ENVIRONEWS

INTERNATIONAL SOCIETY OF ENVIRONMENTAL BOTANISTS

Newsletter

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IN THIS ISSUE

President ISEB's New Year Message

International Society of Environmental Botanists (ISEB) was founded on 3rd December 1994 at a meeting held at the CSIR—National Botanical Research Institute Lucknow under the chairmanship of the then Director, Dr. P.V Sane. Some 28 distinguished scientists, academicians, young research scholars and journalists were present at this meeting. I had also the privilege of being present on that historic occasion. ISEB has just completed 18 years of its existence. If we consider the contributions made by ISEB during the past 18 years, it was certainly not a slow and steady growth but a quantum leap. During this period, the membership of ISEB grew from 28 to over 400 now, covering all corners of India, as well as, in other countries like U.K, U.S.A, Canada, Spain, Bangladesh, Sri Lanka and Lithuania.

With an aim to bring latest complex scientific and technical reports and researches on environment and plant sciences to the reach of non-specialists, ISEB launched a quarterly newsletter, EnviroNews on 1st January 1995. Since then, it is being published regularly, without a single interruption, or delay. Till now, 72 issues have been released and the current issue is the 73rd number in the series. This highly popular news magazine has a global reach, and more than two dozen distinguished authors from overseas have contributed articles in this newsletter from time to time. Some of the articles published in EnviroNews have been cited in prestigious international scientific journals. A scientist from Byelorussia has recently sought permission for translating EnviroNews in her language on a regular basis, for the benefit of her countrymen.

Four International Conferences on Plants and Environmental Pollution (ICPEP) were jointly organized by ISEB and CSIR-National Botanical Research Institute, Lucknow in 1996, 2002, 2005, 2010. These highly successful conferences were attended by nearly 1600 scientists including, some 150 delegates from 46 foreign countries. Proceedings of these Conferences were published in the form of edited books or, in a special volume of reputed international journal, Environmental Pollution published by Elsevier. Besides, on the request of the well known publishers, Taylor & Francis, a comprehensive report on deliberations of ICPEP-3 held in 2005, was published in their reputed scientific journal "Environmental Bioindicators" (Vol 1; 159-171, 2006).

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Happy New Year 2013

President and Members of the Executive of International Society of Environmental Botanists Wish a Very Happy, Fruitful and Prosperous New Year to all Members of ISEB and readers of

ENVIRONEWS

With this issue,

***Environews* enters the nineteenth year of its publication**

ISEB has also started a highly informative and educative website which has become popular all over the world. During the past three years, it has been visited by over 37,000 individuals from more than 140 countries across the globe.

A scientific society which is only 18 years old, can genuinely take pride for the rapid strides made by it, its significant achievements and global reach, Former Director General of CSIR Dr. R.A. Mashelkar in a message had mentioned: "*International Society of Environmental Botanists is a useful off shoot of CSIR's National Botanical Research Institute, Lucknow. I am particularly happy to see it carrying out an important task of bridging international linkages in the field of Environmental Botany*".

As Director of CSIR-NBRI, I have the privilege of heading this Society, following the traditions of my illustrious predecessors, and steering the course of ISEB and EnviroNews with the help and cooperation of my colleagues at NBRI and ISEB. We are not sitting over the past laurels and achievements only, but planning for the future growth and development of ISEB. Among various proposals under our active consideration are, launching of a scientific journal "*International Journal of Environmental Botany*" in near future and organizing ICPEP-5 conference sometime in November-December 2014.

On behalf of ISEB, and on my own behalf, I wish to extend my warmest greetings and best wishes to all members of ISEB and readers of EnviroNews for the New Year 2013

Dr. Chandra Shekhar Nautiyal
President ISEB & Director
CSIR- National Botanical Research Institute & CSIR-CIMAP
Lucknow, India

LETTERS

It is indeed a great pleasure to see the publication of CSIR Award for S&T Innovation for Rural Development to Dr. Nautiyal by Hon'ble Prime Minister in the website of International Society of Environmental Botanists. I am very happy to know that there are over 37,000 hits from nearly 140 countries across the world. It is certainly a great achievement. Please keep it up.

Dr. P. Pushpangadan
Padma Shri Awardee
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Was there any ICPEP conference after the one we attended in 2005? Or there is any new international conference planned in future?

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Reading articles of Environews has always been a pleasure. I request you that you should get some citation index for this newsletter and articles published should be considered as Peer Reviewed articles and also have some impact factor. This newsletter is very pertinent as it covers all important environmental issues and most of the articles are well thought over. Articles are highly informative and cover a vast array of topics. Please see if something can be done about the Impact Factor.

Dr. Monika Koul
Assistant Professor
Department of Botany
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I congratulate you and your editorial team, for bringing out regular issues of the environmental newsletter of International Society of Environmental Botanists. All issues are very informative and have articles of current interest.

You may be happy to note that I have been re-elected as Member Board of Trustees, International Life Sciences, India and Global for a term of 3 years and recently, I have been conferred with Gujral - Bhargava memorial Oration-2012, an award lecture of King George's Medical University, Lucknow, which I delivered on 20th October, 2012.

Prof. P.K.Seth
CEO, Biotech Park & Former Director,
Indian Institute of Toxicology Research, Lucknow;
Former General Secretary, NASI
Sector G, Jankipuram, Kursi Road, Lucknow-**India**
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I am interested in joining International Society of Environmental Botanists. I am a plant ecologist. My work is focusing mainly on desert plants. Currently, we are

establishing a new "Seed Bank and Herbarium" in Sharjah, UAE.
Please let me know, how to apply for the membership of ISEB?

Dr Ali El-Keblawy
Associate Professor, Plant Ecology Dept. of Applied Biology College of Sciences, Univ. of Sharjah & Sharjah Research Academy **U.A.E**
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Your details were given to me by your esteemed colleague, Prof Omprakash Arya, as I had written to him regarding joining the International Society of Environmental Botanists. As you may know I am a black scientist, and I reside in England I am known to a small number of scientists in India, mainly in Bangalore, and Pune but I am unknown by Indian standards. I have an interest in botany and the environment and I am a honorary life member of the American Society of Plant Taxonomists. It would be appreciated if you could allow my registration with the International Society of Botanists as I admire the Society and its work. I look forward to hearing from you.

Dr William F Fearon
U.K
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WELCOME NEW LIFE MEMBERS OF ISEB

Ms. Farah. Deeba is a senior Research Fellow in CSIR in National Botanical Research Institute Lucknow India
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Dr. Mukesh Kumar is Associate Professor of Botany Sahu Jain P.G. College, Najibabad Bijnor India.
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Dr. Poonam Khurana is Assistant Professor of J.P. Institute of Engineering & Technology, Meerut, India
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Dr. R.S. Sangwan is the Chief Executive Officer, Bio-Processing Unit (DBT) Mohali, Punjab India.
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NEWS FLASH

Dr. Chandra Shekhar Nautiyal, President, International Society of Environmental Botanists, Director of CSIR-National Botanical Research Institute and CSIR-Central Institute of Medicinal & Aromatic Plants, Lucknow has been honoured with Lifetime Achievement Award by the Biotech Research Society of India, for his outstanding contributions in the field of agricultural biotechnology for increasing the stress tolerance and enhancing the yield of plants, maximising the economic, environmental and societal benefits to the people of India. The award was presented to him by Prof. Asis Dutta of National Institute of Plant Genome Research, New Delhi on 21 November 2012 at Punjabi University, Patiala.

Prof. P. K. Seth, Chief Executive Officer, Biotech Park, Lucknow, and a Life Member of International Society of Environmental Botanists has been re-elected as Member, Board of Trustees International Life Sciences, India and Global. He has recently been conferred with Gujral Bhargava Memorial Oration 2012 by King George's Medical University Lucknow. An internationally acclaimed neurotoxicologist, biochemist and neurochemist, Prof Seth is a former Director of Indian Institute of Toxicology Research, Lucknow. While Biotech Park is an Institutional Member of ISEB, Prof Seth is one of its founders.

Dr. R.P Singh, Professor, Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow and a Life member of ISEB was awarded "AEB Honor" by the Academy of Environmental Biology on 20th September, 2012 in the Inaugural session of Symposium "Emerging Pathogens and Pollutants" held at the Indian Institute for Toxicology Research, Lucknow for his life time achievements in the field of Environmental Biotechnology/Stress Biology/Science Communication".

Dr. S.C. Sharma, Vice President ISEB, organized a societal programme on the tree plantation drive in the Ram Park, Vishwas Khand, Gomti Nagar, Lucknow on November 18, 2012. On this occasion handicapped and mentally retarded children were invited for planting some useful tree species. Dr S.C. Sharma exhorted the children to treat the trees as their friends.

Dr. B. P. Singh, former Scientist 'H', CSIR-NBRI, Lucknow and an internationally reputed plant virologist of India, has been given' Life Time Achievement Award' by Indian Phytopathological Society, Organizing Committee of National Conference on Managing Threatening Diseases of Horticultural, Medicinal, Aromatic and Field crops in Relation to Changing Climate Situation' held during 3-5

November, 2012 at IIR, Lucknow. The award has been given in recognition of his contributions in the field of Plant pathology, especially in Virology. Dr. Singh is an Advisor I.S.E.B.

Prof. R. S. Tripathi, FNA, INSA Honorary Scientist at NBRI and the Life Member & Advisor, ISEB, was awarded the prestigious "**Professor Birbal Sahni Medal for 2012**" by the Indian Botanical Society for his outstanding contribution in the field of plant Ecology at a special award ceremony organized on 8th December, 2012 during the 35th All India Conference of the IBS at M.S. University, Baroda. On this occasion Prof. Tripathi delivered the Medal Award Lecture on "**My journey from weed biology to plant population ecology and forest ecosystem studies**" Prof. Tripathi participated in the Eleventh meeting of the Conference of the Parties (COP-11) to the Convention on Biological Diversity (CBD) held at Hyderabad and delivered a talk on "Invasive alien plants and their impact on biodiversity of north-east India" on 9th October, 2012 at the Special Side Event on "Biological & Cultural Diversity of North-East India".

CSIR-NBRI celebrates its Diamond Jubilee and Annual Day

CSIR-NBRI celebrated its Diamond Jubilee inaugural and Annual Day functions at Central Lawn of the Botanic Garden on October 25, 2012. Bharat Ratna Dr. A.P.J. Abdul Kalam, Hon'ble former President of India was the Chief Guest of Diamond Jubilee inaugural function, while His Excellency Shri BL Joshi, Governor of Uttar Pradesh, graced the occasion as the Guest of Honour. Prof. SK Brahmachari, Secretary, DSIR, Govt. of India & DG, CSIR, New Delhi, delivered the inaugural address and Dr. CS Nautiyal, Director, CSIR-NBRI, welcomed the guests. Many renowned scientists and eminent personalities were present on the occasion. Later, Dr. Abdul Kalam interacted with more than 200 students and replied to the queries of the young students about nature, environment, science and life. He also planted a sapling of 'Rudraksh', a rare plant species, in the Botanic Garden. On this occasion, a publication titled, **"A success story of 60 years"**, depicting the transformational journey of NBRI, was released by Dr. Kalam. Prof. Brahmachari inaugurated the newly developed Ethno-botanical Gallery in the Exposition of the Institute.

Dr. Nautiyal, in his welcome address, highlighted the transformational structure of the 60 years journey, started under the visionary leadership of Prof. KN Kaul, the founder director of the Institute. Dr. Nautiyal emphasized the efforts being undertaken at the Institute in the direction of Root Biology, Soil Metagenomics, Plant Microbe Interaction, Plant conservation, identification and characterization, including rare and threatened species.

Speaking on this occasion, Prof. Sopory, VC, JNU, New Delhi & Chairman, RC, CSIR-NBRI, congratulated NBRI for the overall progress the Institute has achieved in several areas of traditional and modern plant science research over the last 60 years. Prof. Sopory touched upon the key milestones and transitional changes brought in botanical research at NBRI under the dynamic leadership of the past and present directors.

Prof. Brahmachari, in his inaugural address, informed that every single lab of CSIR is unique in its contribution in the field of Science and Technology. He highlighted the role NBRI played in developing the 'Tactile Garden' at Rashtrapati Bhavan, and the Institute's contribution in the area of Gladiolus, Chrysanthemum, Bougainvillea, leading to its recent recognition as a DUS testing centre by PPV & FRA. He appreciated the selection of NBRI patent on Bio-inoculants as one of the top impact making patents in the 70 years history of CSIR. Two research papers of NBRI (by Vivek Pandey et al and CS Nautiyal et al.), having high citation, find a place in the history of CSIR high academic science. He also apprised about the CSIR award for S & T Innovations given to CSIR-NBRI and Directorate of Agriculture, Govt. of UP by Hon'ble Prime Minister Dr. Manmohan Singh on September 26, 2012. This is a result of translational research done by the Institute. Prof. Brahmachari commended the work being undertaken by the Institute in general and in the area of rural technologies in particular.

His Excellency Shri BL Joshi, Governor, UP, appreciated the efforts of NBRI in the area of plant science research which led to National award given by Hon'ble Prime Minister Dr. Manmohan Singh to the institute jointly with the Directorate of Agriculture, Govt. of UP. He applauded the efforts of the institute in the area of dehydration of flower technology and dissemination of its rural programme along with other green technologies. He emphasized the need for making these technologies available to rural masses.

Dr. APJ Abdul Kalam, in his address, recalled the contribution of NBRI in creating a "Touch and Smell garden'' at Rashtrapati Bhavan. Appreciating the efforts of NBRI in the last 60 years for its role in conservation, sustainable utilization of genetic resources and integrating biodiversity, biotechnology and bioinformatics, Dr. Kalam suggested NBRI to undertake preparation of a national atlas indicating the most suitable plants and herbs based on Indian agro-climatic conditions. He said that such a document will benefit the farmers to engage in right type of plantation in their area and also enable conservation of rare species. Dr. Kalam also suggested a number of areas and priority issues to be looked upon by the Institute for future research. Dr. Kalam stressed the need for developing useful plant genotypes beneficial for stress conditions through genomics and genetic engineering. He further recommended developing new plants with desired traits without affecting the environment, to focus on increasing the cotton production, and to find out the ways for plantation of suitable varieties of fruits, vegetables in J&K and North East India.

In the afternoon, Dr. AK Mattoo, Research Plant Physiologist/Biochemist, USDA Sustainable Agricultural Systems Laboratory, Beltsville, Maryland, USA, delivered the

Diamond Jubilee Keynote lecture, titled, "Agricultural biology in the 3rd millennium : Nutritional food security & specialty crops through biotechnology and sustainable agriculture". Dr. AK Mattoo elucidated that the recent biological revolution in the form of genetic engineering and biotechnology brings several promises such as enhancing the crop production within a shorter time frame; reducing reliance on pesticides, fungicides and fertilizers; prolonging the shelf life of produce and reducing over 50% losses registered during post-harvest; and providing necessary tool kit to translate natural products chemistry into alternative medicine.

In the evening, the Institute celebrated its Annual Day. Prof. SK Sopory, VC, JNU, New Delhi, presided over the function. On this occasion, Prof. Sopory released the Annual Report of NBRI for the year 2011-12 and Dr. CS Nautiyal, Director, NBRI presented the highlights of the Annual Report. He informed that this year the Institute has published a total of 167 research papers in leading national and international journals. Nine patents were filed, while four patents filed earlier were granted this year. Purification of two novel plant proteins (NBRI-12 and NBRI-14) which cause 100% mortality of whiteflies, and the first report of a new strain of *Trichoderma koningiopsis* from India were among the salient contributions of the Institute in the field of plant molecular biology and microbiology. The Institute also organized a number of training programmes under its rural development projects.

Later, two publications titled, "Restoration of degraded land to functioning forest ecosystem" by Drs. Bajrang Singh and VL Goel and "Dainik jeevan mein upyogee paudhe" (Hindi) by Drs. Kamla Kulshreshtha, Sanjeev Ojha, JK Johri and SK Tewari, were released by Prof. SK Sopory and Dr. AK Mattoo, respectively.

Prof. SK Sopory, in his presidential address, expressed his confidence that the Institute is progressing through a transformational journey from basic research to molecular biology, plant physiology, pharmacognosy, transgenic crops, and plant- microbe interaction.

Environmental Awareness Programme by ISEB

On the invitation of Bharitya Balika Vidyalaya Lucknow, an Environmental Awareness and Educational Programme was organized by International Society of Environmental Botanists on 18 October 2012 on the College Campus Led by Ms Kanti Srivastava, Convener Awareness Programme committee of ISEB, a team of experts and volunteers including Dr. K.J. Ahmad, Dr. Kamla Kulshreshtha, Dr Nupur Srivastava, Ms. Aparna Chakraborty and Mr. Vijay Kumar Yadav conducted the one hour long programme before some 150 girls and faculty members. After lectures were delivered by the experts, an interactive session was conducted in which students participated very enthusiastically

Biotech Park, Lucknow

Prof. P.K.Seth

Chief Executive Officer, Biotech Park

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A frontier of Science, Biotechnology, offers enormous possibilities of its use as a premium precision tool for the welfare of society and creation of wealth for sustainable commercial and socio-economic development. The Department of Biotechnology, Government of India and several state governments have set up Biotech parks to support the growth of biotech industries by providing common shared facilities, ready to use laboratories and other infrastructures. There are different models of the Biotech Park depending upon the resources, needs and priorities. The parks have been set up by state governments in partnership with industries, totally by industries or partnership between Central and State governments. DBT in most cases has provided funds for setting up technology incubators in parks.

Biotechnology has become a household name in the state of Uttar Pradesh, with the declaration of Lucknow as "Biotechnology City" on January 03, 2002 during 89th Annual Session of the Indian Science Congress held at Lucknow.

Biotech Park set up by the Department of Biotechnology Govt. of India & Department of Science and Technology, Government of Uttar Pradesh, brings an enabling environment for upcoming entrepreneurs to set up their R& D units in Park. It serves as the nucleus for promotion and growth of biotech industry in the state and partnership with the centers of excellence of the city.

The Park plays an important role in the initial establishment of the startup companies by providing information about possible business avenues; facilities and incentives available under the Government of India and State Government biotech policies, availability of special grants, schemes and loans as well as information about requirements for registration and obtaining IPR. It also provides state-of-art plant tissue culture and biofertilizer facilities which it operates in public private partnerships. It has high capacity solvent extraction plant for obtaining phytochemicals and lead molecules from high value medicinal plants and their purification; molecular biology and analytical quality control laboratories and other common support facilities like bioinformatics, conference

hall, cafeteria, effluent treatment plant, storage, etc. The Park also extends expertise to its incubates from scientists of Local CSIR and ICAR institutions apart from other institutions, universities and par excellence centers of learning in the town and not far away from the famous Indian Institute of technology at Kanpur.

The focus of the Park is on challenges and opportunities surrounding the current biotechnology issues related to technology development which would ultimately result in the development of the State and generate rural employment and social upliftment.

The park has leased out space to 18 carefully selected entrepreneurs which has led to creation of number of new jobs. The Biotech Park's incubator II building has become functional and three companies have leased out space to set up their R&D laboratories. Besides the wet lab space, the incubator II has multipurpose meeting rooms / conference hall to accommodate 300 – 325 persons, offices and other related facilities.

The entrepreneurs at Biotech Park are going to pursue innovative research and produce innovative products. In the Bio-pharma Sector, ABC Genomics, technically supported by a US based company, is developing a hand held microarry for detection of pathogens and a WHO GMP compliant facility for R&D and production of Liposome based delivery fungi, a drug for kalazar treatment, and R&D center for diagnostics are coming up at the Park.

The Park through its Plant tissue culture facility reduced the price of banana plantlets by about 30% leading to increase in banana cultivation in the State. The Park has made substantial contributions to the National Mission on Bio-fuels by developing four high yielding and oil rich varieties of *Jatropha curcas* and providing technical know-how for development of good nurseries and quality planting material. The Park is providing consultation to the companies in the field of bio-fuel and necessary technical guidance, planting material and monitoring of the plants and is helping Department of Rural Development in Jatropha plantation in 1000 hectares and has also helped farmers to set up 10 nurseries.

Biotech Park has the Quality Management System Certificate ISO 9001:2008/ISO 14001:200 Certificate jointly accredited by System of Australia and New Zealand. The Tissue Culture facility at the Biotech Park has been recognized under national certification of Tissue Culture raised plants (TCS- TCP) by the accreditation panel from BCIL.

More than 5000 students from about 40 schools / colleges and more than 1800 farmers visited the Park. The Park is playing an important role in generating the much needed human resource. It imparts training to young students and farmers from remote areas the park is actively involved in organizing the awareness program for farmers and stake holders. Recently Biotech Park has started a finishing school for the graduates and post graduates with the objective to make students employable in Biotech Industry by imparting additional skills through hands on exposure.

The park has changed the paradigm of how science, biotechnology and entrepreneurship can be clubbed for the benefit of stakeholders and the society. The Biotechnology Park, Lucknow has also been a trend-setter since it became fully functional in a span of three years from inception to maturity. It is a showcase of innovation industries and a model of active collaboration between industries, research institutes and academia. Besides holding hands of the start up companies, the Biotech Park has motivated local scientists to venture into Biotechnology. The setting up of Biotech Park has made Lucknow a new hub of biotechnology in North India and Biotech Park is a happening address in the city.

Azotobacter chroococcum: A Potential Organism in the Management of Crop Yield and Quality under Fly Ash Amendment

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India is the sixth largest electricity generating and consuming country in the world. Coal is a principal commercial fuel source of energy for power production in India and it contributes about 70% of total electricity for domestic purposes. With the increasing demand of power, more and more thermal power stations are expected to be commissioned in near future. Thermal Power stations using pulverized or lignite coal as fuel generate large quantities of fly ash as a by-product. In India alone, the production of fly ash is reached to more than 200 MT/year in 2011-12 and is projected to be 300 MT/year in 2016-17. Thus, the managemaent of such a huge quantity of fly ash is of prime concern with regards to its disposal. Moreover, it is categorized as high volume low effect waste under Hazardous Waste (Management and Handling and Transboundary movement) Rules, 2008. Nearly 2000 million tons of fly ash accumulated over a period of time in ash ponds of different thermal plants occupies nearly 1,00,000 acres of land. The problem with fly ash disposal lies in the fact that

not only ash leachates slowly, seep into ground water but also it remains air borne for a long period of time which further contaminates surface water as well as surface soil. With the commissioning of Fly Ash Mission by Government of India in the year in 1994 many projects focusing on the utilization of fly ash as raw material were initiated all over the country. So far a number of uses of this fly ash have been developed viz. substitute to cement in concrete, land filling, mine filling, agriculture etc. Practically fly ash consists of all the elements present in soil except organic carbon and nitrogen, thus it has been found to have a great potential material with manifold advantages in agriculture. Utilization of fly ash for agriculture purpose requires region wise extensive trials to identify suitable dose for a particular soil. It has been proved by several studies that the use of fly ash in agriculture provides a feasible alternative for its safe disposal to improve the soil environment and enhance the crop productivity.

Advantages of fly ash in agriculture

The utilization of fly ash in agriculture is proven helpful as it improves physical properties of soil hence fertility and crop yield to significant level. It alters the texture of soil such a way that it reduces bulk density, increases porosity, aeration and cation exchange capacity which increase water and nutrients holding capacity of soil. This retards the nutrient loss with water. Fly ash contains essential macro-nutrients like P, K, Ca, Mg and S and micro-nutrients including Fe, Mn, Zn, Cu, Co, B and Mo. The characteristic of fly ash to enhance the availability of soil nutrients to plants further attributes to increase value of chlorophyll and carotenoid pigments responsible in the process of photosynthesis. However, it also contains trace levels of Hg, Cd, Cr, Be, Pb, As, etc. Deficiency of organic carbon and nitrogen in fly ash can be fulfilled by addition of organic fertilizers and beneficial nitrogen fixing microbes. Among nitrogen fixing microbes *Azotobacter* is widely utilized as a biofertilizer along with fly ash amendment. It is proved to be beneficial in improving plant growth, yield and fertility of soil as well as nutrient status of crops under different levels of fly ash.

***Azotobacter chroococcum* : A nature friendly source of nitrogen**

A. chroococcum is the most commonly occurring species in arable soils of India. It belongs to the family *Azotobacter*aceae. This family includes various gram negative, aerobic, heterotrophic, catalase positive, free-living diazotrophic bacteria present in neutral and alkaline soil. It fixes nitrogen directly from the atmosphere and releases it in the form of ammonia into the soil. It is categorized under plant growth promoting rhizobacteria (PGPR) as well as it also acts as biocontrol agent against phytopathogens and also well known to thrive under stress conditions. It is also evaluated for its potential of biodegradation of harmful waste products like organophosphate insecticide. *Azotobacter* has been found beneficial to a wide array of crops covering cereals, millets, vegetables, etc under different ago-climatic conditions. It has been also proved that *Azotobacter* inoculation curtails the requirement of nitrogenous fertilizers by 10 to 20% under normal field conditions.

When applied as seed treatment or as soil application, they multiply rapidly and develop a thick population in rhizosphere. They derive food from the oranic matter present in the soil and root exudates. The beneficial influence of Azotobacter on plant growth is attributed to improvement in seed germination and promotion of vegetative growth and root development. Apart from its ability to fix atmospheric nitrogen in soils, it can also synthesize growth promoting substances viz., auxins, gibberellins, cytokinins, vitamins to a little extent it, performs phosphate solubilization. Besides it also has a good potential as biocontrol agent for also management of phytopathogens, nematodes and insects by producing siderophore, antifungal compounds and defense enzymes. Hence *Azotobacter* is not only an eco-friendly source of nitrogen but also provides the growth promoting substances to the plant.

Potential of utilization of fly ash with *Azotobacter*

Fly ash is good source of plant nutrients; however it is deficient in nitrogen. *Azotobacter* not only helps to fulfill the demand of nitrogen but also improves the availability of other nutrients and enhances their uptake by the plants. The polysaccharides secreted by the *Azotobacter* can help to trap heavy metals present in fly ash and hinder their absorption by plants. Therefore, the combination of both fly ash and *Azotobacter* can reduce the demand of expensive chemical fertilizers which later show adverse effects on soil quality. Authors are standardizing the dosage of fly ash with *Azotobacter* as a source of nitrogen in onion with the support of Fly Ash Unit of DST, GOI. Some important observations and expected benefits are discussed herewith.

Fly ash as a carrier for biofertilizer

Fly ash has been recognized as a potential raw material as a carrier for *Azotobacter* formulations. The formulations of *Azotobacter* are available in various carrier and liquid based. However, these formulation materials add to the cost without giving any additional advantage to the soil and crops. Further, they deplete the natural resources. The application of fly ash as a carrier for *Azotobacter* is expected to be an effective way for its management in a useful manner and simultaneously, it will reduce the environmental pollution and cost of formulation material. Up to 50% of fly ash with soil and different organic fertilizers particularly vermicompost was found to be suitable in improving the density of bacterial cells and shelf life of *Azotobacter*. Application of fly ash based inoculum on seed or in soil would also improve the sticking and action of bacterial cells by providing porous surface.

Improvement in establishment, growth and yield of crops

Presence of majority of macro and micro nutrients in fly ash in sufficient amount makes it an efficient material for agriculture. Authors have observed good establishment, survival and less disease in kharif season onion crop when amended with fly ash and *Azotobacter*. Fly ash is rich in silica that is beneficial for plant growth, due, to

overcome abiotic and biotic stresses by preventing lodging (falling over). *Azotobacter* has antifungal and antibacterial properties that increase resistance in plants against pests and diseases, as well as other stresses. Several studies have reported that 50 t/ha dose of fly ash significantly increases yield of some crops like wheat, rice, potato, maize, red gram, musturd, etc. Up to 40 % of increase was observed on inoculating *Azotobacter* with 50% chemical fertilizers in onion during rabi season at 50 t/ha dose of fly ash.

Improvement of soil physical properties and fertility

Management of agricultural sustainability requires optimal soil fertility and physical properties. It is reported earlier, combination of fly ash mixed with organic fertilizer, *Azotobacter* and 50% chemical fertilizer enhanced the fertility of soil and the water holding capacity, cation exchange capacity and availability of N,P,K, Ca, Mn, Zn was better in the soil than non- inoculated treatments. Fly ash also enhances soil bacteria count and enzyme activity of dehydrogenase, urease and alkaline phosphatase which are beneficial for plant growth. *Azotobacter* can survive at high dosage of fly ash even in the presence of heavy metals viz. Pb, Cd, As Cr etc. which could be due to their secretion of extracellular polysaccharide having protective roll against the toxic effects of these metals. Beneficial combined effects of flyash, organic fertilizers and *Azotobacter* on reduced heavy metal availability in soil could also be due to formation of complexes of heavy metals. *Azotobacter* spp. produces siderophores that binds iron, and molybdenum and controlling their concentration in soil.

Improvement in the nutrient uptake of crop

Fly ash is although rich in majority of macro and micronutrient but presence of heavy metals, may cause toxicity in product. In a study conducted by authors when the *Azotobacter* was amended in the presence of fly ash improvement in N, K, Ca and Zn in onion bulbs was observed during kharif season, with fly ash in comparison to chemical fertilizers. The secretion of plant hormones by *Azotobacter* enhances the uptake of many micronutrients by plants that improve their overall performance. At the same time levels of heavy metals viz. Cd, Cr, As, Pb, Hg were within permissible limit or below detectable limit.

Ancillary benefits

High efficiency of *Azotobacter* in atmospheric nitrogen fixation, phosphate solubilization and production of phytohormones and vitamins enables it to be used as a biofertilizer for enhanced plant growth. It has been observed that utilization of *Azotobacter* with fly ash could reduce the demand of chemical fertilizers up to 50%. Also, better association of AM fungi, phosphorus solubilizing microorganisms and actenomycetes was observed in the presence of *Azotobacter* that would further improve the sustainability of soil. Indirectly, it would also help in decreasing soil pollution, emission of CO_2 to environment by inorganic fertilizer industries and the cost.

Epilogue

Integrated nutrient management (INM) is an integral part of the sustainable agriculture which requires the management of resources in a way to fulfill the changing human needs without deteriorating the quality of environment and conserving vital natural resources. Fly ash rich in many macro and micronutrients could be used as a substitute to chemical fertilizers. Its amendment in standardized dose with *Azotobacter* would improve the overall crop production and simultaneously, it will also facilitate an efficient and economic way to combat the problem of rising pollution by fly ash ponds.

Role of Arbuscular Mycorrhizal Fungi In Phytoremediation

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Introduction

Excessive heavy metals contamination in soil have detrimental effect on ecosystems and pose risks to human health (HM) they enter the food chain via agricultural products (Liang *et al.*, 2009). The main source of heavy metal contamination include mining and smelting of metalliferous ores, industrial waste, mineral fertilizers, pesticides, vehicle exhausts and municipal sewage sludge (Qian *et al.*, 2005). When heavy metals particularly copper, zinc, chromium, lead, cadmium are taken up by plants in higher concentrations, they not only inhibit metabolic process but also reduce crop yield in plants. Further, through the incorporation into the food chain they can potentially cause human liver and brain disorders (Bibi *et al.*, 2006). Technologies presently available for the remediation of metal contaminated soils are expensive, time consuming and may produce secondary waste (Fitz and Wenzel, 2002). There is still need of an effective and affordable solution. In addition to sites contaminated by human activity, natural mineral deposits containing particularly large quantities of heavy metals are present in many regions of the globe. These areas often support characteristic plant species that thrive well in these metal enriched environments. Some of these species can accumulate very high concentrations of toxic metals to levels which far exceed the soil levels (Baker and Brooks, 1989). In many ways, living plants can be compared to solar driven pumps which can extract and concentrate several elements from their environment. All plants have the ability to accumulate elements like Mg, Fe, Mn, Zn, Cu, Mo, and Ni (Langille and

MacLean, 1976) which are essential for their growth and development, whereas certain plants have the ability to accumulate heavy metals which have no known biological function e.g. Cd, Cr, Pb, Co, Ag, Se, and Hg (Baker and Brooks, 1989). However, excessive accumulation of these heavy metals can be toxic to most plants. The ability to both tolerate elevated levels of heavy metals and accumulate them in very high concentrations has evolved both independently and together in a number of different plant species (Ernst *et al.*, 1992). Several higher plants developed strategies for heavy metal resistance enabling plants to survive in highly metal contaminated sites (Pilon-Smits, 2005). Zn at low concentration is important as micronutrient but in high concentrations this metal becomes toxic to plants. Plants readily accumulate Zn and excess Zn within tissues, inhibiting plant growth and rendering the crop unfit for human and animal consumption (Jeliazkova and Craker, 2003). Heavy metals are toxic at slightly higher levels than those at which they are required. High concentration of heavy metals in the soil has detrimental effects on ecosystems and is a risk to human health as they can enter the food chain via agricultural products or contaminated drinking water.

Role of AM fungi in phytoremediation

Phytoremediation, a sustainable and inexpensive technology based on the removal of pollutants including HM from the environment by plants, is burning issue in plant research. However, as phytoremediation is a slow process, improvement of efficiency and thus increased stabilization or removal of HMs from soils is an important goal. Various technologies exist that enable the detoxification/deactivation and removal of toxic compounds from the soil, mostly based on physicochemical extraction method. They are costly and completely destroy soil microorganisms. Bioremediation is the use of organisms for the treatment of soil pollution. Root colonizing symbiotic micro-organisms such as arbuscular mycorrhizal fungi (AMF) are mainly involved in phytoremediation, that uses plants for soil remediation. Phytoremediation refers to the use of green plants and their associated microbiota, soil amendments, and agronomic techniques to extract, sequest and/or detoxify various kinds of environmental pollutants (Salt *et et.al* 1998). These techniques have received considerable interest in recent years because of potential cost savings compared to conventional non-biological techniques.

An insight into heavy metal detoxification in plant: Role of AM fungi

Mycorrhiza is the mutualistic symbiotic association (non-pathogenic) of a specific group of soil-borne fungi (obligate) with the roots of higher plants (Sieverding, 1991). Plant receives support from AM fungi, with the help of its symbiotic association, in the aspect of uptake of phosphorus and other nutrients, enhancement of growth hormones, increase of protein content, increase of lipid, sugars, amino acid levels, increase of tolerance to heavy metals, increase of salinity tolerance, and resistance to root-borne pathogens. Studies have reported mycorrhizae in plants growing on heavy metal contaminated sites (Shetty *et al.*, 1995) indicating that these fungi have evolved a heavy metal tolerance. AM fungi provide an attractive system to advance plant-based environmental clean-up. During symbiotic interaction the hyphal network functionally extends the root system of their hosts. Thus, plants in symbiosis with AM fungi have the potential to take up heavy metal (HM) from an enlarged soil volume.

Plants need appropriate below-ground ecosystems, especially at difficult sites. Mycorrhizal fungi enhance root absorption area up to 47-fold (Smith and Read, 1997). The fungi provide nutrients and water otherwise not accessible for plants (Nadian *et al.*, 1997) and facilitate the establishment and survival of vegetation under stress conditions (Jasper *et al.*, 1989). The fungi also stabilize the tailing material with the net of hyphae and improve its structure, as they produce substances that bind soil particles, leading to the formation of soil aggregates (Jastrow *et al.*, 1998). The compounds produced by the extraradical mycelium can also take part in heavy metal chelation. Fungi are known to be able to accumulate significant amounts of heavy metals (Gadd, 1993) varying from a few percent to 20% of dry mass (Tobin *et al.*, 1984), suggesting that microbial biomass may affect the mobility of metals in the soil system. According to the calculations by Söderström (1979), the surface of interaction between fungi and soil is up to 0.14 m^2 in 1 g of soil. They can remove metals from the wastes both by metabolism dependent (bioaccumulation) or independent (biosorption) processes (Gadd, 1993). In the second case, both live and dead biomass can be involved (Volesky and Holan, 1995). The components of the fungal cell wall can be very efficient in binding heavy metals due to the presence of free amino, hydroxyl, carboxyl and other groups (Gadd, 1993). Therefore, saprobic fungi can be commercially grown in bulk culture and their either live or dead biomass used as biosorbents for heavy metals (Fomina *et al.*, 2005). Similar phenomena occur in ectomycorrhizal (Turnau and Dexheimer, 1995), ericoid (Bradley *et al.*, 1982) and arbuscular mycorrhizal fungi (Gonzales-Chavez *et al.*, 2004). Some of these microorganisms can also precipitate heavy metals outside the mycelium e.g. by producing various organic acids or enzymes such as the acid phosphates (Turnau and Dexheimer, 1995) or pigments, which additionally prevents the migration of metals. Arbuscular mycorrhiza (AM), occurring in 80% of plant species and formed by about 120 species of fungi belonging to the Glomeromycota (Schüßler *et al.*, 2001), is the most widespread type of symbiosis between fungi and plants. Besides the formation of the extraradical myceliar net that intensively penetrates the substratum (feature common to all types of mycorrhizas), it forms intraradical hyphae that penetrate intercellular spaces and enter cortical root cells. The formation of comparatively short-lived structures called arbuscules is crucial for the functioning of the whole symbiosis (Smith and Read, 1997). This is the place where the arbuscular cell wall is lined by plant plasmalemma, and the

exchange of substances takes place. AMF have not been shown to produce organic acids such as oxalic acid, however, glomalin, a protein produced by these fungi, seems to be efficient in sequestering Cu, Cd, Pb and Mn (Gonzales-Chavez *et al*., 2004). According to Joner and Leyval (1997), the efficiency of protection depends on the AMF isolate. These authors have also shown that no inhibition of mycelium growth was observed even at 20 mg of NH_4NO_3 -extractable Cd/kg of substratum. Retention of heavy metals in extraradical mycelium of ectomycorrhizas was first proposed as a tolerance mechanism by Denny and Wilkins (1987). The fungi can detoxify metals by intracellular processes (Blaudez *et al*., 2000). A variety of membrane transporters controlling the trafficking of metal ions have been identified recently in plants and microorganisms (Clemens, 2001). Intracellular detoxification in fungi and plants is attributed to metal chelation by cysteine-rich peptides such as reduced glutathione, phytochelatins and metallothioneins (MeT) (Cobbett and Goldsbrough, 2002). Cd-MeT was shown to take part in detoxification of heavy metals in the ectomycorrhizal fungus, *Paxillus involutus* (Courbot *et al*., 2004), while Cu2+-MeT was extracted from *Laccaria laccata* and *P. involutus* and their production was correlated with the tolerance to copper (Howe *et al*., 1997). Despite the increase of glutathione production, the content of phytochelatin was not increased, suggesting that at least in this fungus the cadmium detoxification mechanism is different from the mechanisms observed in the host plant. MeT-like sequences were identified in the ectomycorrhizal fungus *Pisolithus tinctorius* (Voiblet *et al*., 2001) and in the arbuscular fungus *Gigaspora rosea* (Stommel *et al*., 2001), although the metal sequestration capacity and actual MeT-like nature was not determined until recently. The identification and functional characterization of an MeT-encoding gene from *Gigaspora margarita* was demonstrated by Lanfranco *et al*. (2002), and in addition the differences in gene expression in symbiotic and pre-symbiotic stages were shown. Mycorrhizal fungi qualitatively and quantitatively influence the microbial population of the mycorrhizosphere. They are usually accompanied by bacteria such as legume symbiotic nodular bacteria, plant growth promoting rhizobacteria (PGPR), mycorrhiza helper bacteria (MHB) and saprobic fungi. As these organisms influence plants either by interactions with abiotic (Turnau and Kottke, 2005) and biotic components of the soil (Azcón-Aguilar and Barea, 1996), or by stimulating plant growth through the production of vitamins and hormones (Barea, 2000), they should be included in the optimization of the restoration processes as well as mycorrhizal fungi.

Conclusion and future prospects:

Phytoremediation is an emerging biobased alternative technology in the clean up of metal contaminated soil. The prospect of symbiont existing in heavy metal contaminated soil has important implication for phytoremediation. Mycorrhizal associations increased the absorptive surface area of the plant due to extra-matrical fungal hyphae exploring rhizosphere beyond the root hair zone, which in turn enhanced water and mineral uptake. The protection and increased mineral uptake results in greater biomass production which is important for successful remediation. The potentials of phytoremediation of metal polluted soil can be enhanced by inoculating hyper accumulator plants with mycorrhizal fungi most appropriate for polluted sites. The studies related to the dynamics of AM symbiosis in heavy metal phytoremediation have showed the existence of compromise between plant growth and heavy metal tolerance indicating the importance of metal binding process in buffering the soil environment. It is hence important to understand the contribution of AM symbionts to soil productivity and enhanced metal uptake at molecular level. Hence a comprehensive molecular and physiological understanding of mycorrhizospere dissecting the role of plant and mycorrhizal gene interaction in the process would be valuable to decipher plant tolerance mechanism under heavy metal stress specially with respect to phytoremediation.

NEWS & VIEWS

Indoor air pollution a silent killer

Indoor air quality has a great impact on our health. A recent research states that the indoor air quality is 2,200 times more polluted than the outdoor air and can affect an unborn child's IQ. A majority of paints are made of ingredients Volatile Organic Compounds (VOCs), which diminish air quality, and are detrimental to health. These ingredients are highly neurotoxic. Some traditional paints contain high VOC levels which cause lung, hearth diseases, respiratory disorders like chronic obstructive pulmonary disease, skin irritation, headaches, nausea, dizziness, chest congestion and lung irritation. Burning sensation in the eyes, nose and throat.

Eco-friendly paints should ideally be lead free, have VOC contents below 100g/L for a non-flat finish and 50 g/L for a flat finish. VOC emissions not only affect the health of the home-owners but also those who deal with paints on a regular basic, i.e painters.

Source: www Nerolac Healthy Homes.com

Health hazards of biomass burning

Polycyclic aromatic hydrocarbons (PAHs) are formed as a result of incomplete combustion of wood and fossil fuel for residential heating. PAHs are also found in gasoline and diesel motor vehicle exhaust and as by-products of open fires of refuse burning. Motor vehicles are a major source of

atmospheric PHAs in urban environment, while domestic heating, and residential wood combustion, in particular, are a major source of PHAs to outdoor rural air.

Cooking with biomass fuels has been associated with chronic obstractive pulmonary diseases. In India, adults under continuous exposure to smoke from dung and wood has been linked to confirmed tuberculosis. Biomass combustion produces a large number of health damaging are pollutants which include PAHs. Exposure to PAHs may cause cancer, cataracts, kidney and liver damage. Exposure to PAHs is the most a important contributory factors for induction of tumors in lung, urinary bladders, kidney, pelvis, mouth, pharynx, larynx and oesophagus. Residential biomass burning is expected to emit mixtures of PAHs probably adsorbed onto inhalable particles such as fine soot particles.

The major components of wood are cellulose and lignin. Wood also contains resins, turpenes and other substances. The rates of burning of various biomass types under poorly ventilated conditions in rural households vary.

During combustion, some biomass burn with flames while others smolder. Smoldering fires during biomass burning lead to emission of much higher PAH content than flaming fires due to lack of oxygen which favors incomplete combustion. Dry cow dung, used as fuel in some of the traditional grass-roofed households smolders, while wood burns with a flame. Shrubs and crop residues burn with intense flaming fires.

Source: F. A. Lisouza, P.O.Owuor, Joseph O. Lalah, Kenya in Environmental Pollution 159 (2011)

Life Flourishes even in the Cracks

Grasses and other plants that grow in sidewalk cracks are hardy plants that are generally written off as undesirable. They are routinely trampled, savaged by extreme summer heat, washed by rainfall and buried by winter snow. Their survival in such adverse conditions amply proves their resistance. Researchers at Saint Mary's University in Canada have examined plant species in sidewalk cracks and other nooks and corners. Their research demonstrates that hardy species found in the environments are similar to those occupying nature's own inhospitable spaces – steep cliffs and barren rock slopes. While the condition between pavement and cliff do not appear to be similar, the plant species that succeed in side walk cracks have similar qualities to ones that have adapted to inhabit crevices in exposed rocky, windswept places. This shows that our communities are not entirely human-created, unnatural environments but urban species are in many ways structurally and functionally equivalent to natural ecosystems.

The urban environment contains numerous ecological niches that have analogues elsewhere in nature. For instance birds often adapt to human environments. Some songbirds have learned to survive in noisy urban landscapes by changing the melodies they use to communicate. They sing higher notes to trump ambient background city noise and deeper notes in areas with many buildings and hard surfaces.

While some birds and crevice-loving plants have been adapting, the speed and scale of urbanization has pushed many native species to the brink of extinction. Planting native species in our gardens are increasingly important, because indigenous insects, birds and wildlife rely on them. Over millions of years, they have co-evolved to live in local climate and soil conditions.

Source : David Suzuki Foundation

Melting permafrost could speed up climate change.

Permafrost is the permanently frozen subsoil which covers nearly a quarter of the northern hemisphere. Formed during the last iceage it consists of an active layer of up to two meters in the thickness, which starts melting each summer and refreezes each winter, and the permanently frozen soil beneath. Most of the current permafrost formed during the last ice age may extend to depths of more than 700 meters in parts of Siberia and Canada.

Permafrost is one of the keys to the planet's future as it contains large stores of frozen organic matter that if melted and released into the atmosphere, would amplify current global warming and lead to a warmer world. Its potential impact on the climate, ecosystems and infrastructure has been neglected so far. Warming permafrost could radically alter ecosystems and cause costly infrastructural damage to increasing unstable ground.

Melting permafrost releases methane, a powerful greenhouse gas, although this has not yet been included in models of the future climate. Permafrost is estimated to contain 1,700 gigatonnes of carbon-dioxide, the amount currently in the atmosphere. As it melts it could push global warming considerably leading to a runaway climate change.

There is an urgent need to set up monitoring system in countries link permafrost including Russia, Canada, China and U.S.A

Source: Fiona Harvey, environment correspondent guardian.co.uk

Dioxin in plastic containers cause cancer

Dioxin is a highly toxic chemical which causes cancer, especially breast cancer. It is highly poisonous to cells in our bodies and is increasingly_found in breast cancer tissues. Bottled water left in a car should be avoided as heat reacts with the chemicals in the plastic of the bottle and releases dioxin into the water. Also, plastic bottles with water should not be frozen in refrigerator as it also releases dioxins. Heating food in microwave using plastic containers is far more hazardous. This especially applies to foods that contain fat. Instead of plastic containers glass, such as pyrex or ceramic containers should be used for heating food. Paper containers are increasingly being used in fast food restaurants instead of styrene foam containers because of dioxin problem. Plastic wrap, such as cling film, is just as dangerous when placed over foods to be cooked in the microwave. As the food is nuked, high heat causes poisonous toxins to actually melt out of the plastic wrap and drip into the food. Food can be covered with a paper towel instead.

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E-mail: dr_dalemartin@aol.co.uk

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Contact person: CBEES Senior Editor, Ms. Yang
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Contact: Dr Jitendra Pandey
Organizing Secretary ESEB- 13
Centre of Advanced Study in Botany
Banaras Hindu University, Varanasi- 221005
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Contact: Irene Moreno Millan
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Contact: Irene Moreno Millan
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