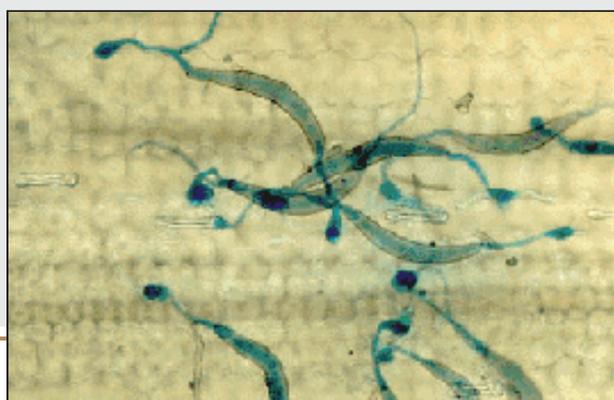


राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो

NATIONAL BUREAU OF AGRICULTURALLY IMPORTANT MICROORGANISMS

NBAM NEWSLETTER



From the Director's Desk

The average temperature in the Indian subcontinent has risen by 0.57°C in the last 100 years and models project that it is likely to rise further to a maximum of 2.5°C by 2050 and 5.8 °C by 2100. Irrigation requirement in arid and semi-arid regions is estimated to increase by 10% with every 1°C rise in temperature. In India, nearly 11 m ha area is affected by salinity and another 16 m ha by water logging. Besides high temperature, droughts, elevated CO₂, extreme rainfall events, frequent floods, cold waves, heat waves, and cyclones are the other important natural disasters that can cause severe crop yield losses. Additionally, these factors are likely to cause serious negative impacts on crop growth and yields and impose severe pressure on agricultural land and water resources.

A wide range of adaptations and mitigation strategies are required to cope up with the negative impacts posed by various stresses on crop productivity. Efficient resource management and crop improvement using classical and biotechnological tools can help to overcome these stresses to some extent. However, such strategies being long drawn and cost intensive, there is a need to develop simple and low cost biological methods for the

management of biotic and abiotic stresses, which can be used on short term basis. Although, effective fungicides are available to manage plant pathogens, but the increased environmental concern over their use has necessitated a large upsurge of biological disease management. The emergence of fungicide resistance among the pathogens, ground water and food pollution and development of oncogenic risks have further created alarming situation. In this context, microorganisms could play a significant role, if we can exploit their unique properties of tolerance to extremities, their ubiquity, genetic diversity, their interaction with crop plants and develop methods for their successful deployment in agriculture production.

Microbes having plant growth promoting attributes can be exploited as a successful strategy for protecting the plants against the deleterious effects imposed by soil-and seed-borne plant pathogens. Thus, the PGPR biotechnologies can be exploited as a low input, sustainable, and eco-friendly technology for stress management in plants. Besides influencing the physico-chemical properties of rhizospheric soil through production of exopolysaccharides and formation of biofilm, microorganisms can also influence response of the plants to abiotic stresses like drought, chilling injury, salinity, metal toxicity and high temperature, through different mechanisms like induction of osmo-protectants and heat shock proteins etc. in plant systems. Use of these microorganisms *per se* can alleviate stresses in crop plants, thus opening a new and emerging application in agriculture. These microbes also provide excellent models for understanding the stress tolerance, adaptation and response mechanisms that can be subsequently engineered into crop plants to cope with climate change induced stresses.

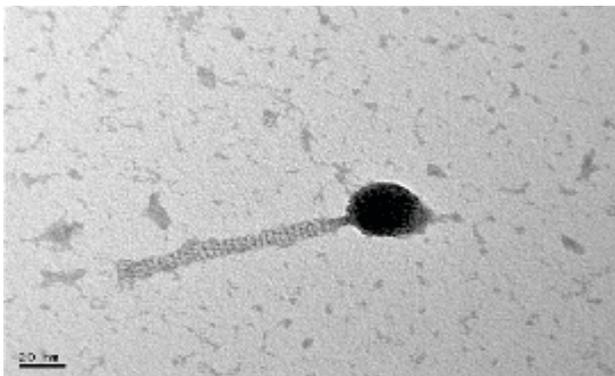
Research Highlights

Isolation and Characterization of bacteriophage infecting *Xanthomonas campestris* pv. *campestris* strains

Chemical control with antibiotics and copper compounds has been the standard since long for controlling bacterial plant diseases, but they possess environmental and health risks. Bacteriophages represent innovative biological control agents because they are highly specific viruses with extreme host specificity and are being currently an attractive option as therapeutic agents as they are safe for humans and highly specific and lethal to the bacteria they target. Commercial phage preparations have come up to prevent bacterial contamination of meat and poultry as well as to control bacteria in human infections.

Due to advancement in therapeutic usage of phages in above areas there has been a resurgence of interest recently in using bacteriophages as part of integrated plant disease management strategies in place of chemical measures. Researches, in which bacteriophage-mediated biocontrol of plant pathogens has been successfully attempted include use against *Xanthomonas pruni*-associated bacterial spot of peaches; bacterial leaf spot of mungbeans; bacterial blotch of mushrooms; to control *Xanthomonas* infections of peach trees, cabbage, and peppers; *Ralstonia solanacearum* infection of tobacco; soft rot and fire blight associated with *Erwinia* and to disinfect *Streptomyces scabies*-infected potato seed-tuber. A fruitful effort in form of a mixture of *Xanthomonas campestris* pv. *vesicatoria* phages against tomato bacterial spot (Agriphage from OmniLytics, Incorporated) is at present commercially available.

At present in our laboratory an attempt is being made to isolate lytic bacteriophages of *Xanthomonas campestris* pv. *campestris* (Xcc), the causal agent of black rot disease in large number of cruciferous plants, including agriculturally important crops such as cabbage, broccoli, and cauliflower. Isolation of bacterial isolates from seventeen black rot diseased samples collected from different cruciferous hosts and geographical regions of India were done. Presumptive Xcc isolates were tested for Xcc-determinative characteristics, *in planta* pathogenicity and



Electron micrograph (300 000x magnification) showing the physical structure of a single bacteriophage particle of Xc9SH3. Black bar .20 nm.

hypersensitive reaction in pepper plants and were further characterised using metabolic and molecular fingerprinting. A total of 7 putative phage solutions were prepared from the soil and plant samples from black rot infected fields. Samples were enriched with overnight cultures of host bacterial strain (cell density, 10^8 CFU ml⁻¹) and incubated for 48 h. The presence of phages was assayed by the soft agar overlay method, as described by Adams (1959). Single plaques were picked, and three to four successive reselection steps were performed for each plaque type isolated on the appropriate indicator lawn. The host range of each phage isolate was tested against 12 Xcc strains using a plaque assay. A virulent phage Xc9SH3 was found to lyse all tested strains of Xcc. The plaque type produced by this phage is lytic, clear and transparent. Transmission electron microscopic observations of phage Xc9SH3 is presented in figure. The phage exhibited long and noncontractile tail and isometric head belonging to Siphoviridae (dsDNA viruses) family of bacteriophages. Based on multiple electron photomicrographs, the average size range of the phage was 100 nm in length and 20 nm in width.

Dr Renu, Senior Scientist

Database on Simple Sequence Repeats (SSRs) developed

SSR database on different species of *Fusarium*, an important phytopathogen was developed and uploaded on the NAGBG website. The database contains information about SSRs identified in three fungal genomes and markers developed from these SSRs along with all the supporting information. It is available online via

http://nabg.iasri.res.in:8080/ssr/ssr_home.html



Fig. SSR Database of *Fusarium*

Dr. D. P. Singh, Senior Scientist

Avenues to exploit Arbuscular Mycorrhizal Fungi for improving nutrient uptake and ISR in crop plants

Mycorrhiza is a symbiotic (generally mutualistic, but occasionally weakly pathogenic) association between a fungus and the roots of vascular plants. In a mycorrhizal association,



fungus colonizes the roots of a host plant, either intracellularly as in arbuscular mycorrhizal fungi (AMF or AM), or extracellularly as in ectomycorrhizal fungi. They are important components of soil life and soil chemistry. Mycorrhizae form a mutualistic relationship with the roots of most plant species. Although, only a small proportion of all species has been examined so far but 95% of those plant families are predominantly mycorrhizal. They are named after their presence in the plant rhizosphere (root system).

Mycorrhizal plants are often more resistant to diseases, such as those caused by microbial soil-borne pathogens. AM fungi and their associated interactions with plants reduce the damage caused by plant pathogens. With the increasing cost of pesticides and the environmental and public health hazards associated with pesticides and pathogens resistant to chemical pesticides, AM fungi may provide a more suitable and environmentally acceptable alternative for sustainable agriculture and forestry. The interactions between different AM fungi and plant pathogens vary with the host plant and the cultural practices. Moreover, the protective effect of AM inoculation may be both systemic and localized. Also this mutualistic association provides the fungus with relatively constant and direct access to carbohydrates, such as glucose and sucrose. In return, the plant gains the benefits of the mycelium's higher absorptive capacity for water and mineral nutrients due to the comparatively large surface area of mycelium, thus improving the plant's mineral absorption capabilities. Plant roots alone may be incapable of taking up phosphate ions that are demineralised in soils with an alkaline pH. The mycelium of the mycorrhizal fungus can, however, access these phosphorus sources, and make them available to the plants they colonize. The mechanisms of increased absorption are both physical and chemical. Mycorrhizal mycelia are much smaller in diameter than the smallest root, and thus can explore a greater volume of soil, providing a larger surface area for absorption.

At present in our laboratory an attempt is being made to exploit

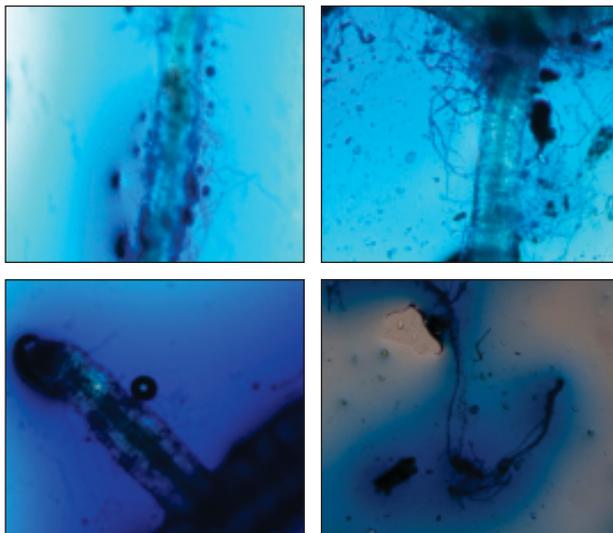


Fig. Root colonization by Arbuscular Mycorrhizal Fungus *Glomous mosseae*

and enhance native AMF activities leading to improved mineral requisition and induced systemic resistance to crop plants i.e. tomato and rice through manipulating on-farm produced (following farmer's friendly protocols) native AMF inoculum and readily available strains (*Glomus mosseae* and *Glomus fasciculatum*).

Udai B. Singh, Scientist

Exploration, preservation and evaluation of endophytic actinomycetes from Indo-Gangetic plain.

Endophytic actinomycetes were isolated from the root, stem and leaf of *Brassica campestris* and *Triticum aestivum* using actinomycetes isolation agar and starch casein agar media with sterility check. Though the use of nystatin, an antifungal compound in the culture media was essential to inhibit the fungal growth but was also found to inhibit the growth of few rare genera of actinomycetes. Morphological, physiological and biochemical characterization of the isolates were done. Protocols for the DNA isolation using enzymatic and nonenzymatic method were standardized.



Fig. Endophytic Actinomycetes from wheat and mustard

Anurag Chaurasia, Scientist

"Isolation and characterization of phosphate solubilizing bacteria (PSB) from termitorial soils of Sanjivani Island (Wadwal-Nagnath Bet), Southern-Maharashtra, India"

This work was carried out under supervision of Dr J M Khire, Head, National Collection of Industrial Microorganisms (NCIM) at NCL, Pune as professional attachment training for three months since Nov. 10, 2012 to Feb. 7, 2013. During this study, 200 bacterial isolates were obtained and through rigorous qualitative & quantitative screening, 6 bacterial isolates belonging to the genera *Pantoea*, *Enterobacter* and *Bacillus* were selected for further study. These isolates were identified by 16S rRNA gene sequencing and further characterized by biochemical tests, carbon source utilization & their ability to grow under different environmental conditions. *Bacillus* strain AH9 was able to grow at a temperature of 50°C. *Pantoea* strains (A3 & A34) were able to grow at salt concentration up to 10% while rests of the strains were able to grow at a range of 0 to 8%



NaCl concentration. *Bacillus* strain AH9 showed highest solubilization index (3.5) as well as maximum solubilization efficiency (250%) while strain AC41 showed maximum phosphate solubilization with 1079.37 mg phosphorus per lt. after 48 hours of inoculation and during this period the pH value of the medium was 3.17 which was lowest among all. Maximum phosphate solubilization was observed at 48 hrs. after inoculation in all the isolates. Production of organic acids like 2-keto gluconic acid & gluconic acid were detected and quantified through HPLC. *Pantoea* strains were found to produce only 2-keto gluconic acid while strains belonging to *Enterobacter* and *Bacillus* produced both gluconic & 2- keto gluconic acid during P solubilization. *Bacillus* strain AH9 produced maximum (39.07 g/lt) organic acids. Treatment of tomato seeds with bacterial isolates, showed that *Pantoea* strain A3, *Enterobacter* strain A37 and AC41 (root length- 10 cm, 11.2 cm & 9.4 cm respectively for A3, A37 & AC41) could enhance the tomato root elongation as compared to control (root length-7.30 cm) where seeds were soaked in distilled water.

Dr. Hillol Chakdar, Scientist

Characterization of haloarchaea isolated from hypersaline niche

Total 17 haloarchaea were isolated, out of which 11 were from Bhayander salt pan hypersaline sample and 6 from Meera road salt pan hypersaline sample. All the distinct pinpoint colonies obtained on haloarchaea agar showed different shades of dark orange and blood red colours indicating the presence of haloarchaea. These isolates were characterized by morphological, biochemical and molecular characterization. The isolates B1(1), B1(2), B4(4), B4(7), B4(9), B5(2), B5(3), M1(1) and M3(1) were short rods whereas isolates B3(4), B3(5), B3(6), B(7), M2(1), M2(2), M4(1) and M4(2) were long rods in shape and size. 16S rRNA gene from all the haloarchaeal isolates was amplified by PCR method using archaea specific primer. The amplicon of size 1500 bp was obtained for all the isolates.

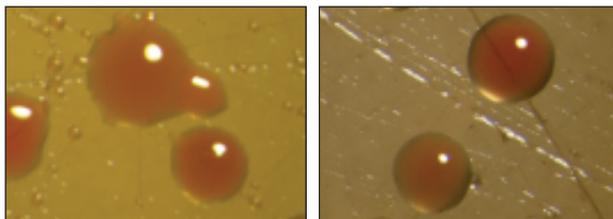


Fig. Haloarchaeal morphotypes on haloarchaea agar media (25% NaCl) at 37°C isolated from hypersaline niche of Mumbai suburban area.

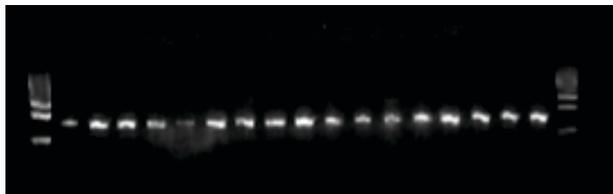


Fig. Amplification of 16S rRNA gene from all the 17 haloarchaeal isolates by PCR programme using archaea specific primers.

Dr. Dipak Nagrale, Scientist

Microbial life in hot water spring explored to boost plants' stress tolerance

Hot water springs harbour unique microbial diversity of thermophiles. These microbes are of special interest as they produce thermostable enzymes and have been used for eradicating heavy metal and organic pollutants in ground water and clearing clogged wells. Also, these microorganisms have the prospects to be explored for novel genes and alleles to improve the heat tolerance capabilities of plants. Exploration to decipher the microbial diversity of thermotolerant microbes from Tattapani hot water spring which has high sulphur content along with other rare elements was carried out. Till date very limited and isolated efforts were made to tapping of microbial diversity and identification of extreme aquatic environment. Large amount of diversity is expected in this region because of the undistributed nature.

The random sampling in and around the hot water springs was performed and a total 21 isolates of fungi and 34 strains of bacteria were isolated. Preliminary results indicate that four fungi and eight bacteria showed luxuriant growth at 55°C. These microbes also showed multifarious plant growth promoting attributes including phosphorous solubilisation, siderophore production, and hydrolytic enzyme production etc. Therefore, inoculating multifarious thermo-tolerant microbes into agricultural and animal wastes seem to be a practical strategy to alleviate heat stress in crop plants. These microbes also provide



excellent models for understanding the stress tolerance, adaptation and response mechanisms that can be subsequently engineered into crop plants to cope with heat stress.

Sudheer Kumar, Alok K. Srivastava, P.L. Kashyap



Human Resource Development

Training/Workshop Organized

- A three day training workshop on “Sensitization cum Training Workshop on Statistical Computing in Agriculture” was held at NBAIM conference hall during 22-24 November, 2012. This training workshop was jointly organized by IASRI, New Delhi and NBAIM, Mau to sensitize the scientist from NARS about SAS software and to familiarize the participants about statistical computing facilities (statistical computing portal, design resources server, macros, eminer etc.) available at IASRI for NARS users.



Fig. Training workshop on Sensitization cum Training Workshop on Statistical Computing in Agriculture.

- A Subject Matter National Training “Bioinformatics: Methods, Tasks and Applications in Microbial Research” was held since Dec. 4, 2012 to Dec. 15, 2012 at NBAIM, Mau under the NABG project. A total of 25 participants including Principal Scientists, Senior Scientists and Scientists from ICAR institutions, Assistant Professors from University departments and research students working in the different areas of biological sciences in various institutions of the country attended this training programme. Resource persons from various institutes like Apsara Innovation-Bangalore, BHU, Varanasi, Novoinformatics, SCF-Bio, IIT-New Delhi, IITR- Lucknow, TERI University- New Delhi, IICB-Kolkata, and IASRI-New Delhi delivered lectures and conducted different practical sessions in this training. Dr T. P. Rajendran, ADG (PP), ICAR, New Delhi addressed the participant as a Chief Guest in the Inaugural session.



Fig. National Training on Bioinformatics: Methods, Tasks and Applications in Microbial Research. Dr T.P. Rajendran, ADG (PP) was the Chief Guest.

Extra Curricular activities

- **Quinquennial Review Team:** The Quinquennial Review Team (QRT), headed by Dr K.V.B.R. Tilak, Former Head, Division of Microbiology, IARI, New Delhi visited the Bureau along with members of QTR Dr. C. Manoharachary and Dr. S.R. Niranjana on August 28-29, 2012 to review the work done by the NBAIM, for the period of 2007-2012. Team visited the laboratories and interacted with the scientists.



Fig. The Quinquennial Review Team (QRT), chaired by Dr K.V.B.R. Tilak



✓ हिन्दी चेतना मास का आयोजन

राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो में निदेशक डा० अरुण कुमार शर्मा की अध्यक्षता में हिन्दी चेतना मास का आयोजन बहुत ही भव्य एवं वृहद रूप से किया गया। पूरे महीने भर ब्यूरो में हिन्दी में प्रतियोगितायें, वाद-विवाद, टंकड़ इत्यादि का कार्यक्रम चलता रहा। मऊ एवं निकट के जिलों के विद्यालयों से आये छात्रों का शैक्षणिक भ्रमण, हिन्दी व्याख्यान, हिन्दी लेखन, वैज्ञानिक निबन्ध, किसान गोष्ठी इत्यादि का आयोजन किया गया। चेतना मास का समापन ब्यूरो के निदेशक ने विभिन्न प्रतियोगिताओं में विजयी प्रतिभागियों को पुरस्कार वितरण के साथ किया तथा साथ ही साथ समस्त कर्मचारियों को हिन्दी के सम्मान में अधिकतम कार्य हिन्दी अथवा द्विभाषीय रूप में करने की अपील की।



एन बी ए आई एम में हिन्दी चेतना मास का आयोजन

NBAIM at UN, CBD, CoP11, Hyderabad

India first time hosted the United Nations, Convention on Biological Diversity, XI Conference of Parties at Hyderabad, 1-20 October 2012, where NBAIM displayed its activities on ICAR stall by means of LED, Kiosk, Posters, live microbial cultures, Scientific literatures etc which were highly appreciated by the visitors from the country and abroad. Many eminent personalities like Dr S K Datta (DDG, ICAR), Dr T. P. Rajendran (ADG, ICAR), Dr K. Kasturirangan (Member, Planning Commission, GOI), Dr P. L. Gautam (Ex-DDG), Dr Balakrishna Pisupati (Chairman, NBA, GOI), Chief Minister Andhra Pradesh Shri Nallari Kiran Kumar Reddy etc visited the stall and appreciated our activities. We convinced the different international organizations for the importance of conserving the microbial biodiversity.



1. Dr S. K. Datta (DDG, CS), Dr. P.L. Gautam, Chairperson PPV&FRA (GOI), Dr K. S. Varapasad, PD, DOR, Hyderabad and Dr A. K. Sharma, Director, NBAIM at ICAR stall, CoP11, Hyderabad



2. Dr K. Kasturirangan (Member, Planning Commission) appreciating NBAIM microbial cultures at ICAR stall in CoP11, Hyderabad



3. Prof. M. S. Swaminathan with Anurag Chaurasia, Scientist (NBAIM) at CoP11, Hyderabad

Expert Consultation Meeting on Agricultural Bioinformatics held at NBAIM

In order to discuss the status, importance and role of bioinformatics in agricultural research and development, an Expert Consultation Meeting entitled "Opening Avenue of Bioinformatics in Agricultural Research: Perspective and Challenges" was held on 26th Nov, 2012. Twenty six participants including the National Coordinator, NAIP Component I Dr. P S Pandey, Dr. Arun K. Sharma, Director NBAIM, Dr. Anil Rai, Head, Centre of Agriculture Bioinformatics, IASRI, New Delhi, partners of NABG project from NBPGR, NBFGR, NBAGR, NBAII and NBAIM and expert scientists from Banaras Hindu University, Varanasi Dr. Ashok Kumar, Dr. L. C. Rai, Dr. R. P. Sinha, Dr. B. K. Sarma attended the meeting.





Fig. Expert Consultation Meeting on Agricultural Bioinformatics

- NBAIM displayed its activity in Farmers fair organized by NEFORD at Dumrau, Mau, October 31, 2012



Fig. Dr A. K. Sharma, Director, NBAIM addressing the farmers

- NBAIM participated in Bharat Nirman, Jan Suchana Abhiyan organized by Press Information Bureau, Ministry of Information & Broadcasting, Govt. of India in Mau, November 1, 2012



Fig. Anurag Chaurasia, Scientist NBAIM addressing the farmers

- NBAIM displayed its activity in Rabi Gosthi at Krishi Bhawan, District Magistrate office, Mau, November 7, 2012



Fig. NBAIM stall at Krishi bhawan, Mau

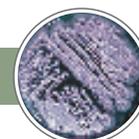
- NBAIM displayed its activity in Kisan Mahotsav at Mau, Dec.13 to Dec 15, 2012

Awards/ Honours

- Dr. A. K. Sharma, Director, NBAIM was awarded the Plant Pathology Leadership Award (Indian Phytopathological Society) in November 2012.
- Dr. Renu was selected as Fellow of Society for Applied Biotechnology in recognition of her outstanding achievements and contributions to the field of microbial biotechnology.
- Mr. Udai B. Singh was selected as Fellow of Society for Applied Biotechnology in recognition of his outstanding achievements and contributions to the field of Agriculture biotechnology.
- Dr. Dhananjaya P. Singh was awarded with Bharat Jyoti Award by India International Friendship Society.
- Dr P. L. Kashyap was awarded with best research poster in National Conference on "Emerging Trends in Plant Pathology" held on 19-20 December, 2012 at SKUAST, Jammu, (India)

Distinguished Visitors

1. Dr K.V.B.R. Tilak, Chairperson QRT visited NBAIM on August 28-29, 2012
2. Dr C. Manoharachary, Member QRT visited NBAIM on August 28-29, 2012
3. Dr S. R. Niranjana, Member QRT visited NBAIM on August 28-29, 2012
4. Dr R. R. Hanchinal, VC, UAS, Dharwad visited NBAIM on November 25, 2012
5. Dr J. S. Sandhu, ADG (Seed), ICAR, New Delhi visited NBAIM on November 25, 2012
6. Dr R. K. Chaudhary, Former OSD, DSR, Mau visited NBAIM on November 25, 2012
7. Dr N. Seetharama, Ex-Director, Directorate of Sorghum Research, Hyderabad visited NBAIM on November 25, 2012





8. V. Shankaran, Director QM, Krishidhan Seed Pvt. Ltd. visited NBAIM on November 25, 2012
9. Dr R. K. Singh, Director NEFORD, Mau visited NBAIM on November 25, 2012
10. Dr P. S. Pandey, National Coordinator, NAIP Component-1, ICAR, New Delhi visited NBAIM on November 26, 2012
11. Dr Anil Rai, Head CABIN, IASRI, New Delhi visited NBAIM on November 26, 2012
12. Dr B. D. Kaushik, Ex Head, Division of Microbiology, IARI, PUSA, New Delhi visited NBAIM on November 27, 2012
13. Dr A. K. Saxena, Head, Division of Microbiology, IARI, PUSA, New Delhi visited NBAIM on November 27, 2012
14. Dr T. P. Rajendran, ADG (PP), ICAR, New Delhi visited NBAIM on December 4, 2012

Publication/Research Paper

- Singh Udai B., Sahu Asha, Sahu Nisha, Singh R.K., Renu, Singh D.P., Manna M.C., Sarma B.K., Singh H.B., K.P. Singh (2012). *Arthrobotrys oligospora* mediated induced systemic resistance and biochemical responses in tomato (*Lycopersicon esculentum* Mill.) affects disease dynamics and enhance bio-protection against *Meloidogyne incognita* and *Rhizoctonia solani*. *Journal of Applied Microbiology* 114:196-208.
- Singh Udai B., Sahu Asha, Sahu Nisha, Singh, Bhanu P., Singh R.K., Renu, Singh D.P., Jaiswal, R.K., Sarma B.K., Singh H.B., Manna M.C., Rao, A. Subba, Prasad, S. Rajendra (2012) Can endophytic *Arthrobotrys oligospora* modulate accumulation of defence related biomolecules and induced systemic resistance in tomato (*Lycopersicon esculentum* Mill.) against root knot disease caused by *Meloidogyne incognita*. *Applied Soil Ecology* 63:45-56.
- Vivek Keshri, Dhananjaya P. Singh, Ratna Prabha, Anil Rai, Arun Kumar Sharma (2013). Genome subtraction for the identification of potential antimicrobial targets in *Xanthomonas oryzae* pv. *oryzae* PXO99A pathogenic to rice. *3Biotech (Springer)* (Accepted).
- Ratna Prabha, Dhananjaya P. Singh, Shailendra K Gupta, Savio Torres de Farias and Anil Rai (2013) Comparative genomics analysis for determinants of changing life style in *Thermosynechococcus elongatus* BP-1, a thermophilic cyanobacterium. *Bioinformation* (Accepted).
- Dhananjaya P. Singh, Ratna Prabha, Lalan Sharma and Arun K Sharma (2013) Induced accumulation of polyphenolics and flavonoids in cyanobacteria under salt stress protect organisms through enhanced antioxidant activity. *American Journal of Plant Sciences* (Accepted).
- Ratna Prabha, Dhananjaya P. Singh, Arun K Sharma (2012). Assessment of codon usage pattern in Nitrogen-fixing uncultured marine Cyanobacterium UCYN-A. *International Journal of Chemical Sciences* 10(4): 2225-2236.

- RP Singh, RN Singh, MK Srivastava, AK Srivastava, S Kumar, RC Dubey, AK Sharma (2012) Structure prediction and analysis of MxαF from obligate, facultative and restricted facultative methylobacterium. *Bioinformation* 8 (21), 1042.
- S Yadav, AK Srivastava, DP Singh, DK Arora (2012) Isolation of oxalic acid tolerating fungi and decipherization of its potential to control *Sclerotinia sclerotiorum* through oxalate oxidase like protein. *World Journal of Microbiology and Biotechnology*, 1-10
- Rajesh Kumar Singh, D. Praveen Kumar, Manoj Kumar Solanki, Pratiksha Singh, Alok K. Srivastava, Sudheer Kumar, Prem Lal Kashyap, Anil K. Saxena, Pradeep K. Singhal and Dilip K. Arora (2012) Optimization of media components for chitinase production by chickpea rhizosphere associated *Lysinibacillus fusiformis* B-CM18. *Journal of Basic Microbiology* 52, 1–10.
- Manoj Kumar Solanki, Sudheer Kumar, Akhilesh Kumar Pandey, Supriya Srivastava, Rajesh Kumar Singh, Prem Lal Kashyap, Alok K Srivastava, Dilip K Arora (2012) Diversity and antagonistic potential of *Bacillus* spp. associated to the rhizosphere of tomato for the management of *Rhizoctonia solani*. *Biocontrol Science and Technology* 22 (2), 203-217

Popular Articles

- Udai B. Singh, Asha Sahu, Nisha Sahu, Renu, Dhananjaya P. Singh, M.C. Manna and Dilip K. Arora (2012). Wonder Microbe- *Pseudomonas fluorescens*: A Special Creature of God. *Science and Technology Reporter*. January-March Issue pp 4-5.
- Renu, Satyendra Pratap Singh, Raghendra Pratap Singh, Ramesh Chandra Yadav, Udai B. Singh and Dilip K. Arora (2012). Microbial bioremediation: an eco-friendly management of nature. *Science and Technology Reporter* (Accepted)
- jktho dqekj flag] ,l0 jktsUnz izlkn] ,0 ,u0 flag] jsuw] mn; Hkku flag] ,oa jkts'k dqekj PkkSgku 2012A Lkjlksa ,oa jkbZ dh vf/kd mRiknu ,oa vk; nsus okyh mUur'khy ,oa izeq[k ladj iztkfr;kWA uUn izlkj T;ksfr] jch fo'ks"kkad&2012A ist la0 17&24A
- Asha Sahu, Udai B. Singh, I. Rashmi, K.C. Shinogi, Radha T.K, Asit Mandal, J.K. Thakur, M.C. Manna (2012) "Arbuscular Mycorrhiza assisted bioremediation: a low-input technology for ecosystem revitalization" *Agrobios Newsletter* 11(8):96-97.
- Abhishek Pareek, Ashok Kumar and Prem Lal Kashyap (December 2012). *Rabi ki Faslon mein keet awam rog prabhandhan. Rajsthani Kethi*. 39-42p.
- Abhishek Pareek, Ashok Kumar and Prem Lal Kashyap (Novemembr 2012). Neem: A Potential Botanical pesticide. *AGROBIOS Newsletter*, XI (6): 37-38.

Book

- **COMPOST HANDBOOK** - Research- Production -Application by Drs. MC Manna, A. Subba Rao, Asha Sahu and UB Singh





(2012) Fertilizer Development and Consultation Organization, New Delhi, India.

Book Chapters

- Uдай B. Singh, Asha Sahu, Dhananjaya P. Singh, Renu, Ratna Prabha, Nisha Sahu, B. K. Sarma, M. C. Manna and Dilip K. Arora (2012). Microbial community in rhizosphere and their impact on plant Biology: An Overview. In: Modern Trends in Microbial Biodiversity of Natural Ecosystem. Asha Sinha, B. K. Sarma and Manisha Srivastava (Eds) Published by Daya Publishing House, India. (Accepted)
- Uдай B. Singh, Asha sahu, Renu, Dhananjaya P. Singh, Ratna Prabha, Nisha Sahu, M. C. Manna and Dilip K. Arora (2012). Microbial diversity and biodegradation of organic pollutants and heavy metals from rhizosphere ecosystem: A mechanistic approach. In: Modern Trends in Microbial Biodiversity of Natural Ecosystem. Asha Sinha, B. K. Sarma and Manisha Srivastava (Eds) Published by Daya Publishing House, India. (Accepted)
- J. K. Thakur, Asha Sahu, Uđai B. Singh, A. Mandal and M.C.Manna (2012). Molecular Techniques in Soil Biodiversity Study. In: Modern Trends in Microbial Biodiversity of Natural Ecosystem. Asha Sinha, B. K. Sarma and Manisha Srivastava (Eds) Published by Daya Publishing House, India. (Accepted)

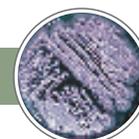
Training Manuals

- Training Manual on National Training on "Bioinformatics: Methods, Tasks and Applications in Microbial Research" Dec. 4-15, 2012. A. K. Sharma, D.P. Singh, A. K. Srivastava, A. Chaurasia, L. Sharma, D.T. Nagrale, R. Prabha and V. Keshri. 2102. Published by National Bureau of Agriculturally Important Microorganisms (Indian Council of Agricultural Research), Kusmaur, Maunath Bhanjan-275 101, India.

Presentation in National /International Seminar/Symposia/Conferences

- Uđai B. Singh, Asha Sahu, Nisha Sahu, Bhanu P. Singh, Kirti Choudhary, Tayyaba Fatma, Renu, Dhananjaya P. Singh and S. Rajendra Prasad (2012). Differential expression of ISR in rice in the presence of *Pseudomonas fluorescens* strain PF-08 and PF-10: A biocontrol approach. In International Conference on "Biotechnology Advances: Omics approaches and way forward (ICBA-2012) held on 20-22 Dec. 2012 at Centre of Biotechnology, Siksha 'O' Anusandhan University, Bhubaneswar, India.
- Renu, Ramesh Chandra Yadav, Uđai B. Singh, Manish S. Bhojar & Arun Kumar Sharma (2012). Detection of molecular diversity among Indian strains of *Xanthomonas campestris* pv *campestris* causing black rot in crucifers. Paper presented in National conference on "Managing Threatening Diseases of Horticultural, Aromatic and Field Crops in Relation to Changing Climatic Situation" & Zonal Meeting of Indian Phytopathological Society (Mid Eastern Zone) held at Indian Institute of Sugarcane Research, Lucknow from 3-5 November, 2012, pp 163.

- Uđai B. Singh, Renu, Dhanajaya P. Singh, S. Rajendra Prasad & Arun Kumar Sharma (2012). Biological control of plant pathogens by *Pseudomonas fluorescens*. Paper presented in National conference on "Managing Threatening Diseases of Horticultural, Aromatic and Field Crops in Relation to Changing Climatic Situation" & Zonal Meeting of Indian Phytopathological Society (Mid Eastern Zone) held at Indian Institute of Sugarcane Research, Lucknow from 3-5 November, 2012, pp 141.
- Renu, Uđai Bhan Singh, Manish S. Bhojar, Ramesh Chandra Yadav, Dhanjay Pratap Singh & Arun Kumar Sharma (2012) Detection of recombination in rice infecting tungro bacilliform viruses of south and south east asia. In International Conference on Biotechnology Advances: Omic approaches and Way Forward (ICBA-2012) held at Bhubaneswar, Orissa, India on 20-22 December 2012.
- Uđai B. Singh, Asha Sahu, Nisha Sahu, R. K. Singh, Renu, Dhananjaya P. Singh, B.K. Sarma, H.B. Singh, A.K. Sharma (2012) *Arthrobotrys oligospora* mediated biological control of diseases of tomato (*Lycopersicon esculentum* Mill.) caused by *Meloidogyne incognita* and *Rhizoctonia solani*. In International Conference on Biotechnology Advances: Omic approaches and Way Forward (ICBA-2012) held at Bhubaneswar, Orissa, India on 20-22 December 2012.
- Asha Sahu, Uđai B. Singh, Nisha Sahu, S.K. Singh, M.C. Manna, A. Subba Rao (2012) "Translocation and Bioaccumulation of Cadmium in African Marigold (*Tagetes erecta* L.) as affected by *Aspergillus awamori* grown in Typic Rhodustalfs" presented in 77th Annual Convention of the Indian Society of Soil Science (ISSS) held at the Punjab Agricultural University (PAU), Ludhiana on 3-6 December, 2012.
- Nisha Sahu, P.Raha, Asha Sahu, Uđai B. Singh (2012) "Influence of Acephate on Microbial Activity in Soil" presented in 77th Annual Convention of the Indian Society of Soil Science (ISSS) held at the Punjab Agricultural University (PAU), Ludhiana on 3-6 December, 2012.
- Ratna Prabha, Dhananjaya P. Singh, Vivek Keshri and Anil Rai (2012). "SSR Identification and Marker Development for Three Different Fusarium sps.". International Conference on "Microbial World: Recent Innovations and Future Trends", KIIT University, Bhubaneswar, Odisha, 22-25 Nov, 2012.
- Vivek Keshri, Ratna Prabha, Sudhir Srivastava, Dhananjaya P. Singh (2012). "Bioinformatics: Next-Generation Sequencing Data Analysis". Indian Lab Automation, Mumbai, 30-31 Oct 2012.
- Alok Kumar Srivastava (2012) Molecular and functional Characterization of Biocontrol Agents: Emerging Trends. National symposium on Emerging Trends in Plant pathology December 19-20, 2012 at SKUAST Jammu.
- Raghendra Pratap Singh, Alok K. Srivastava, R. C. Dubey, and A. K. Sharma (2012) HOUSEKEOMICS: Characteristic



decipherization of chickpea rhizobia in 53rd Annual Conference of Association of Microbiologist of India (AMI) and International conference on “Microbial World: Recent Innovation and Future Trends” at KIIT Bhubaneswar, India.

- Satyendra Pratap Singh, Raghvendra Pratap Singh, Ram Nageena Singh, Anchal Kumar Srivastava, Sudheer Kumar, Alok Kumar Srivastava and Arun Kumar Sharma (2012). Unexplored niche of Actinomycetes: NEEM GUM in 53rd Annual Conference of Association of Microbiologist of India (AMI) and International conference on “Microbial World: Recent Innovation and Future Trends” at KIIT Bhubneswar, India.
- Ram Nageena Singh, Avaniika Singh, Raghvendra Pratap Singh, Anchal Kumar Srivastava, Nidhi Singh, P.L. Kashyap, Sudheer Kumar, D. K. Arora, Arun Kumar Sharma and Alok Kumar Srivastava (2012). Diversity of psychrophilic microorganisms from Leh: A case study of sub glacial communities in 53rd Annual Conference of Association of Microbiologist of India (AMI) and International conference on “Microbial World: Recent Innovation and Future Trends” at KIIT Bhubneswar, India.
- Prem Lal Kashyap, Sudheer Kumar, Ruchi Singh, Alok K. Srivastava and Arun Kumar Sharma (2012) Expression profiling on pathogenicity genes of *Magnaporthe oryzae* to understand rice blast disease spectrum. In: National Conference on “Emerging Trends in Plant Pathology” held on 19-20 December, 2012 at SKUAST, Jammu, (India). Abstract 018: 31-32p.
- Sudheer Kumar, Ruchi Singh, Prem Lal Kashyap, Alok K. Srivastava and Arun Kumar Sharma (2012) Rapid Detection and Quantification of *Alternaria solani* in tomato. In: National Conference on “Emerging Trends in Plant Pathology” held on 19-20 December, 2012 at SKUAST, Jammu, (India). Abstract 072: 59-60 p.
- Anuradha Rai, Alok Kumar Srivastava, Sachi Vardhan, Sudheer Kumar, Prem Lal Kashyap, Dillip Kumar Arora (2012) *Penicillium clavariaeformis*: a rare synnematous fungus from India. BioFest, 2012, International Bio Conference & Event 12-13 December 2012, Leonia International Convention Hyderabad, India.
- Rupali Gupta, Manish Kumar, Satyendra Pratap Singh, Prem Lal Kashyap, Sudheer Kumar, Alok K. Srivastava, Arun Kumar Sharma (2012) Identification and characterization of polyhydroxybutyrate producing bacteria associated with crop rhizosphere and phyllosphere. In: 53rd Annual Conference of Association of Microbiologist of India (AMI) and International conference on microbial world: recent innovation and future trends held from 22-25th November 2012 at KIIT University, Bhubaneswar, Odisha.
- Ram Nageena Singh, Alok Kumar Srivastava and Arun Kumar Sharma (2012) Tools to unveil the agricultural treasure: Next Generation Sequencing, at National Symposium on held

from 19-20 December at SKUAST-Jammu, Jammu and Kashmir

- Prem Lal Kashyap (2012) “Phytopathogenomics in Plant Disease Management: A Paradigm Shift” on 20th December, 2012 in National Conference on “Emerging Trends in Plant Pathology” held on 19-20 December, 2012 at SKUAST, Jammu, (India). 9-10p.

Staff Joined

- Dr Arun Kumar Sharma joined as Director, National Bureau of Agriculturally Important Microorganisms, Kushmaur on August 27, 2012
- Dr Hillol Chakdar joined as scientist at National Bureau of Agriculturally Important Microorganisms, Kushmaur on October 10, 2012.
- Abhishek Kumar joined as Assistant at National Bureau of Agriculturally Important Microorganisms, Kushmaur August 01, 2012
- Rehan Khan joined as Assistant at National Bureau of Agriculturally Important Microorganisms, Kushmaur on July 02, 2012

Our New Director

Dr. Arun Kumar Sharma joined as Director of National Bureau of Agriculturally Important Microorganisms (Indian Council of Agricultural Research), Kushmaur, Maunath Bhanjan-275 101, Uttar Pradesh on August 27, 2012. Dr. Sharma has obtained his M.Sc. and Ph.D. in Botany with specialization in Mycology and Plant Pathology from University of Jammu, Jammu during 1974 and 1980, respectively. He joined the Agricultural Research Services (ARS) of ICAR, New Delhi in 1978 batch and was posted at VPKAS (ICAR), Almora (Uttarakhand) where he served since December 1978 to August 1995, first as scientist and then as Senior Scientist (w.e.f. July 1984). During the period 1992-1994, he worked as Plant Pathologist under Food and Agriculture Organization (FAO) of the United Nations at Guyana, South America. He shifted to Directorate of Wheat Research (DWR), Karnal during 1995 and since then he worked as P.I., Crop Protection under the AICW&BIP. He served as Principal Investigator, Crop Protection under All India Coordinated Wheat & Barley Improvement Project, Directorate of Wheat Research (ICAR), Karnal for 17 years. During his long career, he worked on rust diseases of wheat in various projects like Indo-Australian Network Project on biotic stresses (rusts) and handled several externally funded projects on development of adaptable IPM in rice-wheat cropping system, promotion and validation of IPM modules in rice-wheat system and ICAR AP cess fund Project on Survey and Surveillance for rusts in Wheat. He has organized several trainings and winter schools on wheat biotic stress tolerance, wheat rusts, procedures, and techniques in crop protection, field resistance evaluation and data recording in



wheat. He has visited several countries during his life time, e.g. Guyana, Surinam, Thailand, Malaysia, Kenya, Ethiopia, Syria, UK, USA, and Philippines. Dr Sharma received the Plant Pathology Leadership Award of the Indian Phytopathological Society, 2012; Best Team Award (as Team Leader in DWR) during 2007, South-East Asia Manthan Award, 2009; Chaudhary Devi Lal Best AICRP Award 2012 (as P.I. Crop Protection, AICW & BIP) and a few 'Best Poster' Awards in different Conferences, etc. He has been 'Editor' of the Society of Mycology and Plant Pathology. He was also nominated as the Fellow of the Indian Society of Mycology and Plant Pathology (FISMPP). He has also chaired/co-chaired several sessions in various National and International conferences. He has attended many national and international conferences/symposia and represented India in the 'International conference on Stripe Rust' held in ICARDA, Syria

during 2011. The Scientific contribution of Dr. Sharma is well recognized in national and international scientific community, especially in wheat pathology and IPM. NBAIM family welcomes Dr. Sharma.

Staff Promoted

Sh. Ashok Kumar promoted from senior clerk to assistant

Staff Transferred

Dr Kamlesh Kumar Meena was selected as Senior Scientist (Microbiology) at National Institute of Abiotic Stress Management, Baramati-413 115, Pune, Maharashtra. He was relieved from NBAIM on July 31, 2012.

हिंदी प्रभाग | जुलाई-दिसम्बर - 2012

विज्ञान समाचार (भारतीय कृषि अनुसंधान परिषद्)

“नेशनल एग्रीकल्चर बायोइन्फार्मेटिक्स ग्रीड” परियोजना में डाटावेस का विकास

भारतीय कृषि अनुसंधान परिषद् द्वारा चलाई जा रही एन. ए. आई. पी. योजना के अन्तर्गत वित्तपोषित इस परियोजना के तहत राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो द्वारा एस. एस. आर. डाटावेस का विकास हुआ है। यह डाटावेस मुख्य रूप से मृदा में पाये जाने वाले पौध रोगकारक जीव, फ्यूजेरियम पर केन्द्रित है। इस डाटावेस में फ्यूजेरियम की तीन प्रमुख प्रजातियों में पाये जाने वाले एस. एस. आर. की सूचना एकत्रित है। ये तीन प्रजातिया नामतः फ्यूजेरियम आक्सीस्पोरम, फ्यूजेरियम ग्रेमिनेरम तथा फ्यूजेरियम वर्टीसिलायड हैं। इस डाटावेस में एस. एस. आर. को पहचानने की विधि तथा एस. एस. आर. की पहचान के लिए प्राइमर एवं उनके विकास की विधि का सविस्तार वर्णन किया गया है। यह डाटावेस भारतीय कृषि सांख्यिकीय अनुसंधान संस्थान तथा एन. ए. बी. जी. की वेबसाइट पर उपस्थित है। इस यू. आर. एल. http://nabg.iasri.res.in:8080/ssr/ssr_home.html की सहायता से इसे सीधे देखा जा सकता है। इसकी सहायता से कृषि वैज्ञानिक डाटा के विश्लेषण और रोग प्रवन्धन में आने वाली औपचारिक एवं व्यवहारिक समस्याओं का समाधान प्राप्त का सकते हैं।

जैन्थोमोनास कम्पेस्ट्रिस प्रजाति कम्पेस्ट्रिस के जीवाणुभोजी विषाणु की पहचान एवं गुणवत्ता विश्लेषण

जैन्थोमोनास कम्पेस्ट्रिस प्रजाति कम्पेस्ट्रिस एक पौध रोगकारक जीवाणु है जो प्रायः गोभीवर्गीय फसलों में ब्लैक राट नामक रोग उत्पन्न करता है। इस रोग से निदान पाने के लिए प्रायः रसायनों के प्रयोग का प्रचलन रहा है। ये रसायनिक तत्व मानव एवं पर्यावरण की दृष्टि से हानिकारक होते हैं। इसकें साथ ही साथ इस जीवाणु में इन रसायनों के लिए प्रतिरोधी क्षमता का विकास हो गया है। अन्ततः हमें इनके नियंत्रण हेतु नये-नये रसायनों की आवश्यकता पड़ने लगी है। इस प्रकार इस रोग की गम्भीरता एवं होने वाले हानि को ध्यान में रखते हुए राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो में इस जीवाणु के नियंत्रण हेतु जैविक विधि का विकास किया जा रहा है। इस दिशा में ब्यूरो में एक

जीवाणुभोजी विषाणु की खोज की गयी है। जो इस जीवाणु को नष्ट करने में अत्यन्त कारगर साबित हुआ है। ये विषाणु स्वभाव से अतिविशिष्ट एवं जाति स्पेसिफिक होते हैं। ये केवल जैन्थोमोनास कम्पेस्ट्रिस प्रजाति कम्पेस्ट्रिस को ही संक्रमित करते हैं। यह विधि जैविक होने के साथ-साथ पर्यावरण प्रिय एवं मानव हितकारी है। इस विधि का कोई दुष्प्रभाव वातावरण पर नहीं पड़ने की सम्भावना है। प्रयोगशाला स्तर पर हुए परिक्षण से यह स्पष्ट हुआ है कि यह स्वभाव से लाइटिक फाज है। इलेक्ट्रान सुक्ष्मदर्शी की सहायता से इस वायरक की सरचना एवं गुणवत्ता का विश्लेषण किया जा चुका है। इनमें Xc9SH3 वैकिटिरियों फाज अत्यन्त प्रभावी पाया गया है। जो जीवाणु के सभी स्ट्रेन्स को नष्ट करने की क्षमता रखता है।

पोषक तत्वों की उपलब्धता एवं रोग प्रतिरोधक क्षमता के विकास में माइकोराइजा का महत्व

माइकोराइजा (कवक मूल) कवक जालीय, कवक तन्तु होते हैं, जो उच्च वर्गीय पौधों की जड़ों के साथ सहवास में या तो उनकी परिधि पर अथवा वल्कुट (कार्टेक्स) की कुछ निश्चित परतों की कोशिकाओं में रहते हैं। प्रकृति में पौधों की अधिकांश जातियाँ अपनी जड़ों में कवकमुलीय तन्त्र को किसी न किसी रूप में रखती हैं। कवक की विभिन्न जातियाँ पौधों के साथ प्रकृति सहजीवी सहोपकारिक, अरोगजनक के रूप में पायी जाती हैं। प्रायः ऐसा प्रमाणित है कि ये कवक मूल पौधों की जड़ों में सहवास के समय पौधों से कार्बोहाइड्रेट लेते हैं और इसके बदले पौधों को जल एवं खनिज लवण उपलब्ध कराते हैं। राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो में चल रहे अध्ययन से पता चला है कि ये पौधों में विभिन्न जैविक एवं अजैविक स्ट्रेस के दौरान प्रतिरोधक क्षमता का विकास करते हैं। अभी तक इस प्रक्रिया में होने वाली रासायनिक अभिक्रियाओं का पूरा-पूरा पता नहीं हो पाया है। एक अध्ययन से यह पता चला है कि यह (माइकोराइजा) पौधों की जड़ों को भौतिक रूप से घेरे रखता है। जिससे मृदोपजीवी रोगकारक जीव जैसे फ्यूजेरियम, राइजोक्टोनिया इत्यादि के संक्रमण के लिए खाली सतह नहीं मिल पाता है और इस तरह पौधा संक्रमित होने से बच जाता है। अभी परिक्षण से ज्ञात हुआ है कि





कवकमूल जड़ में विभिन्न प्रकार के रोगकारक प्रतिरोधी रसायनों का संश्लेषण होता है जो रोगकारक जीवों के संक्रमण से पौधे को सुरक्षा प्रदान करते हैं।

इण्डोफिटिक एक्टिनोमाइसिटिस की खोज एवं गुणवत्ता परीक्षण

राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो में इण्डोफिटिक एक्टिनोमाइसिटिस की पहचान एवं गुणवत्ता परीक्षण में हुई खोज के दौरान पता चला है। कि पौधों की विभिन्न जातियों में ये एक्टिनोमाइसिटिस पाये जाते हैं। ये अपनी विशेष गुणवत्ता के लिए जाने जाते हैं। अध्ययन में पता चला है कि गेहूँ एवं सरसों की जड़ों एवं तनों से प्राप्त एक्टिनोमाइसिटिस विशेष प्रकार के वायोएक्टिव रसायन

उत्पन्न करते हैं जिसका प्रयोग रोगकारक सुक्ष्मजीवों की रोकथाम में किया जा सकता है।

क्षार-सह्य आर्कीबैक्टिरिया की खोज

नमक की खाड़ी तथा भिन्न-भिन्न क्षारीय जलाशयों से ऐसे आर्कीबैक्टिरिया की खोज की गयी है जो नमक के 25% घोल में भी जीवित ही नहीं रहते बल्कि प्राकृतिक अवस्था में बढ़ते रहते हैं। इनमें ऐसे जीन की सम्भावना है जो ज्यादा क्षारीय अवस्था में उनके बढ़ने में सहायक होती हैं। ऐसा अनुमान लगाया जाता है कि आने वाले दिनों में जीवाणुओं के इन बहुमूल्य जीन को पौधों में प्रत्यारोपित करके अथवा इनकी उपस्थिति में पौधों को क्षारीय मृदा में उगने में मदद मिल सकती है।

Compiled and edited by

Sudheer Kumar
D.P. Singh
Renu
Anurag Chaurasia
Udai B. Singh

Assisted by

Siddarth Arora
Anchal Kumar Srivastava

Published by

Dr. Arun Kumar Sharma
Director
NBAIM, Kusmaur,
Maunath Bhanjan-275 101

Corresponding Address

Director
National Bureau of Agriculturally Important Microorganisms
(Indian Council of Agricultural Research)
Kusmaur, Maunath Bhanjan 275 101 Mau, Uttar Pradesh
Phone: 0547-2530080 Fax: 0547-2530381
E-mail: nbaimicar@gmail.com Visit us at: www.nbaim.org.in