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Contents

From the Desk of President 1
From Editor's Desk 2
About national seminar & annual meeting 2
Awards and recognitions received by members 4
Research notes and communications 5
An appeal to contribute for Prof. SKMCF 12
Enroll yourself as a member 12

From the Desk of President...

Dear NABSians,

Greetings from NABS.

It is a pleasure in communicating with all of you. This newsletter assumes special significance due to the fact that it carries a lot of our annual activities. As informed earlier, the prestigious award of NABS, Prof.S. Kannaiyan Memorial Award, is being presented to the eminent educationist cum agricultural scientist Prof. Kirti Singh during the interactive workshop cum seminar on "Microbes and Human welfare" slated to be held in July at Tiruchirapalli. During the function, our newly elected Fellows and Associate Fellows will be conferred with Fellowship. Enlarging the activity, we have started recognizing the NABSians for their best research contribution in form of their publication. The first award in this category would be presented on that occasion.

Prof. S. Kannaiyan, our founder president, is an ardent microbiologist. It is fitting that we present all the honours and award during the seminar on 'Microbe and Human Welfare', a topic very dear to Prof. S.K. The Newsletter has also enlarged to include a brief on various scientific achievements. I request all the NABSians to kindly encourage us by sending your best research achievements to the News Letter. Hopefully, during the next EC meeting to be held in July, we may come out with more activity to encourage and honour the NABSians and take NABS to greater heights. This is possible only with the support and help of you, all. I also request you to kindly contribute generously to the Prof.SKM Corpus Fund. I thank all the NABSians, EC member and Prof. T. Marimuthu, the Secretary, for the great job done. I also thank the Committee members who screened the applications for various awards and Fellowship.

Wish you all the best and hoping to meet you at Tiruchirapalli.

President, NABS

2. From Editor's Desk

Greetings to all at NABS.

I am excited that the Academy is conducting the National Seminar on Microbes and Human Welfare, a topic that opens up immense possibilities within the realms of human and environmental well being. Microbes are major components of biological systems and are ubiquitous in nature; even present at sites where no other life forms can exist. Their multifariousness allows them to perform diverse functions that directly impact human welfare across the globe. The topic for the national seminar is, therefore, very appropriate and I sincerely hope that the workshop serves as a major platform for constructive deliberations that leads to mutual learning and knowledge exchange. It would also be a powerful tool to assess challenges on the microbial front and find paths to address them from within the NABS. Yet, while we as specialists debate what the latest findings on microbes vis-à-vis human welfare mean, the rhetoric of popular discussions of microbes, their behavior, evolution and impacts on the environments remains largely unchanged.

Be that as it may, it is imperative that we delve into our mutual interests and as members of this prestigious academy we must commit to our agreements and set a precedent that serves as a benchmark for the future generations. For this to happen we need to align our support with our country's existing priorities. This is one reason why I feel that the developments at NABS has been nothing short of a miracle and it has been seamlessly going through its business, thanks to the tact and acumen of Prof. T. Marimuthu, the Secretary of NABS. In fact, I genuinely feel that NABS is going through an extraordinarily exciting state of affairs.

I take this opportunity to congratulate all the newly elected fellows to the Academy and the winner of the NABS Best Paper Award. My thanks to Dr. N. Thajuddin, Coordinator, Dr. G. Muralitharan, Organizing Secretary and Dr. M. Subramanian, EC member for their painstaking efforts in organizing the national seminar.

M. Anandaraj
Editor - in - Chief

3. About National Seminar & Annual Meeting

NABSians are aware that Interactive Workshop is always a part of the Annual Meeting of NABS. The seventh Annual meeting of NABS will also be a part of National Seminar with the theme, 'Microbes and Human Welfare' organized in collaboration with the Department of Microbiology, Bharathidasan University, Tiruchirappalli, Tamil Nadu on 20 and 21 July, 2013 at the main campus of the University. Dr. N. Thajuddin, EC member will coordinate in organizing the event.

Key events for the two days

1. Inauguration of National Seminar
2. Conferment of Prof. S. Kannaiyan Memorial Award for 2013 on Dr. Kirti Singh, Chairperson, World Noni Research Foundation, Chennai.
3. Release of Abstract of Seminar papers and NABS News Letter, Volume 4 (2), July, 2013
4. Technical Sessions of National Seminar
5. Conferring Fellowships / Associate Fellowship for 2012 on elected Fellows / Associate Fellows
6. Presenting NABS- Best Research Paper Award [Instituted by NABS for the first time]

NABS Members receiving Fellowship for 2012

1. **Alagawadi, A. R.**
   FNABS-072-12
   Dean, PG Studies
   University of Agricultural Sciences
   Dharwad, Karnataka

2. **Balikai, R. A.**
   FNABS-073-12
   Professor of Entomology
   Department of Agricultural Entomology,
   College of Agriculture, University of
   Agricultural Sciences Dharwad 580 005.

3. **Basavarajappa, R.**
   FNABS-074-12
   Professor of Agronomy
   College of Agriculture
   Department of Agronomy
   University of Agricultural Sciences Dharwad,
   Karnataka

4. **Chenna Reddy Aswath**
   FNABS-075-12
   Head , Division of Biotechnology
   Indian Institute of Horticultural Research (ICAR),
   Hessaraghatta, Bangalore- 560 089.

5. **Chowdappa, P.**
   FNABS-076-12
   Principal Scientist
   Division of Plant Pathology
   Indian Institute of Horticultural Research
   Hessaraghatta Lake Post, Bangalore- 560 089

6. **Ganesh Kumar, C.**
   FNABS-077-12
   Senior Scientist
   Indian Institute of Chemical Technology,
   Hyderabad 500 607

7. **Kiresur, V. R.**
   FNABS-078-12
   Professor & Head
   Department of Agricultural Economics,
   University of Agricultural Sciences, Dharwad,
   College of Agriculture,
   Bijapur 586 101, Karnataka

8. **Pious Thomas**
   FNABS-079-12
   Division of Biotechnology
   Indian Institute of Horticultural Research,
   Hessarghatta Lake P.O., Bangalore- 560 089

9. **Prakashkumar, R.**
   FNABS-080-12
   Joint Director
   Kerala State Council for Science, Technology
   and Environment, Sastra Bhavan, Pattom,
   Thiruvananthapuram-695 004.

10. **Selvam, P.**
    FNABS-081-12
    Director (Research)
    Raghavendra Institute of Pharmaceutical
    Education and Research, Near S.K.Uinversity,
    Saigram, Cheyyadu-P.O. Anantapur- 515 721,
    A.P

11. **Singh, A. K.**
    FNABS-082-12
    Head
    Division of Fruits and Horticultural Technology
    Indian Agricultural Research Institute,
    Pusa Campus, New Delhi 110 012

12. **Srivastava, A. K.**
    FNABS-083-12
    Principal Scientist (Soil Science),
    National Research Centre for citrus,
    Amaravati Road, Nagpur- 440 010,
    Maharashtra.

13. **Vikash Kumar Dubey**
    FNABS-084-12
    Associate Professor
    Department of Biotechnolog, Indian Institute of
    Technology, Guwahati, Assam- 781 039

NABS Member receiving Associate Fellowship for 2012

1. **Sandeep Varma, R.**
   ASSOCF-004-12
   Scientist, Department of Cell Biology and
   Immunology, Research and Development,
   The Himalaya Drug Company, Kakali,
   Bangalore 562 123

NABS - Best Research Paper Award for 2013

1. **Dr. D. Prasath**
   Indian Institute of Spcices Research,
   P.B.No. 1701, Marikunnu- 673 012,
   Kozhikode, Kerala

4. Awards and Recognition received by members of NABS

Congratulations to all the NABSians who received awards and recognition from various institutions and organizations in the country and outside.

Name of Member	Awards / Recognitions Received
Arup K. Mukherjee	• Award of Excellence in Sustainable Agriculture & • Fellow of Society for Applied Biotechnology by Society for Applied Biotechnology (2012)
Balikai, R. A.	• Fellow of Society for Plant Research by the Society for Plant Research, Meerut (2012) • Executive Council Member of Ethological Society of India, Bangalore (2013 to 2015).
Edison, S.	• Member, Academic Council, IARI Deemed University, 2013 & 2014; QRT (Quinquennial Review Team) of the ICAR for the Directorate of Mushroom Research and AICRP on Mushroom (2010-2013); Research Advisory Committee of the Central Agricultural Research Institute, Port Blair, A & NI (2010-13); QRT of the Directorate of Medicinal & Aromatic Plants Research, Anand, Gujarat and AICRP on MAP & Betel vine (2011-2013).
Ganesh Kumar, C.	• Fellow of Association of Microbiologists of India by Association of Microbiologists of India (2012)
Janardhana, G. R.	• Matsume International Foundation Visiting Fellowship (2012-13)
Parthasarathy, V. A.	• Adjunct faculty (Horticulture), IARI, New Delhi • Member, Research Council, TNAU, Coimbatore • Chairman, Task Force for developing DUS Guidelines for Citrus, PPV & FRA, New Delhi • Chairman, RAC, NRC (Seed spices), Ajmer • Member, RAC, NBPGR, New Delhi; RAC, NRC (orchids), Pakyong, Sikkim; QRT, DCR, Puthur; QRT, IIVR, Varanasi; QRT, ICAR Complex, Goa.
Renu Agrawal	• Fellow Association of Microbiologists of India by AMI • Coordinator for CSIR-800 programme (2012). Under this programme the technologies are to be demonstrated at village level.
Sivakumar, G.	• Fellow of Society of Applied Biotechnology, India (FSAB) • Recognized as reviewer for "Indian Journal of Agricultural Sciences" and Tropical Journal of Agriculture"
Usha Rani, P.	• Fellow of Royal Entomological Society, UK by Royal Entomological Society, UK. (2012) • Gaurav Samman Award by Indian Institute of Chemical Technology, Hyderabad. India (2011) • SADHANA Achievers Award by Society for the Advancement of Human and Nature, Himachal Pradesh (2011). • Ugadi Purashkar by Tirupati City Chambers (Tirupati Andhra Pradesh) presented by H. E The Governor (2011).
Vincent, S.	• Visiting professor for Calcutta School of Tropical Medicine West Bengal University of Health Sciences, Government of West Bengal (2013).

Note: Full address of members is available in website of NABS [nabsindia.org]

5. Research notes and short communications

i. Bacterial endosymbionts associated with insecticide resistance in *Nilaparvata lugens* (Brown planthopper of rice)

Nilaparvata lugens is an important pest of rice and the crop has been subjected to maximum insecticide exposure. Intense insecticide use resulted in insect resistance to insecticides, pesticide residues, and resurgence of minor pests and caused immense problems to cultivators. It is suspected that some microflora associated with the gut of insects will facilitate for detoxification of insecticides. Many insect-microbial mutualisms involve in many physiological functions of the insects like nutritional provisioning and growth, stress tolerance and detoxification of insecticides. Considering these, this study was undertaken to document the microflora associated with the *N. lugens* and their role in insecticide resistance. Live insects of *N. Lugens* (Brown planthopper of rice) were collected from the rice fields of Hyderabad which have been exposed to heavy spray of insecticides i.e imidaclopid, acephate and acetamiprid. The appendages of the insect i.e head, wings and legs were removed with sterile scalpel and the rest of the insect body was placed in a sterile mortar and thoroughly surface sterilized with 0.1% sodium hypochlorite followed by 70% ethyl alcohol. The internal content of the insect was extracted with the sterile pestle and mortar. The contents were placed in 10-ml water blank and dilutions were prepared up to 10-6. Dilutions were spread plated in Petri dishes containing various special media like nutrient agar, potato dextrose agar and yeast peptone dextrose and Petri dishes were ncubated at 28C for 48-72 h. Seven numbers of culturable bacterial endosymbionts associated with the insects were characterized and identified through on 16 S rDNA analysis. The identified culturable bacteria were *Stenotrophomonas* sp., *Serratia marcescens*, *Staphylococcus sciuri*, *Acinetobacter gyllenbergii*, *Acinetobacter bereziniae*, *Serratia marcescens* and *Serratia* spp.

Fig. 16S rRNA gene amplification from microflora of Nilaparvata lugens from Hyderabad

(Lane 1: 1 kb DNA ladder; Lane 2: BPHH-1; Lane 3: BPHH-2; Lane 4: BPHH-3; Lane 5: BPHH-4; Lane 6: BPHH-5; Lane 7: BPHH- 6; Lane 8: BPHH-7)

These seven bacteria were tested for Acetamiprid 20% SP and Imidacloprid 17.8% SL resistance under in vitro through poisoned food technique and the bacteria *Serratia marcescens* and *Staphylococcus sciuri* exhibited good growth in recommended and even higher than the recommended dose of insecticides. This study concluded that culturable bacterial endosymbionts *i.e. S. marcescens*, *S. sciuri* associated with *N. lugens* may involve in detoxification of insecticides Acetamiprid and Imidacloprid.

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ii. Plant Growth Promoting Rhizobacteria (PGPR) mediated induced systemic resistance in rice plant against sheath rot pathogen

Rice (*Oryza sativa* L.) is susceptible to a number of diseases. Among them, sheath rot disease caused by *Sarocladium oryzae* (Gums & Hawks.) is one of the most devastating diseases and major challenge to rice cultivation. Biocontrol by use of Plant Growth Promoting Rhizobacteria (PGPR) *viz.*, *Pseudomonas fluorescens* represents an attractive alternative disease management approach since PGPR are known for growth promotion and disease reduction in crops. A study was undertaken to test the efficacy of fluorescent pseudomonads strain against sheath rot disease in rice under glass house conditions. Twenty three strains of fluorescent pseudomonads were isolated from various ecosystems of Tamil Nadu state including rice growing areas, forestry and coastal zones. Biochemical and molecular characterization of PGPR strains showed more similarity among the strains isolated from same regions compared to the strains collected from different

ecosystems. The genetic diversity that occurs in PGPR provides an enormous resource for improving biological control of plant diseases. In this study, fluorescent pseudomonad strains were assayed for the production of ACC deaminase, IAA, DAPG, HCN and phenazine.. Among Twenty three PGPR strains Pf1, TDK1 and TV-5 enhanced the plant growth under glass house conditions. Among the various PGPR strains tested under in vitro conditions against the sheath rot pathogen, Pf1, TDK1 and TV-5 strains were found to be effective in inhibiting the growth of the pathogen and also they were found to promote the vigour index of rice seedlings both under roll towel and pot culture studies. Different bioformulations viz., Pf1, TDK1 and TV-5 individually and in combination were developed and tested for their efficacy against sheath rot disease of rice under glass house condition. The bioformulations resulted in reduced disease incidence, significantly increased the plant growth parameters thereby enhanced grain yield when compared to untreated control under glass house conditions. The molecular studies revealed that the bioformulations were found to enhance the induction of the defense related enzymes viz., phenylalanine ammonia lyase, peroxidase, polyphenol oxidase and chitinase when plants were challenge inoculated with sheath rot pathogen.

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iii. Leaf blight disease of *Solanum nigrum* and its management

Solanum nigrum L. (black nightshade) is an important medicinal plant belonging to the family Solanaceae. It contains alkaloids *viz*., solamargine, solanigrine and solasonine. The plant is used for asthma, ulcer, dropsy, cough *etc*. In India, *S. nigrum* is used as hepatoprotective agent. The leaf blight disease of *S. nigrum* caused by *Alternaria alternata* is a serious fungal disease in Tamil Nadu state of India. *Alternaria* leaf spot is characterized by small spots which are initially water-soaked. These spots turn reddish-brown, may reach 1/8 inch in diameter and are roughly circular. Spores of *Alternaria* sp. are dark brown to black and appear in felty black masses on leaves. They generally move by water splashing or air movement. Management of disease through fungicides alone leads to cause soil residual problem and health hazards, besides involving higher input cost. One of the recent approaches for plant disease management isexploitation of biocontrol agents.

Biological control through the use of antagonistic microorganisms has recently emerged as a viable disease management strategy. The main modes of action of the biocontrol agent include competition for nutrients and space, production of cell wall degrading enzymes, production of antifungal diffusible and volatile metabolites and mycoparasitism. Lemongrass oil is an aromatic perennial grass valued for its oil and was also proved fungicidal. Hence in the present study, the effect of fungicides, EC formulated lemongrass oil and biocontrol agent were evaluated against leaf blight disease of *S. Nigrum.*

Field experiment was conducted in the farmer's field at Kallipalayam, Coimbatore district, Tamil Nadu, India for the integrated management of leaf blight disease in S. nigrum. Spraying was done on 30 and 40 days after sowing using fungicides and biocontrol agents viz., Mancozeb (0.2%), Propiconazole (0.1%), EC formulated lemongrass oil, *Pseudomonas fluorescens* (0.2%) and their combinations. The leaf blight disease intensity was recorded on 45 and 60 days after sowing. The leaf blight disease intensity was assessed using 0-9 disease rating scale as described by Pawelec et al., 2006 .The green leaf yield was also recorded.

The results showed that spraying *Pseudomonas fluorescens* (0.2%) on 30 DAS and 40 DAS recorded the highest reduction of leaf blight disease intensity of 48.5% and 62.7% at 45 DAS and 60 DAS respectively followed by spraying Mancozeb (0.2%) on 30 DAS and 45 DAS which recorded the leaf blight disease reduction to an extent of 46.2% and 57.3% at 45 DAS and 60 DAS respectively. In the control, the highest leaf blight disease intensity of 31.4 per cent and 42.4 per cent was recorded on 45 and 60 DAS respectively. The maximum green leaf yield of 22.9 t/ha was recorded in treatment of spraying *P. fluorescens* (0.2%). In control, the lowest yield of 15.6 t/ha was observed. The beneficial effects of these bacteria, in most cases, have been related to their ability to produce plant growth hormones and or antimicrobial substances and to protect growing roots from deleterious root microbes present in the rhizosphere.

The present investigation indicated the usefulness of antagonists for the control of leaf blight disease of S. Nigrum. Hence, this approach can be exploited as it is natural, safe, effective, persistent and durable alternative to chemical pesticides for controlling plant diseases.

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iv. Formalin preserved versus plastinated technique on biological specimens

As a preservative, formaldehyde is a very controversial material. The question of its carcinogenic potential has not yet been answered with authority, however the National Institute of Occupational Safety and Health (NIOSH) recommends that" formaldehyde be handled as a potential occupational carcinogen and that appropriate controls be used to reduce worker exposure".

Other adverse health effects associated with formaldehyde (depending on concentration) are burning of the eyes, irritation of the upper respiratory tract, tightening of the chest, palpitation of the heart and even pneumonia. Because of the strong pungent odour of formaldehyde one probably will never be exposed to concentrations high enough to cause acute damage. The nose and eyes are the best friends here and will warn a person long before the concentration gets very high.

In the department of Veterinary Anatomy and Histology the frequent use of formalin preserved specimen lead to body reaction and carcinogenic effect. Moreover, the animal ethetics committee's acts and regulations instructing the ban of using animals for experiment and dissection purpose, necessitated to find alternative technology for preservation of biological specimens with its natural appearance. In view of these facts, the present study on the preservation of biological specimen was undertaken with its natural appearance.

The two system of digestive and respiratory of each species of bovine, porcine and canine were procured from Vaivakawn and Chaltlang area. Thereafter, one digestive and respiratory system of each species of bovine, porcine and canine were preserved by usual procedure of 10% formalin and another one system of each aforesaid species by the following procedure.

Firstly, these specimens were fixed in Kaserling solution in order to achieve the color preservation and shape of the organs. Thereafter dehydration was done by soaking the specimen in pure acetone at room temperature. These dehydrated specimens were later soaked in the polyester resin or Epoxy for 4-6 days in the Jar depending upon the thickness of the specimens for complete impregnation. Finally, the specimens were collected and the excess resin was drained and later transferred to a mixture of solution containing polyster resin and a catalyst (Hardner). 2-3 percent catalysts mixtures (polyethylene glycol 6000) were used for the hardening and drying of the specimens. These plastinated specimens (i.e. the organs of digestive and respiratory system) with low cost method can be handled freely without causing any carcinogenic effect and can be useful alternative for the study of Gross Anatomy (Fig.). However, histomorphology of these specimens cannot be studied due to harder structure. Further, these specimens can be stored openly without consuming the space like museum jars and chemical.

Fig: Photograph showing plastinated specimen (tongue) of pig

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v. Characterization of anti-fungal antibiotics from *Bacillus subtilis* for management of soil borne disease of tomato

One of the biggest ecological challenges facing microbiologists and plant pathologists in the near future is the development of environmentally friendly alternatives to the extensive use of chemical pesticides for combating crop diseases. The use of biopesticides is considered as one of the most promising methods for more rational and safe crop-management practices. Members of the genus *Bacillus* are often considered microbial factories for the production of a vast array of biologically active molecules potentially inhibitory for phytopathogenic growth. One of the most commonly used and well-studied organism, the bacterium Bacillus subtilis, has an average of 4-5% of its genome devoted to antibiotic synthesis and has the potential to produce more than two dozen structurally diverse antimicrobial compounds. Among these antimicrobial compounds, cyclic lipopeptides of the Surfactin, Iturin and Fengycin (or plipastatin) families have well-recognized potential uses in biotechnology.

In the present study, fifteen *Bacillus* strains were collected from tomato rhizosphere and from Culture Collection Centre, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore, India. They were characterized by biochemical methods and further confirmed by molecular techniques. The *Bacillus* strains were positive for Catalase, Nitrate reduction, Voges-Proskauer's, Carbohydarte fermentation, Gram's staining, Endospore staining, Growth at 7% NaCl, Malonate and ONPG tests. All the fifteen *Bacillus* strains were confirmed for the siderophore production and the *B. subtilis* strain EPCO16, EPC5 and EPC8 were positive for HCN production. The use of 16s rRNA sequence revealed that the strains were belong to *Bacillus subtilis* with the accession number EF139864 (EPCO16); JN211013 (TBR1); EF139862 (EPC5); EF139863 (EPC8) and JF918976 (TBR2). The efficacy of B. subtilis antagonists against *Fusarium oxysporum* f. sp. *lycopersici* and in promoting plant growth was studied in vitro. The endophytic *B. subtilis* strain EPCO16 showed higher vigour index (2311.46) with increase in root length (15.37) and shoot length (8.55). The same B. subtilis strain EPCO16 showed higher per cent inhibition (46.04) over *Fusarium oxysporum* f. sp. *lycopersici* pathogen in vitro. The molecular variability among different isolates of *Bacillus* were analysed by means of RAPD. Fifteen isolates of Bacillus were tested for their genetic variability by RAPD analysis using 10 random primers viz., OPA-01, OPA-09, OPA-11, OPE-02, OPE-04, OPF-06, OPG-19, OPH-19, OPT-04 and OPT-07. Analysis of the genetic coefficient matrix derived from the scores of RAPD profile showed that the minimum and maximum percent similarities among the *Bacillus* species were in the range of 5 to 70% respectively. Cluster analysis using unweighted pair group method with an arithmetic average (UPGMA) clearly separated the isolates into three clusters (I, II and III) confirming the genetic diversity among the isolates of *Bacillus*. Cluster III consisted of only one isolate (COPB16) and cluster I consisted of six isolates (EPCO16, EPC5, TBR1, TBR2, TBR3 and TBR4). All the remaining isolates belonged to cluster II.

The detection of anti-fungal lipopeptide antibiotics namely Iturin-D, Iturin-C, Bacillomycin-A, Bacillomycin-D, Bacilysin, Mycosubtilin, Surfactin, Fengycin-D and Zwittermycin, Mersacidin in *Bacillus* were carried out using the gene specific primers. The B. subtilis strain EPCO16 is positive for Iturin-D (JN257106); Bacillomycin-D (JN257108); Bacilysin (JN226116); Iturin-C (JN257110); Bacillomycin-A (JN257111) and Fengycin-D (JN257113) genes. The *B. subtilis* strain EPC8 (HQ711611) and EPC5 (HQ711610) harbored Surfactin antibiotic. The *B. subtilis* strain TBR1 is positive for Iturin-D (JN257107); Bacillomycin-A (JN257112) and Mycosubtilin (JN257109) antibiotics. Zwittermycin, Mersacidin lipopeptide genes were absent in all the *B. subtilis* strains.

B. subtilis EPCO16 produces Iturin-D, Iturin-C, Bacilysin, Bacillomycin-A, Bacillomycin-D and Fengycin antibiotics and it showed a tremendous control over the Fusarium pathogen. Hence *B. subtilis* EPCO16 strain was further taken for liquid formulation, glass house and field trial studies. EPCO16 liquid formulation recorded the lowest wilt incidence of 17.46% compared to the untreated control (59.50%). Further, *B. subtilis* EPCO16 liquid formulation recorded greater plant height (87.60cm), root length (42.69 cm), fruit yield (280.46 g per plant) at 60 days after transplanting compared to untreated control (plant height 62.30 cm ; root length (30.52 cm), fruit yield (188.96 g per plant). In the field condition, EPCO16 liquid formulation decreased the Fusarium wilt (3.00% incidence) compared to all other treatments. This was comparable with the chemical treatment (3.50%). In case of untreated control, higher wilt incidence

(29.75%) was recorded. The application of EPCO16 recorded maximum plant height (87.61 cm), root length (42.80 cm) and fruit weight (930.34 g/plant) compared to untreated control (plant height - 62.30 cm; Root length - 30.52 cm, fruit weight - 815.98 g/plant). The EPCO16 significantly increased the tomato fruit yield to (36.67 t/ha) compared over untreated control (25.67 t/ha). *B. subtilis* when used as biocontrol agent not only will reduce disease incidence but will help in getting good plant growth promotion thereby indirectly helping in increased yield parameters.

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vi. Endophytic actinobacteria promote growth of wheat (*Triticum aestivum*) under moisture stress conditions

Water deficit is among the most common environmental stresses to affect plant growth and influence crop quality and productivity in the arid and semiarid regions. Plants growing under detrimental environmental conditions, such as those occurring in arid and semiarid soils, undergo moisture limitation and nutrient deficiencies. Plant associated microorganisms are involved in symbiotic and associative microbial activities that help in plants to establish in their environment. The role of endophytic microorganisms in the promotion of plant growth has received increasing attention in recent years as the introduction and/or manipulation of endophytic microbial population may provide a consistent and effective enhancement in the productivity of crops

In the present study drought tolerant endophytic actinobacteria Streptomyces coelicolor DE07, S. Olivaceus De10 and Streptomyces geysiriensis DE27 were isolated from cultivated plants of arid and drought affected regions of Rajasthan, India. These isolates exhibited plant growth promotion traits and intrinsic water stress tolerance from 0.05 to -0.73 MPa. Maximum auxin production was observed in majority of actinobacterial cultures in the logarithmic to stationary phase of growth. Significant enhancement of wheat seedling vigour was recorded by the inoculation of these endophytic actinobacteria. S. olivaceus DE10 recorded maximum accumulation of indole 3 acetic acid (84.34 µg mg-1 protein). Culture and cell-free extract of the endophytes was applied on to wheat seeds to assess the effect on growth in water-stressed soil. Maximum yield was recorded with the inoculation of S. olivaceus DE10 culture (492.77 kg ha-1) and cell-free extract (262.31 kg ha-1). Co-inoculation of S. Olivaceus DE10 + S. geysiriensis DE27 recorded highest yield of 550.09 kg ha-1 while their cell-free extract yielded 524.92 kg ha-1. Overall, wheat seeds treated with cultures showed better plant growth and yield in comparison to control. Direct coating of cultures on seeds yielded better performance than cell-free extract coated on seeds and co inoculation of cultures or cell-free extract proved better than single culture inoculations. Scanning electron microscopy of actinobacteria isolates inoculated to the wheat plants revealed the actinobacterial colonization on roots establishing the endophytic nature of the isolates (Fig.).

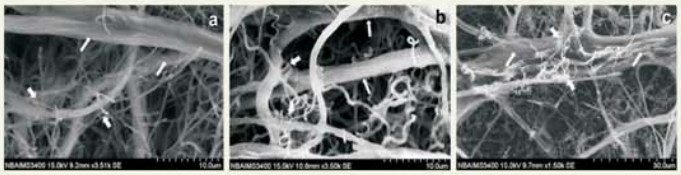

Fig.: Scanning electron microscopy of actinobacteria isolates, showing (a). *Streptomyces coelicolor* De07, (b). *S. olivaceus* DE10 and (c). *S. Geysiriensis* after 10 days of inoculation to wheat plants. Thin arrows represent he wheat roots and thick arrows represent endophytic actinobacterial colonization on roots.

Production of phytohormones, plant growth promotion traits combined with water stress tolerance potential in these endophytic actinobacteria played a cumulative synergistic role that supported enhanced plant growth promotion of wheat in the stressed soil.

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Vii. TNAU Gagdets for management of stored product insects

Principles on which TNAU trapping technology works

- Behavior of the insect is exploited in these technologies
  1. Insect loves "AIR" and move towards air.
  2. Wandering behavior of insects
  3. Insect hide in cracks and crevices.

a. TNAU- Insect probe trap

- The use of trap is relatively a new method of detecting, trapping insects in stored grains. The basic components of a TNAU probe trap consists of three important parts : A main tube, insect trapping tube and a detachable cone at the bottom. Equispaced perforations of 2 mm diameter are made in the main tube.
- The insect trap has to be kept in the grain like rice, wheat etc., vertically with the white plastic cone downside as shown the figure. The top red cap must be with the level of the grain. Insects will move towards air in the main tube and enter through the hole. Once the insect enters the hole it falls down into the detachable white cone at the bottom. Then there is no way to escape and the insects are trapped forever. The white detachable cone can be unscrewed once in a week and the insects can be destroyed

b. TNAU- Pit fall trap

- TNAU model has perforated lid, cone shaped bottom which tapers into a funnel shaped trapping tube.
- Hence sticky coating is dispensed with
- Commercial model is in plastic, simple and economical (cost per trap is Rs. 25/- only).
- Easy to handle.
- Useful for pulse beetle.

c. TNAU- Two-in-One model trap

The probe trap containing the components namely the perforated tube, pitfall mechanism, a collection tube and the cone shaped pitfall trap with a perforated lid and the bottom tapering cone were combined as a single unit. Combination of probe and pitfall increase the trapping efficiency of insects. Best suited for pulse beetles as they are seen only on grain surface wandering here and there. It does not require tedious procedures like coating the inner surface of pitfall cone with sticky materials before trapping to hold pulse beetles. Beetles are captured alive in this trap, which may facilitate release of pheromone and there by attract more insects

d. Indicator device

It consists of a cone shaped perforated cup (3mm perforation) with a lid at the top. The cup is fixed at the bottom with a container and circular dish, which are to be smeared with sticky material like vaseline.

Farmers, before storing their pulses, should take 200 g of pulses to be stored and put them in the cup. When the field carried over beetles start emerging, due to their wandering behaviour, they enter the perforations and get slipped off and fall into the trapping portions. As they stick on to the sticky materials, farmers can easily locate the beetles and can take out the bulk-stored pulses for sun drying. The device with 2mm perforations can be used for cereals.

This will help in eliminating the initial population, which acts as the major source for further build up. Thus, timely detection will help the farmers to preserve their valuable pulses during storage. The device is being popularised.

e. TNAU- Automatic insect removal bin

TNAU insect removal bin can remove insect automatically. The structure has 4 major parts namely outer container, inner perforated container, collection vessel and the lid. The model exploits wandering behaviour of stored product insects as well as the movement of these insects towards well aerated regions. The grains are held in the specially designed inner perforated container. The space between inner and outer container provides good aeration for the insects. Insects, while wandering, enter the perforation to reach the aerated part and while doing so, get slipped off and fall into the collection vessel through a pitfall mechanism provided in the collection vessel. In order to quickly collect the insects, as and when they emerge from grains, perforated (2 mm) rods are fixed in the inner container.

The container will be useful for storing rice, wheat, broken pulses, coriander etc. The insects such as rice weevil, lesser grain borer, red flour beetle, saw toothed beetle, which are commonly found attacking stored grains can be removed automatically by storing grains in this container. Within a very short period of 10 days a majority of the insects (more than 90 per cent) can be removed from the grains. The containers are available in 2 kg, 5 kg, 25 kg, 100 kg and 500 kg capacities.

f. UV Light trap for grain storage godowns

The UV light trap mainly consists of an ultra-violet source (4 W germicidal lamp). The lamp produces ultra-violet rays of peak emission around 250 nano meter. The light is fitted at the centre of a funnel of 310 mm diameter at the top and 35 mm diameter at the bottom. The bottom end of the funnel is attached with a transparent plastic container for collecting the trapped insects. To hang the unit at desired points, three hooks have been provided at the periphery of the funnel. The unit is also provided with a tripod stand.

The UV light trap can be placed in food grain storage godowns at 1.5 m above ground level, preferably in places around warehouse corners, as it has been observed that the insect tends to move towards these places during the evening hours. The trap can be operated during the night hours. The light trap attracts stored product insects of paddy like lesser grain borer, Rhyzopertha dominica, red flour beetle, Tribolium castaneum and saw toothed beetle, Oryzaephilus surnamensis in large numbers.

g. A Device to remove insect eggs from stored pulse seeds (Patent No. 198434)

The gadget has outer container and an inner perforated container with a rotating rod having fixed with plastic brushes on all sides. The seeds with eggs are to be stored in the perforated container and the rod has to rotated one full circumference clockwise and anti-clockwise for 10 minutes 3 times a day (morning, noon and afternoon). Due to the splashing action of the brush in rotating rod, the eggs get crushed and thus the damage is prevented. The treatment does not affect the germination of seeds.

h. Trap for monitoring stored product insects in warehouse

(Patent Application No.1733/CHE/2008, dt.24.7.2008)

The invention disclosed in this application relates to a device for detecting stored grain insects in bagstacks which comprises a main hollow tube having a diameter in the range of 1.8 to 2.0 cm with equispaced perforation in the range of 1.8 to 2 mm on its upper portion with a bend at one end which ends in a transparent collection unit to collect the insects falling down from the bend, the other end of main tube being closed.

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