouse and field, following their application as biological products against plant diseases in different forms such as powder, liquid, aqueous and isotonic formulations. An isolate of C. globosum (TNAU-Cg6) can survive for long term up to twelve months under an isolonic liquid formulation which significantly reduces the incidence of Phytophthora and Pythium pathogens of potato, tomato and chilli crops under glasshouse as well as field conditions. Hence, C. globosum can be a potential biocontrol agent for the integrated and ecological management of Oomycetes pathogens in agri-horti ecosystems. In this review we have discussed the various aspects of biocontrol potential of Chaetomium species.

**Key Words:** Biocontrol agent, Chaetomium globosum, Oomycetes pathogens, Phytophthora spp., Pythium spp.

Weather based Forewarning Model of Groundnut Leaf Spot Disease in Arid and Semi-arid Regions of India

RK Gangwar¹, AK Srivastava¹, RK Prajapati¹ and SS Rathore¹

¹Krishi Vigyan Kendra, Chomu – 303 702, Jaipur, Rajasthan, India; ²Unit of Physics and Agro-meteorology, College of Agriculture, JNKVV, Tikamgarh; ³Krishi Vigyan Kendra, JNKVV, Tikamgarh – 472 001, Madhya Pradesh, India; Email: gangwarrakesh@yahoo.com

Abstract

Groundnut leaf spot disease is one of the important limiting factors for its productivity in India. Early and late leaf spots can cause considerable yield losses when unmanaged. The study was carried out to find out the association between weather factors and disease severity. The maximum temperature (33–35 C) and mean relative humidity (>80 per cent) were found to be highly correlated with disease severity during the study period. The Humid Thermal Ratio (HTR) was also estimated and describes congenial weather conditions criteria for disease development. The geophytopathological model was developed based on HTR, mean temperature and mean humidity and this model explained 72 per cent leaf spot variability. The model was validated at Tikamgarh district of Madhya Pradesh. This study will serve as a scientific basis for the establishment of integrated management module(s) for leaf spot disease in arid and semi-arid regions of India.

Key words: Groundnut, humid thermal ratio, leaf spot, rainfall, temperature

Research Article

Population Structure of Colletotrichum gloeosporioides Associated with Capsicum Anthracnose in North Western Himalayas and Evaluation for Disease Resistance

PN Sharma and A Katoch

Molecular Plant Pathology Laboratory, Department of Plant Pathology, CSK HP Agricultural University, Palampur-176 062, Himachal Pradesh, India. Email: pns1960@gmail.com

Abstract

Colletotrichum gloeosporioides is the second important species of Colletotrichum associated with fruit rot/anthracnose disease of chilli/capsicum in Himachal Pradesh. Pathogen causes mild to severe losses both as pre- and post-harvest pathogen next to C. truncatum (syn. C. capsici). Virulence spectrum of 14 C. gloeosporioides isolates determined on a host differential set comprised of three Capsicum species (C. baccatum, C. chinense and C. annuum), revealed the presence of six pathotypes viz., CgA-1, CgA-2, CgA-3, CgA-4, CgA-5 and CgA-6. Race groups CgA-1 and CgA-5 were most virulent infecting eight of the 11 differential lines. Genetic variability of these isolates determined through ISSR-, ERIC-and BOX-PCR markers exhibited wider diversity. ISSR-PCR marker exhibited maximum polymorphism using 22 alleles, clustering the 14 isolates into four sub cluster at 0.70 coefficient. A combined dendrogram generated using 33 alleles amplified by ISSR, ERIC and BOX primers identified the isolates into two major groups having early divergence from each other. Evaluation of 195 capsicum genotypes comprising local land races, commercial varieties and exotic accessions showed that exotic C. baccatum (EC631750) was resistant to five races followed by a C. chinense (EC631751) and two commercial genotypes Surajmukhi and California Wonder.

Key words: Differential set, ISSR, resistance, variability

Macrofungal Diversity in Adwani Forest of Garhwal Himalaya, Uttarakhand

RP Bhatt, MP Vishwakarma, Upendra Singh and Sweta Joshi

Department of Botany & Microbiology, H.N.B. Garhwal University, Srinagar, Garhwal 246174, Uttarakhand, India; Email: bhatt.rajendra123@gmail.com

Abstract

The Adwani forest situated 18 km away from the Pauri town of Garhwal Himalaya, Uttarakhand, at an altitude of 1750 to 2200 m is predominantly angiospermic forest. The vegetation of this forest comprises of two different zones - the Quercus-Pinus zone starts approximately from 1750-1900 m from m.s.l. and forms the lower belt of the forest. The second zone-the Quercus-Rhododendron extends approximately from 1900-2200 m from m.s.l. and form the upper belt of the forest. The specimens were collected from Adwani forest during July 2011 to September 2012. Twenty four taxa representing twelve genera and six families were documented from the area. Of these, seven taxa were edible and consumed in various parts of Uttarakhand and the rest were non-edible or poisonous.

Key words: Biodiversity, edible, macrofungi, poisonous

Management of Covered Smut of Barley Through Cultural, Chemical and Biological Methods

Arshdeep Kaur, Vineet K Sharma, Ritu Rani and Chander Mohan
Department of Plant Pathology, Punjab Agricultural University, Ludhiana-141004, Punjab. Email: ritubansalpau@gmail.com

Abstract

Five different sowing times viz. Oct. 1, Oct. 15, Oct. 30, Nov. 15 and Nov. 30 and also at five different depths viz. 2.5, 5, 7.5, 10 and 15 cm were studied for the incidence of covered smut. There was significant increase in disease incidence with delayed sowing. Similarly, disease was maximum in case of crop sown at 15 cm depth, whereas it reduced gradually, when seeds were sown 2.5 cm deep. All the fungicidal seed treatments were significantly effective in controlling the disease. Complete disease control was achieved by seed treatment with Bavistin 50 WP (carbendazim 50%) @ 2.5g, Sprint 75 WP (mancozeb 50% + carbendazim 25%) @ 3.0g, Raxil 60 FS (tebuconazole 60%) @ 1.0g, Vitavax power 75 WP (carboxin 37.5% + thiram 37.5%) @ 1.5g and Raxil 2DS (tebuconazole 2%) @ 1.5g Kg⁻¹ seed. However, seed treatments with Dithane Z 78 (zineb 75%) and Dithane M45 (mancozeb 75%) @ 2.5g Kg⁻¹ seed were comparatively less effective showing 72.98, 70.86 and 69.02, 66.96 per cent disease control on plant and tiller basis, respectively. Seed treatment with bio-control agents viz. Trichoderma harzianum, T. viride and Pseudomonas fluorescens was found less effective in controlling the disease than fungicides. Among botanicals, seed treatment with leaf powder of nochi (Vitex negundo) was found to be effective.

Key words: Barley, covered smut, fungicide, management, Trichoderma viride

Status of Viral Diseases of Large Cardamom (*Amomum subulatum* Roxb.) and its Management in Sikkim and Darjeeling, West Bengal

AK Vijayan, BA Gudade, TN Deka and P Chhetri

Indian Cardamom Research Institute (ICRI), Regional Research Station, Spices Board, Tadong, Gangtok-737 102, Sikkim, India; E-Mail: drvijayannambiar@gmail.com

Abstract

Field surveys were conducted in different seasons during 2012-13. Two main viral diseases namely chirke and foorkey affect the productivity of different large cardamom cultivars in Darjeeling district of West Bengal and Sikkim. *Chirke* is serious as far as rate of spread is concerned and *Foorkey* is serious as far as yield loss is concerned. *Chirke* is characterized by mosaic with pale streak on the leaves. The streaks turn pale brown resulting in drying, withering of leaves and finally death of the plants. The flowering in diseased plants is extensively reduced. The *chirke* disease is transmitted by mechanical sap inoculation and also by aphid, *Ropalosiphum maidis* Fitch. Excessive sprouting and formation of bushy dwarf clumps at the base of the mother plants that gradually die, characterize the *foorkey* disease. Numerous small tillers also appear at the base of the affected plants that become stunted and fail to give any yield. The primary spread of the disease from one area to another is through infected rhizomes and further spread within the plantation by aphids, *Micromyzus kalimpongensis*. For the management of viral diseases of large cardamom, resistant cultivars are essential. However, resistant cultivars to *chirke* and *foorkey* viruses are not available. The evaluation of level of resistance in the genotypes of large cardamom is prerequisite for developing resistant cultivars to *chirke* and *foorkey* viruses.

Key words: *Chirke, foorkey, large cardamom, viral diseases*

Molecular Detection of Sugarcane Yellow Leaf Virus in Popularly Grown Sugarcane Varieties in Andhra Pradesh and Characterization of the Virus from the Sugarcane Variety 2003V46

Molecular Detection of Sugarcane Yellow Leaf Virus in Popularly Grown Sugarcane Varieties in Andhra Pradesh and Characterization of the Virus from the Sugarcane Variety 2003V46

TM Hemalatha¹, M Hemanth Kumar¹, S Afsar¹ BV Bhaskar Reddy² and M Subba Rao

¹ Agricultural Research Station, ANGRAU, Perumallapalle, Tirupati – 517 505
² Regional Agricultural Research Station, ANGRAU, Tirupati-517 502, Andhra Pradesh, India. E-mail: hema_agri@yahoo.com

Abstract

Yellow Leaf Disease (YLD) caused by Sugarcane Yellow Leaf Virus (ScYLV) is an emerging disease causing cane yield losses ranging from 60% in the main crop to 100% in the ratoon crop. The average incidence of yellow leaf disease was about 28% in the varieties viz., 2003V46, Co 86V96, Co 86032, Co 7219 and 87A 298 which are popularly grown in Chittoor and Nellore districts. A study was conducted at Agricultural Research Station, Perumallapalle to detect the presence of ScYLV in commercially grown sugarcane varieties in Andhra Pradesh. Using ScYLV specific primers (ScYLV-F, ScYLV-R and 613-F, 613-R), ScYLV was detected by RT-PCR in the commercial sugarcane variety, 2003 V46 with the amplification of 1,110 bp (ORF 1 & 2) and 613 bp (ORF-3 & 4) regions. The products were sequenced and sequence similarity of the isolate from 2003V46 was compared with different ScYLV isolates of India and abroad using nucleotide BLAST programme at National Centre for Bioinformatics. The sequencing analysis revealed that ScYLV isolate from 2003V46 showed 99.0% nucleotide similarity with the ScYLV isolate reported from Coimbatore, Tamil Nadu.

Key words: Sugarcane Yellow Leaf Disease, Sugarcane Yellow Leaf Virus, detection techniques, RT-PCR

Effect of Fungicidal Seed Treatment on Seed Borne Mycoflora and Seedling Vigour of Pigeonpea (Cajanus cajan (L.) Millsp)

A Pradhan, N Lakpale and N Khare

Department of Plant Pathology, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012, India.
E-mail: pradhanashish08@gmail.com

Abstract

Pigeonpea, a very important member of pulses, its seeds also harbours variety of micro-organism which deteriorates the quality of seed. In order to manage the seed borne mycoflora, seeds of pigeonpea variety Rajeev Lochan were treated with five fungicides and results revealed that minimum frequency of mycoflora was recorded in seeds treated with Carbendazim followed by Carboxin. The prominent mycoflora were A. flavus, A. niger, A. fumigatus and mycelia sterilia. Maximum seedling vigour index was recorded in Metalaxyl (2415.28) which was 107.17% more than that of control followed by Carbendazim (2266.38) which was 94.40% higher than that of control. Least vigour index (1165.80) was recorded in control (without fungicide). The above result clearly showed that fungicides taken in the study could be able to reduce the mycoflora associated with pigeonpea seeds and thereby increase root and shoot length, germination percentage and ultimately seedling vigour index.

Key words: Cajanus cajan, fungicides, mycoflora, seedling vigour

New Report


Anita Cherian K, Sindu PG, Linse Paulose and Rema Menon

Banana Research Station, Kerala Agricultural University, Kannara P.O, Thrissur-680652, Kerala, India.
E-mail: anitacherian.k@kau.in

**Key words:** Jack fruit, *Rhizoctonia solani*, seedling blight

Acaulospora soloidea - A New Report of Arbuscular Mycorrhizal Fungal Species from Black Cotton Soil of Maharashtra, India

VS Sawant and UN Bhale

Research Laboratory, Dept. of Botany, Arts, Science and Commerce College Naldurg, Tq. Tuljapur. Dist. Osmanabad 413602 (MS)
E-mail: unbhale2007@rediffmail.com

Key words: Black cotton soil, chilli, Acaulospora, taxonomy, Glomeromycota

New Report

Chasmothecial Stage of *Blumeria graminis* f.sp. *tritici* in Wheat - A First Report from Nilgiri Hills

P Nallathambi, Jagdish Kumar, C Umamaheswari, A Kumar and EP Venkatasalam

*Indian Agricultural Research Institute, Regional Station, Wellington-643231. The Nilgiris, India.*

Email: scientist_thambi@yahoo.co.in.

---

**Key words:** *Blumeria graminis* f.sp. *tritici*, Chasmothecia, Nilgiri Hills, wheat

Short Communication

*Sclerotium rolfsii* Causing Stem Rot in Tomato Crop in Koronivia, Fiji

Anamika

*Department of Agriculture, CAFF, FNU, Fiji E-mail: anamika_bhu01@rediffmail.com*

**Key words:** *Sclerotium rolfsii*, Stem rot, Tomato

**Citation:** Anamika. 2014 *Sclerotium rolfsii* Causing Stem Rot in Tomato Crop in Koronivia, Fiji. *J Mycol Pl Pathol* 44(4): 457-458.
Short Communication

Phenotyping of Groundnut Genotypes for Resistance to Sclerotium Stem Rot

PP Thirumalaisamy, Narendra Kumar, T Radhakrishnan, AL Rathnakumar, SK Bera, KS Jadon, GP Mishra, Riddhi Rajyaguru and Binal Joshi

ICAR-Directorate of Groundnut Research, PO Box 5, Junagadh 362 001, India. E-mail: thirumalaisamyp@yahoo.co.in

Key words: Stem rot, groundnut, Sclerotium rolfsii

Short Communication

A New Edible Variety of *Laetiporus sulphureus* from the Cold Desert of Ladakh

Rigzin Yangdol, Sanjeev Kumar and YP Sharma

Department of Botany, University of Jammu, Jammu 180 006, Jammu & Kashmir, India. Email: yashdbm3@yahoo.co.in

**Key words**: Ethnomycology, Ladakh, *Laetiporus*, taxonomy

Short Communication

*Corynespora ipomoeae*, A Novel Taxon of Dematiaceous Hyphomycetes

NK Verma, JS Surywanshi and AN Rai

*Department of Botany, Dr. H.S. Gour University, Sagar-470003, Madhya Pradesh* *Email:jaishri.surywanshi10@gmail.com*

**Key words:** Biodiversity, *Corynespora*, taxonomy

Abstracts of Papers Presented at the East Zone Meet and National Symposium on Unravelling Plant-Microbe Interactions for Supporting Plant Health at Department of Botany, Gauhati University, Guwahati on 27-28 October, 2014

Key Note Address

Recearchable Issues in Plant Disease Management for Sustainable Crop Production

SS Chahal
Chairman, Agri. Knowledge Foundation, India & Ex- Vice Chancellor, MPUAT, Udaipur (Raj.), 943-H, B R S Nagar, Ludhiana- (Punjab)-141012 E-mail: chahalsps@ yahoo.com

Green Revolution (GR) spreading over the period from 1967-68 changed India's status from a food deficient country to one of the world's leading agricultural nations. The positive impact of GR in India visualized from higher productivity and farm income was further boosted through continuing expansion of farm area, double cropping in farm land and use of seeds with improved genetics in combination with enhanced water resources application, chemical nutrients and plant protection measures. The GR also contributed to better nutrition by raising per capita consumption of vegetable oils, fruits, vegetables, and livestock products with increase in per capita availability of good grain in our country. However, a few decades down the road, it has become evident that benefits of GR associated with unanticipated harmful effects of chemicals. Besides other factors an increase in vulnerability to pests and diseases has emerged as a major constraint which needs to be addressed through indentifying and pursuing researchable issues for more effective management of threatening plant diseases to achieve sustainability of agricultural production.

Past records have shown that diseases like rusts, blights, mildews and blasts are capable of causing complete loss to many crops of economic importance. It led to give priority to field oriented research and intensify efforts for development of resistance varieties. Well defined races of many plant pathogens have been identified. However, mycological research has received reduced attention. Several genera are required to be revised. Identification of several cryptic biological species requires to be carried out through employment of modern molecular techniques.

Tremendous progress has been made in phyto-bacteriology particularly in areas of molecular detection of pathogens, population dynamics, identification races, host reaction, however data in plant plasmid biology, cloning of avr genes, purification of enzymes/isoenzymes, biological control and role of Multiple Adversity Resistance gene are yet to be taken up. There is need to refine characterization viruses through application of advanced techniques. Despite some adverse effects, use of fungicides is likely to continue against plant diseases however to minimize residue problems and risk of developing resistances to fungicides there is need to take up research to explore potential of natural microbial or plant based products which have ample availability in India. It is of paramount importance to generate research data on environmental and mammalian safety.

The focus for developing bio-control should be on developing suppressive soils. It is also desirable to select a naturally occurring population, because the greater complexity in a natural biological system ensures greater stability. Use of resident antagonists should be the focus of bio-control because these are well adapted to then prevalent to agro-ecological conditions.

Genomics has emerged as a new area which if applied in plant pathology can bring out genome sequence data being generated on different microorganisms world over. It can be useful in development of superior genotypes of major crops. Hence, there is need to undertake host pathogen interaction studies, pyramiding base gene combinations in otherwise high yielding and superior cultivars, developing resistance against viruses following RNA interferences or RMA silencing g techniques.

Shift in atmospheric temperature, precipitation, relative humidity and soil moisture affect host as well as pathogens. Some focused studies in relation to climate change have been done elsewhere but it needs to be taken up in local environment as well. Simulation of disease epidemics and management strategies develop in response to natural climate extremes may be useful in adapting long term climate changes. More effective disease surveillance and expert systems for farmers advisory are required to be developed. Sufficient data are available which requires to collate for synthesizing effective IDM models for different host-pathogen systems. Equally important is their validation at farmers' field and popularization on wider scale.

The knowledge of plant disease control has evidently been generated enormously. The future need is to explore new technologies, and bled them and implement to make it more relevant for meeting the new challenges to sustainability of Indian agriculture.

Lead Papers

Proteomic and Metabolomic Analysis of Tea Leaves Infected with Exobasidium vexans and Development of Strategies to Improve Crop Health Status

BN Chakraborty, U Chakraborty and Luis A J Mur

Immu-no-Phytopathology Laboratory, Department of Botany, University of North Bengal, Siliguri-734013, West Bengal, India

Given the economic importance of tea, any threats to yield are of great importance. Blister blight of tea caused by Exobasidium vexans is an economically devastating disease of tea. Scanning electron microscopic observation of the blister blight affected tea leaf surface as well as ultrastructural immunocytochemical localization of E. vexans in leaf tissue using transmission electron microscopy following immunogold labelling with polyclonal antibodies revealed intense labelling. Accumulation of pathogen induced (PI) protein in compatible interaction as well as biochemical and immunological characterization of pathogenesis related (PR) proteins – PR2, PR3 and PR9 in incompatible interaction were studied. Besides, the chemical richness of tea, resistance is also likely to depend on antimicrobial metabolites. The most abundant flavan-3-ols are epicatechin (EC) and gallic acid (GA) derivatives but other important chemical classes include

avr
E. vexans
flavonols such as conjugates of quercetin and kaempherol, coumarate, some purine alkaloids, theobromine and also the purine alkaloid, caffeine. Metabolomic changes in blaster blight infected tea leaf samples were analysed according to disease phenotypes; i.e. either healthy or at one of three stages of disease progression. Fourier transform infrared (FT-IR) spectroscopy to derive metabolic fingerprints and multivariate statistics based on Discriminant Function Analysis (DFA) allowed metabolite changes to be related to disease class. Blister blight infections perturb defence signalling and reduce many anti-microbial compounds presumably to aid disease progression. Hexaconazole a promising fungicide for control of blaster blight and tridemorph (Calixin) an anti-sporulant was applied in recommended doses and their effects were analysed for induction of resistance associated with synthesis of PR proteins. Aqueous leaf extracts of Catharanthus roseus was also found to be effective in management of blaster blight disease in the field. All these treatments induced accumulation of chitinase and β-1, 3-glucanase, which reduced the disease incidence significantly. Ultrathin sections of leaves from induced tea plants embedded in LR-white resin separately treated with PAb-chitinase and PAb-β-1,3-glucanase followed by gold labelling revealed a higher frequency with the PAb-chitinase probe. Tea varieties that are apt to intensively induce such proteins are ought to be agriculturally significant. Metabolomic changes in blister blight infected tea leaves, which was also confirmed by Western alanine ammonia lyase, peroxidase, chitinase and β-1, 3β glucanase, in tea leaves, could also suppress the diseases caused by them. Sustainability of the applied bacteria in soil were tested by PTA-ELISA and Dot immunobinding assay caused by them. Exploration of the immense potential of plant growth promoting rhizobacteria for use as eco friendly biofertilizers and biopesticides is one of the current needs in sustainable agriculture. Keeping this in mind, the present study was undertaken to explore the potential of such microorganisms from the rhizosphere of tea (Camellia sinensis) for the overall improvement in growth and productivity of tea, which is the most important crop of this region. Isolation and testing of bacteria for PGPR activities revealed a large number which showed such activities, of which five were selected for various studies. The selected bacteria were- Bacillus megaterium, Bacillus amyloliquefaciens, Bacillus pumilus, Ochroechromer ancorpus, and Paenibacillus lentimorbus. These bacteria showed positive PGPR traits in vitro such as phosphate solubilization, siderophore production, volatile secretion, antagonism to pathogens and IAA production. 16S rDNA sequencing of the bacteria was done and their phylogenetic relationships determined by RAPD-PCR. Under in vivo conditions, they enhanced seedling growth of tea varieties in the nursery as well as in the field. Plant growth promotion was determined in terms of increase in number of leaves, their biomass and number of shoots. Since insecticides are widely used in tea estates, it is essential that the applied bacteria should have tolerance against such insecticides. In order to determine the tolerance of the bacteria to insecticides, in vitro tests were conducted which indicated that the bacteria could tolerate more than 100 times the concentration applied in the field. These bacteria, besides inhibiting growth of root rot pathogens such as Pelttimus noxius, Portia hypobromena, Sclerotium rolfsii and Sphaerothelie repens in vitro, could also suppress the diseases caused by them in vivo. Sustainability of the applied bacteria in soil were tested by PTA-ELISA and Dot immunobinding assay using polyclonal antibodies raised against the PGPR. Certain bioformulations of the PGPR in talc powder, saw dust and rice husk have also been prepared and their viability tested. The bacteria showed good survivability even up to nine months of storage. Either foliar or soil application of the PGPR led to increase in isomers of catechins, glucanase, alanine ammonia lyase, peroxidase, chitinase and β-1,3β glucanase, in tea leaves, which was also confirmed by Western Blot using PAB of chitinase. Total phenols also increased quantitatively, along with an increase in isomers of catechins, which are important flavonoids of tea leaves. Further, out of the 6 isolates, at least 2 showed tolerance against abiotic stresses such as high salinity. This could be considered as an additional trait which could make the use of the bacteria more broad-based. It is evident from the results of the present study that application of PGPR in the soil lead to biofertilizing the plants through induced systematic resistance and other mechanisms.

Application of PGPR for Growth Promotion and Root Rot Suppression in Camellia sinensis and Elucidation of their Mechanisms of Action

U Chakraborty and B N Chakraborty

Immuno-Phytopathology Laboratory, Department of Botany, University of North Bengal, Siliguri-734013, West Bengal

Exploration of the immense potential of plant growth promoting rhizobacteria for use as eco friendly biofertilizers and biopesticides is one of the current needs in sustainable agriculture. Keeping this in mind, the present study was undertaken to explore the potential of such microorganisms from the rhizosphere of tea (Camellia sinensis) for the overall improvement in growth and productivity of tea, which is the most important crop of this region. Isolation and testing of bacteria for PGPR activities revealed a large number which showed such activities, of which five were selected for various studies. The selected bacteria were- Bacillus megaterium, Bacillus amyloliquefaciens, Bacillus pumilus, Ochroechromer ancorpus, and Paenibacillus lentimorbus. These bacteria showed positive PGPR traits in vitro such as phosphate solubilization, siderophore production, volatile secretion, antagonism to pathogens and IAA production. 16S rDNA sequencing of the bacteria was done and their phylogenetic relationships determined by RAPD-PCR. Under in vivo conditions, they enhanced seedling growth of tea varieties in the nursery as well as in the field. Plant growth promotion was determined in terms of increase in number of leaves, their biomass and number of shoots. Since insecticides are widely used in tea estates, it is essential that the applied bacteria should have tolerance against such insecticides. In order to determine the tolerance of the bacteria to insecticides, in vitro tests were conducted which indicated that the bacteria could tolerate more than 100 times the concentration applied in the field. These bacteria, besides inhibiting growth of root rot pathogens such as Pelttimus noxius, Portia hypobromena, Sclerotium rolfsii and Sphaerothelie repens in vitro, could also suppress the diseases caused by them in vivo. Sustainability of the applied bacteria in soil were tested by PTA-ELISA and Dot immunobinding assay using polyclonal antibodies raised against the PGPRs. Certain bioformulations of the PGPR in talc powder, saw dust and rice husk have also been prepared and their viability tested. The bacteria showed good survivability even up to nine months of storage. Either foliar or soil application of the PGPR led to increase in isomers of catechins, glucanase, alanine ammonia lyase, peroxidase, chitinase and β-1,3β glucanase, in tea leaves, which was also confirmed by Western Blot using PAB of chitinase. Total phenols also increased quantitatively, along with an increase in isomers of catechins, which are important flavonoids of tea leaves. Further, out of the 6 isolates, at least 2 showed tolerance against abiotic stresses such as high salinity. This could be considered as an additional trait which could make the use of the bacteria more broad-based. It is evident from the results of the present study that application of PGPR in the soil lead to biofertilizing the plants through induced systematic resistance and other mechanisms.

Ethnomycology and Mycofoods of Jammu and Kashmir (North West Himalaya)

YP Sharma and S Kumar

Department of Botany, University of Jammu, Jammu, J&K, India-180006; E-mail: yashdbm3@yahoo.co.in

Jammu and Kashmir (J&K) state of Indian lies in the North-western part with an area of 222,236 sq.km. Situated in the north-western Himalayan ranges, the state is mainly mountainous, and comprises of three divisions viz., Jammu, Kashmir and Ladakh. Due to its great altitudinal variation, diverse geological formations and varied climatic zones including subtropical, tropical, temperate, alpine and cold desert, the State harbours immense plant diversity in general, and mushroom flora, in particular. Mushrooms are fast becoming popular in the world and recently there has been an upsurge in the International recognition of mushrooms due to their nutritional and pharmaceutical attributes and traditional medicinal significance. Slowly but surely, they are being recognized as a substitute for the depleting agricultural resources and in alleviating malnutrition particularly in the protein deficient population of the world. World over surveys of macrofungi have been carried out by various researchers but adequate attention has not been given to their traditional mycofoods and ethnomycology in India. Studies on these aspects, therefore, were undertaken in various locations of Jammu and Kashmir state during the period 2008-2013, in order to develop a database on mushroom diversity and their traditional uses. In this study many collections were made out of which, ninety wild mushrooms distributed in forty genera were identified. These includes Agaricus spp., Amanita spp., Astraeus spp., Auricularia sp., Boletus spp., Cantharellus spp., Calvatia spp., Clavaria sp., Cladonia spp., Coprinus spp., Flammulina sp., Geopora spp., Geastrum spp., Gomphusillus sp., Gyrincita sp., Heliella sp., Inocybe spp., Laetiporus sp., Lepiota sp., Lentilus sp., Macrolepiota sp., Morchella spp., Peziza spp., Pleurotus spp., Ramaria spp., Russula spp., Rhizopogon spp., Scleroderma spp., Sepultaria spp., Sparassia spp., Suillus sp., Termitomyces spp. and Verpa sp. etc. Their brief habit and habitat description and ethnomycological aspects including folk taxonomy will be highlighted.
Oral/Poster Presentations

Application of Bioformulation of AMF, PGPF and PGPR Alone and in Combination on Some Plants and their Evaluation on Management of Leaf Blight Disease

A Acharya, BN Chakraborty, U Chakraborty, J Rabha and DK Jha

Immuno-phytopathology lab, Dept of Botany, University of North Bengal, Siliguri-734013, West Bengal; Microbial Ecology Lab, Dept of Botany, Guwahati University, Guwahati-781014, Assam

Sericulture or the silk industry is one of the economically important industries of North Eastern India. Muga sericiculture is based on the growth of muga silkworm Antheraea assamensis Helfer on the leaves of one of its primary host plant Persea bombycina Kost, locally known as 'Som'. Hence the quality and quantity of the leaf of the plant will affect the quality and quantity of the silk produced. Keeping this parameter in mind the present study was carried out to improve the leaf quality and quantity. Eight different morphotypes, viz. S1-S8 collected from Central Silk Board, Boko, Assam were grown in pots under nursery condition in University of North Bengal where the soil was supplemented with varieties of bio-inoculants like PGPR, AMF and PGPF, all singly, jointly as well as in triple treatment. Out of these eight morphotypes, two morphotypes, S5 and S6, showed improved growth and were further transplanted in field where the soil was amended with talc-based formulation of Bacillus pumilus, wheat bran based formulation of Trichoderma harzianum and mass multiplied spores of Arbuscular Mycorrhizal Fungi. Enhancement of growth was evidenced in treated plants by increase in plant height (cm), total no. of branches and no. of leaves. Following the application of these bioformulations, soil phosphate content decreased and root phosphate increased in case of treated plants. Increase in chlorophyll content as well as total soluble protein content was also observed. Significant increase in phenolics (total as well as orthophenol content), as well as in defense enzymes such as chitinase, β-1,3 glucanase, phenylalanine ammonia-lyase, and peroxidase was observed in both roots and leaves following the application of the bioformulation. The leaves of S5 and S6 treated and untreated plants were challenged inoculated with spores of C. gloeosporioides, the causal agent of grey blight disease of the host plant. Assay of two major defense enzymes PAL and POX after every 24 hr of inoculation for 72 hr showed that the level of these enzymes were more in treated plants than in the untreated plants. It was clearly evident that the applications of bioinoculants greatly improved the health status of som plants and also induced systemic resistance in the plant against the foliar fungal pathogen.

Screening for Resistance of Wheat Plants Against Bipolaris sorokiniana Causing Spot Blotch Disease

BN Chakraborty, U Chakraborty, AP Chakraborty and J Sarkar

Immuno-Phytopathology Laboratory, Department of Botany, University of North Bengal, Siliguri 734013, Darjeeling, West Bengal

Wheat (Triticum aestivum L.) is one of the most important grain crops in India that plays a vital role in the national economy. Bipolaris sorokiniana (Sacc.) (syn. Helminthosporium sativum Pammm., King & Bakke) is a hemibiotrophic pathogenic fungus causing spot blotch disease of wheat resulting in damaging the crop yield in India. In the present study, thirty-five isolates of B. sorokiniana have been collected from naturally infected wheat leaves grown in three locations in North Bengal. Germination behavior and growth pattern of all these isolates of B. sorokiniana were studied. Among these isolates of B. sorokiniana, one isolate (WH.PBW.IP.04) which was used for Koch's postulate with the leaves of PBW343 was further identified by 18S rDNA sequencing and deposited in NCBI with accession number KM066949. Polyclonal antibody against this fungal pathogen (B. sorokiniana) was raised in New Zealand white male rabbit and was immunologically characterized. Based on immunobinding assay, appearance of intense colour on nitrocellulose paper using antibody (1", 2" & 3" bleed of Bipolaris was evident when it was probed with homologous mycelia antigen. One month old seedlings of six wheat genotypes (Gayetri-GY, Gandhari-GN, PBW343, Kedar-KD, Kaveri- KW & Mohan Wonder- MW) were evaluated for resistance under artificial inoculation in glass house condition. Three genotypes- GY, GN & PBW343 were susceptible whereas KD, KW &MW were moderately resistant. Besides, following detached leaf inoculation technique, spore suspension (1×10⁵ conidia/ml) of B. sorokiniana were placed on 4 cm long leaf segments of all six genotypes and kept in moist chamber. Susceptible and resistant reactions were evaluated after 96 h of inoculation, based on the infection appeared on leaf. Conidial germination was comparatively high in wheat leaves of susceptible genotype. POX activities were increased in B. sorokiana treated leaves and expression of POX isozyme in pathogen treated leaves was higher than control leaves. Increased accumulation of defense enzymes (chitinase and β-1, 3 glucanase) after 48 and 72 h of inoculation were observed in pathogen treated wheat leaves in respective to control.

Effectiveness of Cymoxanil and Dimethomorph Against Metalaxyl Insensitive Isolates of Phytophthora infestans (Mont.) De Bary in Potato Crop

L Kataki, MK Saikia, LC Bora, K Talukdar and BC Nath

Department of Plant Pathology, Assam Agricultural University, Jorhat-13, Assam, India. E-mail: katakilohit@gmail.com

The cool and humid weather of Assam prevailing during the months of December and January encourages the late blight (c.o. Phytophthora infestans (Mont.) de Bary) disease in potato crop to attain epidiphytic form. The disease occurs every year in epidemic form contributing to heavy yield losses which go as high as 90% in fungicide untreated crop. Despite existing recommended metalaxyl based management practice, late blight disease has proven to be increasingly difficult to manage in Assam may be due to development of resistance among pathogen population. Hence, the present investigation efforts had been made in two potato growing seasons to find out the relative efficacy of cymoxanil and dimethomorph against late blight of potato under different spray schedules. The main objective of this investigation was to select the most efficient and cost effective fungical schedule to replace the existing less effective metalaxyl based schedule. Among the different treatment combinations, one prophylactic spray with 0.25% mancozeb 75% (to be given at the time of canopy closure) followed by alternate application of two cymoxanil 8% + mancozeb 64% @ 0.2% and one mancozeb 75% @ 0.25% sprays at 10 days intervals proved to be the best treatment combination resulted a yield of 17.98 t/ha and provided significantly better control of foliar late blight (98.04%) and tuber infection (0.72%) in field condition with a benefit cost ratio of 6.25:1. However, highest
disease reduction (99.78%) was observed in the plots where dimethomorph 50% based spray schedule was employed.

Transcriptome Analysis of Vigna mungo Infected with Mungbean Yellow Mosaic India Virus

Nibedita Chakraborty and Jolly Basak
Department of Biotechnology, Visva-Bharati, Santiniketan 731235, WB, India, E-mail: nibeditachakraborty@gmail.com

Unraveling the highly complex host-pathogen interaction in crop plants is scientifically challenging and economically important. The mungbean yellow mosaic India virus (MYMIV) is the causal agent of the yellow mosaic disease (YMD) in some important edible grain legumes including Vigna mungo (uradbean), V. radiata (mungbean), and Glycine max (soybean) of which V. mungo is the most affected one. In V. mungo, the disease is critical, open spread and inflicts heavy yield losses annually. In Asia, V. mungo is one of the most important crops as it provides Asian farmers with food and cash income. It is highly digestible, an excellent source of protein that complements the cereal-based diet of the Asian people. In this study, two recombinant inbred lines of V. mungo, namely T9 which is a susceptible cultivar and VM1 is a resistant mutant line were assessed for their differential responses against MYMIV disease, through Suppression Subtractive Hybridization (SSH) technique. In order to identify differentially expressed genes between the MYMIV-resistant and the susceptible line after infecting with MYMIV, the differentially expressed PCR products were ligated to pJET1.2/blunt Cloning Vector. The transformed recombinant colonies were counted and replica plated. Till date, nearly 350 colonies were obtained in the resistant line, while 321 colonies were obtained for the susceptible line, which are expected to represent differentially expressed genes. These colonies have been screened through colony PCR and unique PCR products have been sent for sequencing. After removal of vector sequence, database searches were performed. Until now around 40 sequences from the resistant line have been annotated and searched for their function using the BLASTX and BLASTN algorithms and majority of them showed function related to stress response. Remaining sequence data from the resistant and susceptible line is under annotation process. Selected important functioning differentially expressed genes will be validated by real-time quantitative PCR.

Identification and Characterization of Phaseolus vulgaris Micro RNAs Expressed Under Biotic Stress

Nisha Patwa and Jolly Basak
Department of Biotechnology, Visva-Bharati, Santiniketan 731235, WB, India, E-mail: nisha.patwa90@gmail.com

Phaseolus vulgaris is a vital protein-rich leguminous crop in tropical and subtropical areas of Asia, Africa, Latin America, southern Europe and the USA. However, this crop production is hampered by Mungbean Yellow Mosaic India Virus (MYMIV). Nine cultivars of P. vulgaris namely S-9, Malgudi, Seville, Arjun, LAP1, LAP2, Falguni, Arkasuvridha and Anupam were assessed for their differential responses against MYMIV using morphological and biochemical parameters. MYMIV coat-protein-primer was used to quantify the viral titer by real-time qPCR in all the nine cultivars for four consecutive days after viral inoculation. Combined results provided information about differential responses of nine cultivars against MYMIV. To identify miRNAs related to MYMIV resistances in Phaseolus, sRNA libraries were constructed for control and stressed Anupam cultivar (least affected by MYMIV infection). Deep-sequencing generated 33672751 and 36921004 raw reads from the control and treatment libraries, respectively. To identify the conserved miRNAs, we compared this information with the mature plant miRNAs in the miRBase. Following BLASTN searches and sequence analysis, a total of 295 and 299 known miRNAs were identified in the control and treatment libraries, respectively. To identify new miRNAs and new members of known miRNA families, we used the unique sRNA sequences from the two libraries to map to the Phaseolus genome and predict secondary structures of sequences surrounding mapped sites. Resultant reads were used to identify novel miRNAs by folding the sequences of potential miRNA precursors using the web-based software RNAfold. Finally, a total of 97 and 93 novel miRNAs were predicted in the control and MYMIV treated samples, respectively. The miRNA targets were predicted using psRNATarget server using mature miRNAs as query and the EST sequences of P. vulgaris as subject. The expression profiling of mature miRNAs and their target genes will be validated by RT-qPCR. miRNA targets will be validated by 5' RLM-RACE.

Characterisation of Cultural Gut Microflora in Infected Larvae of Muga Silkworm, Antheraea assamensis Helfer

A Borgohain, R Das, M Chutia, DS Bora, R Samanta, K Dutta and J Sonowal
Central Muga Eri Research & Training Institute, Lahdiogarh, Assam, Email: aborgohain@gmail.com

Sericulture being an agro-based industry plays a major role for creation of sustainable and gainful rural employment. The Indian golden silk producing silk moth Antheraea assamensis Helfer popularly known as muga silkworm, which is semi domesticated in Assam and its adjoining areas of North-East region. Silkworms are affected by a number of diseases due to various biological, chemical, physical, nutritional and environmental factors. Silkworms being poikilothermic respond very quickly to the environmental changes, particularly to temperature and relative humidity. Four silkworm diseases are very common in India viz. Grasserie (viral), Flicherie (bacterial), Muscardine (fungal) and Pebrine (protozoan). Of these diseases, bacterial flicherie is one of the serious diseases of silkworm causing cocoon crop loss to the tune of 70 per cent. In the present study diseased cadavers of muga silkworms were collected from the Jorhat district which were sterilized with 70% alcohol and were dissected and centrifuged to separate the contents of faecal matter from the gut. The aim of the present investigation was to isolate and characterisation of bacteria causing diseases in muga silkworm. Total 20 isolates of bacteria were isolates. The shape, size and colour of bacteria colonies were observed and recorded. Serial dilutions were done to isolate the pure cultures of bacteria from the gut of sil worms. The purified colonies will be identified to generic levels following standard biochemical tests described in Bergey's Manual of Determinative Bacteriology. Various biochemical tests will be performed including gram's reaction, catalase, motility, indole, methyl red (MR) test, sugar fermentation, citrate utilization test etc. The isolates will be used for pathogenicity test as per Koch's Postulate. Pathogenicity test of the isolates have shown that only two bacterial isolates code SM-5 & SM-21 were responsible for bacterial disease in muga silkworm. The isolates on the basis of cultural, morphological and biochemical characters were identified as Bacillus sp. (close to Bacillus thuringiensis) and Streptococcus sp. Hence, the study concludes with this two bacterial species characterisation as pathogenic bacteria which were found in diseased cadavers of muga silkworms.
Microbial Population and Fungal Assemblages of *Alnus nepalensis* and *Castanopsis hystrix* Decaying Leaves in Subtropical Plantation Forest Stand of Manipur, North East India

A Kayini, Ishworani Chongtham and RR Pandey

Department of Life Sciences, Manipur University, Canchipur, Imphal-795 003, India

In the present investigation, an attempt has been made to compare the microbial population and species composition of filamentous fungi, their seasonal occurrence and successional patterns on decaying leaves of *Alnus nepalensis* and *Castanopsis hystrix* in subtropical mixed plantation forest of Eastern Himalayan range. As compared to *C. hystrix* litter, *A. nepalensis* leaves revealed higher bacterial and actinomyces populations throughout the study period, while fungal count was higher in *C. hystrix* leaves during early decay phase. Eighty five fungal species belonging to 44 genera and 1 sterile mycelial form were isolated from both from types by employing 3 cultural methods and the successional changes in fungal assemblages were observed during decomposition. Month of samplings and isolation techniques influenced the species composition of litter fungi. Different microfungi showed differential seasonal preferences during the course of litter decomposition. Most frequent species recorded from both litter types by all three isolation methods were *Cladosporium cladosporioides, Cylindrocladium parvum*, *Fusarium oxysporum*, *Trichoderma koningii* and *T. viride*. *Penicillium* was the abundantly recovered genus with 21 species. Litter fungi of both trees showed highest similarity index during rainy season.

A Comparative Study on Arbuscular Mycorrhizal Fungi Associated with *Oroxylum indicum* (L.) Kurz.

Aatreyc Nath, Liza Handique and Vipin Parkash

Department of Botany, Jagannath Barooah College, Jorhat 785001, Assam, E-mail: aatreycn04@gmail.com

Mycorrhiza is one of the most essential components of soil rhizosphere which aids in plant nutrient uptake and growth. Mycorrhizal associations are known to vary with soil structure and host associating flora, but little is known about its variability in relation to altitude. The present study was undertaken to examine the rhizospheric endomycorrhizal association of *Oroxylum indicum* (L.) Kurz. and their variation if any in two different locations/sites viz, Jorhat district of Assam and Mon district of Nagaland. *O. indicum* also known as Bhatghila is a well known medicinal plant species used for the treatment of human ailments like cancer, jaundice etc. In this study, the target species was screened for mycorrhizal associations for its growth and development. Hyphal, vesicular and arbuscular colonisations were observed in samples obtained from both the sites with a varying degree of occurrence. The arbuscular colonisations were observed in samples obtained from Nagaland in comparison to rhizospheric sample of Jorhat district. However, study on the distributional variation of richness value was observed in Mon district followed by Jorhat district. Where it is low (20.00±1.45). The maximum species richness value was observed in Mon district followed by Jorhat district. However, study on the distributional variation of endomycorrhizal species associated with the target plant species is still under progress. The plant-endomycorrhizal association can be exploited for *ex-situ* conservation of target plant species, apart from usage as an ecological indicator.

Nutritional Factor of Vermicompost and its Effect on Growth, Development and Biochemical Aspect of *Lobia* (*Vigna unguiculata* (L.) Walp)

Anand Kishor and Ranjana Kumari

University Department of Botany, V.K.S.U., Ara (Bihar), E-mail: amkdhr@gmail.com

Amendment of soil with 50% vermicompost seems to favour every aspect of plant growth and development. Germination has been found to increase to the extent of 90% after 5 days of sowing the seeds. Considering various facts of growth and development the root length seems to increase to the extent of 15.5% over untreated host plant. Similarly the shoot length also seems to enhance to the extent of 31% over untreated host plant. A noticeable factor appeared to show when the number of node, internodes and leaf remained the same in treated as well as in untreated plant. A 60% increase in the area of the leaf (sq cm) was noticed in the treated plant. This resulted in greater area for photosynthesis and hence a robust growth to the plant. Nutritional factor of vermicompost also seems to decrease the number of root nodules (70.5%) which indicates that this leguminous nitrogen fixing plant can fulfill its requirement of nitrogen from vermicompost itself. The electrical conductivity in the root (78%) and stem (42%) has been found to increase but in the leaves this value exhibits a decreasing trend (0.47%). During further analysis of the treated host plant an increase in the protein content to the extent of 50% has been noticed in the leaf. This is an indication that supplementation of vermicompost in the soil can enhance the quantity of protein in the leaf even if the number root nodule decreases to a considerable extent. Review of literature indicates that supplementation of vermicompost in the soil helps build up of microbial population of diverse nature in the rhizosphere. This creates better availability of nutritional component available around the root and its rapid uptake by the host plant.

Identification of a Bottle Gourd Fruit-Rot Pathogen and Detection of Chitinase Gene from Bottle Gourd

A Saha, S Das, P Chakraborty, D Saha and Aniruddha Saha

Department of Botany, University of North Bengal, India-734013, E-mail: asahambh@yahoo.co.in

Bottle gourd (*Lagenaria siceraria* (Mol) Standl.) is an economically important crop and is cultivated throughout India as a major vegetable product. Every year, specifically during winter season about half of the fruits are lost due to fungal attack and most of them are in premature phase. In the present work *Colletotrichum gloeosporioides* have been isolated from infected fruit of bottle gourd. The disease was successfully transmitted to healthy bottle gourd fruits by artificial inoculation. Total DNA was isolated from the fungal pathogen and 18s rDNA region was amplified using ITS specific primers (ITS 1 and ITS 4). The size of the amplicon ~550bp. The PCR product was then sent for sequencing. The sequence was analyzed and compared with other sequences submitted in the GenBank using BLAST programme. The identification of the fungal culture was confirmed as *Colletotrichum gloeosporioides* (GenBank Accn. No. KC355249). To control the disease, defense genes like chitinase may be induced in bottle gourd plant using biotic or abiotic inducers. In our preliminary work the chitinase gene was amplified (~650bp) by RT-PCR using chitinase specific primer.
Study of Antioxidant Property of Fungal Endophytes Isolated from the Pitcher Plant Nepenthes khasiana

Archana Nath and SR Joshi
Microbiology Laboratory, Dept. of Biotechnology and Bioinformatics, North Eastern Hill University, Shillong-22, E-mail: archananath3@gmail.com

Nepenthes khasiana is a tropical pitcher plant of the genus Nepenthes and the only species native to India. It is thought to attract prey by means of blue fluorescence. The Nepenthes pitcher plants get their nutrient via digestion of insects by using free radicals. In recent years, fungal endophytes from diverse host species have been extensively studied for valuable compounds. Reports on studies of endophytic fungi from Nepenthes pitcher plants are very scarce. A total of three endophytic fungi were isolated from the plant and were identified by molecular characterization of ITS rRNA sequence. The fungal crude extracts were then evaluated for antioxidant activity by 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging method, reducing power assay and presence of total phenols. All the fungal extracts revealed significant antioxidant activity among which Pestalotiosis sp. showed the most potent activity. The ethanolic extract of the endophytic fungi revealed potential to be bioprospected as antioxidant agent and can be used efficiently by pharmaceutical industries.

Field Screening for Late Blight Resistance in Different Tomato Genotypes

BC Nath, LC Bora, Kh Malemnganba and GC Bora
Department of Plant Pathology, Assam Agricultural University, Jorhat-13, Assam; E-mail: bharatpal05@gmail.com

Late blight caused by Phytophthora infestans is regarded as one of the most serious problems in tomato growing areas throughout the world. A study was carried out in the Horticulture Experimental Farm, Assam Agricultural University, Jorhat, with forty seven (47) genotypes of tomato to assess the late blight resistance in the tomato lines. The experiment was conducted during rabi seasons of 2013-14 following randomized block design with 3 replications. Recommended package of practices were followed throughout the crop period. The tomato variety Pusa Ruby was used as susceptible check, while 'Konbilahi' (Lycopersicon pimpinellifolium) was used as resistant check. The genotypes were graded using 0-5 scale of Potato late blight reaction. Results revealed that minimum disease index (5.0 %) and maximum seed yield (10.25 q/ha), pod yield (28.0 pods/plant) and pods (46.0 pods/plant) respectively, recorded in the plots that were sprayed with difenoconazole (@ 0.05%) as compared to maximum disease index (55.0 %), and minimum seed yield (4.42 q/ha), pod yield (10.83 q/ha) and pods (28.0 pods/plant) recorded in control.

Detection of Some Defense Genes in Camellia sinensis and Analysis of Chalcone Synthase Gene Following Molecular Techniques

Shibu Das, Prosenjit Chakraborty, Arnab Saha, Dipanwita Saha and Aniruddha Saha
Department of Botany, University of North Bengal, India, 734013

Tea is one of the most important beverages of the world but tea plants are exposed to a number of pathogens. Resistance of plants against these pathogens depend upon activation of different defense related enzymes. Among the defense enzymes Chitinase (CHI), Glucanase (GLU) and Chalcone synthase (CHS) have been reported in different plants. Some inducers also induced the above mentioned enzymes in plants. In the present study, chemical inducers like 2,1,3-Benzothiadiazole (BTH) and salicylic acid (SA) have been shown to induce resistance in tea plants against tea pathogens. The genes of the above mentioned three enzymes of tea plants were identified and for this purpose total RNA was extracted from the harvested plant samples. Chitinase, Glucanase and Chalcone synthase gene specific primers were used for the RT-PCR analysis. Sequencing and analysis of CHS gene (~345bp long) of tea plants have been done. Up regulation of the transcripts of the enzymes will be studied in future.

Alcohol Tolerance of Saccharomyces cerevisiae

Barnali Dutta and SK Borthakur
Department of Botany, Gauhati University, Guwahati-781014, Assam, India; E-mail: barnalidutta10@gmail.com

A well known inhibitor for the growth of microorganisms is ethanol. It damages mitochondrial DNA in yeast cells and causes inactivation of some enzymes like hexokinase and dehydrogenase. But there are certain strains of yeast that show tolerance and can adapt to high concentrations of ethanol. The yeast cell that was obtained from starter culture in laboratory pure culture was identified as Saccharomyces cerevisiae. The organism was allowed to grow in YPD (yeast extract-peptone-dextrose) broth containing alcohol. For this they were subjected to various concentrations of ethanol viz., 4%, 8%, 12% and 16% with a control and their level of tolerance of alcohol was tested. A gradual decrease of yeast cells was recorded as the concentration of alcohol was increased. Maximum yield of yeast growth was obtained from the control
followed by 4%, 8% and 12%. The growth is least at 16% ethanol which meant that 16% ethanol expressed least alcohol tolerance ability. The growth behaviour and alcohol tolerance revealed numerous facts and behaviour of the yeast strains associated with traditional alcoholic fermentation.

The Arbuscular Mycorrhizal Fungus Glomus Increases the Growth of Psidium guajava L. and Tetramelos nudiflora R.Br. in Pot Culture Studies

Bidisha Sharma and DK Jha

Microbial Ecology Laboratory, Department of Botany, Gauhati University, Guwahati- 781014, Assam, India, E-mail: dkjhabott7@gmail.com

Beneficial effects of AM fungi on plant growth and productivity have been advocated largely in literature. In our previous study in Kaziranga National Park, Assam, Glomus was found to be the most dominant AMF genera and Psidium guajava and Tetramelos nudiflora were two commonly occurring plants there. Hence, this study was taken with an aim to observe the affect of Glomus on growth of these two plants i.e. Psidium guajava L. and Tetramelos nudiflora R.Br. under pot culture experiments. For this purpose, three dominant species of Glomus found inside the park namely, G. albidum, G. tortuosum and G. magnicule were selected. The AM fungal spores were collected from AMF single spore cultures obtained from soil samples collected in Kaziranga National Park. The plants of Psidium and T. nudiflora were grown in pots containing sterilized soil and then inocula containing AM fungal spores were applied to them. After a few weeks it was observed that the plants with mycorrhiza infection had better growth than the controls. Increased vigour in root, shoot, biomass and chlorophyll content of the mycorrhiza infected plants evidenced these findings. Further, it was observed that the plants where inoculum containing a combination of spores from the all the three selected species were applied, showed better results than those where inoculum with spores from single species were applied. The findings of this study leads to the conclusion that AM fungus Glomus helps in plant growth and this growth can be further accentuated if a combination of Glomus species can be applied.

Endomycorrhizal Association of Melastoma malabathricum L.: A Medicinally Important and Soil Pollutant Accumulator Plant Species

Bijay Sharma, Liza Handique, and Vipin Parkash

Department of Botany, Jagganath Barooah College, Jorhat 785001, Assam, India, E-mail: bijaysharma357@gmail.com

Melastoma malabathricum L., locally known as Phutuki is a well known medicinal plant used for the treatment of diarrhoea, dysentery, hemorrhoids, cuts and wounds, toothache, and stomachache. It is also reported to be a hyper accumulator of aluminium, lead and arsenic and as such used for phytotherapy. However, fewer attempts have been made to study the microbial ecology of the said species. Hence the present study was undertaken to observe the endomycorrhizal associations associated with the target species. Altogether 100 % endomycorrhizal infection was found in all the roots. It was found that the roots had 100 % Hyphal infection, 90% vesicular infection and 40 % arbuscular infection. The quantification of AM spores numbers (50 g soil ) showed that it has moderate (198±8.48) spores. Qualitative analysis revealed that among the isolated spores, Glomus was the predominant genera (53.85%) followed by Acaulospora (38.46%) and Gigaspora (7.69%) respectively. These findings show the importance of interactions between AMF and their host plants in supplying the nutrients especially phosphorus to the plants. The biodiversity analysis of AM fungi associated with the rhizosphere of the target plant species is discussed in this paper and the experiments of inoculation effect on growth and development of the plant species is under progress.

Seasonal Diversity of Arbuscular Mycorrhizal Fungi Associated with the Rhizosphere of Persea bombycina K., in Lakhimpur and Dhemaji District of Assam (India)

DK Hatbaruah and Dipak Konwar

Department of Botany, University of Science & Technology, Meghalaya-793101, E-mail: dkhatbaruah@gmail.com

In the sericulture map of the world Assam is occupying a unique position as all the four commercial types of natural silk (viz. Eri, Muga, Mulberry and Tasar) producing insects and their host plants are found here, 'Som' (Persea bombycina Kost, Family Lauraceae) is the primary food plant of Muga Silkworm (Antheraea assamensis Helfer) that produces the golden yellow ‘Muga’ silk. The present investigation was carried out to study the prevalence of AM fungi in som plants growing in Lakhimpur and Dhemaji district of Assam by determining the extent of root colonization, spore density in the rhizospheric soil and the actual species composition associated with the host. Seasonal dynamics of arbuscular mycorrhizal (AM) fungal community composition in this particular plant species, from five different sites of the selected districts of Assam, India were investigated. In all the sites species variation in AM fungal spore density was observed. Maximum spore density and AM species richness were recorded in the spring season, while minimum spore density and richness were observed during summer season in all the study sites. A total of 11 arbuscular mycorrhizal fungal species representing four genera were recorded. Glomus caledonium and Acaulospora laevis was recorded in all seasons. It has been revealed that the occurrence and distribution of VA-mycorrhizal fungi are largely governed by various physico-chemical properties of the soil as well as by the rhizospheric effect of the host plant.

Arbuscular Mycorrhizal and Dark Septate Fungal Associations in Tea [Camellia Sinensis (L.) O. Kuntze] of Udalguri District, Assam

Deepa Sharma and Highland Kayang

Microbial Ecology Laboratory, Centre for Advanced Studies in Botany, North-Eastern Hill University, Shillong-793022, Meghalaya, India, E-mail: harmsdeepat02@yahoo.com

Arbuscular mycorrhizal fungi (AMF) are obligately symbiotic soil fungi which colonize the roots of the majority of plants. The symbiosis of plant with AMF is the widest spread symbiosis in natural ecosystems. Plant roots are also colonized by a diverse group of melanaceous, septate fungi known as dark septate fungal endophytes (DSE). These endophytes have been reported from various habitats and from a wide range of hosts. Roots of Camellia sinensis (L.) O. Kuntze was collected from natural site (NS) and cultivated site (CS) of Udalguri district, Assam and was studied for AMF and DSE colonization. In the natural site addition of fertilizers and other common agricultural practices have never been practiced, whereas in the cultivated site chemical fertilizers as well as other pesticides have been generally applied in tea plantation. AMF colonization was significantly higher than DSE colonization in both the sites. High degree of AMF colonization was seen,
which ranged from 32.45% to 97.67% in NS, and 20.23% to 72.42% in CS. DSE colonization in NS ranged from 3.24% to 20.28%, while in CS it was in the range of 0.78% to 12.46%. Rhizosphere soil samples from NS and CS were examined for determining the AMF spore population in both the sites. Spore density in the soil rhizosphere of NS ranged from 726 to 1635, while in CS it ranged from 352 to 1635. This study shows that AMF and DSE colonization, as well as spore density were higher in NS as compared to that of CS.

Endophytic and Rhizosphere Soil Fungal Diversity of Citrus macroptera Montr. (Satkara)
Deepanwita Deka and Dhruba Kumar Jha
Microbial Ecology laboratory, Department of Botany, Gauhati University, Guwahati-781014, Assam, India, E-mail: dkjha_203@yahoo.com

Endophytic fungi that inhabit the healthy living tissues of the host plant are a great source of noble secondary metabolites which have many therapeutic uses. Plant rhizosphere mycoflora has received significant attention because of the role played by these microorganisms in plant growth and health. *Citrus macroptera* Montr. is a RET plant from North-east India, which has high medicinal value. The present study was carried out to study the diversity of endophytic and rhizosphere soil fungal flora of *C. macroptera* in four different seasons. A total of 12 morphologically different endophytic fungi and 8 morphologically different rhizosphere soil fungi of *C. macroptera* were isolated. Achlya debaryana was the most dominant endophyte and Penicillium duclauxii was the most dominant rhizosphere soil fungi in *C. macroptera*. The endophytic fungi, Trichothesium roseum showed highest zone of inhibition against Staphylococcus epidermidis when the crude extracts of the endophytic fungi was tested for antimicrobial activity.

Characterization of Trace Metal Resistant Filamentous Fungi Isolated From Soil Contaminated with Paper Mill Effluent
Dhritiman Chanda, GD Sharma, DK Jha, Mohamed Hijri and Fahad Al Otaibi
Microbiology Laboratory, Department of Life Sciences & Bioinformatics, Assam University, Assam, India

Trace metal (TM) pollution of soil is a worldwide problem threatening the quality of human life and a proper environment. We investigated fungal diversity of trace metal polluted site contaminated with paper mill effluent in India. Fourteen fungal strains were identified using ITS of rDNA belonged to Aspergillus, Penicillium, Fusarium, Cunninghamella, Simplicillium, Trichoderma, Rhizomucor, Cladosporium and Hypocreopsis and subsequent screening was carried out to assess their TM tolerance in *in vitro* cultures. The results revealed that the majority of the isolates were tolerant to Ni, Cu, Zn whereas only Penicillium sp. and Aspergillus sp. were able to grow in Cd amended medium. The level of tolerance depended on the fungal isolate and the site of its origin. Minimum inhibitory concentrations (MIC) for Ni, Cu, Zn and Cd were also determined among the all tested fungal isolates. Overall, Aspergillus, Penicillium, Rhizomucor, Trichoderma and Fusarium isolates showed a strong growth in different concentrations of TM. Their MIC ranged between 20 and 25 mM for Zn, 15 and 20 mM for Ni and Cd. Some of these fungal isolates showed a high resistant potential for further investigations regarding the mechanisms of TM tolerance and their use in mycoremediation to clean up TM polluted soil.

Deducing the Role of Toxin Produced by Alternaria macrospora in Development of Leaf Blight Disease and its Degradation by Endophytic PGPR Strains
G Rajesha, S Nakkeeran, A Chandrasekaran, H Manjunath, P Adhipathi and T Indumathi
Department of Plant Pathology, Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.

The experiment was conducted to know the effect of toxin on pathogenesis and its degradation by using endophytic Bacillus and Pseudomonas bio-control agents. Standardization of different solvent system for extraction of toxin revealed diethyl ether as best as reflected by maximum lesion length of 12.33 mm in terms of symptom expression and maximum electrolytic leakage of 123.96 μs/100 mg of fresh weight after exposing for 60 min. Further, 21 days of incubation, pathogen produced maximum dry mycelial weight (0.637 g) and was found to be optimum for isolation of maximum quantity of toxin from the culture. The toxins produced by *A. macrospora* isolate CAM10 was glycoprotein in nature. Among biocontrol agents, *Bacillus* isolates were effective in degrading toxin compared to the *Pseudomonas* isolates. The maximum toxin degradation was noticed in *B. amyloliquefaciens* isolate EBs2 with least notification of 108.00 μs electrolytic leakage.

Characterization of Antimicrobial Compounds Present in the Potential Bacterial Endophytic Biocontrol Agents
G Rajesha, S Nakkirran, P Adhipathi, H Manjunath, T Indumathi and A Chandrasekaran
Department of Plant Pathology, Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.

Fourteen endophytic bacterial isolates of cotton were isolated by following sterility check method and screened for antagonism *in vitro* against the *Alternaria* isolate CAM10. Among the isolates, *B. amyloliquefaciens* isolate EBs2 reduced the mycelial growth of *A. macrospora* to an extent of 69.67% per cent over control. The *P. fluorescens* isolate EP18 inhibited the mycelial growth of the pathogen to the extent of 67.11 per cent over control. Crude antibiotics extracted from *B. amyloliquefaciens* isolate EBs2 and *P. fluorescens* isolate EP18 using ethyl acetate showed maximum inhibition area of 480 mm and 422.00 mm respectively of the isolate CAM10. Following sterility check method and screened for antagonism, the isolates were effective in degrading *P. fluorescens* isolate EP18 using ethyl acetate showed maximum inhibition area of 480 mm and 422.00 mm respectively of the isolate CAM10.

Characterization of Antimicrobial Compounds Present in the Potential Bacterial Endophytic Biocontrol Agents
G Rajesha, S Nakkirran, P Adhipathi, H Manjunath, T Indumathi and A Chandrasekaran
Department of Plant Pathology, Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.

Fourteen endophytic bacterial isolates of cotton were isolated by following sterility check method and screened for antagonism *in vitro* against the *Alternaria* isolate CAM10. Among the isolates, *B. amyloliquefaciens* isolate EBs2 reduced the mycelial growth of *A. macrospora* to an extent of 69.67% per cent over control. The *P. fluorescens* isolate EP18 inhibited the mycelial growth of the pathogen to the extent of 67.11 per cent over control. Crude antibiotics extracted from *B. amyloliquefaciens* isolate EBs2 and *P. fluorescens* isolate EP18 using ethyl acetate showed maximum inhibition area of 480 mm and 422.00 mm respectively of the isolate CAM10. The molecular detection of antibiotic biosynthetic genes depicted the presence of surfactin, iturin, bacillomycin and fengycin among *Bacillus* isolates. The *Pseudomonas* isolates showed positive reaction for the presence of 2, 4-DAPG, pyoluteorin and pyrrolnitrin genes. The GC/MS analysis of crude antibiotics of *B. amyloliquefaciens* isolate EBs2 and *P. fluorescens* isolate EP18 revealed the presence of different antimicrobial compounds from which were pertaining to aliphatic hydrocarbons, fatty acid, lipopeptide, diterpene and plasticizer nature of compounds with antifungal and antibacterial activity.

Some Fungal Endophytes Associated with Meyna spinosa Roxb.
Gayatree Borah, Liza Handique and Vipin Parkash
Department of Botany, Guwahati University, & SFM Division, Rain Forest Research Institute, E-mail: gayatreeb11@gmail.com
Endophytes are a family of microorganisms that grow intra or intercellularly in the tissues of the healthy higher plant and colonizing them without causing any apparent symptoms and noticeable injury to the host. Both fungi and bacteria are the most common microbes existing as endophytes. In recent years, much research has been focused on the bioactivities of endophytic fungi. These microorganisms represent a potential source of novel natural products for medicinal, agricultural and industrial uses, such as antibiotics, anticancer and biological control agents, and other bioactive compounds. A study was conducted to explore the endophytic fungi of *Meyna spinosa* Roxb. belongs to Rubiaceae family, locally known as “Kukura” is a medium sized tree with potential medicinal properties. A total of seven genera of fungal endophytes were isolated from the roots, stems and leaves of the target species and maximum fungal species were found associated with stems as compared to that of leaves and root. All isolates were identified based on colony morphology and examination of spores/conidia or fruiting bodies using stereo and light microscopes. The number of fungal species isolated from the stems, leaves and roots were 5, 3 and 3 respectively. The fungal endophytes isolated from the stems were *Paecilomyces* sp., *Cunninghamella* sp., *Nigrospora* sp., *Absidia* sp., *Rhizopus* sp. and *Fusarium* sp. while *Cladosporium* sp., *Penicillium* sp., *Nigrospora* sp. were isolated from leaves. *Aspergillus* sp. and *Rhizopus* sp. along with *Fusarium* sp. were isolated from the roots of the said plant. A large number of sterile mycelia were also observed in all the three parts of the target species. This study is a significant step towards the enumeration of endophytic fungal diversity from *Meyna spinosa* and assessing their bioactive potential and the study is still in progress.

**Parasitic and Saprophytic Macrofungi in the Hollongapar Gibbon Wildlife Sanctuary, Jorhat, Assam**

**Girish Gogoi and Vipin Parkash**

Rain Forest Research Institute, Jorhat-785001, Assam, India, E-mail: gogoigirish@rediffmail.com

Macrofungi play a significant role in the daily life of human beings besides their utilization in industry, agriculture, medicine, food industry, textiles, bioremediation, nutrient cycling, as biofertilizers and many other ways. They are mostly saprophytic; some are parasitic and sometimes both parasitic and saprophytic. Parasitic fungi are harmful to the important plant species of a forest ecosystem. Saprophytic macrofungi deteriorate important plant species fell in the forest as well as in the timber depots but in other way these fungi are very much important which helps in the nutrient cycling in the forest ecosystem. An attempt is made through this study for the first time to provide an updated list of parasitic and saprophytic macrofungi in Hollongapar Gibbon Wildlife Sanctuary (HGWLS), Jorhat, Assam. There are five numbers of compartments in the HGWLS and frequent survey was done during April 2012 to September 2014 to collect parasitic and saprophytic macrofungi from their habitat. The macrofungi were photographed, collected and allotted accession numbers and preserved for further microscopic study in the laboratory. The taxonomic details of the parasitic and saprophytic macrofungi along with their substrata have also been documented. A total of 101 species belonging to 90 saprophytic; 5 parasitic and 6 both parasitic and saprophytic species have been collected from HGWLS, Jorhat. Saprophytic and parasitic macrofungi were collected from the felled tree trunk, stumps, broken branches, twigs and leaf litter and branches and leaves of living plants.

**Seasonal Variation of Soil Microfungal Community and Enzyme Activities in Soil of Mawphlang Sacred Grove, Meghalaya, India**

**Haobam Romola Devi and MS Dkhar**

Microbial Ecology Lab, Department of Botany, North-Eastern Hill University, Shillong-795 022, Meghalaya, India, E-mail: romola.b@gmail.com

Soil microfungal community and enzyme activities were analyzed in soils of Mawphlang sacred grove located in East Khasi Hills district, Meghalaya, North East India. Soil samples were collected aseptically at monthly intervals from 0-10 cm soil depth for a period of two years. Fungal Colony Forming Units (CFUs) were analysed from the soil samples by dilution plate method using rose bengal agar medium. Seasonal variation was observed in the fungal CFU, soil dehydrogenase and phosphatase activity during the study periods. CFU of fungi, dehydrogenase and phosphatase activity were highest during the rainy months (i.e. June to October) and lowest during the winter months (i.e. November to February). Altogether 78 fungal taxa were isolated and identified of which 5 belonged to Oomycota, 14 to Zygomycota, 57 to Ascomycota, and 2 mycelia sterile. Correlation coefficient (r) was calculated so as to determine the relationship between the fungal count, enzymes activities and the physico-chemical characteristics of soil. During the first year CFU of fungi showed positive significant correlation with soil dehydrogenase activity (0.64, p < 0.05), soil temperature (0.68, p < 0.05) and exchangeable potassium (0.58, p < 0.05). While, in the second year fungal CFU was positively correlated with soil dehydrogenase activity (0.76, p < 0.05 and p < 0.01), soil temperature (0.80, p < 0.05 and p < 0.01), moisture content (0.88, p < 0.05, p < 0.01 and p < 0.001), organic carbon (0.59, p < 0.05), total nitrogen (0.50, p < 0.05) and exchangeable potassium (0.56, p < 0.05).

**Isolation, Production and Optimization of Citric Acid by *Aspergillus* spp**

**Ipsita Bhattacharjee and PK Baruah**

Department of Botany, Cotton College, Guwahati-781001, India.

Citric acid is the most important organic acid, used as a natural preservative, conservative and is also used to add an acidic or sour taste to foods and soft drinks. In this study, fungal species were isolated from soil samples, using serial dilution agar plating method and the isolates were identified based on their microscopic and morphological characteristics. A total of 10 strains of *Aspergillus* spp. were isolated. From the isolates, the dominant fungal species, *Aspergillus niger* and *A. fumigatus* were sub-cultured using Potato dextrose agar (PDA) medium and were used for citric acid production. The spores were mixed in the fermentative medium along with sugarcane molasses and the medium was incubated for 72 hours at 30±1 C. After incubation, the citric acid content was estimated by titrimetric method. Among the two species, higher citric acid production was shown by *Aspergillus niger* in sugarcane molasses medium. Then it was undertaken for optimisation under various pH, temperature, carbon and nitrogen sources. In this assay, the maximum production of citric acid was observed in *Aspergillus niger* at pH 6.0, temperature 30±1 C, carbon source (glucose) and nitrogen source (ammonium sulphate).
Polyconal Antibody Based Immuno-Detection of *Sphaerostilbe repens* in Soil and Tea Root Tissues

J Das, U Chakraborty and BN Chakraborty

Department of Botany, Alipurduar College, Alipurduar, West Bengal, E-mail: jyotsna.das11@gmail.com

*Sphaerostilbe repens* causing violet root rot of tea (*Camellia sinensis*) is evident in tea plantation of foot hills of Darjeeling especially in poorly aerated and water logging condition. Polyclonal antibodies (PAb) were raised in white rabbits separately against mycelia, cell wall and spore antigens of *S. repens*, IgG purified and immunological kits were developed for serological detection of pathogen from soil as well as from tea root tissues. Root antigens were prepared from both healthy and *S. repens* infected twenty five tea varieties (Tocklai and UPASI) and tested using PTA (Plate trapped antigen coated) ELISA formats. Cross reactivity of PAb of *S. repens* were further tested with other 16 fungal pathogens using PTA-ELISA for specific detection. Besides, PTA-ELISA format was also developed for detection of the pathogen in different soil samples collected from tea gardens. Indirect immune-fluorescence using PAb of *S. repens* and FITC-conjugates of goat specific for rabbit globulin were assayed for pathogen detection in soil and tea root tissues. Dot immunobinding assay and Western blot analysis using PAb of *S. repens* were also standardized. Specific immune-cytochemical stain for detection of hyphae of *S. repens* within tea root tissues was developed. All such immunological techniques are very much useful for early detection of pathogen causing violet root rot disease of tea in order to develop strategies for proper management in plants, as these days tea growers are extending tea cultivation practices in plain areas where water logging is very frequent.

Systemic Induction of Phenolics and PR-Proteins by *Trichoderma harzianum* in *Persea bombycina* Kost.

Jintu Rabha, HK Sarma, Amrita Acharya, BN Chakraborty, U Chakraborty and DK Jha

Microbial Ecology Laboratory, Department of Botany, Gauhati University, Assam, E-mail: jinturabha0910@gmail.com; dkjhabot07@gmail.com

Biochemical changes leading to accumulation of phenolics and pathogenesis related (PR) proteins such as peroxidases, phenylalanine ammonia lyase (PAL) and β-1,3-glucanases in plants have been typically associated with induced systemic resistance to pathogens and thus ability of potent bioinoculants like root-colonizing microbes to induce expression of such antimicrobial proteins in plants is being considered as a marker for their potential as biocontrol of plant pathogens. It is now widely accepted that the biocontrol properties of *Trichoderma* spp. are also based on their ability to induce both local and systemic resistance responses. In an earlier experiment, *Trichoderma harzianum* isolate PBR1, colonizing rhizosphere of *Persea bombycina*, was found to promote growth and foliage productivity in the same plant. In the present study, the ability of the fungi was tested for induction of phenolics and PR proteins in 8 morphotypes of *Persea bombycina* under absence of pathogen. Plants were grown in earthen pots containing unsterilized soil. Biochemical changes like total phenol content was assayed in all the PBR1 treated plants seven days after application of the wheat bran formulation of PBR1. Results showed a considerable increase in phenol content in all the morphotypes of som studied as compared to uninoculated control plants with highest increase observed in S-1 morphotype plants whereas lowest increase was found in S-8 plants. Similar trend was also observed in case of peroxidase activity in leaves after treatment with PBR1. Level of β-1,3-glucanase activity in response to PBR1 treatment also varied among different morphotypes. Highest induction of β-1,3-glucanase enzyme as compared to control was observed in S2 plants followed by S5 plants. S4 and S6 plants, however did not showed considerable increase in level of β-1,3-glucanase. Level of PAL enzymes though increased in all treated som morphotypes, the intensity of increase was not that considerable as compared control or to other enzymes.

Endophytes Confer Benefits to Rice Plants Against Aluminium Toxicity in Acidic Soil

Joyashri Das, S Sultana, R Krishnappa, MC Kalita and Dwipendra Thakuria

School of Natural Resource and Management, College of Post Graduate Studies, Central Agricultural University, Barapani, Meghalaya

Crop productivity is mainly hindered by the wide spread phosphorus (P) deficiency and aluminium (Al) toxicity in acidic soils of the world. Almost all terrestrial plants are colonized by endophytes. To what extent the endophytic colonizers can provide advantage to the host plant against P-deficient and Al-toxicity conditions in acidic soil is not fully understood. This study aimed to investigate the effect of endophyte inoculation in rice plant (variety-CAUR3) grown in an acidic soil (pH 5.0) along a toxic Al gradient (control, 100 ppm, 200 ppm and 300 ppm) on plant physiology (chlorophyll-a, -b and carotenoid content, root architecture, cell viability, rhizosphere acidification, diaminobenzidine (DAB) assay and lipid peroxidation activity). Endophyte inoculation improved plants growth in terms of leaf area, dry plant biomass and root:shoot. Chlorophyll-a, -b and carotenoid content in rice leaf significantly increased in plants inoculated with endophyte as compared to uninoculated in presence of toxic Al levels. The 2, 3, 5-triphenyl-tetrazolium-chloride (TTC) assay reflected that the extent of cell viability was more in plants with endophyte inoculation as compared to uninoculated plant. In presence of toxic Al levels, endophyte inoculation improved rice root architecture (values significantly increased in terms of root volume, specific surface area, root diameter and length) compared to that in uninoculated rice plants. Results from rhizosphere acidification indicated that endophyte inoculation enhanced organic acid secretion in the rhizosphere. The DAB assay revealed that endophyte inoculation confers advantage to rice plants against Al-induced stress in acidic soil. Rice plants with endophyte inoculation exhibit low levels of lipid peroxidase activity in leaf compared to that in uninoculated rice plants. In conclusion, this study clearly demonstrated that the healthy root-endophyte interaction in rice plant can provide the fitness benefit to rice crop in terms of the plant adaptability against Al induced stress in acidic soil.

Functional Attributes of Root-Associated Bacteria of Early Successional Plant “*Thysanolaena maxima*” in Slash and Burn Field

Juri Deka, A Khyllep, H Sapalrrliniana, GU Ahmed and Dwipendra Thakuria

School of Natural Resource and Management, College of Post Graduate Studies, Central Agricultural University, Umiam, Meghalaya, E-mail: thakuria.dwipendra@yahoo.co.in

The frequent destruction and disturbance of the above ground plant communities due to slash and burn operations in *jhum* fields lead...
to breakdown of the linkages between above- and below-ground biota communities. In the burnt fields, plant succession occurs with the onset of the pre-monsoon shower and the early successional plant species usually help in rejuvenating the plant-microbe interactions. To what extent the roots of early successional plants establish the association with the members of the soil microbial community is not understood well. This study characterized the endophytic and rhizospheric bacterial colonizers in one of the most common and abundant early generating plant viz. broom grass (*Thysanolaena maxima*). The rhizospheric soil samples along with roots of broom grass collected from burnt fields belong to 5 and 15 yrs jhum cycles (Mualungthu, Mizoram and Changki, Nagaland). Root associated bacteria were isolated using 3 different culture media viz. R2A, TSA and PDA. The tightly adhered soils on root surface were separated and used as rhizospheric soil. The washed and surface sterilized (70% ethanol for 1 min - 2% hypochlorite for 5 min - 70% ethanol for 30 sec and 4 rinses with sterile distilled water) root bits (approximate 1 cm length) were used to isolate endophytic bacteria. Out of 81 bacterial isolates, 67.4% isolates were able to grow up to pH 3.0 and 11.6% can tolerate temperature up to 60°C. The 60.5%, 16%, 48.1% and 87.6% isolates exhibited the capacity to dissolve P in Ca(PO4), AlPO4, FePO4 and phytate amended media, respectively. The 60.5%, 58%, 28.4% and 14.8% out of total 81 isolates were positive for N-fixation, IAA, cellulase and pectinase production. In conclusion, the roots of early generating plants housed an array of potential bacterial colonizers having promising functional attributes, which may be explored for bioinoculant technology in restoring degraded jhum agroecosystem.

Biotransformation of Rice Straw Biomass into Organic Manure Using Cellulolytic Microorganisms and Earthworm Species *Eudrilus eugeniae*

KL Barman and DK Jha

Microbial Ecology Laboratory, Department of Botany, Gauhati University, Guwahati-14, E-mail: kamal.lochan312@gmail.com

The present investigation was carried out to study the efficiency of cellulolytic microorganisms and earthworms for biotransformation of rice straw biomass into organic manure with combine inoculation of cellulolytic microbes and earthworm species *E. eugeniae*. The vermicomposting efficacy of *E. eugeniae* was also conducted in two different seasons to study the influence of seasons on productivity and quality of manure. The maximum decomposition was recorded in the treatment where both cellulolytic microorganisms and earthworms were inoculated together. The biotransformation of rice straw biomass into organic manure resulted in significant increase in nutrient contents over the initial values. The combination inoculation of rice straw biomass with cellulolytic microorganisms and earthworms resulted in significant enhancement in various nutrient contents along with significant reduction in time required for composting as well as C: N ratio in the manure over the biomass inoculated with cellulolytic microorganisms or earthworms alone. The FT-IR spectra confirmed the increase in nitrogen rich compounds in the organic manure generated in the treatment where both cellulolytic microorganisms and earthworms were applied together as compared to where they were applied alone. The biotransformation process was also influenced by seasonal variation and summer was more productive than winter. Thus it can be concluded that cellulolytic microbial species can be efficiently used along with *E. eugeniae* for biotransformation of crop residues into eco-friendly nutrient rich manure within short period of time.

Occurrence and Diversity of Arbuscular Mycorrhizal Fungi in Trap Cultures from Soils of Coal Mining Areas, East Jaintia Hills District, Meghalaya

K Makdoh and H Kayang

Department of Botany, Lady Keane College, Shillong-793001, E-mail: ksanbok@gmail.com

The aim of this work was to evaluate the occurrence and diversity of arbuscular mycorrhizal fungi (AMF) in soil samples from coal mining areas (mining site, four abandoned coal mine spoils of different age series namely 2 years, 5 years, 10 years and 15 years abandoned sites and an un-mined site) of East Jaintia Hills District, Meghalaya. Traps established using *Oryza sativa* L. (upland varieties) and *Zea mays* L. were grown for 120 days in greenhouse conditions, when spore density and species identification were evaluated. In *Z. mays* AMF colonization ranged from 60.15% (2 years abandoned site derived inoculum) to 93.09% (un-mined site derived inoculum). In *O. sativa* AMF colonization ranged from 77.90% (5 years abandoned site derived inoculum) to 82.07% (15 years abandoned site derived inoculum). Highest spore density and Shannon-Wiener species diversity index were observed in an un-mined site derived inoculum in both the trap plants where *Acaulospora delicata*, *A. melvea*, *Claroideoglomus lentum*, *Funnelliformis geosporus*, *Glomus multicaule* and *Rhizophagus clarus* were the most abundant and frequent species. Our study demonstrated that AMF have a widespread occurrence in coal mining areas of East Jaintia Hills District, Meghalaya and they sporulate more abundantly in trap cultures from un-mined site derived inoculum than the overburden spoils.

Identification of Nucellar and Zygotic Seedlings in Khasi Mandarin Using Low Cost Molecular Markers

Karishma Kashyap, Deboleena Kashyap and Sofia Banu

Department of Bioengineering and Technology, Gauhati University, Guwahati – 781014, Assam, E-mail: sofiabani2@gmail.com

Citrus is one of the major fruit crops in the world that occupies the third largest of the fruits (area and production) grown in India. Northeast India is considered a centre of origin and diversity for citrus and of all the citrus varieties grown in Northeast India, Khasi mandarin (C. reticulata) is an important economy of the hills of Eastern Himalayan region, where most of the urban people earn their partial livelihood through cultivation of this indigenous species. The purpose of the study lies on the fact that one of the major issues concerning Khasi mandarin seedling production is its polyembryony which demands the distinction between nucellar and zygotic seedlings at an early stage of plant development. Hence, there arises a need for development of a low cost methodology for differentiating nucellar and zygotic seedlings to overcome the hindrances in citrus breeding programmes. In this study, Inter simple sequence repeat (ISSR) markers were used to detect polymorphism at DNA level among the different samples including the in vitro regenerated plantlets. ISSR markers were used to estimate the differences between nucellar and zygotic embryos among 12 different samples of Khasi mandarin including mothers and off springs, where mother samples were collected from orange orchards in Boko and off springs were being regenerated from seeds by in vitro propagation. 50 ISSR primers were screened from where 41 primers gave amplification out of which 19 primers generated distinct and differentiating DNA

Markers in Khasi Mandarin Using Low Cost Molecular

Identification of Nucellar and Zygotic Seedlings in Khasi Mandarin Using Low Cost Molecular Markers

Karishma Kashyap, Deboleena Kashyap and Sofia Banu

Department of Bioengineering and Technology, Gauhati University, Guwahati – 781014, Assam, E-mail: sofiabani2@gmail.com

Citrus is one of the major fruit crops in the world that occupies the third largest of the fruits (area and production) grown in India. Northeast India is considered a centre of origin and diversity for citrus and of all the citrus varieties grown in Northeast India, Khasi mandarin (C. reticulata) is an important economy of the hills of Eastern Himalayan region, where most of the urban people earn their partial livelihood through cultivation of this indigenous species. The purpose of the study lies on the fact that one of the major issues concerning Khasi mandarin seedling production is its polyembryony which demands the distinction between nucellar and zygotic seedlings at an early stage of plant development. Hence, there arises a need for development of a low cost methodology for differentiating nucellar and zygotic seedlings to overcome the hindrances in citrus breeding programmes. In this study, Inter simple sequence repeat (ISSR) markers were used to detect polymorphism at DNA level among the different samples including the in vitro regenerated plantlets. ISSR markers were used to estimate the differences between nucellar and zygotic embryos among 12 different samples of Khasi mandarin including mothers and off springs, where mother samples were collected from orange orchards in Boko and off springs were being regenerated from seeds by in vitro propagation. 50 ISSR primers were screened from where 41 primers gave amplification out of which 19 primers generated distinct and differentiating DNA

Markers in Khasi Mandarin Using Low Cost Molecular Markers
Diurnal Variation of Aero Mycoflora at Guwahati, Assam
Kathakali Bhattacharjee, GC Sarma and S Kalita
Department of Botany, Handique Girls' College, Guwahati-1, E-mail: kathakalib2@gmail.com

Aero mycoflora contribute a significant proportion among the biological particles present in the atmosphere. A systematic survey was carried out at Guwahati for two years to find out the diurnal variation of fungal flora and its correlation with meteorological parameters. Volumetric sampling method with Andersen sampler and Czapek's Dox Agar medium were used to recover fungal spores from air. Sampling was done for two consecutive years thrice a month and five times in a day at an interval of two hour in the terrace of Environmental Science Department, Gauhati University. The sampling times were 9.00 am, 11.00 am, 1.00 pm, 3.00 pm and 5.00 pm. The meteorological parameters taken in this study were dry temperature, wet temperature, relative humidity and wind speed. All these meteorological readings were taken along with the fungal data all the time of sampling. A total of thirteen fungal species under eleven genera had been recorded during the study period. Among the isolated fungal species Aspergillus sp. was dominant and found to be present all round the year. It was followed by Cladosporium sp. and Alternaria sp. All these dominant species are established fungal allergens. The result showed different diurnal patterns of diurnal periodicities for different months of the year depending upon the meteorological parameters. It was observed that the fungal spores were maximum during the forenoon (11 am) followed by evening (5 pm) and the least around noon at 3 pm. Maximum hourly spore count was observed in the month of August. The different patterns of diurnal periodicities were also observed for different spore types. Some spores are present throughout the day while some are recorded in a particular time of the day and absent otherwise.

Evaluation of Seed Health Status of Traditionally Stored Mungbean [Vigna radiata (L.) Wilczek] Seeds
Kuldeep Talukdar, PK Borah, LC Borah, Lohit Kataky and BC Nath
Department of Plant Pathology, Assam Agricultural University, Jorhat, E-mail: klipsforyar@gmail.com

Storage of seeds constitutes major importance as it relates the association of pathogens with seeds which determine the seed quality. An experiment was conducted to study the seed borne pathogens of mungbean seeds during storage and their management. Four different structures were utilized (viz. earthen pots, gunny bag with dried neem leaves and metallic bean (improved structure) with wood ash (46%) and gunny bag with dried neem leaves (48%). However, in metallic bean (improved structure) with chemicals showed least population of pathogens (33%) even upto 270 days of storage. The percent germination of pathogen seeds in all the treatments decreased with increase in storage duration. Highest percent of germination was recorded at 0 day and gradually decreased after 90, 180 and 270 days of storage.

ITS2 RNA Secondary Structure Analysis Revealed Close Affinity Between Endophytic and Pathogen Fungi: A Case Studied in Fusarium species
Srichandan Parhi, Mrumnnaya Kumar Panda and Kumananda Tayung
Microbial Technology Division, Department of Botany, North Orissa University, Baripada-757003 (Odisha), E-mail: kumanandbotnou@rediffmail.com

Endophytic fungi are microbes that colonized inner plant tissues with causing any disease symptoms. They are believed to have complex lifestyles ranging from borderline pathogenic, to commensalism and to a symbiotic relationship. Several fungal taxa reported as endophytes closely resemble plant pathogenic fungi. Besides, similar named species occur as endophyte as well as pathogen. Moreover, morphologically it is very difficult to distinguish the nature of their lifestyles. Therefore methods are needed to differentiate their endophytic and pathogenic nature and relationships that they share need to be elucidated. In this study an attempt has been made to investigate relationships between endophytic and pathogenic strains within similar named species based on phylogenetic approach and ITS2 RNA secondary structure analysis taking Fusarium as model organism. Own Fusarium isolates isolated as endophytes and pathogens were considered. In addition, sequences of Fusarium with endophytic and pathogenic lifestyles were also retrieved from GenBank and only those sequences having 18S partial, ITS1, 5.8S, ITS2, 28S partial rRNA genes (ITS rDNA) were selected for phylogenetic analysis and ITS2 RNA secondary structure study. The result indicated that ITS rDNA based phylogeny revealed Fusarium species did not cluster together as per their lifestyles. The tree also showed several pathogenic and endophytic forms clustered together within the clade. This indicates that there is close genetic proximity between the endophytic and pathogenic strains. Since structures are more conserved than sequences, we also generated RNA secondary structures of both endophytic and pathogenic forms to make a distinction of conserved and variable region within the ITS2. The generated structures showed some structural similarities between the endophytic and pathogenic forms.

Synergistic Effect of Microbial Bioagents on Growth and Development of Elaeagnus latifolia L. Seedlings
Liza Handique and Vinip Parkash
Mycology and Soil Microbiology Laboratory, Rain Forest Research Institute, Jorhat-785001, Assam, India, E-mail: liza.handique@yahoo.co.in

The role of rhizospheric symbiotic arbuscular mycorrhizal (AM) fungus, non-AM fungus and a bacterium in growth and development of E. latifolia L. seedlings was analysed. The seedlings were inoculated with putative AM fungal strain (Glomus species, Gm1), non-AM fungus (Trichoderma harzianum, Th-13)
and phosphate solubilizing bacterium (*Pseudomonas* species, *Ps*-1) alone and in combind form (both, dual and triple/tripartite consortium) and analysed for their effect on growth parameters i.e. increase in length, diameter, circumference, Sturdiness quotient (S), Biovolume index (B) and Plastochnor index (P) of the target plant species. Qualitative analysis have revealed that the consortium treatment containing *Pseudomonas* sp., *T. harzianum* and *Glomus* sp. resulted in more increase in the length (3.9±1.01), diameter (2± 1.02), circumference and biovolume (92±2.14) including reduced phyto-mortality and initiating rapid phyllogenesis in inoculated seedlings as compared to control seedlings. Similar trend with diminutive variation in all studied parameters as cited above was also observed in other alone and combined treatments than control seedlings which are discussed in detail in this paper. Thus, AM alone and consortium inoculation's proved to boost the resilience and adaptability of this plant species.

**Integrated Management of White Mold of French Bean Through Bioagents and Fungicides**

M Bora and BC Das  
Department of Plant pathology Assam Agricultural University, Jorhat-785013, Assam, E-mail: munnim4u@gmail.com

In the present investigation, attempts were made to evaluate the relative compatibility of *Trichoderma harzianum* with a few other commonly used soil antagonists viz. *Trichoderma harzianum*, *T. koningii*, *T. viride*, *Aspergillus terraeus*, *A. flavus* and Gliocladium virens. The most compatible antagonist was found to be *G. virens* with *T. harzianum* followed by *T. koningii*, *T. viride* and *A. flavus*. In another experiment, the efficacy of different fungicides on radial growth of *S. sclerotiorum* and compatible bioagents were evaluated in vitro. Out of the four selected fungicides viz. captan, mancozeb, copper oxychloride and carbendazim tested, carbendazim was found to be the most effective fungicide in percent inhibition of the mycelial growth of *S. sclerotiorum*, the incitant of white mold of French bean followed by captan at both 10 and 25 ppm concentrations. While copper oxychloride and mancozeb was found least inhibitory to the pathogen. Similarly, the compatibility test of the aforesaid fungicides with the bioagents- *T. harzianum* and *G. virens* were assessed in vitro, it was revealed that carbendazim was highly inhibitory to each of the compatible bioagents at both 10 and 25 ppm concentration followed by mancozeb and copper oxychloride. Captan was found to be least in inhibitory effect against the bioagents at both the concentrations. Therefore, for Integrated Disease Management (IDM), captan was selected as the most effective fungicide to the pathogen (*S. sclerotiorum*) and compatible fungicide with the bioagents. Further, the compatibility of captan with the compatible bioagents was tested in soil by Zentmyer's soil drench technique at four different concentrations viz. 0.1%, 0.2%, 0.3% and 0.4% was done in order to find out the correlation between laboratory and field performance. Captan @ 0.2 % was found to be the best concentration for integration with the bioagents. Under pot condition, integration of captan @ 0.2% with the bioagents - *T. harzianum* and *G. virens* showed significant reduction in percent disease incidence and greater efficacy in increasing plant height, dry weight of root, shoot and crop yield as compared to the control.

**Study on Biodegradation of Alkyd Resin Synthesized from *Ceiba pentandra* (L.) Gaertn. (Kapok) Seed Oil**

Montu Moni Bora and Dilip Kumar Kakati  
Department of Chemistry, Gauhati University, Assam - 781014, India, E-mail: montu.bora@gmail.com

Vegetable oil based biodegradable polymer has drawn tremendous attraction in recent years because of non-petroleum origin, renewability and eco-friendly nature. A good number of seed oils have been used in the synthesis of various polymeric resins like polyester, epoxy, polyurethane and polyester amide which are used in paint, coating, adhesives etc. *Ceiba pentandra* (L.) Gaertn., locally known as kekabu or kapok belonging to the Malvaceae family, is a drought resistant tree cultivated in Southeast Asia, Malaysia, India and Sri Lanka. Kapok seed is found to contain 25% of oil. The present study describes the biodegradation of alkyd resin synthesized from kapok seed oil. The oil from kapok seed is subjected to glycerolysis reaction by reacting with glycerol at 235±5 °C in presence of PbO catalyst. The monoglyceride thus formed was reacted with phthalic anhydride to synthesize the alkyd resins. The product was characterized by FTIR and 1H NMR. The physico-chemical properties like acid value, iodine value, drying test were studied. The resins have also been tested for thermal stability, chemical resistance and pencil hardness. Biodegradability of the synthesized alkyd resins was tested by broth culture technique using *Pseudomonas aeruginosa* and *Bacillus subtilis* strains. The bio-based synthesized resins with the desired properties in terms of physico-mechanical, thermal, and biodegradability has the potential to be used as a thin film material for advanced multifaceted applications.

**Antifungal, Anti-aflatoxin and Antioxidant Activity of Some Plant Essential Oils and their in vivo Efficacy in Protection of Chickpea Seeds During Storage**

Abhishek Kumar Dwivedy, Manoj Kumar, Richa Raghubanshi and NK Dube  
Laboratory of Herbal Pesticides, Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi 221005, (U.P.) India, E-mail: nk.dubeeybh@gmail.com

The study presents efficacy of six essential oils (EOs) viz. *Curum carvi*, *Myristica fragrans*, *Cinnamomum camphora*, *Pelargonium odorantissimum* and *Cymbopogon citratus* as food preservatives based on antifungal, antiaflatoxin and antioxidant activity. The minimum inhibitory concentration of EOs against aflatoxigenic strain of *Aspergillus flavus* (LHP-10) and thirteen other foods borne storage molds ranged between 1.25 to 6.0 μL/mL. The oils inhibited aflatoxin secretion at 1.0 to 5.0 μL/mL. EOs also exhibited radical scavenging activity through DPPH assay as IC<sub>50</sub> value ranged between 3.96 to 96.63 μL/mL. The antifungal action of EOs was observed in terms of reduction in ergosterol content of plasma membrane of *A. flavus*. The EOs exhibited >50% protection of chickpea samples against fungal association without affecting their germination during in vivo testing in storage containers. In view of antifungal, antiaflatoxinogenic, antioxidant potential and in vivo practical efficacy, the test EOs are recommended as plant based food preservatives.

**Evaluation of Growth Status of Rice Varieties Following Seed Bacterization with Plant Growth Promoting Rhizobacteria**

P Bhattacharjee, P Sashankar, AP Chakraborty, U Chakraborty and BN Chakraborty  
Immunop Mycology Laboratory, Department of Botany, University of North Bengal, Siliguri-734013, West Bengal

Rice (*Oryza sativa* L.) is one of the world’s most important staple crops and a major part in the diet of more than half the world’s population. In the present study ten potential rhizobacteria showing in vitro PGPR activities were tested in three indigenous rice
Growth Promotion and Disease Suppression Effect of Isolated Plant Growth Promoting Rhizobacteria (PGPR) against Brown Root Rot Disease of Tea (Camellia sinensis (L.) O. Kuntze) P Morang, BK Dutta, DK Jha, SN Kumar and Dileep Kumar BS

Department of Ecology & Environmental Science, Assam University, Silchar, Assam India 788014

Growth promotion and disease suppression in tea through isolated rhizobacterial strains viz. PM 43, PM 105 & PM 112 against brown root rot by Fomes lamoensis under nursery/field condition was done. Three year old tea plants (clone TV 1) treated with pathogen and bacterial strains showed better survival as compared to pathogen alone infested plants. In bacterial treated tea plants highest number of new leaves, number of lateral branches, shoot height, root length, fresh weight of shoot and root and dry weight of shoot and root were observed. The enzyme level studies, activity of defensive enzymes such as L-phenylalanine ammonia lyase (PAL), peroxidase, chitinase, β-1, 3-glucanase were estimated. It seems probable that accumulation of higher amount of phenolics and induction of defense responses by the PGPR could be one of the mechanisms of action by which disease reduction occurs.

Archaeal Ammonia Oxidizing Community: Impact of Slash-Burn Practice, Functional Microbial Guilds and Plant Species

Prathana Hazarika, C Zothansiami, H Saplalrinliana, DK Jha and Dwipendra Thakuria

School of Natural Resource Management, College of Post Graduate Studies, Central Agricultural University, Umiam – 793103, Meghalaya, E-mail: thakuria.dwipendra@yahoo.co.in

In recent years, ammonia oxidizing archaea (AOA) community has been increasingly recognised for its contribution in N-mineralization processes in soil. In jhum agro-ecosystem, crops solely depend on mineralisation of native N pool for N nutrition and overall plant health. To-date, the impact of slash and burn operation and associated changes in functional microbial guilds on AOA community is not fully understood. Hence, this study aimed at investigating the impact of slash and burn operation (burn and unburn soils from 5 yrs jhum cycle) on AOA community composition. Further, within each soil type the introduced functional microbial guilds (the base line communities of N-fixers, Phosphate Solubilizing Bacteria (PSB), Cellulose Degrading Bacteria (CDB), and the combination of N2-fixers+PSB+CDB in presence or absence of a baseline fungal community) on AOA community also studied in microcosm experiments. The AOA community in soil was targeted by amplification of AOA gene from genomic soil DNA using the primer pair (ArchamoA-1F and ArchamoA-2R). The amplified products were discriminated into denaturing gradient gel electrophoresis (DGGE fingerprint) of AOA community. The non-metric scaling ordination and analysis of similarity (ANOSIM) of AOA DGGE profiles indicated that the composition of AOA community was significantly altered by the burning practice followed by the changes in functional microbial guilds. However, the presence or absence of plant species (rice) on AOA community within each soil type seems to be the weakest influencing factor as compared to burning practice and composition of functional microbial guilds. In conclusion, AOA community composition responded to the changes in functional microbial guilds, but such changes did not obscure the boundary of the variation in AOA community induced by the burning. Future study should investigate the relationship of N-mineralisation rate and AOA gene abundance in soil in response to the burning practice, functional microbial guilds and plant species influence.

Molecular Characterization of Potato Virus Y Infecting Potato and Tomato in Sub-Himalayan West Bengal and Brahmaputra Valley of Assam

Prosenjit Chakraborty, Arnab Saha, Shibu Das, Dipanwita Saha and Aniruddha Saha

Department of Botany, University of North Bengal, India, PIN-734013, E-mail: asahanbu@yahoo.co.in

Sub-Himalayan region of West Bengal and Brahmaputra valley of Assam are rich reservoir of genetic variability and diversity. Different horticultural crops which produce important fruits, vegetables and spices are found to be cultivated in this region. Different horticultural crops which produce important fruits, vegetables and spices are found to be cultivated in this region. Different horticultural crops which produce important fruits, vegetables and spices are found to be cultivated in this region. Different horticultural crops which produce important fruits, vegetables and spices are found to be cultivated in this region. Different horticultural crops which produce important fruits, vegetables and spices are found to be cultivated in this region. Different horticultural crops which produce important fruits, vegetables and spices are found to be cultivated in this region. When the nucleotide sequences of the isolates were compared with those of other potyviruses available in the GenBank, it showed 99% (potato sample) and 93% (tomato sample) nucleotide sequence similarity with infecting potato.
**Molecular Marker Based Analysis of Infected and Non Infected Aquilaria malaccensis from Assam**

Purabi Sarkar, Ananya Bhowmick, Darshana Baruah, Rasika Bhagwat, Narendra Y Kadoo and Sofia Banu  
Department of Bioengineering and Technology, Gauhati University, Guwahati, 781014, Assam, India, E-mail: sofiamanu2@gmail.com

Aquilaria malaccensis (family Thymelaeaceae) is a highly valued endangered medicinal plant of Northeast India. The plant is mainly important for the production of agarwood which is dark resinous heartwood that forms in Aquilaria when certain fungi infect the stem and the trunk. This resin helps the tree to protect from further infections, hence it is a kind of defense mechanism. From the resin, a very costly essential oil called agar oil is extracted. In the present study, we used 100 inter-simple sequence repeat (ISSR) markers to analyze the genetic diversity pattern and differentiation among seven populations comprising 53 individuals of the species, dispersed across the Brahmaputra valley of Assam. The study was also conducted to differentiate infected plants from the non-infected ones. Of the 50 ISSR primers initially evaluated, 16 primers generated distinct and reproducible DNA amplicons. Using these 16 primers, 160 discernible DNA amplicons were generated of which 155 (93.37%) were polymorphic. Nei's genetic diversity ($h$) and Shannon's index ($I$) among the populations were estimated as 0.2529 (0.1698) and 0.3925 (0.2277), respectively. Total genotype diversity among the populations ($H_t$) was 0.2480 (0.0285), while within population diversity ($H_i$) was 0.1384 (0.0118). The mean coefficient of gene differentiation ($G_{st}$) was as high as 0.4422 and the gene flow ($Nm$) were 0.6306, indicating genetic differentiation among the populations. Analysis of molecular variance (AMOVA) indicated that 38% variance was attributable to among-population variation and 62% to differences within populations. The UPGMA dendrogram clustered the populations irrespective of geographic distances. The pattern of genetic diversity observed in A. malaccensis indicated existence of diverse array of genotypes, implicating the need for preservation of every population. The study could not identify markers distinguishing infected samples from non-infected samples, no unique genotypes specific to infected samples could be identified.

**Arbuscular Mycorrhizal Fungi Associated with Two Upland Rice in Jhum and Crop Rotation in Relation to Soil Physico-Chemical Parameters**

Pynbeitsyon Nongkling and H Kayang  
Microbial Ecology Lab., Centre for Advanced Studies in Botany, Department of Botany, North-Eastern Hill University, Shillong-793022, Email: pnonkling26@gmail.com

AM fungi colonization and spore density of two upland rice varieties namely kha saw (KS) and kha sohpieng (KP) growing under jhum cultivation and crop rotation were observed. In both the agricultural sites same varieties of upland rice were planted (JKP and JKS under jhum cultivation; CKP and CKS under crop rotation). The soil physico-chemical parameters were estimated to study the relation with AMF colonization and spore density. Soil samples were analyzed for available phosphorus, total nitrogen, exchangeable potassium, pH, organic carbon, soil temperature, soil moisture content and were correlated with AMF colonization and spore density. Under jhum cultivation, the AMF colonization of both the rice varieties JKP and JKS were negatively correlated to soil temperature, available phosphorus and exchangeable potassium and positively correlated to moisture content. Soil pH also has a negative correlation with AMF colonization in JKS. Spore density was negatively correlated with soil temperature, pH, available phosphorus and exchangeable Potassium in both JKP and JKS. A positive correlation between spore density and moisture content was observed in JKP. While, under crop rotation, the AMF colonization of both the rice varieties CKP and CKS showed negative correlation with soil temperature and available Phosphorus. Spore density showed negative correlation with pH, Organic carbon and available Phosphorus in both CKP and CKS. Correlation analysis demonstrated that AMF colonization and spore density of upland rice is affected by some soil parameters.

**Analysis of Terpenoid Genes from Aquilaria species Using Bioinformatics Tools**

Rafiqul Islam and Sofia Banu  
Department of Bioengineering and Technology Gauhati University, Guwahati-781014, Assam, E-mail: sofiamanu2@gmail.com

Agarwood is highly valuable resinous and fragrant heartwood derived from Aquilaria and Gyrinops plants. Resin production is considered as one of the plant defense mechanisms which retard the fungal growth and activate the healing process of plants. Aquilaria is widely used in traditional medicines, as a digestive, sedative, and anti-emetic and also as an incense and perfume, and this huge demand for the agarwood products has led all Aquilaria spp. being endangered and listed in the Appendix II of the CITES. The major components of agarwood are sesquiterpenes and phenyl ethyl chromones. Owing to a lack of genomic information, the molecular basis of wound-induced sesquiterpenes biosynthesis and agarwood formation remains unknown. The biosynthesis of sesquiterpenes occurs via the MVA and DXP pathways, and 4 key enzymes are commonly involved in this process which are: (1) 3-hydroxy-3-methylglutaryl-coenzyme A reductase (HMGR), (2) DXP synthase (DXPS), (3) farnesyl diphosphate synthase (FPS); and (4) sesquiterpenes synthases. In this in silico study we are trying to find out DEG which is related to resin (Agarwood) formation in Aquilaria and they were annotated in details at bioinformatics levels. We have downloaded all the full length c-DNA sequences of the genes involved in the terpenoids pathway in Aquilaria from the NCBI genbank and DDBJ nucleotide sequence database. The downloaded sequences were blast against NCBI nucleotide sequence database and find out similar sequences in other plant species whose function has been determined already. This study provides extensive transcriptome information for Aquilaria spp. and valuable clues for elucidating the mechanism of wound-induced agarwood sesquiterpenes biosynthesis and their regulation.

**In vitro Evaluation of Fungicides Against Ganoderma lucidum Causing Basal Stem Rot of Areca nut**

Ranjana Chakrabarty, TC Sarma and GC Acharya  
Department of Plant Pathology, Assam Agricultural University, Ghy-781 017, Assam, E-mail: ranjana_74@yahoo.co.in

Basal stem rot/Ganoderma wilt, caused by Ganoderma lucidum (Curtis Ex.Fr.) Karst is one of the major constraints in arecanut cultivation in Assam. Pure culture of Ganoderma was done from the fruiting bodies of diseased arecanut palm. Seven fungicides were assayed for their efficacy against the test pathogen at 0.1, 0.2 and 0.3 per cent concentration. Among the systemic fungicides, Hexaconazole 5EC and Tridemorph 80EC completely inhibited the growth of G. lucidum at all the concentrations. Among the contact
fungicides, Mancozeb 75 WP (86.11) gave maximum control against the pathogen, followed by Copper Oxychloride 50 WP and Captan 50 WP with 86.00 and 85.89 per cent inhibition over control at 0.3% concentration respectively. Compatibility study of fungicides with Trichoderma viride T16 revealed that systemic fungicides, Carbendazim 50 WP, Hexaconazole 5 EC and Tridemorph 80 EC are highly sensitive to T. viride with 100 per cent inhibition at all the tested concentration. Non-systemic fungicides, Mancozeb 75 WP was found to be compatible, whereas Copper Oxychloride 50 WP and Captan 50 WP showed lower to moderate degree of compatibility with T. viride T16.

Biodiversity of Endomycorrhizal Fungi Associated with Some Medicinal Plant Species of Jorhat, Assam

Rashmita Sonowal, Liza Handique and Vinip Parkash

Department of Botany, Jagannath Barooah College, Jorhat 785001, Assam. E-mail: rashmitasonowal000@gmail.com

Rhizospheric region of the soil is one of the key site for intimate plant microbial interaction among which mycorrhiza is known to be the most important member of functional soil microbial community in natural ecosystem and creates an intimate link between plant roots and soil. In this study, an attempt was made to compare the mycorrhizal biodiversity of different medicinal plants. Three plant species belonging to three different families were screened out for endomycorrhizal spore diversity and root colonization. 100 % hyphal infection was observed in Vitek negundo L. and Terminalia chebula Retz. while only 40 % infection was found in Justicia adhatoda L. Vesicular infection was found to be 90% in T.chebula and 70% in both F. negundo and J. adhatoda. The arbuscular infection was 100% in J. adhatoda, it was 30% in T. chebula and 60% in V. negundo. The spore count was highest (154) in case of T. chebula followed by J. adhatoda (67); while minimum (25) was observed in V. negundo. Qualitative analysis revealed that among the isolated spores, Glonous was the predominant genera (60%) followed by Acaulospora and Scutelllospora respectively. The study confirmed that the mycorrhizal biodiversity of VAM fungi differ in different plants specially in medicinal plants. VAM fungi are well known to be used as biofertilizers, bioregulators and bioprotectors. Thus it can be speculated that these associations will help to sustain the general plant vigour of these target plant species under a variety of adverse and inhospitable ecological conditions.

Phenol and Peroxidase have Positive Role in Systemic Resistance Against Fusarium oxysporum in Brinjal

Reena B Kalita and DK Jha

Department of Botany, Gauhati University, Guwahati

Phenol content and peroxidase activity were evaluated for their possible role in systemic resistance against F. oxysporum fsp. melongenae. Leaves of brinjal plants preinoculated with Pseudomonas fluorescens, Glonous mossaeae (Bioagents) and treated with vermicompost challenged with F. oxysporum fsp. melongenae (Fom) were examined for their phenol content and peroxidase activities. Phenolic content were examined by the methodology given by Zieslin and Ben-Zaken, 1993 and peroxidase activity was determined by the procedure given by Hammerschmidt et al (1982). Result of the study revealed that both phenol content and peroxidase activities were increased in bioagents and vermicompost treated plants. Phenol content showed an increasing trend from 0 hour to 96hrs while in control plants it declined after 72 hrs. Similarly, peroxidase activities increased maximum in 72hrs in all the treated brinjal plants but declined after 48hrs in the control plant. Brinjal plants inoculated with the bioagents and vermicompost challenged with Fom resulted in lesser disease index as compared to control plants.

Growth Strategies and Environmental Importance of Some Corticolous Lichen from North-East India

Rupam Debnath and Jayashree Rout

Department of Ecology and Environmental Science, Assam University, Silchar 788011, Assam, India. E-mail: rupam.debnath@yahoo.in;

Lichens are the unique group of plants comprising microbial symbions between fungi (mycobiont) and an alga (phycobiont or cyanobiont). An exploration was done from Arunachal Pradesh and Barak Valley of Southern Assam and their growth strategies were studied. Most of the area of Arunachal Pradesh is dominated by macro lichen (foliose to fruticose form) where in Barak Valley few foliose lichens are found frequently. Both the area exhibit an enormous growth occurrence of corticolous (bark inhabiting). Few lichen species are attempted as new addition to the lichen flora of Arunachal Pradesh during the study. Lichen symbions were identified where of the total algal symbions studied, the genus Trebouxia was found to be the most frequent symbiotic phycobiont contributing 70% followed by Trentepohlia with 20% and Nostoc with 10%. The study also reveals the effect of different degree of hydration on the physiology of the algal partner for the survival of the lichen and its contribution in sustaining lichen biomass colonized in tree bark. They are among the most significant indicators of environment and also are sensitive towards habitat variation. Pollution free area was found most suitable for the lichen growth as lichens are also known as pollution indicator. Altitudinal variation, vegetation pattern and environmental factors like temperature, humidity were found responsible for the variation in lichen biomass formation. Lichen produces very important secondary metabolites. Some of macrolichens are have very good antioxidant, antimicrobial properties.

Estimation of Fungal Population from the Gut Contents of Two Earthworm Species i.e. Eisenia fetida (Exotic) and Perionyx excavatus (Indigenous) in Decomposing Leaf Litters under Laboratory Condition

Ruth Laldinthar and MS Dkhar

Department of Botany, North Eastern Hill University, Shillong- 793 022, Meghalaya, India. E-mail: ruthlaldinthar@yahoo.in;

Fungal CFU of gut contents of Eisenia fetida and Perionyx excavatus decomposing leaf litter of Polyalthia longifolia and Rhododendron arboreum were studied under the laboratory condition for 6 months. Results showed that fungal CFU was higher in E. fetida as compared to P. excavatus. The fungal CFU followed the trend foregut > midgut > hindgut in both the earthworm species. In the sets treated with E. fetida containing decomposing leaf litter of P. longifolia, 21, 20 and 15 fungal species were isolated from the foregut, midgut and hindgut.
respectively, whereas, in case of R. arboreum, 17, 15 and 14 fungal species were isolated from foregut, midgut and hindgut respectively. In the sets treated with P. excavatus containing decomposing leaf litter of P. longifolia, 20, 13 and 8 fungal species were isolated from the foregut, midgut and hindgut respectively, whereas, in case of R. arboreum, 18, 14 and 13 fungal species were isolated from foregut, midgut and hindgut respectively. Majority of the fungal species isolated belonged to Deuteromycota (9 genera, 26 species) followed by Zygomycota and Ascomycota (5 genera, 3 species each) and the least was in Mastigomyctoma (1 genus, 2 species). The common fungal species isolated from all the gut-contents of the two earthworm species were Aspergillus flavus, Fusarium oxysporum, Penicillium canecens, Phoma pomorum, Trichoderma koningii and T. vireid.

**Prospects in Plant Growth Promotion and Kinetic Evaluation of Biosurfactant Production by Pseudomonas nitroreducens Toko85 Isolated From Coal Mine Spoil of Tikak Colliery, Assam**

SA Tapadar, A Hussain and DK Jha

Microbial Ecology Laboratory, Department of Botany, Gauhati University, Guwahati-14, India, E-mail: sufl_nature@yahoo.com; dkjhabot07@gmail.com

Open cast coal mining practices is one of the major factors leading to massive damage to landscapes and biological communities. These practices in Makum coal field along Patkai hills range caused severe negative influence which is within one of the biodiversity hot spots of India. However, many potential microbes can able to survive in the harsh conditions. Some of the attributes of these micro industries/systems can be explored for the betterment of both flora and fauna. In the present investigation, plant growth promoting traits and kinetics of biosurfactant production of indigenous producing Pseudomonas nitroreducens TOKO85 were studied. Pseudomonas nitroreducens TOKO85 was isolated from coal mine dumping soils of Tikak colliery (East) of Tinsukia district of Assam using coconut oil enrichment method. Primary biosurfactant testing was performed using drop collapse and paraffin M test. The kinetics of biosurfactant production was then evaluated up to 32 days using E<sub>h</sub> assay. The bacteria showed positive results for both drop collapse and paraffin M test. Highest emulsification index of culture supernatant was observed on 11<sup>th</sup> day (80.18±0.31) and sharp reduction was observed on 12<sup>th</sup> day (55.48±0.91). Interestingly, it was observed that cell culture of the indigenous producing TOKO85 were able to survive in the harsh conditions. Some of the attributes of these industries/systems can be explored for the betterment of both flora and fauna.

**Rhizospheric Soil Organic Carbon Content on Ectomycorrhizal Inoculated Dipterocarpus retusus Blume Seedlings.**

S Arena and Talijungla

Department of Botany, Nagaland University, Lumami–798 627, Nagaland, India. E-mail: cindyjamir86@gmail.com

Mycorrhizal fungi play an essential role in forest ecosystem. An experiment was conducted in field condition, two native ectomycorrhiza viz. Scleroderma citrinum and Russula rosea were inoculated near the roots of 5<sup>th</sup> month old Dipterocarpus retusus seedlings. After inoculation seedlings growth and ectomycorrhizal colonization to the root of the seedlings were observed. Rhizospheric soil organic carbon was also analysed. Seedlings inoculated with Russula rosea has shown higher ectomycorrhizal colonization and also with higher concentration of rhizospheric soil organic carbon. Ectomycorrhizal fungi obtain carbon from the host plant to maintain their biomass and the hyphal network of the ectomycorrhiza is an important avenue for the transport of carbon from roots to the soil. This suggests that increase in ectomycorrhizal colonization demand more carbon from the host plant and helps in the sequestration of soil organic carbon. Ectomycorrhizal fungi act as a strong sink of carbon in the ecosystem. Scleroderma citrinum inoculated seedlings also shown higher content of rhizospheric soil organic carbon as compared to the rhizospheric soil of control seedlings. There was positive correlation between the ectomycorrhizal colonization to the seedlings root and rhizospheric soil organic carbon content.

**Bio-efficacy of Herbal Extracts in Controlling Red Rust Disease of Tea [Camellia sinensis (L)]**

O. kuntze] Caused by Cephaleuros spp.

SR Sarmah, B Payeng, R Begum, P Dutta and BK Barthakur

Mycoology & Microbiology Department Tocklai Experimental Station, Tocklai Tea Research Institute, Cinnamara, Jorhat-8.

'Red rust', the only algal disease in tea caused by two the species of an alga i.e. Cephaleuros parasiticus & C. mycoidea, is becoming the most devastating one during the recent years in North Indian tea cultivation. These steam and leaf pathogens of tea respectively, emerge in epidemic form in different tea areas of Brahmaputra Valley. It has been difficult to eradicate the pathogens from the affected sections even after taking appropriate preventive measures using plant protection chemicals. The use of hazardous toxic chemicals leads to the pesticide residue and MRL issues and it is of serious concern in the present day context. To reduce the load of chemical inputs, much attention has been paid in the use of non-toxic 'biological control' measures against plant pathogens, as an integrated approach. Effort has been made continuously to control various tea diseases by using ecofriendly native herbal extracts and antagonistic microbes. In this investigation water and solvent extracts of certain native herbs i.e. Cassia alata, Amphiheine opulentum, Polygonum sinensis, P. hemilontii, Polanasis icosandra, Ipomoea convolvulus, Argemone mexicana and locally isolated antagonistic/hyperparasitic microbial strains i.e. Microbial 1 (PSM-10), Microbial 2 (BST) and Microbial 3 (AZR) were isolated antagonistic microbes. In this investigation water and solvent extracts of certain native herbs i.e. Cassia alata, Amphiheine opulentum, Polygonum sinensis, P. hemilontii, Polanasis icosandra, Ipomoea convolvulus, Argemone mexicana and locally isolated antagonistic/hyperparasitic microbial strains i.e. Microbial 1 (PSM-10), Microbial 2 (BST) and Microbial 3 (AZR) were evaluated in laboratory and in field experimentations for controlling red rust disease of tea. Solvent extract of C. alata, A. opulentum and A. mexicana produced lowest biomass of C. parasiticus and subsequently 99.1, 96.2 & 97 % reduction of parasiticus biomass growth of the pathogen respectively. Aqueous extracts of the tested herbs alone or in combination, reduced the disease intensity up to a desirable level from 48.9 to 76.19 %. Tested herbs alone or in combination, reduced the disease intensity up to a desirable level from 48.9 to 76.19 %.
Surface Sterilization Methods can Bias the Endophytic Diversity Interpretations
Sabira Sultana, Joyashri Das, PJ Handique and Dwipendra Thakuria
School of Natural Resource and Management, College of Post Graduate Studies, Central Agricultural University, Barapani, Meghalaya. E-mail: thakuria.dwipendra@yahoo.co.in

Surface sterilization method is the key to the success of endophytic research in plants. Numerous studies reported endophytic diversity in plants, where several methods of surface sterilization have been reported during last several decades. To date it is not clear, whether surface sterilization methods can bias the results of endophytic communities and their interpretations. This study aimed to demonstrate how surface sterilization methods [Method-1: Sodium hypochlorite (2% Cl, 5 min) - 95% Ethanol (30s) - 70% Ethanol (30s) - 3 rinses in sterile water, Method-2: 70% Ethanol (1 min) - Sodium hypochlorite (2% Cl, 5 min) – 70% Ethanol (30s) – 4 rinses in sterile water and Method-3: 70% Ethanol (1 min) - Sodium hypochlorite (2% Cl, 5 min with Tween20 solution – 4 rinses with sterile water containing Tween20 solution] impact the results of culturable and non-culturable endophytic community (as revealed by DGGE fingerprinting) in rice seeds and roots. Among three common test methods, method-2 was the most effective in eliminating surface contaminations in seeds and roots (tested in final rinsed water using three culture media viz. NA, TSA and PDA). The scanning electron microphotographs also indicated the existence of variations in results among 3 test surface sterilization methods. Results of non-metric multidimensional scaling ordination and analysis of similarity (ANOSIM) performed on DGGE profiles revealed that the variability associated with surface sterilization methods do exist in terms of community compositions; and this supports the conclusion that surface sterilization methods can bias the endophyte diversity interpretations.

Bioaugmentation of Lycopersicum esculentum Mill. Using Native Arbuscular Mycorrhizal Fungi in Sterile Soil
Soram Inaobi Singh, BK Dutta and DK Jha
Microbial and Agricultural Ecology and Biodiversity Conservation Laboratory, Department of Ecology & Environmental Science, Assam University, Silchar-788011, Assam. E-mail: soraminaobi@gmail.com

The present study revealed differences in the growth and development response of the plants to the application with different levels of inoculum concentration of the native arbuscular mycorrhizal fungi compared to uninoculated control. Treatment with one fourth of the normal (N times the most probable effective propagule number) mycorrhizal inoculum concentration showed the best result in terms of leaf fresh weight and highest total chlorophyll content. Then, the half of the normal (half of the most probable effective propagule number) mycorrhizal inoculum concentration showed the best result in terms of leaf number, root length, shoot fresh weight and leaf dry biomass and the normal (N, most probable effective propagule number) mycorrhizal inoculum concentration showed best results in shoot length, root fresh and dry biomass. The two times normal (two times of the most probable effective propagule number) mycorrhizal inoculum concentration showed the worst results in nitrogen uptake capacity. Consequently, the four times the normal inoculum gave effective growth response in terms of shoot dry weight, total dry biomass and resulted highest mycorrhizal inoculation effect compare to other mycorrhizal treatment plant and control treatment. Generally, phosphorous uptake capacity was higher in all the mycorrhizal treatment plants compared to control treatment and little variation was observed among the mycorrhizal treatment plants which may be due to different infection rates. Thus, the present study showed an increasing trend of growth and development with the increase in mycorrhizal inoculation with best results in terms of leaf number, shoot length, biomass, and plant nutrient uptake capacity and mycorrhizal inoculation effect.

Communities Structure of Arbuscular Mycorrhizal Fungi with Climatic Variation Across Distinct Land Uses
Soram Inaobi Singh, BK Dutta and DK Jha
Department of Ecology & Environmental Science, Assam University, Silchar-788011, Assam. E-mail: soraminaobi@gmail.com

A descriptive ecological study of the communities of Arbuscular mycorrhizal fungal (AMF) with climatic variation was conducted for the species richness, abundance and regeneration pattern in sporulation across distinct land uses in the tropical wet evergreen mixed forest in the Barak river valley of southern Assam, northeastern India. The AMF were identified morphologically according to microscopic features and other taxonomical informative characteristics of the spores. The mean spore population density was highly variable among the distinct land uses during the different seasons. Forty two species of AMF were recovered from the distinct land use systems with different percentage frequency occurrences of each individual species. The total spore numbers were highly variable among the distinct land uses. Fungal communities were dominated by Glomus species and followed by Acaulospora species, while only one species was recorded for Enterobasidium genus. In general, the overall frequency index among the genera was significantly higher in the genera of Glomus. Rich species abundance and diversity was observed in Undisturbed Reserve Forest land use among the distinct land uses. But no such variation was observed between the Regenerating and Disturbed Reserve Forest land uses. The reason may be due to the low density of host plants as well as ecological disturbances and unfavourable edaphic conditions for regeneration of AM fungal population occurred in the said forest land uses. Change in land use does not appear to reduce AM fungal diversity; instead, it influences AMF community structure and maintains a high diversity of arbuscular mycorrhizal fungi.

Microbial Exploitation of Organic Matter for Improving Paddy Soil Quality
Sunita Gaind and YV Singh
Indian Agricultural Research Institute, New Delhi. E mail: sugaind75@rediffmail.com

Overuse of chemical fertilizers, intensive crop cultivation and poor management of resources has damaged the soil environment leading to yield stagnation. However, the crop productivity needs to be increased further to provide food security to the ever growing Indian population. The situation demands for adoption of efficient approaches that can prevent the nutrient depletion from soil. Microorganisms are the invaluable gift of nature that can be exploited to decompose undesired organic residues and application of composted product to soil can improve its quality and hence productivity. A field study was conducted to compare the effect of organic fertilization (OF), integrated nutrient management (INM) practices and conventional fertilization (CF) on soil organic matter, soil organic carbon, microbial biomass carbon and crop yield under rice cultivation during 2010-2013. Organic fertilization included the application of vermicompost (VC) and farm yard manure (FYM) each added at 6t/ha along with Azolla and cyanobacterial
inoculants, whereas INM included the application of 1/2 the recommended dose of chemical fertilizer + VC and conventional fertilization had recommended dose of NPK (N>P>K). The OF practiced paddy soil recorded an organic matter content of 4.5 %, higher than INM and CF practiced soil. After three years of rice cultivation, total organic carbon, oxidizable carbon and microbial biomass carbon were also highest (27.26 mg/g, 13.6 mg/g and 0.717 mg/g respectively) in soil devoid of receiving any synthetic fertilizer. Amendment of soil with VC and FYM not only added organic matter but also improved the diverse microbial population responsible for nutrient cycling. The organic farming practice holds good promise under availability of mature compost in sufficient amount. Economical statistics showed that integrated farming practices are more beneficial and can save 50 % of synthetic fertilizer without compromising with the yield.

**Effects of Fertilization and Microbial Additions on Rice Crop Productivity**

Sunita Gaind and YV Singh

Indian Agricultural Research Institute, New Delhi, E-mail: sugaind175@rediffmail.com

The conventional approaches to increase crop productivity through high inputs of chemical nitrogen and phosphate fertilizers and pesticides is no longer sustainable due to their escalating cost and adverse effects on soil health. The utilization of crop residues in the form of composted products and application of crop specific microbial inoculants is an attractive, cost effective and environment friendly alternate to costly chemical inputs and can be explored to improve crop productivity under soil-plant-microbe interaction. Adoption of such practices may build up the biological activity which is an integral component of soil management strategy. A field experiment was conducted in split plot design where Basmati rice (Pusa 1121) was grown in Kharif season for three years extending 2009 to 2012. The three practiced fertilization regimes included organic fertilization (vermicompost (VC) and FYM @ 6 t/ha each +Azolla and cyanobacterial inoculants), integrated nutrient management (VC@6 t/ha + 1/2 the recommended dose of chemical fertilizer) and conventional fertilization (N>P>K). The increase in macro and micro-porosity of soil due to build up of organic matter enhanced the available water content and field capacity of soil receiving organic fertilization (OF). Moreover, higher population of microorganisms indicated by the microbial biomass carbon (743 μg/g) and organic carbon content of 1.2 % was recorded in OF treatment. The rice yield under OF was highest (4.72 t/ha) compared to 4.36 t/ha under CF an improvement of 8.25 % after three years of crop cultivation. The economic calculations showed that organic farming is more beneficial when produce is sold at a premium price of 25 %.

**Identification of Cryptic Endophytic Fungi Using Microscopic Images**

Susmita Paul, SR Joshi, Ranjan K Bhagobaty and MC Nihalani

Microbiology Laboratory, Department of Biotechnology & Bioinformatics North-Eastern Hill University, Shillong 793 022, E-mail: susmitapaulbp@gmail.com

Fungal endophytes are known to be nano-factories of a wide array of bio-technologically relevant metabolites. Identifying fungal endophytes that propagate within the healthy tissues of a plant is often troublesome since majority of them do not sporulate under laboratory conditions and exhibit cryptic morphology. The present study aimed to develop a database of images of cryptic endophytic fungi isolated from ethnically used plants of the North-East region with a view to identify them using computer aided image analysis. Colonies of endophytes grown on a two different standard growth media using the Triple point inoculation technique were photographed. The colony morphology along with lactophenol cotton blue micrographs of fungi obtained using a Leica DM 1000 microscope were compared to generate a possible identity of the isolates. Majority of the isolates were found to be ascomycete and one of them was characterised as *Diaporthe* sp.

**Locational Variability in Rhizospheric Endomycorrhizae Associated with Abrroma augusta L. and their Synergistic Role in Accumulation of Some Phytochemicals**

Vipin Parkash, SC Biswas and AJ Saikia

Mycology & Soil Microbiology Research and Technology Laboratory, Rain Forest Research Institute, Jorhat-785001, Assam, India, E-mail: bhardwajvpnpark@rediffmail.com

*Abrroma augusta* L., whose overexploitation has predicted it as a plant of worthy conservation, is mainly used for the treatment of various gynaecological disorders in the traditional system of medicine and is also gaining importance in the other phyto-therapeutic disciplines. The present study was an attempt to study the locational variability endomycorrhizae associated with *A. augusta* and to see the synergistic effect of bio-inoculation on status and accumulation of some phytochemicals associated with this endangered plant species. Through this study, it was observed that a total of 22 species of AM fungi belonging to 3 genera (*i.e.* Glomus, Gigaspora and Acaulospora) were isolated from the rhizospher of soil of *A. augusta*. Natural occurrence of AM fungal isolates was observed maximum (10) in Amsoi study site, roadside and paddy field habitats (16, each) along with low elevation range (50-80 m asml) (37), while the studied parameters were lowest in Kokilamukh (1) location, fallow and riverine habitats (1, each) along with mid-elevation range (80-110 m asml) (5). The maximum species richness value (16.94) was observed in Amsoi whereas minimum or approximate no species richness (0.00) was observed in Kokilamukh. The highest diversity index value was in Amsoi (0.06) while Titabor and Kokilamukh locations had almost meager diversity index value (0.01). Species richness and diversity index with respect to AM fungal spore population associated with rhizosphere of *A. augusta* exhibit a direct proportionality (0.91).

The inoculated plants were analyzed for Seed fatty oil (%), total root (bark) alkaloids, total protein content (%), total saponins (%) and kernel proteins (%). It was observed that all the studied parameters as cited above were highest in case of the inoculated plant (37.0±0.57, 0.32±0.05, 0.30±0.001, 0.09±0.003, 30±0.20, respectively), with respect to both the wild and experimental control plants. Total protein content (%) and Seed fatty oil (%) were quantified more in the wild plant samples rather than the experimental control sets; while total root (bark) alkaloids, total saponins (%) and kernel proteins (%) were approximately the same. Again, quarterly quantitative analyses of *A. augusta* leaves indicated five-fold increase in total plant alkaloids.

**Fungi Associated with Seeds of Different Varieties of French Bean (Phaseolus vulgaris L.)**

Y Saio and MS Dkhar

Microbial Ecology Laboratory, Centre of Advanced Studies in Botany, Department of Botany, North Eastern Hill University, Shillong-793022, Meghalaya. E-mail: syarielyn@gmail.com

The present investigation was conducted to determine the seed mycoflora of 10 French bean (*Phaseolus vulgaris* L.) varieties, viz., Phygop, Maram, Naga Local, Manipur, FB 18, FB 19, FB 61, FB 62, Director 1 and Director 3. Seed samples were collected from two districts of Meghalaya i.e., East Khaisi Hills District (Mylliem) and Ri Bhoi District (ICAR, Umiam) and tested by Dilution Plate method (Johnson and Curl, 1972) for their mycoflora. Altogether, a total of 13 genera and 20 fungal species were isolated from the 10 varieties. The highest number of fungal
species was recorded in FB 18 and the lowest was recorded in the Naga Local variety. Species of *Pencillium*, *Aspergillus* and *Cladosporium* were found to be dominant, occurring in almost all the varieties of French bean seeds and the least dominant were species of *Nectria*, *Arthroderma*, *Minimeda*, *Acremonium*, *Axaarthron*, *Phytophthora* and *Porna eupynaer*. The highest colony form units (CFU) were found in the FB 61 variety and lowest in Naga local variety. The species diversity index was recorded to be highest in Phynorgo variety and lowest in the Manipur variety, whereas, the species dominance index was highest in Naga Local variety and lowest in Phynorgo variety. From the present study, it can be seen that the seed mycoflora of the French bean varieties was dominated by the storage fungi as compared to the field fungi. Moreover, the high species -diversity index in the Phynorgo indicated that the Phynorgo variety was favourable for the habitation of a wide range of seed mycoflora, whereas, high species dominance index in Naga Local variety. From the Naga Local variety only two fungal species were isolated *i.e.*, *Aspergillus flavus* and *Arthroderma* spp.

**Actinomycetes of Semi and Deep Water Rice Ecosystems of Assam Antagonistic to *Rhizoctonia solani* Causing Sheath Blight Disease**

NK Gogoi, LC Bora and KK Sharma

Department of Plant Pathology, Assam Agricultural University, Jorhat, E-mail: nkkgogoi2009@gmail.com

Sheath blight caused by *Rhizoctonia solani* Kuhn is a major disease of rice in Assam affecting ahu, sali, boro and bao paddy. There is an exigency for searching new anti-microbial substances as many microorganisms are becoming resistant to plant pathogens, fungicides/pesticides and clinically available antibiotics. Actinomycetes, which are noteworthy as antibiotic producers, are an important group of microbes having potential as biocontrol agent. In this study, attempt was made to isolate actinomycetes species antagonistic to *R. solani* from semi and deep water rice ecosystems of Lakhimpur and Dhemaji districts. Rhizosphere soil samples were collected from 13 different locations of Lakhimpur and Dhemaji districts and isolated 45 actinomycetes species in three specific media. Isolated actinomycetes strains were screened against *R. solani* in vitro by dual culture method. 24-78 percent inhibition of was observed by six different actinomycetes strains. Morphological, cultural and biochemical properties of isolated strains were studied. Micro-morphology was studied by cover slip culture on the growth of four pathogenic bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Enterobacter aerogenes* and *Proteus mirabilis*), one pathogenic fungi (*Sclerotinia sclerotiorum*), and one species of yeast (*Candida albicans*). The majority of the bacterial strains were found to inhibit the growth of the test pathogenic fungi, bacteria and yeast. Of the 48 isolates, 27 were *Bacillus* sp, 9 were *Staphylococcus aureus* and 12 were *Corynebacterium* species. Among these *Bacillus* species showed good activity against the test organisms.

**In vitro Antifungal Efficacy of the Fruit Extracts of *Azadirachta indica* A. Juss in Inhibiting the Growth of Some Pathogenic Fungi Causing Post Harvest Decay of *Averrhoa carambola* L. Fruits**

Appu Das and TC Sarma

Department of Botany, Guwahati University, Guwahati-781014, E-mail: appudas122@gmail.com ; tarunchandasarma@yahoo.com

The main objective of this research work deals with the study of antifungal activity of the fruit extracts of *Azadirachta indica* A. Juss by agar well diffusion method against four fungal pathogens- *Alternaria alternata*, *Aspergillus niger*, *Fusarium oxysporum* and *Penicillium* sp. which are pathogenic to *Averrhoa carambola* L. fruits and cause decay of the fruits under post harvest condition. Crude extracts of *Azadirachta indica* A. Juss fruits were prepared by using chloroform, methanol and water as solvent which were evaluated at three different concentrations (20 mg/ml, 10 mg/ml and 5mg/ml) against the fungal pathogens. The chloroform fruit extract was most active and showed maximum antifungal activity and can play a vital role to control the pathogenic fungi.

**Rust Disease on Bean and Pea - A Case Study of Golaghat District, Assam, India**

Apurba Saikia and A Kutum

Department of Botany, DR College, Golaghat, Assam, E-mail: animaksutum.drc@gmail.com

The beans and peas are major pulse crops among the farmers of Golaghat district. In the present studies we have noticed certain fungal diseases among the beans and peas which severely damage the productivity of the pulse crops and as a result decrease of economic value among the farmers of the districts. The pulse crops are particularly attacked by pathogens viz. *Uromyces appendiculatus* (Pers.) Fries. and *U. fabae* (Pers.) de Bary, which causes severe damages of the beans and peas by forming rust. In this study we are focusing on the pathogen, symptoms, disease cycle and control measures to aware the farmers for future generation.

**Proximate and Mineral Change Analysis in Onion (Allium cepa) Due to Infection by Fungi**

J Devi, TC Sarma and J Kotoky

Department of Botany, Guwahati University, Assam

Onions, a crop of great economic importance, plays an essential role in dietary resource. These plants have tremendous nutritional value and therefore, arouse interest for medicinal purpose. The aim of the present investigation was to determine proximate and mineral change in healthy and infected onion samples. The results of the study revealed that due to mold infection biochemical parameters like total carbohydrate, ascorbic acid, ash, dry matter, moisture and mineral content indicates reduction in nutrient values in infected samples than in the healthy ones.

**Quantitative Estimation of Total Carbohydrate Content in Healthy and Infected Rhizomes of Three Varieties of Ginger Available in Assam.**

Sadhana Medhi, TC Sarma and J Kotoky
Application of Leaf Extract of Polygonum barbatum (L.) Against Some Fungi Pathogenic to Pineapple Fruit [Ananas comosus (L.) Merr.].

Purabi Sarmah Baruah and TC Sarma
Department of Botany, Gauhati University, Gauwhati – 14, E-mail: psbaruah11@gmail.com, tarunchandrasarma@yahoo.com

Polygonum barbatum (L.) under the family Polygonaceae is a plant with great medicinal value and its antifungal property was tested against eight important fungi viz. Alternaria alternata, Aspergillus flavus, A. niger, Fusarium moniliforme, F. oxysporum, Macrophomina phaseolina, Penicillium funiculosum and Rhizopus stolonifer which were pathogenic to pineapple fruit [Ananas comosus (L.) Merr.] in post harvest condition. In the study, methanol, ethanol and water extract of Polygonum barbatum (L.) leaf was used for evaluation of in-vitro efficacy against the fungal pathogens causing post harvest diseases of pineapple fruit by agar cup diffusion method. The result revealed that the methanol extract was most effective against Fusarium moniliforme with the maximum zone of inhibition (22.5 ± 0.3 mm) followed by ethanol extract (21.5 ± 0.2 mm) and water extract (13.4 ± 0.4 mm).

Some Macrofungi Associated with Timber Yielding Plants of Nagaon District, Assam

Ratul Kumar Nath and TC Sarma
Department of Botany, Gauhati University, Gauwhati 781 014, E-mail: tarunchandrasarma@yahoo.com

Nagaon district of Assam is a subtropical heavy rain fall area of N.E. region with deciduous and evergreen forests. Timber yielding plants in these forests are facing fungal decay mostly by the macrofungi. Different forms of sporophores are seen on the living as well as on the fallen trees. A survey was carried out during 2012-2013 in Nagaon district, Assam encompassing the diversity of macrofungi associated with timber yielding plants. A total of 31 species belonging to 14 genera and 8 families were identified amongst 72 samples of macrofungi collected. It was observed that some of them had importance from the point of their medicinal value, besides their role in the degradation of wood.

Growth Promotional Activity of Piriformospora indica upon Co-Cultivation with the Medicinal Plant Tinospora cordifolia (Willd.) Hook.F.

Pori Deka and Debabrata Baishya
Department of Bioengineering, Gauhati University Institute of Science and Technology, Gauwhati-781014, Assam, India, E-mail: ddrbaishya@gmail.com

Piriformospora indica, a root endophyte fungus, is a model organism of the fungal order Sebacinales (Basidiomycota), as it is able to increase the biomass and grain yield of crop plants upon co-cultivation. To study the impact of growth promotional activity of P. indica culture filtrate on medicinal plant Tinospora cordifolia, healthy leaves were inoculated in vitro in MS media. 2, 4-D (3mg/L) for callus induction. Callus initiated were co-cultivated with P. indica. 0.5g of callus of inoculated with 3pl/l of P. indica culture filtrate showed an increase in biomass up to 2.0 g whereas the non inoculated plants showed only 0.9 g of callus within a period of 20 days (from the day of co-cultivation). Thus, co-cultivation of P. indica culture filtrate with medicinal plant was found to be promising for production of a large quantity of biomass.

Response of Black Gram (Vigna mungo (L.) Hepper) to Rhizobium Inoculation and Study of the Rhizosphere Effect.

Minati Sarma Baruah and Manju Rani Devi
Department of Botany, Morigaon College, Morigaon, Assam.

Biological nitrogen fixation plays an important role in sustainable crop production and maintaining the fertility of the low nitrogen containing soil in pulses. The nitrogen fixing bacteria, rhizobia, is a very important group of rhizosphere organisms. The production of pulses increases considerably if the rhizobia can establish symbiotic relationship with the plants. Rhizobium inoculation improves nitrogen fixation, crop yield and nutrient availability of soil. In the present investigation, inoculation of Rhizobium enhanced nodule number/ plant, nodule mass, plant dry weight, weight of the pod/plant, over the uninoculated control in black gram. The results also show greater abundance of microorganisms in the rhizosphere in the absence of rhizobial inoculants.

Role of Microbial Biofertilizer in Improving Plant Tolerance and Productivity of Tea in Assam

PN Bhattacharyya, M Madhab, I Phukan and BK Barthakur
Tocklai Tea Research Institute, Tea Research Association, Jorhat 785008, Assam, India, E-mail: prananbananda.01@rediffmail.com

Tea [Camellia sinensis (L.) O. Kuntze], belonging to the family Theaceae, is an economically important dicotyledonous perennial crop, extensively cultivated in Assam, North-East India. Significant quantity of crop loss takes place every year due to vigorous attack of a wide variety of tea pathogens responsible in causing several serious tea diseases. Management of tea pathogens using chemical fungicides is, however, prohibitive since the latter is known for its potentiality in creating soil quality deterioration, environmental pollution, MRL (maximum residue limit) problems, pest resurgence, and impedance for natural regulatory agents and lethal and sub-lethal effects on non-target organisms including humans. The present investigation has, therefore, been conducted with the soil microbial resources, exploitation and utilization of which are proved to be an essential component in the management of sustainable tea ecosystem. Bacterial isolates like Azotobacter sp., Azospirillum sp., Bacillus spp., and Pseudomonas spp., fungal isolates like Aspergillus sp., and Trichoderma sp., and AM fungi like Glomus fasciculatum were identified as potential biofertilizers for their use in tea plantations. These isolates successfully enhanced the available nutrient level in soil after their periodic application in field and thereby preparing the plant more resistant against pathogenic attack. Total microbial population numbers and various plant growth parameters like plant dry weight, no. of fresh leaves and branches and root length were increased significantly after the plants were treated with these microbial inoculants. The study, thus, strengthens the concept of exploitation of beneficial microbial inoculants in sustainable agriculture.