

# Abstract Book

Sixth International Conference  
on  
Plants and Environmental Pollution  
**(ICPEP-6)**

**27-30 November, 2018**



*Organised by*

**International Society of Environmental Botanists**

**&**

**CSIR-National Botanical Research Institute  
Lucknow, INDIA**





# CSIR-National Botanical Research Institute

(Council of Scientific & Industrial Research)  
Lucknow - 226001



Herbal Colors for Gulal



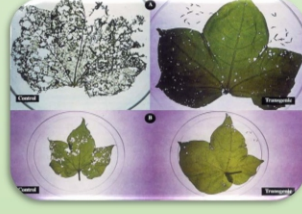
Herbal Cough Syrup



Herbal Hair Color



Whitefly Resistance Technology



Insect Resistant Bt-cotton Technology

## Technologies Available for Commercialization

- *Trichoderma* Consortium Technology for Plant Growth Promotion and Biological Control of Phytopathogenic Fungi
- Technology Package of Bacillus Strain for Plant Growth Promotion and Control of Phytopathogenic Fungi
- Herbal Sindoor Technology
- Herbal Antioxidant Formulation
- A Potential Herbal Combination for Alleviating Urolithiasis, Nephrolithiasis and Post Lithotripsy Conditions (ESWL)
- Floral Crafts from dehydrated Flowers & Foliage
- Agro-Technology for Gladiolus, Tuberose, Chrysanthemum Flowers

## We Provide Technologies and Know-How



Herbal Formulation for Diabetes Management (NBRMAP - DB)



Alcohol Free Herbal Hand Sanitizer



Nutri-Jam An Herbal Jam Rich in Nutrition



Herbal Lip Balm



Tobacco & Chemical Free Herbal Mixture



Herbal Fermented Health Drink



Herbal Lipstick



Polyherbal Dental Cream



Low Grain Arsenic Rice Cultivar CN1794-2-CSIR-NBRI (Muktashree)

For details please contact

Director, CSIR-National Botanical Research Institute,  
Rana Pratap Marg,  
Lucknow - 226001 U.P. (India) Phones : 0522-2297802,  
2297804, 2205848, 2205839; Fax : 0522-2205836, 2205839  
Website : [www.nbri.res.in](http://www.nbri.res.in); E-mail : [director@nbri.res.in](mailto:director@nbri.res.in)

# Abstracts

**Sixth International Conference  
on  
Plants and Environmental Pollution  
(ICPEP-6)  
27-30 November, 2018**

*Organised by*

**International Society of Environmental Botanists**

**&**

**CSIR-National Botanical Research Institute**

**Lucknow, INDIA**



# *Publication Committee*

**Dr. P.A. Shirke**

(Chairman)

**Dr. Vidhu Sane**

(Convener)

**Prof. R.S. Tripathi**

Dr. R.D. Tripathi

Dr. Nandita Singh

Dr. Vivek Pandey

Dr. Seema Mishra

Dr. Amit Kumar

Dr. K.N. Nair

Dr. P.C. Abhilash

Dr. Sudhakar Srivastava

Dr. Anjum Farooqui

Dr. Pankaj K. Srivastava

Dr. Soumit K. Behera

Dr. Shekhar Mallick

Dr. K.K. Rawat

Dr. Farah Deeba

Mr. Rajat R. Rastogi

Mr. Dilip Kumar Chakraborty

Mr. D.B. Shukla

## *Organizing Secretaries*

Dr. R.D. Tripathi

Dr. Nandita Singh

Dr. Vivek Pandey

# *Preface*

**E**nvironmental pollution is increasing exponentially with each passing season due to drastically changing human needs. The "Sixth International Conference on Plants and Environmental Pollution" (ICPEP-6), to be held in Lucknow, India, would be the venue when the luminaries of Environmental Science across the world would assemble to discuss and deliberate on the pressing environmental issues, and lay the path for future course of actions and research in the area of Plants and Environmental Pollution.

The "Sixth International Conference on Plants and Environmental Pollution" (ICPEP-6), was able to kindle for submission of about 413 abstracts for the four day event. These abstracts have been compiled into this "Abstract Book" which we received from the distinguished in the area of Environmental science to the novice research scholars, however, with gleam of new ideas.

The abstracts included in this volume were received within the prescribed time limit. All the submissions were peer reviewed and edited and classified into the eight themes of the conference and the abstracts were segregated in different sessions for oral and poster presentation. This time there was a lot of zeal from the young researchers for the oral presentation, keeping their enthusiasm in mind, the ratio of oral presentations were increased as compared to the last conference with opportunities to the young minds as well as to the peers of the respective sessions.

We place on record our deep sense of appreciation to Prof. S.K. Barik, Director CSIR-NBRI and President ISEB, for his whole hearted support in terms of logistic and expert opinion. We are thankful to Drs. R.S. Tripathi, P.V. Sane and K.J. Ahmad for their timely apt suggestions and encouragements. We are beholden to our contributors who regardless of their various assignments and commitments acceded to our request to commit their valuable time and expertise.

We are thankful to the Scientific Program Committee for categorizing the abstracts and editing them. We are also thankful to the staff of ISEB Secretariat for their co-operation in various ways.

We are indebted to the various sponsoring agencies for financial support which made this publication accomplishable. Finally the efforts of M/S Army Printing Press and their team metamorphosed the publication to the present form, we sincerely thank these people.

**Publication Committee  
ICPEP-6**

## *Scientific Programme Committee*

**Prof. R.S. Tripathi**

(Chairman)

**Dr. R.D. Tripathi**

(Convener)

Prof. R.P. Singh

Dr. O.P. Dhankher (USA)

Dr. F.J. Corpas (Spain)

Dr. Nandita Singh

Dr. Vivek Pandey

Dr. Prabodh Trivedi

Prof. G.S. Singh

Dr. Debasis Chakrabarty

Dr. Sanjay Dwivedi

Dr. Anjum Farooqui

Dr. Amit Kumar Gupta

Prof. M. Iqbal

Dr. S.N. Jena

Prof. Kumkum Mishra

Dr. Amit Kumar

Prof. Sheshu Lavania

Dr. Shekhar Malick

Dr. Seema Mishra

Dr. Soumit K. Behera

Dr. Pankaj Kumar Srivastava

Dr. P. Suprasanna

Dr. Preeti Tripathi

# *Contents*

<b>Special Lectures</b>	<b>:</b>		<b>1</b>
<b>Session S-I</b>	<b>:</b>	<b>Climate Change: Adaptation, Mitigation, Carbon Sequestration and Food Security</b>	<b>5</b>
<b>Session S-II</b>	<b>:</b>	<b>Biodiversity: Prospection and Conservation</b>	<b>33</b>
<b>Session S-III</b>	<b>:</b>	<b>Environmental Biotechnology and Microbiology</b>	<b>71</b>
<b>Session S-IV</b>	<b>:</b>	<b>Environmental Impact Assessment</b>	<b>103</b>
<b>Session S-V</b>	<b>:</b>	<b>Sub-tropical and Tropical Oak under Global Change</b>	<b>113</b>
<b>Session S-VI</b>	<b>:</b>	<b>Biomonitoring and Bioremediation</b>	<b>129</b>
<b>Session S-VII</b>	<b>:</b>	<b>Plant Response to Environmental Pollution</b>	<b>175</b>
<b>Session S-VIII</b>	<b>:</b>	<b>Contemporary Issues in Environment and Plant</b>	<b>215</b>
		<b>Author Index</b>	<b>241</b>





## **Special Lectures**



SL-1

## Environmental Crisis

*J.S. Singh\**

Department of Botany, Banaras Hindu University, Varanasi-221005, INDIA, Email: singh.js1@gmail.com

The Earth today is experiencing environmental conditions which it has never experienced in the past. For example, the CO<sub>2</sub> concentration has varied only between 180 to 280 ppm during the past 420,000 years but it has now increased to >400ppm. This human-dominated era which started since 1850 is now termed Anthropocene. The Living Planet Index (biocapacity of the Earth) fell by 56 per cent and Ecological Footprint (area of biologically productive land or sea required to produce food, material and energy) exceeded the Earth's biocapacity by 50%. The anthropogenic activities, to a great extent, are responsible for bringing about global climate change. Predictions indicate that the average temperature of the Earth's near surface could increase by 5.8°C, and sea level may rise by an additional 88 cm by the year 2100. The total temperature increase from 1850-1899 to 2001-2005 is 0.76 [0.57 to 0.95]°C, and the rate of sea level rise was 1.8 mm/yr between 1961-2003, and 3.1 mm/yr between 1993-2003. Using a Systems approach focusing on feedbacks, tipping points and non-linear dynamics, scientists have postulated that the Earth System may be approaching a planetary threshold and a rapid human-driven pathway towards a much hotter conditions- the hothouse earth (away from the glacial-interglacial cycles) and a changed biosphere, when parts of the earth can be devoid of human population. Important feedbacks that could maintain the earth system in Holocene-like conditions are weakening relative to human forcing but the Earth System has to be maintained in habitable, interglacial-like state. For India, predictions include: frequent dry days, 38% drop in per capita water availability by 2050, 50 million people would be displaced in coastal area due to sea level rise (two islands in Sunderbans are already submerged), by 2035 food grain production may fall by 30%, vector borne diseases and those associated with floods and droughts will increase, and 25% flora and fauna may be at a high risk of disappearance by 2030. World-wide, 2.2 billion people now living under moderate to

severe water stress will increase to 4 billion by 2025. 350 million ha of tropical forests have been deforested (0.8% per year) and 500 million ha of secondary and primary forests have been degraded, affecting the generation and flow of ecosystem services vital for human well-being. Biodiversity is the underpinning of ecosystem services. These services include (i) provisioning Services- goods such as food, fresh water, wood and fibre, (ii) regulating services- disease control, climate regulation, water purification, flood regulation, etc., (iii) cultural services- education, recreation, etc., and (iv) supporting services-nutrient cycling, soil formation, primary productivity, etc. Fourteen out of identified 24 services are now declining. According to one estimate, the current economic value of the 17 ecological services for 16 biomes is in the range of US \$ 16–54 trillion per year. Studies indicate that we have entered into a phase of mass extinction, today we seem to be losing two to five species per hour from tropical forests alone. This amounts to a loss of 16 million species populations per year or 1800 populations per hour. Artificial light is emerging as an important threat to biodiversity, particularly in coastal areas, which can increase prey intake by wading shorebirds, resulting in the depletion of local invertebrate densities, in the long term, and certain nesting sea turtles are more predominant in dark areas relative to well-lit coastal areas.

**Key words:** Environment, Biodiversity, Ecosystem, Climate.

SL-2

## Biodiversity: A Vital Resource for Civilization, Economic Development and Wellbeing

*C.K. Varshney*

Professor Emeritus and Distinguished Adjunct Professor (AIT, Bangkok.), School of Environmental Science, Jawaharlal Nehru University, New Delhi-110067, INDIA, Email: ckvarshney@hotmail.com

Biodiversity is the most complex feature of our planet and extremely vital for human society. It refers to diversity of living organism-plants, animals and microorganisms- at multiple scales of biological organization (genes, populations, species, and ecosystems) and can be considered at any geographic

scale -local, regional, or global. Biodiversity has evolved over millennia, is inherently dynamic, multidimensional, omnipresent and, regarded to have transformed earth's primeval atmosphere into oxygen rich atmosphere and more importantly it is only system that harvest and stores solar energy at a planetary scale. Humankind is obligately dependent on biodiversity for food, breath, medicine and other basic needs and wellbeing. The nexus between biodiversity and human civilization is the single most important factor responsible for sustaining human survival, scientific and industrial progress, economic growth and cultural evolution. Biodiversity viewed in the context of sustainable development offers opportunities for poverty eradication, human well-being and livelihood. In spite rapid stride in the growth of science and technology human dependence on biodiversity is rising and likely to remain indispensable in foreseeable future. Unfortunately, biodiversity is grossly undervalued and

under cared and often taken for granted. Wide spread deforestation, loss of habitat, growing pollution and climate change are serious threats to biodiversity. The current rate of global diversity loss is estimated to be 100 to 1000 times higher over the background extinction rate. It is estimated that half of all the species on the planet could go extinct by 2050- only 32 years from now. Biodiversity loss is a crisis of historical and planetary proportions. Biodiversity loss may amplify climate warming, and could lead to additional, unforeseen, and potentially irreversible shifts in the earth system. Despite numerous commitments, biodiversity loss continues to accelerate in all regions. The situation is alarming and unless urgent action taken now, poverty eradication, food and water security and sustainable future will remain elusive.

**Key words:** Biodiversity, Pollution, Climate change, Extinction.

**Session I**  
**Climate Change: Adaptation, Mitigation,  
Carbon Sequestration and Food Security**



SI/KN-1

## Challenges and Chances to Get More Crop per Drop by using Abscisic Acid Receptors

*Erwin Grill*

Chair of Botany, Technical University of Munich, GERMANY, Email: erwin.grill@wzw.tum.de

Plants are ferocious consumers of water. More than two third of anthropogenic fresh water use is channelled into agriculture contributing to social conflicts over water resources. The atmospheric carbon dioxide is taken up by plants for biosynthesis of organic compounds and this carbon influx is inherently associated with massive efflux of water vapour. The lecture will address the mechanisms involved in the homeostasis of plant's water status and whether high yield of plants can be combined with reduced water consumption by harnessing recent insights into the control of transpiration by the phytohormone abscisic acid (ABA).

**Key words:** Abscisic acid, Plant water status, Water use efficiency.

SI/L-1

## Vetiver Plant Type Suitable for Disaster Management in Climate Change Regime

*Umesh C. Lavania*

Department of Botany, Lucknow University, Lucknow-226007, INDIA, Email: lavaniauc@yahoo.co.in

Vetiver grass, *Chrysopogon zizanioides* (L.) Roberty, a perennial C4 grass, industrially valued for its aromatic essential oil in the roots, has of late attracted global attention as a natural means for multifarious environmental applications including detoxification of degraded soil and water. In order to realize enhanced potential of this grass to address environmental concerns, extensive studies are undertaken to identify and / or develop suitable genotypes, and extend scope of vetiver phytotechnology as a natural means to sequester atmospheric carbon deep into subsoil horizon, reduce landslides and mitigate spoiled soil dumps. The key prerequisites to address

such challenges are that the given genotype/s must be seed infertile to realize non-invasive features, must have low oil in its roots to serve as deterrent to root diggers, should sport deep penetrating web-forming root system to facilitate soil binding, and root architecture facilitating high heavy metal absorbing capacity to rehabilitate toxicity of the degraded soil dumps. Success achieved in this direction shall be illustrated to substantiate the utility of vetiver grass as a potential bio resource to address such environmental concerns.

**Key words:** Vetiver grass, Phytotechnology, Natural disaster, Environmental conservation, Remediation.

SI/L-2

## Climate Change: Past, Present and Future: Adaptation and Food Security

*A.K.M. Nazrul Islam*

Ecology and Environment Laboratory, Department of Botany, University of Dhaka, Dhaka, BANGLADESH  
Email: nazrul.islam.akm@gmail.com

The composition of the atmosphere is changing at an unprecedented rate because of manmade activities. Earth's climate has changed before many times in the last two billion years. But something important is different at present. The topic will be discussed in relation to (i) The Evolution of the Earth (Past and Present conditions) (ii) Increase of Human Population and its influence (iii) The change of CO<sub>2</sub> Concentration in the atmosphere (iv) An attempt to explain climate change in relation to adaptation and food security. The ancient and the future continent of the planet and the time span from about 20 kyr BP to the present will be discussed. The evidence for climate and chemistry from several different sources permits to know the environmental conditions in fair detail for a period substantially longer than that in recorded human history. The history of human population growth was calculated by extrapolation from census figures that exist for the present day agricultural societies and by examination of archaeological remains. Atmospheric CO<sub>2</sub> Concentration has gone both up and down during the long geologic history of the earth and the human inputs of CO<sub>2</sub> are one-way flux to the atmosphere, due principally to burning fossil fuel and deforestation, and to other land use practices and conversions. The

total human induced emissions of CO<sub>2</sub> were relatively constant from 1780 to 1860. Recent estimates suggest that the gross CO<sub>2</sub> emissions from deforestation and land use changes during the 1980s are approx. 1.6 Gt. of C per year. It was concluded that changes in carbon dioxide is a key factor in climate change and have had an important influence on climate, at least for the past 160 thousand years. Abundance of CO<sub>2</sub> was relatively high during the warmer Cretaceous and Eocene epochs. – interrupting measurements of isotopic composition (<sup>13</sup>C) of organic material from plankton preserved in ocean sediments laid down during the Cretaceous period and concluded that the level of CO<sub>2</sub> during the Cretaceous was 4 to 12 times higher than today. It appears from the data that a value between about 600 and 700 ppm may have applied during the most recent warm period of the Eocene. Evidence showed that temperature has decreased by about 3°C over the past 6000 years. From sea level studies of Bangladesh, it was postulated that an inundation of up to one third of the country due to 1m and 3 m rises in relative sea level by estimating the area below the 1m and 3 m contour lines due to changes in river gradients, sedimentation and drainage; the primary impact of global mean sea level on Bangladesh will be an increase in flooding in the depressed basins upstream rather than only at the coast or within the tidal limits. The warmest temperatures during the past 10,000 years occurred and the peak temperatures were observed during the period known as Hypsithermal, about 8000 to about 5000 radiocarbon years from now. Greenhouse gas emissions by the developing world have committed us to a mean sea level rise of only 2.7 to 3.5 cm by 2030 and 5.0 to 6.5 cm by 2100. Global climate change will increase the stress on agricultural systems, potentially decreasing yields at the very time when demand for food is growing dramatically. The question that requires an answer include: Are we approaching catastrophic climate change? The ends of the Earth will occur? Will The planet **exist**? The answer is very complex and uncertain. Future food habit may be changed dramatically.

**Key words:** Climate change, Earth's evolution, Future conditions, Food security.

SI/L-3

## Caring Our “Green Lungs”: Nurturing and Protecting Urban Trees and Forests under the Threats of Climate Change, Urbanization, and Pollution

*Somidh Saha<sup>1,2\*</sup>, Gerhard Sardemann<sup>1</sup>, Annika Fricke<sup>1</sup>, Sarah Meyer-Soylu<sup>1</sup>, Colette Waitz<sup>1</sup>, Oliver Parodi<sup>1</sup>, Andreas Seebacher<sup>1</sup>, Christine Rösch<sup>1</sup>, Jürgen Kopfmüller<sup>1</sup>, Axel Albrecht<sup>3</sup>, Bernd Stähler<sup>4</sup> and Andreas Matzarakis<sup>5</sup>*

<sup>1</sup>Institute for Technology Assessment and System Analysis, Karlsruhe Institute of Technology, Karlstrasse 11, D-76133 Karlsruhe, GERMANY; <sup>2</sup>Chair of Silviculture, University of Freiburg, Tennenbacherstrasse 4, D-79085 Freiburg, GERMANY; <sup>3</sup>Forest Research Institute of Baden-Württemberg, Wonnhaldestrasse 4, D-79100 Freiburg, GERMANY; <sup>4</sup>Garden Department of City of Karlsruhe, Lammstrasse 7a, D-76131 Karlsruhe, GERMANY; <sup>5</sup>Centre for Medical Meteorological Research, German Weather Service, Stefan-Meier-Strasse 4, D-79104 Freiburg, GERMANY, Email: somidh.saha@kit.edu

Cities and heavily urbanized areas in Germany are facing the challenge of preserving their green spaces (“green lungs”) under pressure from growing population and expanding infrastructure. At the same time, the vulnerability of urban regions to climate change-induced extreme weather events such as drought and heat waves has been increasing. Trees and green spaces in urban areas reduce air pollution, mitigate heat stress and provide other ecosystem services. But they too are vulnerable to climate change and air pollution (e.g. NO<sub>x</sub>). Therefore, there is an urgent need to assess the resilience of urban trees and forests to climate change and pollution impacts in order to reduce vulnerability. Significant trade-offs may exist between conflicting management goals in urban trees and forest management which should be minimized through participatory decision making. In this context, participation of civil society, research institutions, local public institutions, and other stakeholders is of vital importance for future adaptation planning for urban green areas. In this presentation, we will present an innovative trans disciplinary concept to increase the



resilience of urban trees and forests to multiple stressors of climate change and pollution. We will demonstrate how we could combine basic research, applied research, policy research, governance, and civil society under a trans disciplinary framework. We will present a case of on-going research in the city of Karlsruhe, Germany which is funded by the “Future Cities” program of the German Government. Our presentation may motivate Indian researchers, city planners, and policy makers to formulate similar trans disciplinary research for urban trees and forests in India cities; where problems of urban sprawling, pollution, and climate change are acute. We believe our presentation fulfills: the objective of the “Smart Cities” program by the Indian Government, and Indo-German bilateral research focus on climate change adaptation for future cities.

**Key words:** Climate change, Air pollution, Vulnerability assessment, Urban forestry, Urban greening, Environmental governance, Adaptation planning

SII/L-4

## Climate Change and Carbon Sequestration Monitoring in India

*S.P.S. Kushwaha*

Indian Council of Forestry Research and Education, Dehradun-248006, Uttarakhand, INDIA, Email: spskushwaha@gmail.com

Forests play a vital role in maintaining the atmospheric carbon balance by sequestering it into products like biomass, wood, and timber in addition to improving the soil fertility, providing a large number of ecosystem services, and thus, mitigating climate change over time. However, lack of accurate and spatially-explicit information on the carbon exchange components from diverse forest ecosystem types in India limits regional scale carbon budgeting. Remote sensing-driven ecosystem models are well-established tools for estimating gross primary productivity (GPP) over large areas. The present study used tall tower eddy covariance (EC) data and satellite-derived variables to estimate the carbon source/sink status of the a northern Indian mature moist deciduous/semi-evergreen sal (*Shorea robusta*) forest at Barkot in Dun Valley and upscale the GPP over entire Valley sal forest area.

One-year (2014-2015) observations on the ecosystem scale  $\text{CO}_2/\text{H}_2\text{O}$  fluxes and other micro-meteorological observations were analysed for elucidating the diurnal and seasonal pattern of carbon fluxes together with their response to biophysical and environmental parameters. Daily average minimum and maximum air temperatures in the study area ranged between 10.31 to 32.36 °C. Environmental factors governing carbon flux components were found to be related to maximum and minimum net ecosystem exchange (NEE) of carbon, GPP, and the ecosystem respiration ( $R_e$ ). On daily scale, maximum absorption of carbon took place on 244<sup>th</sup> day of the year (DoY) with a NEE value of  $-5.51 \text{ gC m}^{-2} \text{ day}^{-1}$  while maximum release took place on 219<sup>th</sup>DoY with a NEE of  $+7.83 \text{ gC m}^{-2} \text{ day}^{-1}$ . Highest GPP was observed on 244<sup>th</sup>DoY with a value of  $14.12 \text{ gC m}^{-2} \text{ day}^{-1}$  while lowest of  $0.21 \text{ gC m}^{-2} \text{ day}^{-1}$  on 61<sup>th</sup>DoY. Highest  $R_e$  of  $11.94 \text{ gC m}^{-2} \text{ day}^{-1}$  was noticed on 218<sup>th</sup>DoY and lowest of  $2.50 \text{ gC m}^{-2} \text{ day}^{-1}$  on 12<sup>th</sup>DoY. Clear variations in monthly NEE, GPP and  $R_e$  were observed during the study period. Higher leaf area index (LAI) and sufficient moisture conditions resulted in higher carbon sequestration during September through March. During pre-monsoon season (April-June), the NEE was lower due to lower LAI and higher vapour pressure deficit (VPD). During the rainy season (July-August), the carbon sequestration potential was highly impeded by cloudy conditions and the rain-accelerated  $R_e$ . Annual GPP,  $R_e$  and NEE of sal forest was  $2916.19 \text{ gC m}^{-2} \text{ year}^{-1}$ ,  $2408.32 \text{ gC m}^{-2}$ , and  $-507.89 \text{ gC m}^{-2} \text{ year}^{-1}$ .

For upscaling of GPP to entire Dun Valley biome, four remote sensing-driven models, viz., (i) temperature-greenness (TG) model, (ii) greenness-radiation (GR) model, (iii) light use efficiency (LUE) model, and (iv) satellite image-based LUE ( $\text{LUE}_{\text{RS}}$ ) model were parameterized with EC measurements and compared with 8-day Moderate Resolution Imaging Spectroradiometer (MODIS) GPP products. Our results showed that TG model had the highest root mean square error (RMSE) of  $1.28 \text{ gC m}^{-2} \text{ day}^{-1}$  while GR and  $\text{LUE}_{\text{RS}}$  models had moderate RMSE of  $0.99 \text{ gC m}^{-2} \text{ day}^{-1}$  and  $0.98 \text{ gC m}^{-2} \text{ day}^{-1}$ , respectively. The closest GPP estimate was obtained through LUE model with RMSE of  $0.93 \text{ gC m}^{-2} \text{ day}^{-1}$ . The RMSE for all four models were 4 times lower than that of MODIS GPP. Lower maximum LUE ( $\epsilon_{\text{max}}$ ) in MODIS GPP

algorithm contributed to higher RMSE. Our study highlights the need of EC data for estimation of net ecosystem level carbon exchange and calibration of satellite image-based GPP model for upscaling over large area.

**Key words:** Climate change, Carbon sequestration, GPP.

SI/L-5

## **Nitrate Seed Priming (Nitropriming) vis-a-vis Climate Resilient Agriculture**

**Bandana Bose**

Seed Priming Laboratory, Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221005, INDIA, Email: bbosebhu@gmail.com

In this century we are facing the biggest threat of climate change due to increasing population, demand for food, fodder and shelter, industrialization, urbanization including squeezing and over exploitation of arable land. Climate is now changing very erratically. Hence it is the time for Climate Resilient Agriculture so that our planet can be ready to face the challenges of food security now as well as in future by maintaining the sustainable development via adopting various technologies. Seed, being best delivery system in agriculture the plant scientists are engaged in developing various technologies which can protect crop seeds from various stresses, faced during germination in field. Seed priming is where controlled hydration and dehydration is employed in seed by initiating the process of germination but the protrusion of radicle is restricted. Seed priming ensures proper and synchronized germination and seedling development. Since more than three decades Bose and her group are working with seed priming technology using various salts containing nitrates, phosphates, carbonates and sulphates and have observed that among these, salts of nitrates performed best in normal as well as in stressed conditions. Plants, obtained from nitrate primed seeds develop the capacity to tolerate the drought, heat, cold, submergence and heavy metal stresses. This treatment also improves the quality of the produce. The influence of nitrate treatment has been drawn on the basis of studies related to germination physiology, nitrogen and antioxidant metabolism in the growing plants and their yield attributes. Therefore now this treatment technology can

be termed as nitropriming for its enormous beneficial effects instead of nutripriming. During nitropriming  $\text{NO}_3^-$  ion is fluxed in the seed and  $\text{NO}$ , an important signaling molecule for various abiotic stresses may be generated via the increased activity of nitrate reductase (NR) enzyme, as was observed in nitro primed okra seeds. Therefore it can be concluded that nitropriming is a suitable option to adopt for Climate Resilient Agriculture in this era. This lecture will summarize the impact of nitropriming on important field crops and its possible mechanism of action in respect to stress amelioration in various field crops.

**Key words:** Climate change, Seed, Nitro priming, Stress responses, Field crops.

SI/O-1

## **Adaptive Capacity of Different Norway Spruce Provenances to Lethal Drought**

**Tamalika Chakraborty\*, Tomasz Czajkowski and Andreas Bolte**

Thünen Institute of Forest Ecosystems, Alfred-Möller-Str. 1, 16225 Eberswalde, Germany Email: tamalika.chakraborty@thuenen.de, tomasz.czajkowski@thuenen.de, andreas.bolte@thuenen.de

Events of severe heat waves and droughts are becoming frequent in central Europe and impacting forest ecosystems. Norway spruce (*Picea abies*) is the most important commercial tree species in Germany. However, spruce is sensitive to drought, and thus maintaining forest structures with spruce will increase the risk of forest damage and loss of economic value. Our recent studies on European beech (*Fagus sylvatica*) revealed a high variation of drought tolerance among beech provenances. This enables to increase drought resistance and resilience of beech forest stands by selecting more drought tolerant provenances from the rear edge of the beech forest distribution with low precipitation rates within the growing season. Motivated by our previous research on European beech, we studied response of Norway spruce sourced from different European provenances to extreme drought. In a greenhouse pot experiment, a lethal drought was simulated using spruce seedlings of eight provenances in summer of 2017 (treatment: 100 plants per provenance, control: 20 plants per

provenance). Drought was applied until plants' death; during the experiment soil water availability (SWA, percentage proportion of available water AW), gas exchange, plant water status (pre-dawn water potential) and survival rate for each provenance were recorded. Based on survival rates, symmetric logistic survival functions (2 PL) for the different provenances were fitted. We found varying responses of mortality of plants between provenances to drought. The critical mortality rate of 50% (LD50) at remaining soil water availability (SWA) ranged from 7% for a provenance from East-German lowland with low yearly precipitation to 8.3% for a Bavarian mountainous provenance with considerably higher yearly precipitation. First seedlings of all provenances died when SWA had fallen below a critical threshold of 20%. These outcomes demonstrate the general possibility to increase drought resistance of Norway spruce regeneration by using more drought-tolerant provenances.

**Key words:** Adaptive forest management, Climate change impacts, Drought, LD50, Provenance trial, Tree mortality.

SI/O-2

## **Potential Impacts of Climate Change and Air Pollution on Plant Diversity in Nigeria: A Review**

*O.M. Mudasiru<sup>1,2\*</sup>, A.E. Ayodele<sup>2</sup> and T.S. Rana<sup>1</sup>*

<sup>1</sup>Plant Diversity, Systematics & Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, INDIA; <sup>2</sup>Department of Botany, University of Ibadan, NIGERIA Emails: opeyemi.mudasiru2013@gmail.com, bayodele@yahoo.com, ranats@nbri.res.in, a.e.ayodele@mail.ui.edu.ng, ranatikam@gmail.com

Climate change has become an issue in biodiversity sustainability and is one of the most disastrous global challenges of the millennium. Climate change gives rise to high temperature, erratic rainfall, high sea level and drought. Vegetation reflects environmental conditions. The diversity and the distribution of the world's vegetation is the product of a complex suite of interactions between individual plants, animals and a multitude of climatic and environmental variables. Every plant and animal plays a role in the forest ecosystems. Nigeria is rich in biodiversity

because the country is endowed with a variety of plants and animal species found in the boundless forests and grasslands. Nigerian plant species occur in different numbers within the country's vegetation that range from the rainforest and mangrove along the coast in the South to the Sahel in the North. Most of the plant species sustain the rural economy. Attention of Nigerians has been focused on plant species because of their forestry importance and commercial uses in a number of ways that affect human lives such as construction works, nutrition, entertainment, forensic medicine, pharmaceutical and cosmetic industries. In spite of the socio-economic and medicinal values of the plant species to human well-being and sustainable development, Nigerian plant species are still facing prejudicial challenges of climate change. These ecological dilemmas were directly attributed to high level of human activities due to deforestation, over population, over harvesting of wild plants for logging, medicine and food; pollution in the cause of energy generation through firewood, electric power supply and industrialization processes. The consequent effects of which were decline in soil fertility, lowering of potable water, shift in the seasons, starvation, increase in incidence of pests and diseases and increased crime rate. This paper highlights the threats, challenges and effects of climate change and air pollution on the Nigerian plant species as well as suggesting possible remedy to the menace through intensive afforestation programmes by establishing woodlots, shelterbelts, orchards and agro-silvicultural system as well as the application of effective environmental management actions to reverse the process and safe-guard future occurrences.

**Key words:** Climate change, Deforestation, Air pollution, Over-harvesting, Nigeria.

SI/O-3

## **Study of Ecotypes with Respect to Productivity**

*Nisa Yusuf Babwane*

SIES college of Arts, Science and Commerce, Sion West, Mumbai- 400022, Email ID: nisababwane@gmail.com

This study dealt with physical and physiological characters of plants growing in favorable and

unfavorable condition. Plants selected for this study were *Cynodon dactylon*, *Nerium oleander* and *Ficus benjamina*. Leaf samples collected from the plants were studied and analysed. Physical characters were includes leaf area index, dust load on the leaves, injured leaf area, pH of soil and water holding capacity of soil. Physiological characters were includes protein content of leaves, starch content of leaves and chlorophyll content of leaves and also total carbon content of soil. The results of this study found that the plants growing in favorable region have more productivity as compared to the ones growing in unfavorable region. Plants growing in garden site differ from plants growing in roadside both morphologically and physiologically.

**Key words:** Leaf area index, Dust load, Water holding capacity, Roadside.

SI/O-4

## **Postharvest Training and Services Centers can Help in Food Security and Environmental Protection by Reducing the Postharvest Losses**

*Mohmad Arief Zargar*

Department of Botany, University of Kashmir, Srinagar-190006, J&K, INDIA, Email: arifk11@yahoo.co.in

30-50% (1.2–2 billion tons) of all food produced on the planet is lost and not consumed. 40–50% of horticultural crops produced in developing countries are lost before consumption. It indicates that about 50% of investments made for production of food goes waste, especially on fertilizers, pesticides, fuel, energy, labour and water. Food production (agriculture) is one of the major causes of pollution and even climate change. So rather than increasing food production, it is better to reduce the loss of what is produced. Therefore, reducing postharvest food losses are more fruitful than increasing food production in terms of economic and environmental costs/returns. Commodity System Assessment (through well-structured questionnaires) of fresh fruits (apple and cherry) and vegetables (onion and potato) in Kashmir revealed improper harvesting and obsolete practices of post harvest handling and management as main causes for huge post harvest losses. The biggest causes are temperature

mismangement of apple and cherry, and postharvest sprouting of onions and potatoes. Following standard procedures of harvesting and post harvest handling can drastically reduce postharvest losses, with no or little additional cost, but certainly high returns. However, stakeholders, especially growers, neither know the cause of problem nor the means to control it. So first and foremost step would be to sensitize and practically educate them about the causes of problem, and the need and ways to control it. Though simple and standard techniques do exist in developed countries to address many such causes, but the access/means and knowledge about them is lacking among stakeholders in developing world (like Kashmir). Thus, practical education/ training of stakeholders through Postharvest Training and Services Centers (PHTSC) can help in reducing Postharvest Losses, which in turn can increase food availability and food security and thereby reduce over-reliance on production-oriented activities and hence help in environmental protection.

**Key words:** Postharvest Losses, Training, Education, Knowhow, Handling, Food security, Pollution.

SI/O-5

## **Impact of Climate Change on the Potential Distribution of Himalayan Juniper (*Juniperus squamata*), an Alpine Shrub in Himalayas**

*Maroof Hamid<sup>1</sup>\*, Anzar A. Khuroo<sup>1</sup>, Rameez Ahmad<sup>1</sup> and Bipin Charles<sup>2</sup>*

<sup>1</sup>Centre for Biodiversity and Taxonomy, Department of Botany, University of Kashmir, Srinagar-190006, J&K, INDIA; <sup>2</sup>Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Srirampura, Jakkur PO, Bengaluru-560064, INDIA, Email: hamidmaroofmudasir@gmail.com

In recent times, the rising annual mean temperatures due to contemporary climate change have shifted the latitudinal and altitudinal limits of many species. This is particularly concerning for alpine species, for which there may not be sufficient suitable habitats available at higher altitudes to facilitate their upslope migration. *Juniperus squamata* (Himalayan juniper) is a dwarf cushion-forming alpine shrub, which occurs at an altitude ranging from 3000-4500 m, and

acts as natural conservation microrefugia for many threatened species endemic to Himalayas. The present study models the potential distribution of *J. squamata* using ensemble approach in *Biomod2* package for present and future (RCP's 2.6 and 8.5 covering 2050 and 2070). The results indicated an expansion of climatic suitability of *J. squamata* towards much higher elevations into areas that are currently unsuitable and on the other hand, several currently suitable areas may become climatically low or unsuitable in the future. Currently, the total climatically suitable area for this species is 126774.66 km<sup>2</sup>, with an additional area becoming suitable under RCP 2.6 (2050 and 2070) and RCP 8.5 (2050 and 2070). The results also revealed a northward shift and upslope advance of existing suitable climate for *J. squamata* in future climate scenarios. Hopefully, the research insights from the present study will help in understanding the impacts of climate change on alpine vegetation in Himalayas with wide implications for scientifically-informed adaptation and mitigation strategies.

**Key words:** Alpine, Climate change, Himalayas, Microrefugia, Mountains.

SI/O-6

## Impact of Conservation Agriculture Practices on Productivity and Stratification of Soil Carbon in Indo-Gangetic Plains of India

*Ajay Kumar Mishra*<sup>1\*</sup>, *Hitoshi Shinjo*<sup>1</sup>, *Hanuman Sahay Jat*<sup>2</sup>, *Mangi Lal Jat*<sup>2</sup>, *Raj Kumar Jat*<sup>3</sup> and *Shinya Funakawa*<sup>1</sup>

<sup>1</sup>Terrestrial Ecosystem Management Laboratory, Graduate School of Global Environmental Studies, Kyoto University, Kyoto, JAPAN; <sup>2</sup>International Maize and Wheat Improvement Centre, New Delhi, INDIA; <sup>3</sup>Borlaug Institute of South Asia, International Maize and Wheat Improvement Centre, Bihar, INDIA, Email: akm8cest@gmail.com

Climate change and food security threatens the present agriculture and is of great concern in developing

countries particularly India. Conservation agriculture (CA) offers a low-cost strategy for mitigating climate change by sequestering carbon in soil and is based on the principles of minimal tillage, residue recycling and crop diversification for resource conservation and sustainable agriculture promote soil carbon restoration by tipping the balance in favor of carbon inputs relative to carbon outputs. Carbon storage (sequestration) in the soil can be achieved by maximizing carbon inputs and minimizing carbon outputs. Soil carbon fractions are influenced by the agronomic management practices adopted in CA systems. Contrasting cropping systems, tillage and residue management have a significant influence on soil quality, C and N cycling. SOM stratification (SR) and carbon management index (CMI) as an indicator of soil quality, related to the rate and amount of SOC sequestration generally used for natural and managed ecosystems. In general, the high values of stratification ratio (proportion of a soil property at the surface layer to that at a deeper layer) indicate good soil quality and are usually used to assess agricultural practices. Experimental trials in two research station (Karnal, Haryana, India and Samastipur, Bihar, India) on CA was established in 2012. This study aimed to 1) assess the stratification of soil carbon pools; and 2) evaluate the soil quality of different CA practices using SR and CMI values as the primary assessment parameters. Soil carbon stock increased in zero tillage and permanent beds as compared to conventional practices. Responses of SR in different CA practices to change of soil depth were significantly different with the highest value in zero tillage. The SR values of labile carbon fraction differed significantly only up to plow layer (0-5:5-15 cm). Short-term practices (5-years) of CA in Indo-Gangetic plains of India influences the distribution and stratification of soil carbon pool. Our study revealed that SR of carbon pool serves as an efficient indicator for short-term changes offered by CA practices. CA systems not only sequestering substantial carbon in soil but also enhances productivity and resilience of the cropping system to attain the goal of sustainable agriculture.

**Key words:** Carbon sequestration, Stratification ratio, Infiltration rate, System productivity, Residue load.

SI/O-7

## Winged Bean (*Psophocarpus tetragonolobus* L. DC.): A Completely Edible and Underutilized Legume in Tropical Countries for Food and Nutritional Security

*Ajeet Singh\* and P.C. Abhilash*

Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: ajeetbhu97943@gmail.com

Winged bean (*Psophocarpus tetragonolobus* DC), aptly described by National Academy of Sciences, United States of America as a 'supermarket on a stalk' is an underexploited legume of the tropics. The leaves, shoots, flowers, young pods, seeds and tubers are all edible and rich sources of proteins, minerals and vitamins. The crop can be luxuriously grown in hot and humid tropical countries and can be easily grown on roadside, boundaries of field, and home gardens. Owing to its high nutritional significance and ecological adaptations, it can be projected as a futuristic crop under changing climatic conditions. Therefore, extensive field survey has been conducted in Eastern Uttar Pradesh for knowing the occurrence and distribution of winged bean as well for collecting germplasm for large-scale exploitation. While the cultivation of winged bean is extremely low in Eastern UP, our study indicates that it can grow well in hot and humid environment and even in disturbed and nutrient poor soils. Large scale exploitation of winged bean can complement the food and nutritional security initiatives in tropical countries and therefore, suitable conservation and crop improvement programs are imperative for ensuring the environmental sustainability of winged bean cultivation.

**Key words:** Environmental sustainability, Food security, Nutritional security, Tropical countries, Winged bean.

SI/O-8

## Estimation of Carbon Sequestration Potential of *Citrus sinensis* in Tropical Zone of Arunachal Pradesh

*R. Bordoloi\*, H. Dabi, B. Das, A. Paul and O.P. Tripathi*

Department of Forestry, North Eastern Regional Institute of Science and Technology (Deemed to be University), Nirjuli-791109, Arunachal Pradesh, INDIA, Email: ritashree.100@gmail.com

The study was carried out to determine the carbon stock and net carbon sequestration potential of land cover under *Citrus sinensis* plantation in tropical agro-climatic zone of Arunachal Pradesh. Altogether, fifteen (0.1ha each) permanent plots were established along the altitudinal gradients and carbon stock was measured using standard methodology / allometric equations and carbon sequestration potential using age of the plantation crops. Soil samples were also collected in replicate and brought to the laboratory for further chemical analysis. Stand density of the plantation ranges from 476 stems/ha to 620 stems/ha having the basal area variation of 3.36 m<sup>2</sup>ha<sup>-1</sup> to 10.63 m<sup>2</sup> ha<sup>-1</sup>. The individuals have been grouped into four age classes i.e., 10, 15, 20, >25 years. The aboveground biomass values of the plantation crop were 23.45 Mg ha<sup>-1</sup>, 30.57 Mg ha<sup>-1</sup>, 70.89 Mg ha<sup>-1</sup> and 71.43 Mg ha<sup>-1</sup> in aforesaid age-classes. The belowground biomass was 8.54 Mg ha<sup>-1</sup>, 8.86 Mg ha<sup>-1</sup>, 20.56 Mg ha<sup>-1</sup> and 20.71 Mg ha<sup>-1</sup> in 10, 15, 20 and >25 year old plantation, respectively. Total biomass carbon calculated from the plantation crop ranged between 20.89 Mg C ha<sup>-1</sup> and 50.67 Mg C ha<sup>-1</sup> and biomass carbon accumulation was positively correlated and increased with increase in age of plantation ( $r^2 = 0.99$ ). The soil organic carbon content ranged from 35.89 Mg C ha<sup>-1</sup> to 75.76 Mg C ha<sup>-1</sup> among plantation the different ages. The litter carbon content varied from 0.56 MgC ha<sup>-1</sup> to 2.46 Mg C ha<sup>-1</sup>. Total carbon stock in the present study ranges from 57.79 Mg C ha<sup>-1</sup> to 101.44 Mg C ha<sup>-1</sup>. It was found that older plants sequester comparatively more carbon than the younger ones except in some of the carbon pools like litter and soil, which could be mainly attributed to management practices in form of litter collection. The combined approach of statistical regression along

with field based data were used to predict the carbon density map using various geospatial tools coupled with satellite data.

**Key words:** Carbon sequestration, Citrus plantation, Regression, Vegetation indices.

SI/O-9

## Integrated Farming Strategies for Climatic Resilient Agriculture under Rain-Fed Conditions in North West Himalayan Regions

**Gulshan Kumar\* and Hem Chander**

Division Botany, Department of Bio-Sciences, Career Point University Hamirpur, Himachal Pradesh-176041, INDIA  
Email: sharmagulshan1980@gmail.com, hemchander78@gmail.com

The results of the national innovation on climatic resilient agriculture (NICRA) investigations on integrated farming strategies to cope with rain-fed conditions of Hamirpur district of Himachal Pradesh are being described. On the basis of hydrological and technical as well as social and cultural conditions, appropriate technological strategies have been implemented to combat the effects of climate change. The main objective was to enhance the resilience in agriculture. The top most priority of the present study was to way out the source of water for meeting minimum critical water needs of crop diversification and maintenance of ecological balance under rain-fed conditions and to analyze their technical/economical feasibility as well as their affordability for future users. The present study reveals that it is economically feasible to apply decentralized technologies and strategies in farming system for climatic resilient agriculture universally.

**Key words:** Crop diversification, Livestock, NICRA, Rain-fed, Resilience.

SI/O-10

## Detection of Mycoflora and Mycotoxin in Raw and Roasted Peanut Kernels in Bangladesh

**Md. Maniruzzaman Khandaker<sup>1\*</sup>, Tasmilur Rahman<sup>1</sup>, Motiur Rahim<sup>2</sup>, Maksuda Begum<sup>2</sup> and Tariqul Islam<sup>2</sup>**

<sup>1</sup>Department of Botany, Jagannath University, Dhaka, BANGLADESH; <sup>2</sup>Food Toxicology Research Lab, BCSIR, Dhaka, BANGLADESH, Email: maniruzzamanbot@gmail.com

Raw peanut kernel samples were collected from thirteen areas of Bangladesh for determination of mycoflora and mycotoxin. Fungi associated with the tested samples throughout the investigation were *Aspergillus flavus*, *A. niger*, *Aspergillus* sp. (1), *Aspergillus* sp. (2), *Penicillium* sp., *Fusarium* sp., *Rhizopus* sp. and *Curvularia* sp. *A. flavus* was the most occurred fungus followed by *A. niger*. Colonies of fungi were formed in 79.81% to 98.10% of raw peanut kernels. Out of the thirteen samples, eight samples were found to be contaminated with the range 11.91ppb to 182.62ppb of total aflatoxins and five samples were free from aflatoxins. Another ten samples of roasted peanut kernels were collected from different areas of Bangladesh for determination of mycoflora and mycotoxin association. Fungi associated with the roasted samples were *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus* sp. (1), *Aspergillus* sp. (2), *Penicillium* sp., *Fusarium* sp., *Rhizopus* sp. and *Curvularia* sp. A total of 3630 fungal colonies were formed. Among these fungal colonies the highest 39.12% of colonies were formed by *Aspergillus flavus* and the lowest 1.68% colonies were formed by *Curvularia* sp. The highest 73.91% of the kernels of sample 01 were found infected while in sample 05 it was 25.17%. Out of ten roasted peanut samples four were detected with various amounts of aflatoxins (B1, B2, G1, G2). The highest 38.94 ppb of total aflatoxins were detected in sample 02 and the lowest 5.67 ppb of total aflatoxins were found in sample 01. Six roasted samples were free from aflatoxins.

**Key words:** Raw peanut kernel, Roasted peanut kernel, Mycoflora, *Aspergillus flavus*, Aflatoxin.

SI/O-11

## **Overstory Species Regulation of Understory Tree Physiology and Microclimate: A Case Study in Three Contrasting Tropical Deciduous Forest Associations of Terai Region in Northern India**

*Nayan Sahu*

Department of Botany, Indira Gandhi National Tribal University, Amarkantak, M.P., India, Email: nayansahu@igntu.ac.in

The understory is imperative to tropical forest ecosystems and reflects a high stress environment where vital resources that plants need are often in short supply. Understory lacks much needed detail physiological data for the development of site and species-specific predictive carbon budgeting models of understory vegetation response to change in forest types and management strategies. Exhaustive leaf gas exchange, chlorophyll fluorescence, microclimate, leaf water relations, Leaf area index (LAI) and Phytosociological attributes were quantified across three contrasting forest association (FA): Dry mixed (DM), Teak forest, and Sal mixed (SM) in tropical moist deciduous forest of terai region for investigating role of over story tree association in controlling microclimate and understory tree physiological performance. The variations were largely explored among five understory woody species (*Mallotus philippensis*, *Tectona grandis*, *Shorea robusta*, *Clerodendrum viscosum* and *Tiliacora acuminata* belonging to four different growth forms (understory tree, tree sapling, shrub and climber). Dominant monoculture Teak FA showed higher diurnal photosynthetic rates (all the 5 species) owing to increased understory PAR (Photosynthetically active radiation) availability (due to applied silvicultural practices and uniform phenophases). Heterogeneous canopies (SM) provided extremely low PAR and sun fleck (availability) to understory vegetation thereby limiting assimilation rates as compared to Teak forest under ambient conditions. Dry mixed FA showed higher understory LAI values in contrast to other FA due to modified local competitive hierarchies, heterogeneous resource availability and utilization among species.

Overall a complex interlinking was found between microclimatic variables, photosynthetic responses and species association. Polynomial quadratic regression functions applied to explore relationships, showed PAR and vapour pressure deficit (VPD) as major factors limiting understory leaf level photosynthesis. Addressed diurnal and spatial variability in microclimate, tree physiology along different species associations will provide vital inputs for various dynamic global vegetation models in predicting and refining net ecosystem exchange at regional and global level.

**Key words:** Understory photosynthesis, Gas exchange, Plant functional types, Sunflecks, Leaf area index, Ecophysiology.

SI/O-12

## **Mid-Pliocene and the Present Climate -Vegetation Equilibrium: Arctic-Asian Monsoon Teleconnections**

*Anjum Farooqui\* and Salman Khan*

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow-226007, INDIA Email: afarooqui\_2000@yahoo.com

The sea ice covers in the Arctic contributes to seasonal weather changes in tropics and have immense implications on Earth's climate. The oceanic circulation leading to exchange of cold and warm water creates weather conditions that we experience. During Mid-Late Pliocene epoch the CO<sub>2</sub> level reached 355-415ppm and the temperature was 2-3°C higher than the present. Global climate is rapidly evolving in present time with increased CO<sub>2</sub> concentration (406 ppm: NOAA, 2017) and the projected global mean temperature is estimated to be 1.84-3.60°C. An alarming rate of CO<sub>2</sub> increase is attributed to global warming enhanced by anthropogenic activities. Since vegetation of a particular area at a given time is in equilibrium with the prevailing climatic conditions, the pollen grains preserved in the natural archives are derivatives of the then existing vegetative cover in a particular time bracket. The vegetational reconstruction through pollen evidences in sediments allows us to infer climatic conditions and its fluctuation through a time period. The palynological studies of IODPHole (IODP-910C) from Arctic region has been partially analyzed in a time bracket of 3.4-2.6 Ma (Mid-Pliocene Epoch). The overall palynological results reveal a high percentage of broad leaf temperate



taxa namely *Alnus*, *Corylus*, *Betula*, *Carpinus*, *Quercus* suggesting a relatively warmer temperate climate in the region supporting the vegetation that grows well in frost free climatic conditions. Similar synchronous trend of high to low percentage of pteridophytic and bryophytic spores along with fungal spores was observed. The study is also supported by moderate percentage of dinoflagellate cysts, poorly preserved brackish water centric diatoms indicating the paralic sediment deposition. The inferred warm temperate climate in the Arctic polar region during the mid-Pliocene and its consequences on the Asian Monsoon system is potentially important for predicting the impacts of global warming in the near future.

**Key words:** Pliocene, Climate, Vegetation, Arctic, India.

SI/O-13

## **Intercropping Practices in Juvenile Oil Palm Plantations to Evaluate Crop Yield and Carbon Sequestration Services in Mizoram, Northeast India**

*Soibam Lanabir Singh, Uttam Kumar Sahoo\* and Anudip Gogoi*

Department of Forestry, School of Earth Sciences and Natural Resource Management, Mizoram University, Aizawl-796004, Mizoram, INDIA, Email: uksahoo\_2003@rediffmail.com; uttams64@gmail.com

Oil palm cultivation involves a long gestation period (3-4 years) in the initial years after planting posing a threat to smallholder farmers, and hence intercropping could provide for additional revenue. The experiment was carried out between 2016 and 2018 to determine the yield of crops and its effect on growth and development of main oil palm. Different intercropping experiments were designed with standard oil palm density (148 palms ha<sup>-1</sup>) in an intensive three-year sequential cropping. Complete randomized block design with three replicates was adopted and the treatments consisted of: Sole oil palm (T<sub>0</sub>); Oil palm + Maize (T<sub>1</sub>); Oil palm + Turmeric (T<sub>2</sub>); and Oil palm +Ginger (T<sub>4</sub>). Results showed that maximum oil palm growth development in terms of height, girth and estimated above ground biomass was observed in T<sub>0</sub>, however, the different treatments did not have any significant

difference (p<0.05). On an average, the yield of maize, turmeric and ginger intercropped were 2.68, 6.15 and 6.96 t ha<sup>-1</sup> respectively, which are lower than average yields from sole crops. It was observed that the intercropping of maize had significantly (p<0.05) increased yield while turmeric and ginger decreased over the years. Maximum above ground biomass (33.35 Mg ha<sup>-1</sup>) and carbon storage (15.67 Mg C ha<sup>-1</sup>) was found in Oil palm +Maize intercropping systems with significantly higher carbon sequestration rate (5.22 Mg C ha<sup>-1</sup> yr<sup>-1</sup>) as compared to other treatments. The results indicate that intercropping in juvenile oil palm plantations could have coupling effects both beneficial in providing additional crop yield and also carbon sequestration services. The practice can be an alternative to shifting cultivation and helpful in reclaiming degraded lands in the wake of climate change mitigation efforts.

**Key words:** Intercropping, Oil palm, Carbon sequestration.

SI/O-14

## **Prospects of Bamboo Resources Available in Northeast India in Boosting Socio-Economic Condition of the People and in Mitigating Climate Change**

*L.B. Singha<sup>1</sup>\*, O.P. Tripathi<sup>1</sup>, M.L. Khan<sup>2</sup> and R.S. Tripathi<sup>3</sup>*

<sup>1</sup>Department of Forestry, North Eastern Regional Institute of Science and Technology (Deemed to be University), Nirjuli, Arunachal Pradesh, INDIA; <sup>2</sup>Department of Botany, Dr. H.S. Gaur Central University, Sagar, Madhya Pradesh, INDIA; <sup>3</sup>National Botanical Research Institute, Lucknow-226001, UP, INDIA Email: lbsingha@hotmail.com, khamml61@gmail.com, tripathirs@yahoo.co.uk

Northeast India is rich in bamboo resources as it provides favorable ecological niches for different bamboo species. The region harbors more than 60% of the country's bamboo resource in terms of diversity, and more than 66% of the growing stock of bamboos is present in this region. They are mostly woody, native and endemic. Only a few exotic species are found in the region. *Bambusa balcooa*, *B. tulda*, *B. nutans*, *B. cacharensis*, *B. polymorpha*, *Dendrocalamus giganteus*, *D. hookeri*, *D. sikkimensis*, *D. latiflorus*,

*Schizostachyum dullooa*, *Melocanna baccifera* etc. are large-sized bamboos with high commercial values and multiple applications. Tender shoots of *ca.* 16 bamboo species in both fresh and fermented forms are highly commercial as vegetable with an annual consumption of more than 7000 tonnes and a net annual income of *ca.* 50 million rupees, contributing significantly to the socio-economic condition of the rural people. Most of the bamboo species occurring in the region are grown in home gardens, whereas few develop into pure brakes forming secondary successional forests. Due to fast growing nature, bamboos act as an important carbon sink. The rate of carbon sequestration by bamboos may exceed that of the native tree species. Large-sized bamboo species accumulate more than 290 tonnes  $\text{ha}^{-1}$  biomass with a net primary productivity of *ca.* 47 tonnes  $\text{ha}^{-1} \text{yr}^{-1}$ , which is almost double the rate exhibited by eucalypt clones. The carbon pool in standing crop of many bamboo species with *ca.* 149 tonnes of C  $\text{ha}^{-1}$  in 6 years old plantations is even higher than that of 40 years old teak forests which accumulate hardly *ca.* 126 tonnes of C  $\text{ha}^{-1}$ .

**Key words:** Bamboo resources, Northeast India, Carbon sequestration, Carbon pool, Standing crop

SI/O-15

## Soil Temperature and Soil Moisture Influence on Soil Respiration Rates under *Pinus roxburghii* Vegetation Cover

*S. Sivaranjani\** and *V.P. Panwar*

Forest Soils Discipline, Forest Ecology and Climate Change Division, FRI, Dehradun, INDIA Email: ranjani.agri@gmail.com, vppanwar@yahoo.com

The amount of soil respiration that occurs in an ecosystem is controlled by several factors. Carbon enters in terrestrial ecosystem through photosynthesis and return back into atmosphere as soil respiration. In forest ecosystem, respiration is mainly dominated by soil respiration which accounts for about 60-80 per cent of the total respiration. The soil respiration has been reported to account for carbon emission of  $>100 \text{ Pg yr}^{-1}$  globally and specifically in forests, may represent

the main determinant of the ecosystem C-balance. Changes in soil organic carbon storage as well as in soil respiration may affect the atmospheric  $\text{CO}_2$  concentration and global carbon cycle. Thus the present study was undertaken to find the affects of environmental parameters on soil respiration rates under *Pinus roxburghii* vegetation cover using environmental gas monitor instrument.  $\text{CO}_2$  emissions, soil temperature and soil moisture were recorded on monthly basis. Results of the study reveal that the rate of soil respiration increased with increase in temperature and soil moisture. Thus, the soil temperature and soil moisture content exerted the primary and secondary factors to control soil respiration respectively. Maximum soil respiration rates were observed during June ( $0.34 \text{ g CO}_2 \text{ m}^{-2} \text{ hr}^{-1}$ ) and July ( $0.75 \text{ g CO}_2 \text{ m}^{-2} \text{ hr}^{-1}$ ). These rates may be attributed to the high soil temperature and soil moisture rates during these months besides higher air temperature and precipitation factors which start declining from August. Seasonally, soil respiration showed positive relationship with soil temperature and soil moisture. Therefore, soil respiration rates can be affected by climate change.

**Key words:** Soil respiration (Rs), Soil Temperature (Ts), Soil Moisture (SM).

SI/O-16

## Ecosystem Carbon Pool and Net Primary Production in a Tropical Matured Forest of North-Eastern India

*Ratul Baishya<sup>1\*</sup>* and *Saroj Kanta Barik<sup>2</sup>*

<sup>1</sup>Department of Botany, Faculty of Science, University of Delhi, Delhi-110007, INDIA; <sup>2</sup>National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: rbaishyadu@gmail.com, sarojkbarik@gmail.com

Tropical forests of north-east India provide such vital ecosystem services as biomass and carbon sequestration. However, sufficient data on all these aspects are limited and mostly aboveground biomass information is only available. Most biomass estimation studies involving Net Primary Production (NPP) estimation considers only the increment in aboveground biomass (AGB) and litter fall, completely ignoring the

belowground biomass (BGB) component. For estimating ecosystem level NPP of a forest, time series biomass data for tree, shrub, herb and litter components are pre-requisites. This data gap prompted us to undertake this study in the tropical matured forests of Meghalaya, North-Eastern India. We attempted to study the species diversity, ecosystem biomass, ecosystem carbon pool including aboveground, belowground component, soil carbon, detrital biomass and NPP of the forest. The forest biomass was estimated using aboveground and belowground allometric models. The aboveground biomass, belowground biomass, herb and shrub biomass and detrital biomass were 313.8 Mg ha<sup>-1</sup>, 50.82 Mg ha<sup>-1</sup>, 12.43 Kg ha<sup>-1</sup>, 37.11 Kg ha<sup>-1</sup> and 9.84 Mg ha<sup>-1</sup>, respectively. The tree diameter classes between >30-80 cm girth classes contributed 202.75 Mg ha<sup>-1</sup> and 31.56 Mg ha<sup>-1</sup> contributing 64.61% and 62.1% to the total tree AGB and BGB. The total soil organic carbon upto 1 m depth was 83.22 Mg C ha<sup>-1</sup>. The ecosystem biomass, ecosystem carbon, total aboveground NPP and belowground NPP in the forest were 374.51 Mg ha<sup>-1</sup>, 265.52 Mg C ha<sup>-1</sup>, 12.26 Mg ha<sup>-1</sup> yr<sup>-1</sup> and 1.35 Mg ha<sup>-1</sup> yr<sup>-1</sup>, respectively. The tropical matured forest of the region showed higher carbon sequestration capacity in comparison to other forests.

**Key words:** Ecosystem biomass, Net primary production, Tropical matured forest, Carbon sequestration.

SI/O-17

## Tree Ring Analysis of *Pinus roxburghii* from FRI, Dehradun

*Sangeeta Gupta and Tarun\**

Forest Research Institute, New Forest, Dehradun, Uttarakhand-248006, India, Email: tarunfri@gmail.com

The study presents the dendro-climatic response of *Pinus roxburghii* established in reserve forest of Forest Research Institute estate. A collection of 3 tree-ring chronologies were studied for their dendro-climatic response to changing temperature and precipitation. The various parameters like ring width, early wood, latewood were used to reconstruct the climatic variable. The tree ring chronology has a significant response to the minimum temperature of May-June. The ring chronology also had a significant correlation with the

number of hours of sunshine in the month of November-December.

**Key words:** Dendro-climatology, Palaeoenvironment, Conifers, Tree-rings, Climate.

SI/O-18

## Understanding Interaction of Abiotic Variables on Net Primary Productivity in Indian Tropical Deciduous Forest

*Soumit K. Behera<sup>1,2\*</sup>, M.D. Behera<sup>2</sup> and R. Tuli<sup>1,3</sup>*

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Centre for Oceans, Rivers, Atmosphere and Land Sciences, Indian Institute of Technology, Kharagpur, INDIA; <sup>3</sup>UIET, Panjab University, Sector 25, Chandigarh, INDIA, Email: soumitkbehera@gmail.com

Net primary productivity (NPP) represents a major component of net ecosystem production (NEP), which is the net carbon (C) input from the atmosphere into the biosphere, the other component being the release of C through decomposition or combustion of organic matter. NPP is considered to be the best integrator measure of resource effects on ecosystem processes. Patterns of terrestrial NPP may change in response to changes in species association, microclimate, CO<sub>2</sub> concentration, natural disturbances and other environmental factors. Improved understanding of plant functional types (PFT) level NPP may aid predictions of ecosystem response to ongoing climate and land-use changes. Modelling NPP in tropical deciduous forests is very challenging and suffers from data inadequacy and field measurements. Field data on the interactions of tropical forest NPP to abiotic factors are needed to resolve uncertainties among PFTs particularly for seasonally dynamic deciduous ecosystems. Investigating the NPP patterns among PFTs will help in assessment of carbon sequestering potential of these forests and further setting benchmarks for carbon offset agreements among tropical countries. The present work investigates on the NPP patterns of three PFTs {dry mixed (DM), sal mixed (SM) and teak plantation (TP)} having distinct tree associations, canopy stratification, different carbon assimilation rates and microclimate within a broad Indian tropical deciduous forest. We also tried to analyse the

biodiversity (represented by species richness, SR) and productivity (NPP) interactions pattern emerging in above three PFTs. Principal component analysis (PCA) and generalized linear models (GLM) were used to examine the relationship between individual structural, taxonomic and microclimatic variables against NPP within individual PFTs. GLM analysis revealed that leaf area index (LAI) as the best predictor for NPP followed by air temperature among microclimatic variables in all 3 PFTs.

**Key words:** Tropical deciduous forest, Leaf area index, Net primary productivity, Plant functional types, Generalized linear models.

SI/O-19

## Litter Functional Traits and Nutrient Dynamics in Tropical Trees Species under Elevated CO<sub>2</sub> Environment in India

Apurva Rai<sup>1,2\*</sup>, Ashutosh Kumar Singh<sup>1</sup>, Nandita Singh<sup>1</sup> and Nandita Ghoshal<sup>2</sup>

<sup>1</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India; <sup>2</sup>Department of Botany, Banaras Hindu University, Varanasi-221005, INDIA Email: apurvaraievs09@gmail.com, ashutosh.evst@gmail.com, nanditasingh8@yahoo.co.in, n\_ghoshal@yahoo.co.in

Increasing CO<sub>2</sub> potentially leads to changes in litter quality and litter input in forest soils. It is, therefore vital to understand leaf litter traits in response to increased atmospheric CO<sub>2</sub>. We conducted a field experiment to examine how the litter functional traits and nutrient dynamics respond to e-CO<sub>2</sub> concentration in FACE (Free Air CO<sub>2</sub> Enrichment) facility in CSIR-NBRI, Lucknow, U.P, India. Litter was analysed for concentrations of carbon (C), nitrogen (N), soluble sugars (SS), lipids, lignin, cellulose, hemi-cellulose (HC) and soluble phenolics (SP). We found that elevated CO<sub>2</sub> significantly increased C/N, lowered litter N concentration in leaf litter of Butea and Teak plantations, respectively. Increase in litter biomass production (Butea and Teak) under e-CO<sub>2</sub>, resulted in significant increase in the flux of N, SS, SP and lipid into the soil. Our study demonstrated the changes in litter biomass

production and litter quality during exposure to e-CO<sub>2</sub> which could significantly alter the input of nitrogen, soluble phenolics, soluble sugars, lipids, cellulose, and lignin to soils, and so also the biogeochemical cycle of the prevailing ecosystem.

**Key words:** FACE, Tropical species, Litter functional trait, Mass loss, Nutrient flux.

SI/O-20

## Tree Community Regulate Soil Multifunctionality in a Tropical Dry Forest

Ashutosh Kumar Singh<sup>1,2\*</sup> and Nandita Singh<sup>2</sup>

<sup>1</sup>Academy of Scientific and Innovative Research (AcSIR), CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: ashutosh.evst11@gmail.com

Tropical dry forest covers large areas of tropical region and characterized by a mosaic type of tree communities that can be recognized as a co-dominant multi-species sites to predominant mono-species. The previous forest management practices resulted in incorporation of some exotic species and recombination of the forest vegetation. However, we know little about the effect of multi-specific, mono- (here *Shorea robusta*, *Hardwickia binate* and *Tectona grandis*) and an alien-specific (*Lantana camara* L.) sites on soil multifunctionality (provision of multiple ecosystem functions and services together that linked to soil). We were assessed soil individual functions such as availability of soil nutrients (N and P), fractions of soil organic carbon (SOC) and glomalin related soil protein (GRSP), microbial biomass C, CO<sub>2</sub> efflux and extracellular hydrolytic (acid and alkaline phosphatase,  $\alpha$ -glucosidase, dehydrogenase and fluorescein diacetate) and oxidative (phenol oxidase and peroxidase) enzymes to topsoil (0-15 cm depth) and subsoil (15-30 cm depth) layers on the seasonal basis (summer, winter, and rainy) in a highland TDF of India. Soil multifunctionality index was calculated by averaging Z-scores of these parameters. We found that irrespective of soil depth and season, the extent of a

numerous soil individual functions and soil multifunctionality was higher at the multi-specific sites followed by mono- and alien-specific sites. It suggests that under similar soil type and climatic condition higher plant diversity promote soil multifunctionality. However, in particular, we found that soil pH, alkaline phosphatase and phenol oxidase activity were higher at the alien-specific sites compared with native mono and multi specific sites. The multivariate (principal component analysis) analysis also showed the discrimination of alien specific sites from intermixed mono and multi specific sites. These results suggest that *L. camara* sites alter the soil environment as they are very different from those created by native species. We concluded that *L. camara* sites are least important in regards to promote soil multifunctionality. Eventually, this study has broad implication in understanding revegetation of tropical forest aimed to expedite maximum ecosystem benefits.

**Key words:** Glomalin related soil protein, Soil organic carbon, *Lantana camara*, Soil enzyme, Hydrolytic enzymes, Oxidative enzymes.

SI/O-21

## **Ecosystem Services Assessment and Community Role in Conserving the Services in Tropical Deciduous Forests of Kamrup District of Assam in North-East India**

**Sangeeta Deka\***, Om Prakash Tripathi and L.B. Singha

Department of Forestry, North Eastern Regional Institute of Science and Technology, (Deemed to be University), Nirjuli-791109, Arunachal Pradesh, INDIA Email: deka\_sangeeta@yahoo.co.in, tripathiom7@gmail.com, lbsingha@hotmail.com

Ecosystem services accentuate on the benefits that people derive from varied ecosystems (MA, 2005a). These are mainly categorized into provisioning, regulating, supporting and cultural services. Varied dimensions of human well-being namely basic human needs, economic needs, environmental needs and subjective happiness are a few particular benefits derived from the ecosystems. Literature review revealed that there is paucity of empirical data on

ecosystem services of tropical deciduous forests in Northeast India, in general, and Kamrup district of Assam in particular. Hence, assessment of ecosystem services is extremely important to evaluate the impact of ecosystem services on the livelihood of the local people. Keeping above in account, present study aims to assess the prevalent ecosystem services of the study area and examine peoples' perceptions, knowledge and attitude towards various services. Dominant services related to utility were identified, categorised and ranked following the standard methodologies. Drivers for change of ecosystem services were also identified, prioritized and analysed with emphasis on its impact on livelihood. A checklist of the plant diversity from the study site was recorded. Information about the condition of cultural services in terms of spiritual belief was documented. Assessment of ecosystem services potential of selected forests was carried out with an aim to strengthen the ongoing conservation efforts undertaken by the government, NGOs and local community. Findings of the assessment would be helpful for the decision makers to prioritise the forests for conservation purpose based on their ecosystem services.

**Key words:** Ecosystem services, Peoples' perception, Drivers of change in ecosystem services, Dominance, Conservation.

SI/O-22

## **Mainstreaming the Tropical Underutilized Legume Winged Bean [*Psophocarpus tetragonolobus* (L.) DC.] for Providing Household Food and Nutrition Security**

**Vinayak Singh, Arpit Chauhan, Shafquat Fakhrah, Sagar Prasad Nayak, Kunwar Sarvendra and Chandra Sekhar Mohanty\***

Genetics and Plant Molecular Biology Division, CSIR-National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, INDIA, Email: visiranj@gmail.com, arpit12191@gmail.com, shafquatfakhrah@gmail.com, sarvendrakr88@gmail.com, sagar.nayak51@gmail.com, sekhar\_cm2002@rediffmail.com

Winged bean *Psophocarpus tetragonolobus* (L.) DC. is a tropical legume with high protein and oil

content. The plant is endemic to northeast India and is infested with the anti-nutrient condensed tannin (CT). Leaf being the site of biosynthesis of condensed tannin so, a comparative transcriptome analysis detected the responsible transcripts and their corresponding enzymes in the biosynthesis of CT. Based on the similarity searches against gene ontology (GO) and Kyoto encyclopedia of genes and genomes database (KEGG) revealed 5210 transcripts involved in 229 different pathways. A total of 1235 contigs were found to be differentially expressed between high and low-CT lines of winged bean. There were 2237 simple sequence repeats (SSRs) in high-CT lines and 1618 SSRs in low-CT lines. This study and its finding will be helpful in providing information for functional and comparative genomic analyses of condensed tannin biosynthesis in legumes in general and winged bean in specific. A detailed investigation on CT-biosynthesis is reported for the first time in any underutilized legume crop through this study. Marker-assisted selection and breeding between the diverse lines for mapping population development is underway. Validation of specific genes and their further silencing through virus-induced gene silencing is attempted with preliminary-level level of success. Regeneration of the plant from cotyledonary and nodal explants have successfully optimized with an aim for establishing molecular transformation of *P. tetragonolobus*.

**Key words:** Winged bean, Anti-nutrient, Condensed tannin, Transcriptome, Underutilized legume, Virus-induced gene silencing.

SI/O-23

## Underutilized Wild Edible Plants Sustain Climate Change as Future Food Plants in Uttar Pradesh for Their Sustainable Utilization in Commerce Trade and Market

*Anand Prakash*

Ethnobotany and Ecology Division, CSIR-National Botanical Research Institute, Lucknow-2206001, India Email: pranand1964@gmail.com

Large numbers of people in many developing and developed countries of the world are seriously facing

hunger, malnutrition, under nourishment, lack of adequate vitamins and minerals in their diet. Malnutrition among the children is rampant resulting anaemia a very serious problem throughout the world. Although, India has passed through various revolutions and achieved unprecedented development in the food crop productivity and many crops have increased their manifold productivity but the challenges of malnutrition and threat of climate change continues vigorously. Underutilized wild edible plants may sustain the effect of climate change; appear to be the crop of future and need focused attention as it can meet nutritional needs. Present paper highlights some of the underutilized wild edible plants species like *Basella alba*, *Bauhinia purpurea*, *Boerhavia diffusa*, *Capparis zeylanica*, *Crotalaria juncea*, *Diplazium esculentum*, *Ipomoea aquatica*, *Physalis minima*, *Portulaca oleracea*, *Alangium salvifolium*, *Anthocephalus chinensis*, *Antidesma ghaesembilla*, *Averrhoa carambola*, *Bridelia squamosa*, *Buchanania lanzan*, *Carissa opaca*, *Cordia dichotoma*, *Dillenia pentagyna*, *Diospyros exculpta*, *Ficus racemosa*, *F.virens*, *Flacourtia indica*, *F.jangomas*, *Grewia hirsuta*, *Limonia acidissima*, *Madhuca longifolia*, *Manilkara hexandra*, *Pueraria tuberosa*, *Rumex dentatus*, *Schliechera oleosa*, *Spondias pinnata* and *Xeromphis uliginosa* etc. as a future food crop provide newer tastes, texture, aroma, flavour and recipe may sustain the effect of climate change for their sustainable utilization in commerce and trades need urgent attention in human welfare.

**Key words:** Underutilized wild edible plants, Climate change, Future food plants, Sustainable utilization, Uttar Pradesh.

SI/O-24

## Effect of Training Systems on Light Interception and Gas Exchange Parameters in Jamun [*Syzygium cumini* (L.) Skeels]

*A.K. Trivedi\**, *A.K. Singh*, *A. Bajpai* and *K.K. Mishra*

ICAR-Central Institute for Subtropical Horticulture, Rehmankhhera, P.O.-Kakori, Lucknow-226101, INDIA Email: ajayakumartrivedi@gmail.com

Availability and capture of light by the canopy, utilization of light in the photosynthesis and translocation of photosynthates to the developing crop decides the productivity. Several factors individually as well as in combination affect different steps of a physiological process and finally quantum and quality of produce. Orchards are usually characterized by light resource limitations. Canopy architecture and leaf display traits affect light capture at the canopy as well as microenvironment of each leaf. Arrangement of leaves as well as light capture efficiency of plant is determined by the architecture of tree canopy. Plants can maximize canopy light interception by increasing both leaf surface area and the efficiency of light interception for each unit of leaf area. Manipulation of tree canopy affects light interception, growth and productivity. Jamun canopy exhibits lot of variation in size, compactness, shape and branch orientation. This directly or indirectly affects light interception and gas exchange parameters of the crop. Proper understanding of the jamun canopy characteristics and gas exchange parameters may be used for new technological interventions for adequate light management to enhance efficiency. Variability in light interception, leaf area index and gas exchange parameters in jamun [*Syzygium cumini* (L.) Skeels] cultivar CISH J-37 (Jamwant) plants grown in three systems of canopy viz., control, open and palmate were recorded. Availability of diffused and direct light varied significantly viz., 27.64%, 33.38%, 29.66% and 23.33%, 28.67%, 25.59% in control, open and palmate canopy respectively. Considerable variation in gas exchange parameters viz., net assimilation rate (5.62 - 11.78  $\mu\text{mol CO}_2\text{-m}^{-2}\text{s}^{-1}$ ), stomatal conductance (43-81  $\text{mol H}_2\text{O m}^{-2}\text{s}^{-1}$ ), vapour pressure deficit (1.08-3.76 kPa) and transpiration rate (1.22-2.28  $\text{m mol H}_2\text{O m}^{-2}\text{s}^{-1}$ ) was found. In accordance with this substantial variability in yield and fruit quality traits was recorded. Study exemplifies that open canopy architecture having optimal ratio of diffused and direct light, more net assimilation rate and stomatal conductance have better and yield and fruit quality.

**Key words:** Jamun, Canopy, Light interception, Leaf area index, Photosynthesis.

SI/P-1

## Growth and Yield Responses of Wheat (*Triticum aestivum*) Plants Treated with Ethylene Diurea (EDU) under Elevated $\text{CO}_2$

Surabhi<sup>1,2\*</sup>, Veena Pande<sup>b</sup> and Vivek Pandey<sup>1</sup>

<sup>1</sup>Plant Ecology and Climate Change Science, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Department of Biotechnology, Kumaun University, Bhimtal-263136, Uttarakhand, INDIA  
Email: surabhi447@gmail.com

Wheat is the most important food resource on the earth and is consumed by large part of the world's population. Rising carbon dioxide and phototoxic zone due to anthropogenic activities in atmosphere cause global warming and impact crop productivity. Ethylene diurea (EDU), a synthetic chemical, is an ozone protectant which protects plants from ozone damage. Studies related to interactions involving EDU and  $\text{CO}_2$  in wheat plants are scarce and unclear, therefore there is need to study crop response under these conditions. Our study evaluated the cumulative effect of elevated  $\text{CO}_2$  and EDU on two wheat cultivars PBW154 and WH1105. The experiment was conducted in Free Air Concentration Enrichment (FACE) facility having 3 ambient  $\text{CO}_2$  (400ppm) and 3 elevated  $\text{CO}_2$  (550ppm) rings of 10 m diameter each. Each ring has 4 subplots of 4.5  $\text{m}^2$  for each cultivar. EDU foliar spray at (200 ppm) was given manually by hand sprayer on leaves. Total plant height, biomass and photosynthesis of wheat cultivars showed significant differences in treated conditions (EDU+ $\text{ECO}_2$ ) as compared to their respective control (EDU+ $\text{ACO}_2$ ). We found that yield parameters changes e.g., grain numbers per plant, 1000 grain weights were much more in ( $\text{ECO}_2$ +EDU) as compared to ( $\text{ACO}_2$ +EDU) conditions. Improved photosynthesis and better yield might be the result of reduced ozone induced injury under the cumulative treatment of  $\text{ECO}_2$  and EDU. This study showed that beneficial effects of rising  $\text{CO}_2$  on  $\text{C}_3$  crops would be partially negated by high ambient  $\text{O}_3$  concentrations.

**Key words:** Elevated  $\text{CO}_2$ , Ozone stress, EDU (Ethylene diurea), Wheat, Vegetative phase, Flowering phase.

SI/P-2

## Over-expression of *CarMT* Gene Provides Tolerance against Drought Stress by Modulating Antioxidants and Physiological Performances in *Arabidopsis thaliana* L.

Arvind Kumar Dubey<sup>1,3\*</sup>, Rekha Sharma<sup>2</sup>, Veena Pande<sup>2</sup> and Indraneel Sanyal<sup>1</sup>

<sup>1</sup>Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Botany, LBS PG College, Gonda <sup>3</sup>Department of Biotechnology, Kumaun University, Bhimtal Campus, Nainital, India Email: arvindbiotech28@gmail.com

Drought is one of the major abiotic stress which negatively affects plant growth and crop yield. Metallothionein (*MTs*) is a low molecular weight protein, mainly involved in metal homeostasis, while, in drought stress, is still to be largely explored. The present study was anticipated to investigate the role of *MT* gene against drought stress. The chickpea *MT* based on its up-regulation under drought stress was overexpressed in *Arabidopsis thaliana* to explore its role in mitigation of drought stress. The total transcript of *MT* gene was up to 30 fold higher in transgenic lines. *Arabidopsis* plants transformed with *MT* gene showed longer roots, better efficiency of survival and germination, larger siliques and higher biomass compared to WT. The physiological variables (A, WUE, G, E, qP and ETR) of WT plants were reduced with drought stress which were recovered in transgenic *Arabidopsis* lines. The enzymatic and non-enzymatic antioxidant (APX, GPX, POD, GR, GRX, GST, CAT, MDHAR, ASc and GSH) levels were also enhanced in transgenic lines to provide tolerance. Overall, the results suggest that *MT* gene is actively involved in the mitigation of drought stress and could be the choice for genetic engineering strategy to overcome drought stress.

**Key words:** *Arabidopsis*, Chickpea, Drought, Metallothionein, Physiological performance, ROS.

SI/P-3

## Effects of Drought on Seedling Growth and Activity of Antioxidative Enzymes in Rice (*Oryza sativa* L.) with Response to Salicylic Acid

Preeti Verma, Anjali Srivastava and P.K. Singh\*

Department of Botany, Udai Pratap Autonomous College, Varanasi-221002, INDIA, Email: drpksinghupc@gmail.com

Drought is one of the serious abiotic threats to the agriculture worldwide. This is due to uneven distribution of rainfall and climatic conditions. Rice is one of the important staple diet severely affected by drought induced change in plants, which results into reduction in the plant productivity. An experiment was conducted to investigate the amelioration properties of salicylic acid (SA) in rice plant under water scarcity. Salicylic acid (SA) is recognised as signal transducing molecule as well as regulator of oxidative damage in plants under adverse environmental conditions. Presoaking seed treatment with 0.5mM SA was observed in rice plants subjected to drought condition in rice field. SA increased growth characteristics under both drought condition and irrigated rice fields. SA was observed with ameliorative effect on rice seedling under drought condition especially improvement in water use efficiency (WUE) and antioxidative system in the present study. SA was found to enhance the activities of antioxidative enzymes such as superoxide dismutase (SOD), peroxidase (POD), catalase (CA) and glutathione reductase (GR). Present study reveals that SA reduced oxidative damage by significant enhancement in the activity of SOD (EC 1.15.1.1), POD (EC 1.11.1.7), GR (EC 1.6.4.2) while the activity of catalase (EC 1.11.1.6) was reduced under the drought stress condition in rice plants. We concluded that SA regulates the activity of antioxidative enzymes through accumulation of reactive oxygen species (ROS) and may be signal transduction mechanism in abiotic stress tolerance in plants.

**Key words:** Drought acclimation, Salicylic acid, Antioxidative enzymes, *Oryza sativa* L., Sustainable agriculture.



SI/P-4

## Evaluation of Sodicity Tolerance, Growth and Yield Performance of Aloe Species at Different Soil Sodicity Levels

**T.S. Rahi\***, Anand Prakash, Faizia Iram and Lal Bahadur

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA Email: tsrahi8@gmail.com

*Aloe* species are succulent in nature with multiple importances. Five *Aloe* species viz. *Aloe vera*, *Aloe vera* Accessn, *Aloe maculata*, *Aloe ferox* and *Aloe spicata* were examined on naturally existing 10 different soil sodicity (pH) levels as Control (7.75-8.20), Level-2 (8.20-8.40), Level-3 (8.45-8.55), Level-4 (8.56-8.68), Level-5 (8.70-8.90), Level-6 (8.91-9.0), Level-7 (9.01-9.15), Level-8 (9.16-9.30), Level-9 (9.31-9.55) and Level-10 (9.56-10.20). Two months old suckers 3 to 4 leaved with 10 to 15 cm height were transplanted in November 2016 at 75 cm plant to plant distance in 3 x 3 m size bed with three replications at Distant Research Centre, Banthra. Hoeing, weeding and uniform irrigations were done as and when required. Plant growth observations were recorded at two months interval. After one year of plantation, mature leaves were harvested for the assessment of leaf yield. Growth data was analysed with factorial randomized bloc design (RBD). It was observed when species were pooled together plant growth (plant height and leaf length) reduced significantly from pH level-3 onwards as compared to control plots, but no significant difference was noticed from pH level 6 to 10 for leaf length. Number of leaves per plant decreased significantly with increasing pH levels, where as widths of leaves did not decline significantly up to pH level-7. There was no significant difference for thickness of leaves when data was pooled across the pH levels and observation intervals. *Aloe vera* Accession was found significantly superior for many growth traits as compared to *Aloe vera* and other *Aloe* species. Width of *Aloe maculata* and *Aloe spicata* was significantly higher and lower respectively with other species. As far as observation intervals is concerned, growth traits of all *Aloe* species increased significantly from 4<sup>th</sup>

observation interval as compared to 1<sup>st</sup> and 2<sup>nd</sup> observation intervals. It is also interesting to know that high growth occurred in all *Aloe* species during the period of June and July. After that plant growth adversely affected during heavy rains as well as dormant winter season from December to January. The leaf yield of *Aloe vera* Accession has been better than *Aloe vera* up to pH level-5 and for rest of the species up to pH level 10. Leaf yield was considerable high in *Aloe vera* in the control plots to pH level 10 amongst the rest of species. Gel yield also followed the same trend up to pH level-6 as in case of leaf yield.

**Key words:** *Aloe* species, Soil sodicity, Leaf yield, Gel yield.

SI/P-5

## Interactive Effects of eCO<sub>2</sub> and Drought on Pyrethrin Content in *Tanacetum cinerariifolium* Flowers

Farah Deeba<sup>1</sup>, Vivek Pandey<sup>2</sup> and Laiq-Ur Rahman<sup>1</sup>

<sup>1</sup>Biotechnology Department, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow-226015, INDIA; <sup>2</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: farahnbri@gmail.com

Pyrethrin, a natural insecticide, extracted from the glandular trichomes on the achenes of *T. cinerariifolium* flowers, is an eco-friendly approach to control the various insects specifically mosquitoes. Indiscriminate use of synthetic pyrethrins led to the development of resistance in mosquitoes and is also hazardous for environment and humans. Having the qualities of being environmental friendly and short life time, natural pyrethrin is a good alternative to synthetic ones. In India pyrethrin yield is very poor which ranges from 0.6 to 0.79% of per flower dry weight, while in Kenya and Australia, it is common to find clones with pyrethrin content of 3.0 % and more. Under present changing climate scenario, levels of CO<sub>2</sub> in the atmosphere will increase ultimately leading to increase in average global temperatures along with recurrent droughts. In order to analyse the interactive effects of drought along with eCO<sub>2</sub>, *T. cinerariifolium* plants were grown under eCO<sub>2</sub> conditions for observing the effects of eCO<sub>2</sub> on pyrethrin content simultaneously

with two regimes of drought stress i.e. mild drought (MD; 40-50% RWC) and severe drought (SD). It was found that the flower size of the plants grown in eCO<sub>2</sub> condition was larger as compared to their respective controls grown under ambient conditions. Biomass of *T. cinerariifolium* was found to be reduced during the MD and SD stress in ambient as well as in eCO<sub>2</sub> conditions. However, biomass reduction was more prominent in ambient ring as compared to eCO<sub>2</sub> ring. Pyrethrin contents were found to be progressively increased during MD and SD respectively, under eCO<sub>2</sub> conditions. On the contrary its content was found to be significantly decreased in MD and again increased in SD as compared to its respective control in ambient conditions. The amount of pyrethrin was found to be higher in ambient condition as compared to eCO<sub>2</sub>. Present study reveals that eCO<sub>2</sub> condition helps plants to adapt under drought condition(s) simultaneously increasing the secondary metabolite production thus increasing its economic value as medicinal plant.

**Key words:** *Tanacetum cinerariifolium*, Drought stress, eCO<sub>2</sub>, Pyrethrin, Secondary metabolite.

SI/P-6

## Effects of Elevated Carbon Dioxide and Tropospheric Ozone on Sorghum

Mitul Kotecha<sup>1,2\*</sup>, Vishal Prasad<sup>2</sup> and Vivek Pandey<sup>1</sup>

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg Lucknow-226001, INDIA; <sup>2</sup>Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: mitulkotecha@ymail.com

Tropospheric O<sub>3</sub> is phytotoxic to the plants and chronic ozone exposure negatively impacts photosynthesis, stomatal conductance, chlorophyll, nitrogen and protein content thereby reducing yields and biomass. Phytotoxic effects of tropospheric O<sub>3</sub> on plant growth and physiological processes are often ameliorated in CO<sub>2</sub> enriched environment. A limited number of studies of interactive effects of elevated CO<sub>2</sub> and O<sub>3</sub> on herbaceous vegetation are conducted and have produced variable results. The present study evaluated the impact of elevated CO<sub>2</sub> and ambient O<sub>3</sub> on morphological, physiological, biochemical traits and fibre content in two varieties of sorghum using ethylene

diurea (EDU) as a foliar spray (300 ppm). Average ambient ozone concentration during the experiment was 61.6 ppb and average ambient and elevated CO<sub>2</sub> concentration (eCO<sub>2</sub>) during the experiment was 412.56 ppm and 562.53 ppm, respectively. EDU treatment resulted in less lipid peroxidation along with increased chlorophyll content, biomass and yield. EDU alleviated the negative impacts of ozone by enhancing activities of antioxidants and antioxidative enzymes. The present study indicates that prevailing ozone concentrations in and around Lucknow city have unfavorably affected various physiological and biochemical characteristics of two sorghum cultivars leading to significant growth reductions. EDU application protected plants against harmful effects of ambient ozone whereas elevated CO<sub>2</sub> could ameliorate adverse effects of ozone. Two cultivars selected for experiments responded differentially at either developmental stage of life cycle. PHS-111 performed better in terms of growth and enzymatic activity over VHS-999. It indicates PHS-111 was more responsive to EDU treatment and (eCO<sub>2</sub>).

**Key words:** Tropospheric ozone, EDU, Forage crops, Fibre content.

SI/P-7

## Phosphate Solubilization by *Trichoderma koningiopsis* (NBRI-PR5) under Abiotic Stress Conditions

Touseef Fatima, Isha Verma\*, Udit Yadav, Sanjeev Kumar and Poonam C. Singh

Division of Microbial Technology, CSIR-National Botanical Research Institute-226001, Lucknow, INDIA  
Email: poonamnri@rediffmail.com

Phosphorus (P) is one of the major bioelements limiting agricultural production. Phosphate solubilizing fungi play a noteworthy role in increasing the bioavailability of soil phosphates for plants. Phosphate (P) solubilizing fungi contribute considerably in microbial phosphate mobilization. However, effects of different abiotic stresses on P solubilization mechanisms in *Trichoderma* are largely unexplored. In the present study we selected a P solubilizing *Trichoderma* to study the mechanism of P solubilization under alkaline and

drought conditions. Among 33 *Trichoderma* isolates (NBRI-PR1–NBRI-PR33), NBRI-PR5 was selected after screening for stress tolerance, antagonistic activity against phyto-pathogens and P solubilization. The selected strain, *Trichoderma koningiopsis* (NBRI-PR5) was characterized and identified using ITS sequencing (Accession no. JN375992). Results show that NBRI-PR5 uses different mechanisms of P solubilization under in-vitro alkaline and drought conditions. NBRI-PR5 produced organic acids for solubilizing insoluble tricalcium phosphate (TCP) at high pH stress. In drought conditions NBRI-PR5 accumulated poly phosphate in its mycelia and produced alkaline phosphatase enzyme for P solubilization. The study concludes that *T. koningiopsis* employs different mechanisms of P solubilization in different stress conditions and therefore, it can be used in management of stressed soils.

**Key words:** *Trichoderma*, Abiotic stress, Phosphate solubilization, Bioavailability.

SI/P-8

## Climate Change and the Current Scenario of *Rhizoctonia solani* Incited Disease of Solanaceous Vegetables

*Amjad Shahzad Gondal\**, *Abdul Rauf and Farah Naz*

Department of Plant Pathology, Arid Agriculture University, Rawalpindi, PAKISTAN Email: amjad@msu.edu, amjadshahzad@live.com

Solanaceous vegetables; Potato (*Solanum tuberosum* L.), tomato (*Lycopersicon esculentum* L.) and chilli (*Capsicum annum* L.) are the dominant vegetable crops worldwide that are generally cultivated in the warm or tropical climate. They are grown throughout the year in all parts of Pakistan. The quality and quantity of the produce is directly affected by the climate change as host plants and their pathogens are prone to erratic climatic factors like temperature, relative humidity, rainfall and CO<sub>2</sub> prevailed during different crop seasons. *Rhizoctonia solani* is an important soil-borne fungal pathogen that is well adapted to various environmental conditions. It causes black scurf, damping-off, stem canker and root rot in these crops. Present study documents the scenario *R. solani* incited diseases in the Pothohar region of Pakistan. Survey of

different locations of districts Rawalpindi, Jhelum, Attock, Chakwal and Islamabad revealed maximum mean disease incidence (MDI) on potato was recorded in Attock (37.4%) followed by Islamabad (35.8%), Jhelum (31.76%) and Rawalpindi (30.5%) while minimum in Chakwal (20.2%). Maximum MDI on tomato was observed in Islamabad (38.7%) followed by Attock (36.3%), Rawalpindi (34.9%) and Chakwal (29.6%) while minimum in Jhelum (27.5%). MDI on chillies was maximum in Attock (30.9%), followed by Islamabad and Jhelum (29.5%), while minimum in Chakwal and Rawalpindi (27.3%). Since the climate of the region has considerable temperature variations. Daytime temperature reaches above 40°C during the summer while ranges between 0-10°C in winter. The average annual rainfall is abundant at 1,249 millimetres (49.2 in). The fungus can remain active at a range of temperatures and remains dormant as sclerotia. The optimum temperature ranges 24-31°C for potato tuber development, vegetative growth in chilli and the emergence of tomato seedlings also provide optimum temperatures for *R. solani* disease development; 24-32°C. In addition to temperature, soil moisture greatly influences the amount of *R. solani* inoculum in the soil that ultimately favours the disease development. Considering the changed climatic conditions, there is a dire need to devise mitigation strategies for sustained vegetable production.

**Key words:** *Rhizoctonia solani*, Solanaceous vegetables, Maximum mean disease incidence (MDI), Climate change.

SI/P-9

## Adaptation of Guar [*Cyamopsis tetragonoloba* (L.) Taub.] Plants in Response to Abiotic Stress of Light, Temperature and Drought

*Shiv Narayan\**, *Komal Pandey and Pramod Arvind Shirke*

Plant Physiology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA Email:shivnarayan2388@gmail.com, pashirke@nbri.res.in

Guar [*Cyamopsis tetragonoloba* (L.) Taub.] is an annual Kharif legume capable of growing under poor fertility and grown mainly in arid and semi-arid region

of India. It is grown as a vegetable for human consumption, forage, green manure and as a grain crop. The endosperm of guar seed contains galactomannan used as a food and non-food item. We studied the performance of two guar varieties namely RGC-1002 and Sarada under different abiotic conditions. Photosynthesis in response to light, temperature and water stress was measured in the month of May and June. In photosynthesis Vs light response curve, we observe the maximum photosynthetic saturation at  $1200 \mu\text{mol m}^{-2}\text{s}^{-1}$  of light in RGC-1002, whereas  $800 \mu\text{mol m}^{-2}\text{s}^{-1}$  of light in Sarada. While in temperature response, the maximum photosynthesis ranged from  $35\text{-}38^\circ\text{C}$  in RGC-1002 and  $28\text{-}30^\circ\text{C}$  in Sarada. In water stress condition, RGC-1002 (RWC= 68%) shows significantly higher photosynthesis than Sarada (RWC= 58%). Our studies suggest that RGC-1002 is better adopted for abiotic conditions of high light, high temperature and water stress than Sarada at physiological level.

**Key words:** Guar, Photosynthetic Photon Flux Density, Water stress, Relative Water Content.

SI/P-10

## Impact of Elevated $\text{CO}_2$ and/or $\text{O}_3$ on Rice Varieties under Open Field Conditions

*Rushna Jamal\**, *Mitul Kotecha*, *Rekha Kannaujia*, *Vivek Pandey*

Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow 226001, INDIA, Email:

Human activities are contributing to increase in the concentrations of atmospheric carbon dioxide ( $\text{CO}_2$ ) and other greenhouse gases, including tropospheric ozone ( $\text{O}_3$ ). Indo-Gangetic plains (IGP) region is one of the most heavily populated and polluted region of India. Rice is the most important cereal crop grown in this region. There are reports of stagnation and even decline in rice production which has been attributed to many biotic and abiotic factors. We argue that elevated  $\text{CO}_2$  and/or  $\text{O}_3$  might be contributing towards these yield losses. In the present experiment, we are assessing impact of elevated  $\text{CO}_2$  (550 ppm) and/or  $\text{O}_3$  (+20 ppb) on growth, physiological, biochemical, molecular, yield and nutritional quality parameters of twenty four rice

varieties grown under Free Air Concentration Enrichment facility (FACE). The study would yield rice germplasms that are tolerant to anticipated climate change as well as possible mechanistic understanding of response of rice plants to combined stresses. The study would yield robust data about how rice physiological, genetic and yield parameters will respond to anticipated changes in the atmosphere which may help improve modelling and breeding efforts in the future.

**Key words:** Ozone, Elevated  $\text{CO}_2$ , Rice, Indo Gangetic Plains, FACE.

SI/P-11

## Interaction between Climate Change Drivers and Nutrient Fertility: Temperature, $\text{CO}_2$ , and Phosphorus

*Vangimalla R. Reddy*<sup>1\*</sup> and *Shardendu K. Singh*<sup>1,2</sup>

<sup>1</sup>USDA ARS, Crop Systems and Global Change Laboratory, Bldg 001, Rm 342, BARC-W Beltsville, MD, USA; <sup>2</sup>School of Environmental and Forest Science, University of Washington, Seattle, WA, USA Email: vangimalla.reddy@ars.usda.gov, shardendu.singh@ars.usda.gov

Climate change is already affecting the global natural resource base that societies depend on to provide food, fiber, fuel, and recreational services. An increase in the global air temperature (T) and carbon dioxide ( $\text{CO}_2$ ) concentration is associated with the alterations in atmospheric chemistry such as emissions of greenhouse gases (e.g.,  $\text{CO}_2$ , methane, nitrous oxide, and chlorofluorocarbons). Temperature,  $\text{CO}_2$ , and nutrient availability are among the major determinants of crop's adaptation that drive their productivity. In natural settings, the productivity of an agro-ecosystem depends on the intricate balance between multiple environmental drivers. Lately, our understanding of crop response to individual environmental factors has advanced significantly, but information on multiple interacting factors is needed to understand full impacts of climate change on crop productivity. Even though a large proportion of crop productivity globally occurs in nutrient-limited conditions, crop response to climate change drivers has often been investigated under well-fertilized condition. Thus, the interactive impacts of temperature,  $\text{CO}_2$ , and phosphorus (P) fertility on crop

productivity are still unclear. To fill in this knowledge-gap, soybean was exposed to the combinations of two levels of each T (optimum and elevated, eT), CO<sub>2</sub> (ambient and elevated), and P fertilization (sufficient and deficient, dP) throughout the season. Results showed that dP was the most detrimental to soybean vegetative growths while eT was the most detrimental to reproductive growth. The elevated levels of CO<sub>2</sub> and temperature (separately or jointly) compensated, at least partially, the detrimental impacts of P deficiency on vegetative growth, such as biomass production. However, compensatory effects of eT under P deficiency completely disappeared for the reproductive development, such as pod development. This indicated that plant response to combined stresses (e.g., eT+dP) is exclusive, which might not be accurately inferred from results obtained when stresses (e.g., eT or dP) imposed individually. Furthermore, the impacts of a given stress situation might be even more complex due to the contrasting nature of responses between plant attributes (e.g., vegetative versus reproductive growth). The potential implication of these results might be associated with the P-fertilizer management due to its link with the agroecosystem and environmental pollution.

**Key words:** Abiotic stress, Climate change, Interaction, Photosynthesis.

SI/P-12

## Interaction of Soil CO<sub>2</sub> Efflux with Soil Parameters in Three Different Forest Communities in Tropical Deciduous Forest of Northern India

*Shruti Mishra<sup>1\*</sup>, Soumit K. Behera<sup>1</sup>, L.B. Chaudhary<sup>1</sup>, M.K. Jain<sup>2</sup> and Vipin Kumar<sup>2</sup>*

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India; <sup>2</sup>Indian Institute of Technology, Indian School of Mines, Danbhad-826004, India Email: mishrashruti.1989@gmail.com

Tropical forests containing 30% of global soil carbon (C) are a critical component of the global carbon

cycle helpful in maintaining the balance of atmospheric CO<sub>2</sub> concentrations and their response to environmental change. Increasing primary productivity in tropical forests over recent decades has been attributed to CO<sub>2</sub> fertilization and greater biomass in tropical forests could function as a substantial carbon sink in the future. However, the carbon sequestration capacity of tropical forest soils is uncertain and feedbacks between increased plant productivity and soil carbon dynamics remain unexplored. Soil CO<sub>2</sub> efflux is directly related to both microbial and root activities and are largely controlled by environmental factors such as precipitation, soil moisture and temperature. Soil CO<sub>2</sub> efflux is a major component for assessing the carbon sequestration capacity of the forest ecosystems as part of the global carbon cycle. The present study was conducted in Katarniaghat Wild Life Sanctuary (KWLS) in three forest communities (Teak plantation, Sal mixed and dry mixed forests). Diurnal soil CO<sub>2</sub> flux ( $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ ) was measured in post monsoon season using automated LI-COR 8100 soil CO<sub>2</sub> flux system (LI-COR, USA) with attached survey chamber (8100-103; 20 cm diameter). Variations in soil water potential was measured using in Psypro (Wescor Inc., USA). Soil was sampled seasonally from two depths (0-15 and 15-30 cm) at three times intervals (morning, afternoon and evening) in each forest community for diurnal measurement of soil water potential. We tried to understand the interaction of soil physical and chemical properties with soil CO<sub>2</sub> efflux in each forest community. We observed average efflux rates of  $3.04 \pm 0.39$ ,  $3.24 \pm 0.47$ ,  $3.41 \pm 0.72$  ( $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ ) in Teak plantation, Sal mixed and dry mixed forests, respectively. Maximum total organic carbon (TOC) was observed in Sal mixed forest ( $20.28 \text{ g kg}^{-1}$ ) followed by dry mixed forest ( $19.90 \text{ g kg}^{-1}$ ) in post-monsoon season. Soil physical properties (majorly bulk density, particle density, porosity and water holding capacity) are strongly correlated with soil CO<sub>2</sub> efflux in comparison to soil chemical properties (majorly total organic carbon, pH, EC, total nitrogen and total phosphorus). The soil physical properties revealed strong positive control over soil carbon sequestration in tropical deciduous forests of India.

**Key words:** Soil CO<sub>2</sub> efflux, Soil water potential, Tropical deciduous forest.

SI/P-13

## Assessment of Essential Nutrients in Soil and Litter in Tropical Deciduous Forest of Northern India

Shruti Mishra<sup>1\*</sup>, Soumit K. Behera<sup>1</sup>, L.B. Chaudhary<sup>1</sup>, M.K. Jain<sup>2</sup> and Vipin Kumar<sup>2</sup>

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, India; <sup>2</sup>Indian Institute of Technology, Indian School of Mines, Danbhad-826004, India, Email: mishrashruti.1989@gmail.com

In forested ecosystems, litter fall represents the main pathway of nutrient transfer from the plants to the soil through process of primary productivity. Forest litter plays an important role in determining nutrient cycling, and maintaining ecosystem function. Essential nutrients such as Co, Cu, Fe, Mg, Ni and Zn play a significant role in plant development. The litter nutrient content changes with plant community influence the structure and activity of microbial community inhabiting in the soil. In the present study, we quantified the essential and non-essential nutrients in soil along with litter in three forest communities [Teak plantation (TPF), Sal mixed (SMF) and dry mixed (DMF) forests] at Katarniaghat Wildlife Sanctuary, India. Soil samples were collected from two soil depths (0-15 and 15-30 cm) from each forest site randomly. Nutrient contents like Chromium (Cr), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), Arsenic (As), Selenium (Se), Molybdenum (Mo), Cadmium (Cd), Lead (Pb) were quantified in soil and litter. Essential nutrients like Fe, Cr, Mn, Ni, Zn, Cu were highest in DMF followed by SMF and TPF in soil. Maximum Zn content was observed in TPF, while SMF observed maximum Cu in surface soil (0-15 cm). Maximum nutrients in litter was observed in DMF among all forest communities. Maximum concentrations of Ni and Zn were observed in SMF and TPF litter. Litter carbon was highest in DMF among all forest communities. Different species composition in three forest communities resulted in different nutrient concentrations in soil and litter pool, which needs further long term monitoring for understanding the interaction of tree association with nutrient dynamics.

**Key words:** Nutrients, TOC, Tropical deciduous forest, Litter chemistry.

SI/P-14

## Impact of Elevated Ozone on Leaf Nutrient Properties of *Leucaena leucocephala*: A Fiber Yielding Tree

Pratiksha Singh<sup>1,2\*</sup>, Ashish Tewari<sup>2</sup> and Vivek Pandey<sup>1</sup>

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, India; <sup>2</sup>Department of Forestry & Environmental Science, DSB campus, Kumaun University, Nainital-263001, Uttarakhand, India, Email: prachi68singh@gmail.com

Tropospheric Ozone (O<sub>3</sub>) concentration is continuously rising due to industrialization and various anthropogenic activities. High O<sub>3</sub> levels negatively affect different plant species, changing their growth pattern as well as leaf nutrient properties. This study is based on the long term impact of elevated ozone (EO<sub>3</sub>) on leaf nutrient properties of *Leucaena leucocephala* at different time intervals (6, 12, 18 and 24 months). *Leucaena* seedlings were grown under ambient ozone (AO<sub>3</sub>) and EO<sub>3</sub> (+20ppb) rings at Free Air Ozone Enrichment (FAOE) facility, CSIR-NBRI, Lucknow. We estimated different leaf nutrient properties viz., [Carbon(C), Nitrogen(N), C/N ratio, Phosphorus(P), Sodium(Na), Potassium(K) and Calcium(Ca)] and plant fiber (Crude fiber(CF), Acid detergent fiber(ADF), Neutral Detergent fiber(NDF), Acid detergent lignin(ADL) under ambient and elevated O<sub>3</sub>. Under EO<sub>3</sub> leaf C, N and P content insignificantly increased whereas Na and C/N ratio were insignificantly decreased in comparison with AO<sub>3</sub> at different time interval. *L. leucocephala* leaf Potassium was decreased significantly at 18 months interval under EO<sub>3</sub> while calcium content was significantly increased after 24 month interval. *Leucaena* fiber content, CF, NDF and ADF showed significant reduction after 18 and 24 months interval under EO<sub>3</sub> while ADL showed no significant change. As *L. leucocephala* leaf nutrient content showed no significant changes under EO<sub>3</sub>, it showed its tolerance to high O<sub>3</sub>. Low NDF and ADF values found under EO<sub>3</sub> are desirable in forage from

the standpoint of its nutritive quality for ruminant herbivores. Results showed that *L. leucocephala* is tolerant to high ambient O<sub>3</sub>.

**Keywords:** FAOE, Tropospheric O<sub>3</sub>, *Leucaena leucocephala*, Leaf nutrients, Fiber Content.

SI/P-15

## Effect of Environmental Variables in the Assembling of Tree Community in Tropical Moist Deciduous Forest of Himalayan Terai

**Omesh Bajpai<sup>1\*</sup>, Venkatesh Dutta<sup>1</sup>, Rachna Singh<sup>2</sup>, L.B. Chaudhary<sup>3</sup> and Jitendra Pandey<sup>2</sup>**

<sup>1</sup>Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, Uttar Pradesh, INDIA; <sup>2</sup>Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, INDIA; <sup>3</sup>Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, INDIA, Email: omeshbajpai@gmail.com

Tropical forests play a vital role in the global carbon and energy cycles. The region along the Himalayan foothills in northern India forms one of the distinct eco-climatic regions of the world. The objectives of the study are to find out the different tree communities and summarize major edaphic and climatic variables affecting the tree community assembling in the tropical moist deciduous forest. The forests of Dudhwa National Park (DNP), a good representative of tropical moist deciduous forest of Terai region has been selected to explore of edaphic and climatic variables. The cluster and non-metric multidimensional scaling (nMDS) analyses grouped the forests of DNP into five major forest types: Sal miscellaneous forest (SMF), Sal-Asna miscellaneous forest (SAMF), Low land miscellaneous forest (LMF), Teak plantation (TP) and Eucalyptus plantation (EP). Each forest type has its specific species composition and dominance. The monoculture nature of EP was clearly indicated by highest dominance index (0.7566) followed by TP with dominance index 0.4963. Whereas the lowest dominance index (0.1659) with highest Simpson index (0.8341) was computed for LMF, indicating its highest heterogeneity. The LMF also showed the highest

species diversity by highest value of Shannon index (2.1540). While EP was the community with very poor species diversity indicated by lowest Shannon index (0.5611). The SAMF exhibited the highest equitability index (0.7505), where the species were more evenly distributed. The nMDS and Pearson's correlation studies reveal that the assembling of different forest communities is affected by the different environmental variables such as, Total organic nitrogen (TON), Electric conductivity (EC), Soil bulk density (BD), Soil porosity (SP), Available phosphorous (P), Potassium ion (K) and Water holding capacity (WHC) (edaphic) and Air temperature (AT), Absolute air humidity (AAH) and CO<sub>2</sub> (climatic). The study also reported 23 site-specific species, which require proper conservation measures due to their low ecological amplitude and narrow range of distribution.

**Key words:** Trees, Phytosociology, Environmental variables, Cluster analysis, nMDS, Dudhwa National Park, Tropical moist deciduous forest.

SI/P-16

## Emission of GHGS and Community Level Physiological Profiles of Microbes is Altered by Soil Amendments

**Nishtha Mishra\*, Pratibha Verma, Priyanka Chauhan and Aradhana Mishra**

Division of Plant-Microbe Interactions, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, India, Email: mishramyco@yahoo.com

This study was conducted to elucidate effects of long-term fertilization practices on plant growth, GHGs emission (methane and carbon dioxide), and microbial diversity in rice field soil. The rice field selected for experiments represented balanced and imbalanced fertilization practices. Among five treatments [Control (SC), 100% urea (SU), NPK-Zn (NPK), 50% NPK-Green manure-biofertilizer (NGMBF) and biofertilizer (BF)], a significant increase in root growth parameters was observed in NGMBF treatments which was closely followed by BF treatments. Similarly, further analysis of yielding attributes also exhibits the same pattern of growth where an increase in different yielding parameters was evident in NGMBF treatment. Soil incubation studies showed highest CH<sub>4</sub> and CO<sub>2</sub>

emission on day3 with NPK treated soil in submerged condition whereas it was least in BF treated soil. Dehydrogenase activity in soil was also analyzed and it was recorded highest in BF treated soil. The structure of the microbial community in different soil amendments was analyzed through the sole-carbon-source utilization profiles using ECO Biolog plates. As compared to SC, maximum changes in the community structure was

recorded in the BF treatment which was followed by NGMBF, SU and NPK. These findings suggest that sustainable management practices like amendment with BF in the soil are needed to mitigate CH<sub>4</sub> and CO<sub>2</sub> emission from rice cultivation.

**Key words:** Climate change, Fertilizer, Methane emission, Soil microbial diversity.



**Session II**  
**Biodiversity: Prospection and Conservation**



SII/KN-1

## **Biodiversity and Traditional Knowledge in India in 21<sup>st</sup> Century**

*P. Pushpangadan\*, V. George and T.P. Ijinu*

Amity Institute for Herbal and Biotech Products Development, Peroorkada P.O. Trivandrum-695005, Kerala, INDIA E-mail: paluprakulam@yahoo.co.in

21<sup>st</sup> century is now acclaimed as the century of biology – The advancements made in Biological sciences if applied appropriately can transform the biodiversity rich nations like India to economic powers. India is blessed with a uniquely rich and varied biodiversity rich traditional knowledge system and above all a literate/skilled and intelligent human capital is well placed to make such a transformations to happen. Knowledge-based, value-added product development and its commercialization has become one of the fastest economic activities in the world. The liberalization of the global trade policies and other economic reforms evolving currently with the emergence of the United Nations Convention on Biological Diversity (CBD) and the World Trade Organization (WTO) requires a deeper study and understanding, especially in the light of the latest path breaking achievements in science and technologies. The history of human civilization and development of economic systems are all inherently and inveterately interwoven with our biological resources. Economic activity of humankind continues to derive its sustenance directly or indirectly from the biological resources. The unknown potentials of genetic diversity found in the biological organisms, particularly the plants represent a never-ending biological frontier of inestimable value. Genetic diversity will enable breeders to tailor crops to meet the increased productivity, adapt changing climatic conditions, disease resistance and also to meet the other essential needs and future aspirations of humankind. Biogenetic resources are the primary source of valuable genes, chemicals, drugs, pharmaceuticals, natural dyes, gums, resins, enzymes or proteins of great health, nutritional and economic importance. India became the first country in the world implement article 8j as benefit sharing of TK with a tribal community namely Kani. Kani model / Pushpangadan model of benefit sharing experiment for which Pushpangadan got the award of

Equator Initiative prize from UNDP at Johannesburg in 2002.

**Key words:** Biodiversity, Traditional Knowledge, Pharmaceuticals, Genes, Chemicals, Sustainable Development.

SII/L-1

## **Bioprospection of Traditionally used Medicinal Plants**

*N.K. Dubey*

Department of Botany, Banaras Hindu University, Varanasi-221005, INDIA, Email: nkubeybhu@gmail.com

India is a mega-biodiversity rich country and has varied climatic zones comprising approximately 17000-18000 species of flowering plants of which 6000-7000 are estimated to have medicinal usage in folk practices. In India, around 25,000 effective plant-based formulations are used in traditional and folk medicine and the country enjoys an important position in the global pharmaceuticals sector. From ancient times, people are known to use the traditional medicinal plant *Materia medica* and their bioactive compounds for health care purposes. Basically, the medical formulations are developed from different plant parts or their synthetic analogs together with their folklore systems. According to World Health Organization report, more than 80 per cent of world's population depend on plant based medicines for their health care needs. The traditionally used medicinal plants have a large range of therapeutic properties, inhibiting growth of pathogens or kill them without causing toxicity to the host cells Due to immense use of allopathic and synthetic antimicrobial drugs, microbes have developed resistance to different antibiotics Herbal extracts and preparation from medicinal plants had come across its journey from the very beginning of the 20<sup>th</sup> century. Recently, scientists are focusing to develop modern medicines based on the purified active ingredients through modern chemical and biological technologies. Traditionally used medicinal plants are still recognised as common practice for cure of different diseases. Their disease curing ability is attributed to presence of different phytochemicals including alkaloids, flavonoids and terpenoids. Traditional knowledge offers the source of new drugs developments from plants. Due to recent

developments in gene technologies, many biotechnologically rich but biodiversity poor countries are involved in the act of biopiracy by illegally patenting the traditional knowledge of other countries. Hence, there is urgent need of bioprospection of traditionally used medicinal plants in order to have sovereign right on biodiversity.

**Key words:** Bioprospection, Medicinal plants, *Materia medica*.

SII/L-2

## Conservation of Desert-Steppe Diversity in European Russia

*Irina N. Safronova*

Komarov Botanical Institute, Russian Academy of Science, Professor Popov Street, 2. St. Petersburg, 197376, RUSSIA  
Email: irasafronova@yandex.ru

A large area in the south of European Russia is in the steppe zone. Nature reserves are very important in the conservation of steppe vegetation. The Bogdinsko-Baskunchaksky Reserve was established in 1997 in the South of the steppe zone. It includes hill Bolshoye (Big) Bogdo (150 m above sea level) and the plains surrounding lake Baskunchak. Desert-steppes are the most xerophilous type of steppe (with firm-bunch grasses as dominants and dwarf semi-shrubs as codominants). Feather-grass steppes (*Stipeta sareptanae*, *Stipeta lessingiana*, *Stipeta capillata*) are widespread on loamy and loam-sand soils. On the sandy soils *Stipeta pennatae* steppes are formed. The vegetation of the Bogdinsko-Baskunchaksky Reserve displays not only common but also unusual features. Bolshoye Bogdo has varied lithological composition, relief, and soil profiles. In this regard its vegetation is very heterogeneous and represented by a large number of plant communities which may be combined into various series “ on limestones, Tertiary clays, and sandstones. *Agropyreta desertori* and *Artemisieta tauricae* communities are widespread on limestones. Communities of dwarf semi-shrubs are very varied on Tertiary clays: *Artemisieta lerchiana*, *Artemisieta pauciflorae*, *Atripliceta canae*, *Anabasieta canae* and *Kochieta prostratae*. Communities of *Agropyreta fragili*, *Artemisieta marschalliana* are associated with sandstones. On a small area a variety of Caspian-

Lowland desert-steppes is well represented. The establishment of the reserve is facilitating the restoration of steppes on the plains which were earlier occupied by fields.

**Key words:** Steppe zone, Russia, Desert-steppes, Firm-bunch grasses, Dwarf semi-shrubs.

SII/L-3

## Climate Change and Crop Productivity : What is at Stake?

*K. Raja Reddy*

Fellow of Crop Science Society of America and American Society of Agronomy, Department of Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39762, USA, Email: Kreddy@pss.msstate.edu

Today's world faces a great challenges producing adequate food, fiber, feed, industrial products and ecosystem services for the globe's 7.5 billion people. With nearly 76 million people added every year, we must develop agricultural food production and ecosystem goods and services to meet future population of over 8 billion by the year 2025 and more than 9.7 billion by 2050. Added to these stresses is a threat of global climate change resulting from increased greenhouse gas concentrations in the atmosphere and depletion of the ozone layer assumed due to anthropogenic activities. Agriculture production and productivity are highly sensitive to changes in climate and weather conditions. Therefore, changes in regional and global climate, particularly the climatic variability, have been implicated to affect local as well as global food, fiber and forest production and ecosystem goods and services. Crops grown in future environments will be subjected to a climate for which they were not bred. Over 30 years, a series of experiments have been conducted in sunlit plant growth chambers to study impacts of climate change factors (atmospheric CO<sub>2</sub>, temperature, water, UV-B radiation, nutrition) in several crops including native rangeland grass species. Our studies have shown that more carbon was fixed in high-CO<sub>2</sub>-grown plants at all levels of water and nutrient deficient conditions and across a wide range of temperatures, water regimes, and UV-B levels. Furthermore, developmental events such as flowering and crop maturity, and leaf initiation were relatively

insensitive to high-CO<sub>2</sub>, UV-B or nutrients and were mostly temperature dependent. Since crop growth in indeterminate crops such as cotton is very plastic, additional carbon available in a high-CO<sub>2</sub> environment favored more vegetative and reproductive growth under optimal conditions. Crop reproductive processes, however, were very sensitive to both higher and extreme climatic conditions predicted in future climate (higher and more frequent episodes of temperatures and UV-B radiation). Elevated CO<sub>2</sub> did not ameliorate the damaging effects of either higher temperatures or UV-B radiation on processes related crop yield. More recently, we have been exploring genotype by environment interactions to understand the variability and to assist the breeders select the best lines suited in a changing climate in their breeding programs.

**Key words:** Global climate change, Anthropogenic activities, Food security, Future environments, Breeding programs, High-CO<sub>2</sub>-grown plants

SII/L-4

## Plant diversity characterization using satellite remote sensing

**S.P.S. Kushwaha**

Indian Council of Forestry Research and Education, Dehradun-248006, Uttarakhand, INDIA, Email: spskushwaha@gmail.com

Biological diversity means the variability among living organisms from all sources including, *inter-alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Amazing forest diversity- 16 Type Groups, 46 Sub-Groups and 221 Ecologically Stable Natural Vegetation Formations. One of the 18 mega-diverse countries (ranked between 10<sup>th</sup> and 12<sup>th</sup>) with four global biodiversity hotspots (Himalaya, Indo-Burma, Western Ghats and Sri Lanka, and A & N Islands). Accounts for 7.8% of recorded species: 45,968 recorded species of plants & 91,364 species of animals comprising 11.18% flora and 7.44% fauna globally. With only 2.5% of the world's land area, supports 16% of world's population 18 % of the domestic cattle population.

Humanity, along with all species, is dependent on the planet earth. Degradation of our environment will affect the carrying capacity of life on the planet and this in turn will affect the number of people that the planet can support. Many of the natural resources of the planet when degraded have impacts far beyond what is commonly perceived. Due to the large body of research that has been done, it is now clear that many of the world's ecosystems are under intense pressure from human encroachment, the harvesting of natural resource and land clearing. This pressure is causing the destruction or degradation of habitat and species and permanent loss of productivity, threatening biodiversity and with it human well-being. The resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances like flooding, drought, forest fire, insects, ocean acidification and other global change drivers such as land use/cover change, pollution, over-exploitation of natural resources.

International protocols require regular monitoring, conservation, and sustainable utilization of biodiversity. India has done some exercise under NBSAP programme though it didn't result in a seamless countrywide biodiversity spatial database. We took this challenge under a jointly funded programme of the Department of Space and Department of Biotechnology, Government of India and used remote sensing and GIS technology effectively. In process, we also made use of landscape parameters such as interspersions and juxtaposition and multi-criteria analysis together with field inventory of plant diversity. A total of 16,577 field plots were laid in different vegetation types across India. Even species utility was taken into account. It took 10 years to complete this mammoth job with high precision. Today country has wall-to-wall natural vegetation types, disturbance regimes, fragmentation and plant richness database. No such survey has been carried out by any country of the world. Needless to mention that this database has provided much needed impetus to biodiversity conservation efforts in the country.

**Key words:** Plant diversity, Satellite remote sensing, GIS, Ecosystem

SII/O-1

## Comparative Analysis of Grazing Impacts on the Plant Diversity and Composition of Tungnath and Shokhrak Alpine Rangelands in Western Himalayas

Anirban Roy<sup>1\*</sup> and B.S. Adhikari<sup>2</sup>

<sup>1</sup>Department of Plant Sciences, K.J. Somaiya College of Science and Commerce (University of Bombay), Vidyavihar, Mumbai, Maharashtra, INDIA; <sup>2</sup>Department of Habitat Ecology, Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, INDIA, Email: anirbanroy247@gmail.com

The western Himalayan region of Uttarakhand represents India's one of the most biodiverse alpine temperate region as well as a religious-cultural hotspot undergoing rapid cultural and ecological change. This area represents the home of origin for many plant groups including horticulturally valuable species of *Pedicularis*, *Rhododendron*, *Oxygraphis* and *Primula*. Alpine meadows here also provide pastures for sheep, mule and cow herders. Stocking levels for livestock here have quadrupled over the last five decades and shrubs are encroaching into many historical rangelands. Herders' voice concerns over both herb-shrub encroachment and shrinking grasslands in this study, we sought to determine: (i) Are alpine rangelands in Tungnath overgrazed and degraded? (ii) What are the local impacts of grazing on plant diversity and community composition? (iii) Which environmental variables covary with these differences in species composition across the grazing gradient? and (iv) How herbaceous communities in Tungnath (grazed) differs from Shokhrak (grazing prohibited under Kedarnath Management Plan)? The results of this study are discussed in the light of the management and conservation of alpine meadows of the Western Himalayas. The genesis of this study lies in this conflict, wherein it was realized that a sound understanding of the ecology of the temperate forests and alpine meadows and the impacts of pastoralism was needed to ensure effective management of these fragile environments.

**Key words:** Alpine, Meadows, Grazing, Shokhrak, Tungnath, Western Himalayas.

SII/O-2

## Quantifying Forest Cover Changes in Response to Climate Change using Machine Learning Model

Joity Hossain<sup>1\*</sup> and Sopan Patil<sup>2</sup>

<sup>1</sup>Environmental Forestry, Bangor University, Bangor LL57 2DG, Wales, UK; <sup>2</sup>Catchment Modelling, School of Environment, Natural Resources and Geography, Bangor University, Bangor, LL57 2UW, UK, Email: joityh@yahoo.com

Anthropogenic activities have been attributed as a dominant cause for recent warming of the climate. Forest dynamics across the world have also been altered due to climate change. Abiotic (fire, wind, drought, precipitations) and biotic disturbances (insects, pathogens) have elevated more than 27% due to longer warm and dry conditions which are affecting forest formation. A Random Forests (RF) based machine learning model was trained with historical data of land cover, slope, elevation, aspect and future data of temperature and precipitation to find the effect of climate change between a selected area of Amazon forest on Brazilian site and an area of boreal forest on Canadian site. During training phase, coefficient of determination (R<sup>2</sup>) score for Amazonian site was 0.901, whereas score for Canadian Boreal site was 0.797. RF classification model has been revealed almost same fate for both zone but for different reason. According to this study, RCP 8.5 would be more distressing compare to RCP 4.5 for both study sites in both time scale (2041-2060 and 2061-2080). Relatively, Amazon site forest cover found under significant threat due to future climate change than boreal site. But both site might lose huge diversity of tree species and cropland for future higher temperature. If climate shift continue consistent with RCP 8.5 Amazon will lose 88% deciduous species, whereas boreal site will lose 42%. According to model, heavy rain fall, prolong drought, forest fire will facilitate evergreen species over deciduous and crop species in tropical zone. On the other hand, intense and longer drought could bring less succession rate, and pest attack, which might cause vast destruction of deciduous forest diversity in boreal site. While shallow rooted crop might have affected more by prolong drought, heavy rainfall in short period

would be facilitated some woody and shrub species in boreal zone of Canada.

**Key words:** Climate change, RCP, Machine learning

SII/O-3

## **Diversity of Cyanoprokaryotes from Broknes Peninsula of Larsemann Hills, East Antarctica: First Report**

*Pratibha Gupta*

Botanical Survey of India, Ministry of Environment, Forest & Climate Change, Government of India, AJCBIBG, Botanic Garden, Howrah-711103, INDIA, Email: drpratibha2011@rediffmail.com

Antarctica is an extreme environment and contains many unique geological, glaciological and biological features and it is a gift of nature in natural forms but due to changes in climatic conditions, we can see the effect of Global environmental changes in Antarctica. The Larsemann Hills area are located approximately halfway between Vest fold Hills and Amery Ice Shelf on South-eastern coast of Prydz Bay which includes two main peninsulas, the western named Stornes and the eastern named Broknes. Human activities in this area are promoted by the coastal location and ice free landscape. The further scientific research and the potential for tourist visits may affect the cyanoprokaryotes (cyanobacterial) diversity. The Antarctic environment is highly sensitive and susceptible to the impacts of human activities and has much less natural ability to recover from disturbance than the environment of other continents. These changes ultimately affect the growth and diversity of Cyanoprokaryota. Cyanobacteria are ubiquitous, microscopic, inhabiting the world's oceans, freshwater bodies, soils, rocks, etc. and are responsible for most of the global production of organic matter by photosynthesis. Thus, they play a fundamental role in the world's ecosystems and their kaleidoscopic diversity, systematic and phylogeny is indispensable. Cyanoprokaryotes play a very important role in monitoring the water quality and there are prospects of utilisation of cyanoprokaryotes genetic stock in multiple significant ways. As Stornes peninsula comes under the Antarctic Specially Protected Area (ACPA) hence the samples were sampled from diverse habitat

of Broknes Peninsula. Altogether 16 species of Cyanoprokaryotes, belonging to 09 genera were recorded from diverse habitat of Broknes Peninsula of Larsemann Hills, East Antarctica as new record from this area.

**Key words:** Diversity, Cyanoprokaryotes, Broknes Peninsula, Larsemann hills, Antarctica.

SII/O-4

## **Assessment of genetic diversity using ISSR and SCoT markers in natural populations of *Ormosia robusta* Baker- a critically endangered species from Northeast India**

*R.K. Nilasana Singha<sup>1</sup>, Ashiho A. Mao<sup>1\*</sup>, Deepu Vijayan<sup>1</sup> and S.K. Barik<sup>2</sup>*

<sup>1</sup>Botanical Survey of India, Eastern Regional Centre, Shillong-793003, INDIA; <sup>2</sup>National Botanical Research Institute, Lucknow-226001, INDIA, Email: nilasana@gmail.com, aamao2008@gmail.com

*Ormosia robusta* is a perennial tree species belonging to the family Fabaceae. The species is critically endangered and has been reported from India, Bangladesh, Myanmar, and Thailand. In India, this tree species was reported from Arunachal Pradesh and Assam. Recent field surveys led to the discovery of new distributional records of this critically endangered species from Itanagar and Pasighat (Arunachal Pradesh), Balpakhrum and Baghmara (Garo hills, Meghalaya) and Lengpui (Mizoram). Because of its small population size with only ten individuals, there is a possibility of low genetic variability among the individuals. It is therefore essential to study the genetic variability within as well as among different populations, to have an insight into the possibility of genetic drift. In the present study, we used inter-simple sequence repeats (ISSR) and started codon targeted (SCoT) fingerprinting to study the genetic diversity of inter- and intra-population variability of *O. robusta* collected from five locations. The screening was carried out using 20 ISSR and 20 SCoT primers. The clear and reproducible DNA fragments generated from 17 ISSRs and 16 SCoT primers, ranged from 200 bp to 800 bp. The profiles of all the ten plant samples collected from

five locations viz., Itanagar (1), Pasighat (2), Baghmara (1), Balpakhrum (5) and Lengpui (1) displayed a high level of polymorphism among them, indicating wide genetic variation, albeit their small number.

Key words: Critically endangered species, *Ormosia robusta*, inter- and intra- population diversity, ISSR and SCoT markers

#### SII/O-5

### The Ramsar Convention – A Bid to Conserve the Wetlands of National Importance

**Arti Garg**

Botanical Survey of India, Central Regional Centre, 10-Chatham Lines, Allahabad-211002, INDIA Email: kad\_arti396@yahoo.com, artibsi.garg@gmail.com

Wetlands remain submerged under water for most part of the year constructing lands transitional between terrestrial and aquatic eco-systems. Their habitats embody plant succession from open waters to land and vice versa, with distinct ecosystems, ecological characteristics, functions and values. They provide numerous ecological services, act as migratory corridors for flora and fauna and possess predominantly hydrophytic vegetation often representing primitive and highest evolved plants. Being dynamic and influenced by man-made and natural activities, wetlands need frequent monitoring. The Ramsar Convention was signed in 1971 as the only global, inter-governmental environment treaty to deal with a particular ecosystem which provides framework for national action and international cooperation for conservation and wise use of wetlands and their resources. Main objective of this convention was to call international attention towards depleting wetlands of international importance, provide framework for international discussion and cooperation toward mutual benefits, highlight wetland functions, values, goods and services with willingness to make a commitment for reversal of wetland losses. At present there are 169 signatories, with India being one comprising twenty six Ramsar sites. The Major obligations of participant countries of the convention were to designate wetlands for inclusion in the List of Ramsar sites, promote wise use of wetlands in their territory, promote international cooperation especially with regard to trans-boundary wetlands, shared water

systems, and shared species and finally to create wetland reserves.

**Key words:** Environment, Inter-governmental, Ramsar convention, Treaty, Wetlands.

#### SII/O-6

### Development of DNA Barcodes for Delineating Representative Mangrove Species of West Coast India

**Kundan Kumar\* and Ankush Ashok Saddhe**

Department of Biological Sciences, Birla Institute of Technology & Science Pilani, K.K. Birla Goa Campus, Goa-403726, INDIA, Email: kundan@goa.bits-pilani.ac.in

Plant DNA barcoding is complex and require more than one marker as compared to animal barcoding. Mangroves are diverse estuarine ecosystem prevalent at tropical and subtropical zone, but anthropogenic activity turned them into vulnerable ecosystem. For conservation strategies, there is a need to build molecular reference library based on molecular marker alongwith morphological characteristics. In the present study, we tested the core plant barcode (*rbcL* + *matK*) and four promising complementary barcodes (ITS2, *psbK-psbI*, *rpoC1* and *atpFatpH*) in 14 representative mangroves species belonging to 5 families from west coast of India. Data analysis was based on barcode gap analysis, intra- and inter-specific genetic distance, Automated Barcode Gap Discovery (ABGD), Taxon DNA (BM, BCM), Poisson Tree Processes (PTP) and General Mixed Yule-coalescent (GMYC). The *rbcL* locus showed highest PCR efficiency and sequencing success (100%) rate, followed by ITS2 and *matK*. Using a single locus for analysis, ITS2 exhibited the highest discriminatory power (87.82%) but combinations of *matK* + ITS2 provided the highest discrimination success (89.74%) rate except for *Avicennia* genus. Single ITS2 barcode locus resolved *Rhizophora apiculata* and *R. mucronata* based on GMYC analysis and *Sonneratia* species were demarcated using ABGD tools with relative gap width (X=1.5). Further we evaluated 3 additional markers (*psbK-psbI*, *rpoC1* and *atpFatpH*) for *Avicennia* genera (*A. alba*, *A. officinalis* and *A. marina*) and of them, *atpF-atpH* locus was able to discriminate between three species of *Avicennia*



genera based on ABGD and TaxonDNA analysis. Our analysis underscored the efficacy of *matK* + ITS2 markers with *atpFatpH* as the best combination for mangrove identification in the west coast India region.

**Key words:** DNA barcoding, Mangroves, West coast, India.

SII/O-7

## Leaf Colonising Algae-*Phycopeltis* spp. (Trentepohliaceae, Chlorophyta) from the Southern Western Ghats, Kerala, India

*Binoy T. Thomas\**, *M.V. Bhagya* and *V.P. Thomas*

Phycotechnology Laboratory, Department of Botany, Catholicate College, Pathanamthitta, Kerala, INDIA  
Email: bttkripa@gmail.com

The study is the pioneer investigation of leaf colonising algae, *Phycopeltis* spp. from the tropical ecosystems of Kerala, India. *Phycopeltis* is the most abundant and distinct representatives of epiphyllous algae in the tropical ecosystems. The genus *Phycopeltis* was established by Millardet and it belongs to the order Trentepohliales, class Ulvophyceae and the division Chlorophyta. Presence of  $\beta$ -carotene and haematochrome are the unique features of the order Trentepohliales. While possessing a remarkable diversity in the tropical ecosystems, the genus *Phycopeltis* appears under-described in this region. Nine species of *Phycopeltis* from the semi-urban and rural areas of Pathanamthitta District, Kerala, India were isolated such as *P. arundinacea* (Montagne) De Toni, *P. irregularis* (Schmidle) Wille, *P. epiphyton* Millardet, *P. flabellate* Thompson and Wujek, *P. aurea* Karsten, *P. vaga* Thompson et Wujek, *P. treubii* Karsten, *P. treubioides* Thompson and Wujek and *P. minuta* Thompson and Wujek. It was found that species richness and diversity indices of *Phycopeltis* spp. were more prevalent in the natural forest and in monsoon seasons; limited in the region of semi-urban areas and summer season. *Phycopeltis* was more widespread on the adaxial side of the moist leaves during all seasons. The study confirms the diversity of epiphyllous *Phycopeltis* spp. in the tropical ecosystem. The detailed surveys of leaf colonising *Phycopeltis* spp. are desirable and can be expected to find new

discoveries before getting adversely affected by global climate change and anthropogenic influences.

**Key words:** *Phycopeltis*, Phyllosphere, Rural-natural forest, Semi-urban, Trentepohliales.

SII/O-8

## Status and Distribution Pattern of Native and Endemic Species on the Shimla Water Catchment Wildlife Sanctuary of Western Himalaya

*Dipika Rana*<sup>1</sup>, *Kulraj Singh Kapoor*<sup>2</sup> and *Anupam Bhatt*<sup>1</sup>

<sup>1</sup>CSIR-Institute of Himalayan and Bioresource Technology, Palampur-176061, Himachal Pradesh, INDIA; <sup>2</sup>Himalayan Forest Research Institute, Panthaghati, Shimla-171009, Himachal Pradesh, INDIA Email: dipikahfri@gmail.com

Invasions and endemism represents the two most extreme conditions of the possible geographical distributions of species. The areas with high percentage of native and endemic species indicate the high conservation value of that particular area. The biogeographic provinces with high diversity of native and endemic species show the pristine ecosystems with least disturbance, whereas low richness of the sensitive biodiversity elements indicates high disturbance and opening the way for the invasion of non-natives. Therefore, the native and endemic plants in a natural ecosystem play an important role in the conservation and preservation of an ecosystem. In the present times the high anthropogenic pressure and climate change have increased the stress on natural ecosystem and leading to rapid loss of native species and proliferation of non-native species. Maintenance of naturalness (nativity) and uniqueness (endemism) of the ecosystem has become a big challenge. The extinction of the indigenous species has caused biodiversity reduction, habitat loss and alteration of natural ecological processes. Introduced species pose threat to biodiversity by direct competition with native and endemic plant species. The present study was undertaken in the Shimla Water Catchment Sanctuary of Western Himalaya in which out of the total reported 476 species, 245 species were native to the Indian Himalayan Region (IHR), remaining 231 species were

non-natives, while 8 species were endemic and 85 species were near endemic to the IHR. Total 312 species were quantified, of which 53.85% species were native, while 46.15% were non-native. 20.19% of the total species were near endemic and 2.56% of the total was endemic to the IHR. 71.43% trees, 66.15% shrubs and 47.94% herbs were natives, whereas among these native species, 40.00% trees, 27.90% shrubs and 29.52% herbs were near endemic. Among the native species 4.65% shrubs and 3.80% herbs were endemic species. The altitudinal distributions of the native, non-native and endemic species were also evaluated.

**Key words:** Indian Himalayan Region, Catchment, Sanctuary, Endemic, Near Endemic, Native.

#### SII/O-9

### **Traditional Knowledge on the Utilization of Plant Species for Health Care**

*Jaskirat Kaur\**, *Rajinder Kaur* and *Avinash Kaur Nagpal*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA  
Email: jaskirat888@gmail.com, swab2002@yahoo.com, avnagpal@rediffmail.com

The present study was aimed at exploring the traditional knowledge of local inhabitants of Kapurthala district on the utilization of plant species for health care management. Since times immemorial, plants have been used for various purposes by human population. About 80% of the total world population is depending upon plants for their health care. The traditional knowledge of local inhabitants has been passed from generation to generation mostly through oral communication and in doing so part of it might be lost. So there is growing interest in documentation of traditional knowledge. People rely on plants for many health problems like fever, cough, diarrhea, constipation, cuts and wounds etc. This study was based on questionnaire based personal interviews, field study and direct observations. Successive field surveys were carried out from April 2015 to May 2016 mainly in search of traditional healers or practitioners. Information was also gathered from house wives, farmers, teachers and elderly people of the study area. Information was also cross checked for authenticity from the available

literature. Total 35 persons were selected for the study and information of about 25 plant species was gathered. Out of 25 plant species, maximum number of plant species recorded was herbs followed by shrubs, trees and climbers. Leaves comprised the major plant part used. Information gathered can be used in search of new herbal medicines by the researchers in the field of modern drug development.

**Key words:** Traditional knowledge, Healthcare, Kapurthala, Punjab.

#### SII/O-10

### **Flower Traits and its Variability as an Adaptive Strategy for Augmenting Reproduction in Plants Growing in High Altitude Environments**

*Mustaqeem Ahmad<sup>1</sup>\*, *Sanjay Kumar Uniyal<sup>1</sup>*, *Daizy R. Batish<sup>2</sup>* and *H.P. Singh<sup>3</sup>**

<sup>1</sup>High Altitude Biology Division, CSIR-Institute of Himalayan Bioresource Technology, Palampur-176061, HP, INDIA; <sup>2</sup>Department of Botany, Panjab University Chandigarh-160014, INDIA; <sup>3</sup>Department of Environmental Studies, Panjab University Chandigarh-160014, INDIA  
Email: mustaqeem.env@gmail.com, suniyal@ihbt.res.in, daizybatish@yahoo.com, hpsingh\_01@yahoo.com

Flower traits are key to reproductive success of a plant species. Along an altitudinal gradient, owing to limited growing season and thereby pollination success, flower traits become crucial. Therefore, flower display area (FDA), flower longevity and resource investment should be higher in plant populations growing at higher altitudes as compared their low altitude counterparts. We hypothesized that altitudinal variation of flower traits handles reproductive success of plants. To test this, a study was conducted along an altitudinal gradient of 2000 to 4000 m asl in the Dhauladhar mountain range of western Himalaya during May 2015 to September 2017. Along this altitudinal gradient, twenty-one, 20×20 m permanent plots were established, one each at every 100 m rise in altitude. Twenty-five plant species were identified and 10 to 20 individuals of each were collected from the marked plots. Only healthy looking, fully mature plants were collected for flower trait (display area, mass and flower count) analyses. After fruiting, seed count and seed mass were

also recorded for the selected 25 species. These were used as indicators of reproductive fitness. The relationship between altitude and traits for every population sample were determined with a Pearson's parametric product moment(r) test at 95% confidence. To test the effect of elevation on reproductive traits, linear model of ANOVA was used. The results revealed that except for specific flower area and seed count, reproductive traits positively and significantly correlated with altitude. Seed traits were associated with flower traits wherein FDA and flower mass were of prime importance. Increased flower visibility seems to ensure pollination while larger seed size in populations of high altitude species gives them a chance to survive in harsh environments. We suggest flower traits variations along altitude to be helpful for reproductive success of plants.

**Key words:** Himalaya, Flower traits, Altitude, Reproductive fitness, Adaptations.

SII/O-11

## **Impact of Community based Forest Management (Community/Collaborative Forestry) System in the Chure region Conservation and Development of Nepal**

*Damodar Sharma*

Democratic Foresters', Association of Nepal, Kathmandu, NEPAL, Email: damodar.dfan@gmail.com

There is a growing concern regarding the conservation and development of Chure hill of Nepal, although land degradation of the Chure area of Nepal is primarily contributed by different types of landslides and mass wasting phenomena including flooding and inundation. Landslides cause a huge loss of human life and property as well as environmental degradation in Nepal requiring extra resources for relief and recovery. Chure region is extended up to India, Bhutan & Pakistan from Nepal, covering 33 districts of Nepal with 12.6 % of country area. It is the youngest mountain of the world, and suffering from mass erosion, landslides and other environmental externalities which make the region vulnerable. The ecological niche in and around the region makes the region more sensitive and fragile. Government has given greater emphasis

on the protection of Chure through initiation of 'Rastrapati Chure Conservation Program' since 2009. It is an attempt to identify the problems, challenges and issues of Chure forest conservation and to propose an effective conservation plan using qualitative as well as quantitative methods of analysis. Chure region has many opportunities of employment and income generation through establishment of environment friendly green enterprises. Thus it is an urgent need to formulate short-term to long-term strategies with policy priorities actions and result-oriented efforts in order to establish Chure as a rich bio-diversity zone, with hazardless and improved livelihoods of its people. To bridge this research gap, this research is on Community and Collaborative Forestry contributing role toward Chure development and Conservation completed. The paper discusses how development and conservation initiatives carried out in the chure areas from the Community based Forest Management practice. This paper also principally discusses the lessons learned on Community and Collaborative Forests complementary for Chure development/conservation to fulfill the broad objectives of the President Chure Terai Madhesh Plan and millennium development goals. Based on the conclusion that action research several recommendations for better management of Community based Forest. At present forestry database show that 2.00 million households or 37 % of the population of Nepal is involved in community forestry management program, 19361 Community Forestry User Groups (CFUGs) have been formed 1,813478 hectares of National forest have been handed over as community forests and 2,250,858 households have benefited from CF. It has been estimated that 3.75 million hectare of forest land of Nepal can be put under Community Forestry. Whereas there are 28 Collaborative Forest Management groups, who are managing more than 71,000 ha Forest. There are three major partners responsible to protect and manage Terai forest, including Department of Forest (DOF), local government and local communities in CFM. CFM is a concept, which has emerged after the 2000 A. D. It has been estimated that more than 4.5 million hectare of forest land of Nepal can be put under Community based Forestry. Currently, this management system is recognized by forest policy, 2015 and Forest Act (1993) 2nd amendment 2017. Community based Forestry Management is being tools to address the issues of

users including nearby as well distant users, who have as well have not access and control over national forest since last 7 decades because of government policies and programs. At the same time, there are numbers of issues and challenges emerged due to the unclear roles and responsibilities among three partners. The newly enacted “Local Government Operating Act 2074” has also created confusion in the operation of Collaborative Forest Management. Likewise, benefit sharing ratio is also not clear so far. According to the New Constitution, numbers of laws are being formulated or in the process of amendment. Capacity building, local level development, livelihood promotion as social development; Income generation activities through forest base enterprises with employment generation as economic development and water source and soil conservation as well as alternative energy as environment conservation were found fruitful in the Chure and surrounding Terai area development.

**Key words:** Socio-economic Impact, Development spectrum, Community based forestry, Community Forestry, Collaborative Forestry, Chure Conservation.

SII/O-12

## **Traditional Agroforestry for Biodiversity Conservation, Food and Nutritional Security of Mizo Community of Northeast India**

*Uttam Kumar Sahoo\* and Soibam Lanabir Singh*

Department of Forestry, School of Earth Sciences & Natural Resource Management, Mizoram University, Aizawl-796004, Mizoram, INDIA, Email: uksahoo\_2003@rediffmail.com, uttams64@gmail.com

We evaluated 137 home gardens for their species composition and product outputs and use by the Mizo community, the study covered five districts of Mizoram. As many of 460 plant species belonging to various user groups were encountered in the study, the majority of the plant species belonged to vegetables, fruits and medicinal plants followed by firewood, ornamental species, timber and other category. Many other utility species such as spices, beverages, broom, handicraft etc were also widely reported from the gardens. Nevertheless the composition of species varied with

garden size and elevation range; generally the small gardens had maximum species diversity than the larger garden while lower altitude had higher species richness than the higher altitude. The multistrata nature of most home gardens further reveal their ecological significance in providing suitable niches to various species at different altitudes. The species that were grown in the gardens, to some extent, were related to the socio-cultural and demographic factors of the home garden owners and associated traditional knowledge in managing these resources. Many of the landraces, rare and endangered species were found domesticated in the garden. These findings reveal that home gardens are production system maintained purposively for harvesting diverse products for food and nutritional security and are important avenues for species conservation at household level.

**Key words:** Homestead agroforestry, Biodiversity conservation, Nutritional security, Mizo community.

SII/O-13

## **Medicinal Plant Diversity in Chandra Prabha Wildlife Sanctuary, Chandauli District, Uttar Pradesh**

*Nitisha Srivastava\* and Achuta Nand Shukla*

Botanical Survey of India, Central Regional Centre, 10, Chatham Lines, Allahabad-211002, Uttar Pradesh, INDIA  
Email: srivastava\_nitisha@yahoo.com

India is floristically rich country and is recognized in twelve mega biodiversity centers in the world. It is also blessed with rich medicinal plant diversity. Forests are the major sources of medicinal plants; besides these they are also cultivated. Protected areas play a very significant role in conservation of medicinal plants and traditional knowledge. Chandra Prabha Wildlife Sanctuary (CPWLS) is situated in the district Chandauli. The presented study was carried out in the area of CPWLS for survey and collection of medicinal plants. Information on medicinal properties of plants encountered in the present study was generated using various relevant literatures. A total of more than 120 medicinally important plant species were reported. Medicinal plants of CPWLS belong to various families. Out of these many plant species fell into the rare,

endangered and vulnerable status categories. The present study aimed to document the traditional uses of different plant parts of medicinal plants. This study can serve as baseline information on medicinal plants and could be helpful to further strengthen the conservation of this important resource.

**Key words:** Medicinal plants, Chandra Prabha Wildlife Sanctuary, Rare, Resources.

SII/O-14

## History of *Bougainvillea*: A Long Journey from Brazil to India

**S.C. Sharma**

CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: scsharmagardener@gmail.com

*Bougainvillea* is one of the most colourful, drought resistant and pollution tolerant climbing shrubs. Their colourful bracts make the *Bougainvillea* as the preferred choice for the landscaping of parks and gardens in tropical and sub-temperate regions and known as 'Glory of the Tropics'. *Bougainvillea* is the member of the family Nyctaginaceae. *Bougainvilleas* have attained popularity due to their bracts, which appear in various colours and shades. The plant was first collected by a French Botanist, Commerson in 1769 from Rio de Janeiro (Brazil). Commerson named the plant after Lois Antoine de Bougainville the French Navigator, with whom he went on a voyage round the world. History of *Bougainvillea* is ca 250 years old. It has travelled a long distance from Brazil to India. There are ca 350 *Bougainvillea* cultivars of *Bougainvillea* all over the world. 50 % of the *Bougainvillea* cultivars have been evolved in India. India has been recognized as the International Registration Authority for *Bougainvilleas* by the International Society for Horticulture. CSIR-National Botanical Research Institute (NBRI), Lucknow is maintaining an unique rich germ-plasm collection of 250 species/cultivars in the Botanical Garden. NBRI is well recognized for its R & D work on *Bougainvilleas*. Institute has evolved ca 30 novel *Bougainvillea* cultivars, which remain in high demand in the floriculture industry. *Bougainvillea* has flourished very well in India than its centre of origin.

**Key words:** *Bougainvillea*, Commerson, Brazil, Louis Antoine de Bougainville.

SII/O-15

## Phylogeography and Population Genetics of Common Reed (*Phragmites australis*) an Obnoxious Aquatic Invader in India with Comparison of Native Populations in Canada

**Gowher A. Wani<sup>1,2\*</sup>, Manzoor A. Shah<sup>1</sup>, Zafar A. Reshi<sup>1</sup>, Marie-Ève Beaulieu<sup>2</sup>, Alain R. Atangana<sup>2</sup> and Damase P. Khasa<sup>2</sup>**

<sup>1</sup>Department of Botany, University of Kashmir, Srinagar-190006, J&K, INDIA; <sup>2</sup>Centre for Forest Research (CEF) and Institute for Integrative and Systems Biology (IBIS), Université Laval, Québec, QC G1V0A6, CANADA  
Email: gowhar.wani88@gmail.com

Whether invasive species vary in morphological traits and at molecular level across native and non-native regions, though much speculated, is not supported by adequate quantitative data. Furthermore, the origin of differences in traits influencing competitive success between exotic and native wild populations of alien species is subject of debate. Therefore, deciphering the driving factors among-population divergence and the relative contribution from natural selection and neutral genetic differentiation is important in evolutionary biology. On the basis of morphometric traits, we compared five putative native populations of *Phragmites australis* in Quebec, Canada (haplotype QN), six putative populations exotic to Quebec (haplotype QE), and five populations invasive in Kashmir, India (haplotype KE), for seven quantitative traits. CpDNA PCR-RFLP analyses identified only one putative native *P. australis* population in Quebec. Using ten chloroplastic DNA microsatellite loci, we also compared nine populations each of haplotypes KE and QE, and one population of haplotype QN. Among- and within-population variation was significant for all measured traits, except for leaf width. Variation between haplotypes was highly significant for leaf width. Invasive haplotypes showed the highest values for the characters that were studied. Phenotypic differentiation among populations was moderate to high. The ten loci were variable, and moderate levels of genetic diversity were found within populations. Moderate genetic differentiation was observed between haplotypes and

populations, indicating occurrence of gene flow between populations. Principal coordinates analysis clearly distinguished three haplotypes. Phenotypic divergence exceeded genotypic divergence, indicating divergent selection amongst populations. The invasive populations in Kashmir and Quebec harboured highest proportion of common alleles of comparable size, and belonged to similar haplotypes. Furthermore, their polyploidy nature suggests the European nativity of Kashmir populations.

**Key words:** Common reed, CpDNA microsatellite loci, Haplotypes, Phenotypic and genetic differentiation, Plant invasion.

SII/O-16

### **Species Diversity and Carbon Stock in Three Temperate Forest Types of Garhwal Himalayas, Uttarakhand, India**

*Siddhartha Kaushal and Ratul Baishya\**

Department of Botany, Faculty of Science, University of Delhi, Delhi-110007, INDIA Email: kaushal.siddhartha@gmail.com, rbaishyadu@gmail.com

With immense pressure on natural resources due to unsustainable rapid development and anthropogenic activities, climate change is the worst fear of the century. The exponential carbon emissions have prioritized our goals to curb this rise and thus Carbon sequestration is nature's answer to this problem. The state of Uttarakhand has 45.43% forest cover and offers various forest types because of climatic and geographic variations offered by the Himalayas. The present study aims to report the species diversity in three temperate forest types (2144-2285m) of Garhwal Himalayas along with tree species biomass and carbon stock. The stem density was observed between 275-360 trees ha<sup>-1</sup> with total tree biomass density ranging between 480 to 859 Mg ha<sup>-1</sup> and corresponding carbon stock density between 220-397 Mg C ha<sup>-1</sup>. Species dispersal for majority of the species in all the three forest types was of contagious type. Simpson's dominance index showed strong positive correlation with both elevation (0.79) and total carbon density (0.78), while species richness (SR) showing negative correlation with both indicating reduction of diversity with altitude. The phytosociological data indicated a net negative

correlation between species density (-1.0) and frequency (-0.81) with total carbon density. However, strong positive correlation (0.74) was observed between basal area and carbon density reflecting the contribution of the forest with higher girth trees towards biomass and carbon stock which further necessitates the conservation of such forests for carbon sequestration.

**Key words:** Natural resources, Carbon sequestration, Biomass and carbon, Forest types, Conservation.

SII/O-17

### **Environmental Determinants of Plant Richness in the Eastern Himalaya**

*Rajendra Mohan Panda\* and Mukunda Dev Behera*

Centre for Oceans, Rivers, Atmosphere and Land Sciences (CORAL), Indian Institute of Technology, Kharagpur, West Bengal, INDIA, Email: rmp.iit.kgp@gmail.com

Understanding underlying causes of high plant diversity is imperative for mountain ecosystems. The study on the Indian Eastern Himalaya assesses effects of physiographic, climate, edaphic and disturbance on plant richness of a national database. 1475 species from 411 geospatial locations between elevation ranges 129 and 4412 m were considered. Eight out of 35 environmental variables were selected after optimisation involving multicollinearity test and principal component analysis. Generalised additive model (GAM) cross-validation results were validated using Ordinary least squares and structural equation model (SEM) for independent and multivariate analysis, respectively. Potential evapotranspiration is found to have a significant climatic predictor, with an explained deviance of 22.5% and showed positive correlation with plant richness. Precipitation seasonality and temperature seasonality displayed negative correlations with plant richness. Elevation could explain 21.9% deviance, whereas cation exchange capacity could describe the maximum deviance by any variable i.e., 24%. The best model could describe 51.1% in plant richness with contributions from climate, physiography, soil and disturbance. SEM grossly underestimated the GAM results and described 26% variance of the best model indicating superior execution of nonlinear settings to species-environment relationships. Decision tree

described increase in temperature seasonality ( $> 476.8$  CV) could enhance plant richness at  $PET > 1163$  ha  $yr^{-1}$ . Precipitation seasonality ( $d'' 82$  CV) could increase plant richness with decrease in temperature seasonality ( $d'' 476.8$  CV). Precipitation seasonality (value  $> 109$  mm) and precipitation ( $> 1719$  mm) could increase plant richness with rise in temperature seasonality ( $> 463.6$  CV). Precipitation seasonality ( $> 93$  CV) and precipitation ( $> 2983$  mm) could reduce plant richness further, even at low level of temperature seasonality ( $463.6$  CV). It infers that climate defined by water-energy dynamics and its heterogeneity act in synergy in describing plant richness. Comparison of different modeling approaches is suggested to crosscheck validity of model selection.

**Key words:** Eastern Himalaya, Plant richness, GAM, SEM.

#### SII/O-18

### Assessment of the Diversity of Invasive Alien Plants and its Role in Ethnomedicine in Western Madhya Pradesh, India

*Vijay Vishnu Wagh*

Plant Diversity, Systematics and Herbarium Division, CSIR–National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, INDIA, Email: vijaywagh65@gmail.com

Tribal community of Jhabua district uses the forest resources especially plants primarily for curing various ailments. Ethnobotanical practice has prevailed in this area since the ancient time and the invasive plants are not the exception. Exhaustive field surveys were conducted for the collection of the ethnobotanical data and voucher specimen. Information regarding ethnobotanical uses of plants was collected from the tribals using a semi-structured questionnaire. Several extensive reviews which studied invasive plant species are available. From this survey, a total of 102 plant species belonging to 38 families were reported for curing 37 types of ailments. Asteraceae was the dominant family and in life form category herbs stand dominant. Leaf is the most frequently used plant part, where as decoction is the highly preferred preparatory method for medicine preparation in the study area. 56% of the invasive plants showed a use value of more than

0.50. This indicates the high acceptance of these plants in the primary health care. We also discussed the degree of invasiveness and habitat preference of these species. The use of invasive alien plant species relieves the pressure on the native plant species that leads to the native plant diversity conservation. Finding of this study can be used as an ethnopharmacological basis for selecting plants for future phytochemical pharmacological studies.

**Key words:** Ethnomedicine, Invasive, Tribal, Jhabua.

#### SII/O-19

### *Aconitum duclouxii* H. Lév. (Ranunculaceae)- A New Record for the Indian Flora

*Danish Husain<sup>1,2\*</sup>, Priyanka Agnihotri<sup>1,2</sup> and Tariq Husain<sup>1,2\*</sup>*

<sup>1</sup>Plant Diversity, Systematics & Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, INDIA  
Email: husainmohddanish@gmail.com

The genus *Aconitum* L. (Ranunculaceae) characterized by hooded zygomorphic flowers with hidden nectaries and characteristic seed-coat ornamentation comprises of *ca.* 300 species worldwide and is represented by 27 species and 5 varieties from India. This highly medicinal genus is confined to Himalayan region and taxa are well represented in both western and eastern Himalaya. While examining the herbarium vouchers from The Natural History Museum, London (BM) during the revisionary study on the tribe Delphineae, we came across a specimen of *Aconitum* sp. collected by *F. Kingdon-Ward* (Coll. No. 20246) in 1950 from Walong, Lohit Valley, Assam (now Arunachal Pradesh) at an altitude of 10,000 ft. asl. This herbarium voucher has been identified and annotated as *Aconitum duclouxii* H. Lév. by Y. Kadotain the year 2000. After more closer studies and critical examination of the specimen, we could conclude that the annotation by Kadota is agreeable and literature surveys confirm that the taxon has never been reported from Indian Himalayan Region, thus, confirming a new record for Indian flora. Previously, the taxon was known endemic to Yunnan, China and this study show

the extended distribution of the taxon in Arunachal Pradesh which is adjacent to Yunnan region, thus making the new report from India. *A. duclouxii*s closely allied to *A. nagarum* Stapf and both of them belong to *Aconitum* subgen. *Aconitum*, a group of biennials with paired tuberous roots, but differs from the latter in having pedicels with spreading glandular hairs, bracteoles broader, carpels with hirsute golden hairs, petals with a comparatively shorter lip, and petal-lip with inconspicuous veins and entire, non wavy margins.

**Key words:** *Aconitum*, Assam, Ranunculaceae.

SII/O-20

## Role of the Plants Used in the Traditional Medicine

**Mukul Kumar**

Department of Botany and Plant Physiology, M.B.A.C., Agwanpur, Saharsa, (B.A.U. Sabour), Bihar, INDIA  
Email: drmukul.bau@gmail.com

Plants have played a fundamental role for the development of cultures ever since man first arrived to that region approximately 10000 years ago. Through history, man has utilized vegetable resources as a source of nutrition, medicines, fuel, and building materials and they even occupied an important place within their system and rites. The use of plants for treating diseases keeps being necessary Tokoshi zone in Bihar, which, due to high costs, have a difficult access to western medicines and, therefore, use to really on their own traditional remedies. On the other hand, the integrated forms of modern and traditional medicines are often practiced by many physicians nowadays. This has given origin to a popular medicine comprising the use of more than 100 local plants, which have been botanically identified. The illnesses cured with the plants are of course, strictly related with the health situation of local communities. Wound healing aids, renal and stomach infections, headaches, and colds are the most common ailments which natural resources are used for. Nonetheless less frequent diseases, such as cancer, diabetes, and malaria, are also treated with different plant extracts. According to the World Health Organization about 80% of the world population uses natural remedies and traditional medicine. Such medicine comes from plant resources that provide a

series of benefits to the local, regional, and national populations and include raw materials, patrimony protection, and scenic beauty.

**Key words:** Fundamental, Nutrition, Medicines, Fuel, Physicians, Protection.

SII/O-21

## Documentation of Pollinator Floral Calendar: A Case Study from Kashmir Himalayas

**Zubair A. Rather<sup>1\*</sup>, Anzar A. Khuroo<sup>1</sup>, Shoukat Ara<sup>2</sup>, Rameez Ahmad<sup>1</sup> and Maroof Hamid<sup>1</sup>**

<sup>1</sup>Centre for Biodiversity and Taxonomy, Department of Botany, University of Kashmir, Srinagar-190006, J&K, INDIA;  
<sup>2</sup>Research and Training Centre for Pollinators, Pollinizers and Pollination Management, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar-190025, J&K, INDIA, Email: zubairrather4@gmail.com

Insect pollinators play a vital role in the pollination of plants occurring in natural as well as human-dominated ecosystems. Thus the availability of sufficient forage resources, pollen and nectar, throughout the calendar year is the pre-requisite for the sustainable population of pollinators, and the productivity of pollinator-dependent ecosystems. The present study documented the insect pollinator and flower interactions in different seasons during the years 2012-2016 in Kashmir Himalaya. Based on systematic surveys and field observations, at each site, interactions were recorded at five points along 30m trail by moving in parallel directions for 60 minutes. Flowering period for a particular pollinator foraging plant species was observed from the date of opening of first flower to the date of shedding of last flower. Our results suggested that majority of forage resources are available in the month of May (84%) followed by June (70%), July (53%), April (46%), whereas the insect pollinators especially managed honey bees suffer for forage resources in the winter months of December, January and February during which only 3.77%, 4.71%, 8% forage resources are available respectively. The present study provides pollinator floral calendar of frequently visited forage plants and the period of their availability for the pollinators in different seasons across the year. The results from the present study will help



in better management of honey bees in apiculture and also continuous availability of pollinators for sustainable productivity in agriculture and horticulture in this Himalayan region.

**Key words:** Pollinators, Pollination, Floral calendar, Himalayas, Agriculture.

SII/P-1

## Traditional Uses of Biodiversity amongst the *Bhangalis* and the Practices for their Conservation

*Alpy Sharma*<sup>1\*</sup>, *Sanjay Kr. Uniyal*<sup>2</sup> and *Daizy R. Batish*<sup>3</sup>

<sup>1</sup>High Altitude Biology Division, CSIR-Institute of Himalayan Bioresource Technology, Palampur-176061, Himachal Pradesh, INDIA; <sup>2</sup>High Altitude Biology Division, CSIR-Institute of Himalayan Bioresource Technology, Palampur, HP 176061 INDIA; <sup>3</sup>Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: sharmaalpy@gmail.com, suniyal@ihbt.res.in, daizybatish@yahoo.com

Recognizing the importance of biodiversity and its conservation, the present study was conducted to document traditional uses of biodiversity and various conservation practices followed by the *Bhangalis*-residents of Chhota Bhangal. The Chhota Bhangal lies in the lap of Dhauladhar mountain range, Himachal Pradesh. Field surveys were carried out to the area and personal interactions were held with the *Bhangalis* to record use of wild plants for edible purposes. The study also targeted documentation of plants derived household products and the traditional conservation practices prevalent in the area. The results revealed use of 50 wild plant species for edible purposes. Maximum of these were used as vegetable (mean=8.9) while the minimum was for brew (mean= 0.4). *Bhangalis* used 55 plants derived products of which majority were used as indigenous tools (34). For making these products, 20 species belonging to the 12 families were used. Maximum of these belong to the family Pinaceae and 50% of used species were trees. As evident, since their livelihood is dependent on bioresources, *Bhangalis* ensure their flow and availability by following traditional practices for forest, soil, water, and grassland conservation. Presence of a sacred grove dedicated to local deity *Ajayapaal* has

resulted in maintenance of a thick *Cedrusdeodara* forest from which no resources are extracted except in emergencies. For water, setting up of *baudies* (water reservoirs) and *devtaals* (sacred ponds) such as *Dynasur* are pertinent examples. Polluting them is a sin. For soils, terraces and bund formation are important practices. *Ghasnis*- for grassland protection ensures sustainable availability of fodder during lean season. In a nut shell, besides using biodiversity, the *Bhangalis* are also involved in practices that guide its conservation. Unfortunately, these practices are breaking under the influence of market forces and changing lifestyle. Thus, strategies for their documentation, preservation and maintenance become important.

**Key words:** *Bhangalis*, Biodiversity, Conservation, Management, Market.

SII/P-2

## Poplar and Other Fast-Growing Tree Culture Outside Forest

*Anita Tomar*<sup>\*</sup>, *Anubha Srivastav* and *Abhijeet Pandey*

Forest Research Centre for Eco-rehabilitation, 3/1, Lajpat Rai Road, New Katra, Allahabad, Uttar Pradesh, INDIA  
Email: anitatomar@rediffmail.com

Plantation forestry outside the forest in India is largely based on fast-growing trees. This is particularly true for agroforestry which is practised by individual growers in their farmland and wasteland. Trees are systematically planted in farmland as block plantation or boundary plantation, or maintained as scattered trees for various tangible and intangible benefits. The Forest Survey of India has estimated the growing stock of trees outside forest at 1573 billion cubic metre (27.3% of total growing stock). However, the annual wood production of trees outside forest is about 13 times more than the forest, suggesting the popularity of fast-growing trees outside the forest. The boost to tree planting outside the forest was provided by the National Commission on Agriculture, 1976 and the National Forest Policy, 1988. *Eucalyptus*, *Casuarina*, *Populus*, *Dalbergia*, *Tectona*, *Melia* etc. are among the most popular plantation trees. Despite this, several policy interventions are adversely affecting the interests of

tree growers. Difficulties in obtaining felling and transit permits, absence of a favourable minimum support price mechanism, non-availability of soft bank loans, absence of agroforestry cooperatives, Uncertainty about marketing/ sale of end produce, Small landholding, Poor technical knowhow regarding planting practices and suitable tree crop combinations, inadequate availability of superior planting material, etc., pose serious challenge to the grower. *Populus deltoides*, in particular, witnesses large fluctuations in the price of wood which renders the planting rate of this species highly variable from year to year. A low level of technical knowledge about tree cultivation too sometimes results in losses to growers. Insufficient research grant is also proving a handicap in technical innovations in plantation forestry. An initiative was taken by Forest Research Centre for Ecorehabilitation (A Centre of Forest Research Institute, Dehradun) for planting fast growing tree outside forest in which *Poplar deltoides*, *Eucalyptus*, *Tectona grandis*, *Gmelina arborea* agroforestry trial are proposed in Gorakhpur, Basti, Varanasi, Balia and Allahabad districts.

**Key words:** Trees outside forest, Challenges, Policy, Poplar, Plantation forestry.

SII/P-3

## Morphological and Cytogenetical Analysis of *Sechium edule* (Jacq.) Swartz

*Asikho Kiso*<sup>1\*</sup>, *Sanjay Kumar*<sup>2</sup> and *Limasenla*<sup>1</sup>

<sup>1</sup>Department of Botany, Nagaland University, Lumami-798627, INDIA; <sup>2</sup>Department of Botany, Banaras Hindu University, Varanasi-221005, INDIA Email: mhasikhono@gmail.com, ksanjay79@gmail.com, limasenla@mail.org

*Sechium edule* (Jacq.) Swartz, belongs to the family Cucurbitaceae and commonly called as Chayote. The plant chayote is a native of Mexico, but considerable diversity is also found in the Indian subcontinent where it is grown widely in the North-East and Southern regions of India. Fourteen Chayote fruit variety were collected from Nagaland, India under the district of Kohima, in order to study their phenotype and genotype characters. Both the qualitative (shape of fruit, colour, spines distribution, furrows, ridges, texture, taste, fibres present or absent), quantitative traits of *Sechium* (fruit length, width, area, volume,

weight, lenticels, days of harvest and fruit per plants) and information on vegetative as well reproductive (Leaf, flowers, inflorescence and fruits) parts of the *Sechium* were studied for its morphological characters. From the investigation, the collected germplasm of the fruits shows great variation in its appearances (shapes, colour, spines distribution) and weight. The plant was found to be herbaceous, monoecious, perennial, climber, supported by branched tendrils and leaves, with light to dark green fruits. Chromosome count are tried to establish correct chromosome number in all the 14 genotypes as well as ploidy level and deviations, if any. Since the distribution of the species is restricted to a limited area across the world, it is worthwhile to preserve and conserve the species.

**Key words:** *Sechium edule* (Jacq.) Swartz, Phenotype, Genotype, Chromosome number, Genetic diversity.

SII/P-4

## Diversity of Parasitic Algae *Cephaleuros* Species (Trentepohliaceae, Chlorophyta) In Kerala, India

*Binoy T. Thomas\**, *M.V. Bhagya* and *V.P. Thomas*

Phycotechnology Laboratory, Department of Botany, Catholicate College, Pathanamthitta, Kerala, INDIA Email: bttkripa@gmail.com

The genus *Cephaleuros* comprised of subaerial green algae (Chlorophyta) belonging to the class Ulvophyceae, under the order Trentepohliales and the family Trentepohliaceae. Leaves of thirty seven host plants were collected from ten different spots of Pathanamthitta district, Kerala, India including agricultural land, forest and plantations. Macroscopic features of algal thallus were observed under a hand-lens and a stereoscopic microscope. Several adequate sections of the infected leaves were taken and identified using monograph of Thompson and Wujek (1997). Four parasitic species of *Cephaleuros* were isolated such as *C. virescens* Kunze & EM Fries (1832: 327), *C. parasiticus* Karsten (1891:32), *C. diffusus* Thomson & Wujek (1997: 32) & *C. microcellularis* Y. Suto & S. Ohtani (2009: 2226). Generally, thallus has a prostrate system and an erect system. Prostrate system is hidden in subepidermally or intramatrically. The erect system is reduced to simple and multicellular setae and 3-8

celled sporangiophores. As far as *C. parasiticus* was concerned, *C. virescens* was widely distributed and observed in thirty five host plants. In *C. parasiticus*, lesion occurs on both adaxial and abaxial side of the leaves and causing necrosis of whole leaf tissues of leaves, but in the case of *C. virescens* lesion occurs at adaxial side and necrosis occurs at epidermal and palisade cells of leaves. *C. parasiticus* was observed in plants of *Lagerstroemia speciosa* and *Anacardium occidentale*. *C. diffusus* caused necrosis in the leaves of *Artocarpus incisus* and leading to early leaf falling. *C. microcellularis* caused lesions on epidermal and palisade leaves of *Anacardium occidentale*. All *Cephaleuros* species caused either leaf or fruit spot in a wide range of wild plants and plantation crops of economic interest in Kerala, India. The present study concluded that *Cephaleuros* species pose direct threat to the host plant and affect their metabolism.

**Key words:** Trentepohliales, Tropical, *Cephaleuros virescens*, *C. parasiticus*, *C. diffusus*, *C. microcellularis*.

#### SII/P-5

### An Enumeration of Medicinal Macrofungi from Hamirpur Region of Himachal Pradesh

*Jyoti Pathania\* and Hem Chander*

Division Botany, Department of Bio-Sciences, Career Point University, Hamirpur, H.P., INDIA Email: angeltikshu1990@gmail.com, hemchander78@gmail.com

During the ongoing studies on diversity of macrofungi, specimens of macrofungi were randomly collected from thirteen localities (*viz.* Chheorin, Doh, Baru, Bohni, Saloni, Bhoti, Tikkar- Khattryan, Kohin, Tikkar-Sujanpur, Doli-Sujanpur, Harson, Ghadalwin and Fafan) of Hamirpur region of Himachal Pradesh and twelve species of medicinal macrofungi *viz.* *Auricularia auricula judae*, *Bovista pusilla*, *Daldenia concentrica*, *Ganoderma applanatum*, *Ganoderma lucidum*, *Lenzites acuta*, *Phellinus gilvus*, *Pleurotus ostreatus*, *Schizophyllum commune*, *Trametes pubescens*, *Trametes versicolor* and *Tyromyces chioneus* were identified. These macrofungi have medicinal utility against/as anti-dementia, anti-aging, anti-bacterial, anti-cancer, anti-diabetic, anti-fungal, anti-genotoxic, anti-hypertensive,

anti-inflammatory, anti-HIV, anti-oxidant, anti-parasitic, anti-tumor, anti-viral, cardio-vascular, chemo-protective, fever, gastrocyte protective, hypocholesterolemia, immune stimulating, immune-modulation, metal ion chelating, prebiotic, stomach ulcer and upset, stypitic, whooping cough and wound healing.

**Key words:** Anti-cancer, Anti-HIV, Hamirpur region, Macrofungi, Medicinal properties.

#### SII/P-6

### Altitudinal Variation in Traits of Rhododendrons

*N. Abenthung Kithan\*<sup>1</sup>, Sanjay Kumar<sup>2</sup> and N.S. Jamir<sup>1</sup>*

<sup>1</sup>Department of Botany, Nagaland University, Lumami-798627, Nagaland, INDIA; <sup>2</sup>Department of Botany, Banaras Hindu University, Varanasi-221005, INDIA Email: nabenthung@gmail.com, ksanjay79@gmail.com, nsjamir@nagalanduniversity.ac.in

The quantitative trait variation was studied among the Rhododendrons of Kohima, Kiphiri (3096, 3112 and 3430 masl) and Wokha at three different altitudes in each district of Nagaland. The quantitative traits such as phenotypic variation (Vp), genotypic variation (Vg), environmental variation (Ve), variation due to interaction of genotype and environment (Vgxe) with genotypic and phenotypic coefficient of variation (GCV and PCV) were recorded. The phenotypic variance was high in leaf breadth (71.7%) supported by the variations due to environment (86.2%) at an altitude of 3096 of Kiphiri district. The traits such as number of branches and number of inter nodes showed close relationship in GCV and PCV and suggest less environmental effect. The phenotypic variation leaf breadth was high (66.6%) at 3112 masl and the Length of peduncle showed close relationship between gcv and pcv indicate less environmental effect on the trait. The altitude 3430 masl was found not suitable for the variation in leaf breadth but more suitable for the variation in peduncal length due to genetic variation (97.9%). The traits with high variation may be useful for further investigation into the Rhododendrons.

**Key words:** Rhododendrons, Altitudes, Phenotypic variation, Genotypic variation.

SII/P-7

## Propagation and Multiplication of some Bryophytes under *in vitro* Condition

*Mridula Maurya*

Botany Department, University of Lucknow, Lucknow-226007, U.P., India, Email: mridulamaurya.mailbox@gmail.com

Bryophytes are earlier land plants and are well known as primary colonizers on bare land. They commonly grow in moist and humid places under shady condition but they are often associated with disturbed habitat, barren rock surface under extreme climatic conditions and mineral enrichment. Hence they play large role in habitat formation for secondary colonist. They also serve as indicator of environmental pollution due to their simple thallus composition. Here studies have been done on propagation and multiplication of members of aytoniaceae family due to their unique properties (medicinal value/ interesting chemical compounds having medicinal value, insect repellent/ antibacterial and antifungal, biogeoindicator, pollution indicator,

**Key words:** Bryophytes, Environmental pollution, Propagation, Multiplication, Aytoniaceae.

SII/P-8

## Lichen Diversity of Udala Area in Mayurbhanj District of Odisha, India

*Srimay Pradhan*<sup>1\*</sup>, *Prashant Kumar Behera*<sup>2</sup>, *Sandeep Kumar Nayak*<sup>3</sup> and *Kunja Bihari Satapathy*<sup>1</sup>

<sup>1</sup>Post Graduation Department of Botany, School of Applied Sciences, Centurion University of Technology and Management, Bhubaneswar, INDIA; <sup>2</sup>Lichenology Laboratory, CSIR-National Botanical Research Institute, Lucknow, INDIA; <sup>3</sup>Post Graduation Department of Botany, Utkal University, Bhubaneswar, INDIA

Email: srimay.pradhan@cutm.ac.in, bkprashant10@gmail.com, sandeepnayak75@gmail.com, kbsbotuu@gmail.com

Lichens are Thallophytes which comprise a unique group of plant consisting two unrelated organisms, a fungus and an alga, growing together in a close symbiotic association and can grow in most

adverse conditions of climate and substrate. They are universally distributed organisms occurring in varied climatic conditions ranging from the poles to the tropics in earth and look like crust, spreading rapidly over the surface (crustose lichens) or leafy and loosely attached to the surface (foliose lichens) and branched or shrubby, hanging from tree twigs or branches, with a single attachment (fruticose lichens). The lichens are considered valuable bio-monitors of environmental change and exhibit sensitivity to the air pollution. Udala community development area (21° 34' 37.7832" N 86° 33' 55.1124" E), in the Mayurbhanj district of Odisha is endowed with rich forest cover and home to many tribes and enriched with variety of tree species such as *Shorea robusta*, *Pterocarpus marsupium*, *Buchanania lanzan*, *Azadirachta indica*, *Phyllanthus emblica*, *Mangifera indica*, *Madhuca indica*, *Terminalia arjuna*, *Terminalia bellerica*, *Syzygium cumini*, *Pongamia pinnata*, *Ficus* sp. *Shorea robusta* dominates in all forest in the region. An extensive exploration was conducted to find out the diversity of lichens in Udala community development area during 2017-18. Over 219 specimens of lichens (169-foliose, 50-crustose) were collected from the bark of trees in the study area and were identified as 22 species under 15 genera and 11 families. The dominating genera were *Dirinaria*, *Parmotrema*, *Diorygma*, *Letrouitia*, *Pyrenula* and *Graphis*, while *Graphidaceae*, *Parmeliaceae*, *Physciaceae*, *Teloschistaceae*, *Letrouitiaceae* were dominating families. The findings of the present study revealed that lichen diversity is rich in this area and needs further study to conserve these lower plants.

**Key words:** Lichen, Udala, Mayurbhanj, Odisha.

SII/P-9

## A Preliminary Investigation on Mosses of Nagaland (North-East India)

*Vinay Sahu*<sup>\*</sup> and *A.K. Asthana*

Bryology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA

Email: sahuvinay8@gmail.com, drakasthana@rediffmail.com

The present study deals with the investigation of moss taxa of Nagaland. This state is covered by hill ranges and is very rich in medicinal and economically

important plants. During the present study investigation on bryophytes collected from Dzukou valley, Saramati Hills and Thanamir have been carried out. It revealed the occurrence of 99 species of mosses belonging to 52 genera of 26 families. Among the investigated families in mosses, Bryaceae, Dicranaceae and Pottiaceae seem to be more dominant in the region, followed by Meteoriaceae and Polytrichaceae. Genus *Pogonatum* and *Pohlia* have maximum 6 number of species followed by Genus *Bryum* and *Dicranum* with 4 species. *Atrichum crispulum* Schimp ex Besch. has been recorded as new to India, while 54 species of mosses have been reported for the first time from Nagaland.

**Key words:** Nagaland, Moss, North-East India.

SII/P-10

### ***In vitro* Seed Germination, Regeneration and Synthetic Seed Production Based Micropropagation of a Terrestrial Medicinal Orchid (*Malaxis acuminata* D. Don)**

*Anuprabha*<sup>1\*</sup> and *Promila Pathak*<sup>2</sup>

<sup>1</sup>GGSD College, Sector-32, Chandigarh-160032, INDIA; <sup>2</sup>Orchid Laboratory, Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: anu857pu@gmail.com, ppathak2007@gmail.com

*Malaxis acuminata* is a rare, terrestrial, pseudobulbous, shade loving, and medicinal orchid of Himalayan region. It is used as aphrodisiac, febrifuge and has a cooling effect. Commercially known as 'Jeevak', its dried pseudobulbs from a constituent of 'Ashtavarga' drugs used in the preparation of ayurvedic tonic 'Chyavanprash'. Its natural populations are decreasing mainly due to habitat destruction and commercial collection pressures, so several efforts have been made to develop an efficient micropropagation system. Presently the immature seeds (6, 10, 14 wap) were inoculated on M medium with plant growth regulators [IAA (1 mg l<sup>-1</sup>) and BAP (1 mg l<sup>-1</sup>)], organic supplements [YE (2 g l<sup>-1</sup>)] and AC (2 g l<sup>-1</sup>). Combination containing IAA supplemented with AC proved optimal for early germination and rapid protocorm multiplication; media containing

IAA+BAP+AC combination proved optimal for early rhizogenesis and seedling development. The morphogenetic response of pseudobulb explants were varied depending upon *in vivo* grown plants and *in vitro* raised plantlets. *In vivo* explants induced regeneration response via direct PLB formation at BAP 3 mg l<sup>-1</sup>. Interestingly, TDZ (3 mg l<sup>-1</sup>) supplemented with AC (2 g l<sup>-1</sup>) and IAA (2 mg l<sup>-1</sup>) + TDZ (3 mg l<sup>-1</sup>) + AC (2 g l<sup>-1</sup>) proved optimal for regeneration, culture multiplication and healthy plantlet formation in the *in vivo* and *in vitro* explants respectively. Synthetic seed technology is today avital tool for the *in vitro* propagation and conservation of plants. Protocorm like bodies (PLBs) formed *in vitro* were encapsulated in 3% sodium alginate matrix to form synseeds. Encapsulation ensures slow growth and long term preservation. The effect of storage at 4°C and 25°C was tested on the conversion frequency of seeds at 15 days intervals. Their multiplicity and conversion frequency was markedly impaired upon storage. The protocol developed in the present investigation can be commercially exploited and used as a means for the rapid propagation and conservation.

**Key words:** Pseudobulb, Mitra medium, Micropropagation, Protocorm like bodies, Orchid.

SII/P-11

### **A Preliminary Study on the Relative Abundance and Diversity of Insect Pollinators in Different Fruit Orchards of Kumaun Himalaya, India**

*Fasuil Farooq*<sup>\*</sup> and *Manoj Kumar Arya*

Insect Biodiversity Laboratory, Department of Zoology, DSB Campus, Kumaun University, Nainital-263002, Uttarakhand, INDIA, Email: faisalmalik.jk@gmail.com

Pollinators are regarded as important keys for the production of fruits to increase farmers income. The present study aims to study the relative abundance and diversity of insect pollinators in three fruit orchards, i.e. apple, peach and apricot orchards, respectively. Scan sampling method was used to explore the diversity of insect pollinators. Observations of the insect pollinators were conducted from 8.00 to 11.00 AM and 2.00 to 4.00 PM in sunny days. A total of 563 individuals

were collected, belong to 47 species in four order (Hymenoptera, Diptera, Lepidoptera and Coleoptera). Number of species of insect pollinators found in apple orchard (31 species) and peach orchard (22 species) were higher than that in apricot orchard (13 species). Insect pollinators in all the three fruit orchards were dominated by giant honey bee (*Apis dorsata*) followed *Apis cerana* and *Bombus haermorrhoidalis*. Higher foraging activities of insect pollinators occurred in the morning.

**Key words:** Abundance, Diversity, Fruits, Insects, Species.

SII/P-12

## Ecology and Economy of Grasses of Trans-Himalayan Region

*Mudassir Ahmad Bhat\**, *Priya Badgal*, *Poonam Chowdhary* and *Amarjit Singh Soodan*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA  
Email: mabhat90@gmail.com

Poaceae constitutes the fifth largest angiosperm family as far as the number of species is concerned. Within monocotyledons, the family stands at the second rank after Orchidaceae and includes more than 11000 grass species distributed in 700-800 genera. India is a megabiodiversity country that harbours a rich diversity of grasses. Poaceae has emerged as the largest plant family in the country with a representation of 268 genera and 1300 species. Ever since their origin and diversification, grasses have evolved a number of biotic and abiotic interactions that have made them an important component in almost all ecosystems but dominant elements in the grasslands of the world. Apart from monitoring, grasses have been found to possess tremendous potential to maintain the carbon balance and mitigating the damage to the environment. Several grass species have been identified and recommended as bioenergy crops to obtain bio-fuels that would reduce the burning of fossil fuels and release of Green House Gases (GHG's) into the atmosphere. Within the country, north western Himalayan region has been recognized

as one of the biodiversity hotspots. Himalayan grasslands have been classified into five types viz., warm temperate grasslands, cool temperate grassy slopes, sub alpine meadows and thatches, alpine meadows and steppe formations of the trans-Himalayas. Grasses have significance in human life far beyond meeting the basic requirements of food and fodder. Economic uses include their use as raw material of sugar and beverages (the sugarcane), as constituent of baking powder, pies and puddings, building materials for huts and tree homes (machons), art and craft, vaulting poles (bamboos and reed grasses), paper, sweeping brooms (broom grasses) and finishing and stiffening material in textiles (corn starch). Several grasses are sown as lead plants to reclaim the unused lands like mud flats and tidal estuaries (eg. cord grass) and alkaline and saline lands. The present study reports the ecological and economic importance of grasses of Trans-Himalayan region. The grasses for which data on the economic and ecological significance has been presented in the paper include *Piptatherum gracile* Mez, *Piptatherum munroi* (Stapf) Mez, *Stipa brandisii* Mez, *Brachypodium sylvaticum* (Huds.) P. Beauv., *Koeleria macrantha* (Ledeb.) Schult., *Trisetum aeneum* (Hook.f.) R. R. Stewart, *Agrostispilosula* Trin., *Calamagrostis holciformis* Jaub. & Spach., *Calamagrostis pseudophragmites* (Haller f.) Koeler, *Muhlenbergia huegelii* Trin, *Deschampsia cespitosa* (L.) P. Beauv., *Dactylis glomerata* L., *Poa alpina* L. *Eremopoa altaica* (Trin.) Rozhev., *Alopecurus himalaicus* Hook. f., etc. and economically important include *Koeleria litvinowii* Domin, *Trisetum spicatum* (L.) K. Richt., *Festuca pratensis* Huds., *Lolium perenne* L., *Poa albertii* Regel, *Poa pratensis* L., *Alopecurus arundinaceus* Poir., *Phleum alpinum* L., *Bromus catharticus* Vahl, *Bromus inermis* Leyss, *Elymus nutans* Griseb., *Elymus dahuricus* Turcz. Ex Griseb., *Bromus japonicus* Houtt., *Hordeum brevisubulatum* (Trin.) Link, *Pennisetum orientale* Rich., *Setaria italic* (L.) P. Beauv. and *Tenaxia cumminsii* (Hook. f.) N.P. Barker & H.P. Linder.

**Key words:** Poaceae, Grassland, Himalayas.

SII/P-13

## Characterization of Most Potent Species of *Bauhinia* using Gel Electrophoresis

*Kumari Nutan Sinha\**, *Tanuja Singh* and *Jyoti Kumari*

Department of Botany and Biotechnology, Thakur Prasad Singh College, Patna-800001, Bihar, INDIA, Email: nutanm2@gmail.com

To trace the interrelationships and for identification and characterization of diversity among four species of medicinally most potent plants, *Bauhinia* viz. *Bauhinia acuminata*, *Bauhinia purpurea*, *Bauhinia racemosa* and *Bauhinia variegata* belonging to sub-family Caesalpinaceae, cytological study with respect to chromosome number, somatic chromosome length of component arms of chromosome, T. F% and chromosome type variation were investigated. Results showed that the three species have chromosome number  $2n=28$ , the value of the total chromatin lengths was lowest ( $53.48\mu$ ) in *Bauhinia racemosa* and highest ( $57.32\mu$ ) in *Bauhinia purpurea* while in *Bauhinia acuminata* this value was  $56.78\mu$  suggesting a close relationship between *Bauhinia purpurea* and *Bauhinia acuminata*. The T.F% values of *Bauhinia acuminata* and *Bauhinia purpurea* stand close to each other. Seed storage Protein profiles of four species of *Bauhinia* were analysed by sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE). Total seed storage protein of *Bauhinia* species resolved on 10% SDS Polyarylamide gels showed variations in their banding pattern. Results of SDS-PAGE pattern of a few protein bands were up regulated whereas some other bands showed down regulation. Beside the common bands among the studied taxa, 7.37, 31.85, 41.56, 54.854 and 261.143 kDa proteins were found to be common in *B. acuminata* and *B. purpurea* and 261.143 kDa protein was found common in all the four species. Maximum genetic affinities were observed between *B. acuminata*, *B. purpurea* (45.45%), while minimum between and *B. racemosa* and *B. variegata* (20%). On the molecular level, the present study gave the results with wide variations in their band numbers. Maximum number of protein bands (11 bands) was observed in *B. racemosa*, while minimum (7 bands) in *B. purpurea* and *B. variegata*.

**Key words:** Cytogenetics, Electrophoresis, *Bauhinia*, Potent, Investigation, Variations.

SII/P-14

## Studies on Plant Resources in Gunjan Ecological Park, a Freshwater Pitlake in Raniganj Coal Field Area, West Bengal India: Implications for Sustainable Use

*Pinaki Chattopadhyay<sup>1\*</sup>*, *Saikat Mondal<sup>2</sup>*, *Pallavi Chattopadhyay<sup>3</sup>* and *Debnath Palit<sup>1</sup>*

<sup>1</sup>Department of Botany, Durgapur Government College, Durgapur, West Bengal, INDIA; <sup>2</sup>Department of Zoology, Raghunathpur College, Purulia, West Bengal, INDIA; <sup>3</sup>Department of Microbiology, Amity University, Lucknow campus, Lucknow District, Uttar Pradesh, INDIA, Email: iampinu7@gmail.com, sairaniganj@gmail.com, pallavi96chatto@gmail.com, drdpalit@gmail.com

Pitlakes are formed as a result of water deposition or storage in a huge pit which has been created due to open cast mining. Pitlakes are storage of huge amount of water which indirectly and directly supports ecological succession by sustaining many flora and fauna nearby. The present study is an outcome of the exploration of flora at embankments and adjoining areas of pitlake of Gunjan ecological park, a 30 years old freshwater pitlake in Raniganj Coal Field Area of Asansol subdivision, Paschim Burdwan District, West Bengal, India. In the present treatise we have enumerated 210 species of angiosperms, 12 species of pteridophytes, 5 species of bryophytes, 9 species of algae, 70 species of macro fungi, 2 species of slime moulds and a species of crustose lichen. The plant species were identified using standard literature. This pit lake is enriched with floral assets like medicinal plants, vegetables, fruits and some edible mushrooms and this pit lake based ecological park promoting ecotourism also. There is immense opportunity to carry out further research work particularly for exploration of plant resources in this pit lake. Judicious and rational exploitation of plant resources in a sustainable way can conserve biodiversity, maintained ecological balance and also enhance socio-economic upliftment of local stakeholder.

**Key words:** Pitlake, Plant diversity, Gunjan Ecological Park, Ecotourism, Floral assets.

SII/P-15

## Assessment of Molecular Diversity of *Ribes grossularia* using RAPD Markers

*Diksha Molpa, Pooja Saklani\*, Pawan Singh Rana and Chandresh Chandel*

HNBGU (A Central University), Srinagar-246174, Uttarakhand, INDIA, Email: poojasaklani@rediffmail.com

*Ribes grossularia* is also known as 'Himalayan Currant' mainly found in open rocky slopes at altitudes of 2400-3300 m. It has low tocopherol content and high percentage of gamma-tocopherol. It has anti-inflammatory and anti-tumoral effects. In the present study, leaves of plant were collected from ten locations of Uttarakhand. Twenty RAPD primers from Operon series (OPA 1-20) were screened for the finger printing but only three primers OPA-04, OPA-10 and OPA-12 gave satisfactory results. The primer amplified DNA products from each location generated significant band patterns. On the basis of band pattern produced by each primer, the phylogenetic tree comprising of total ten accessions of *R. grossularia* was constructed by UPGMA. In the dendrogram, the accessions were divided into two major cluster groups i.e cluster 1 and cluster 2 based on the genetic variability. Among both clusters second major cluster was found more diverse. The genetic variability study for the *R. grossularia* species is not only valuable for the conservation of their germplasm but would also be useful for breeding new or novel varieties.

**Key words:** *Ribes grossularia*, RAPD, UPGMA.

SII/P-16

## Lichen Communities and Species Indicate Climate Thresholds in Indian Himalayas

*Rajesh Bajpai\* and D.K. Upreti*

Lichenology Laboratory, Plant Diversity Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Ptatap Marg, Lucknow-226001, INDIA, Email: bajpaienviro@gmail.com

Lichens are considered as one of the best material for carrying out environmental pollution monitoring and climate change. Due to their higher sensitivity against microclimate changes, lichen communities quickly predict the climate and environmental changes in a particular area within short duration of one or two decades, while higher plant require more time. The lack of vascular and root system and dependency to absorb water and nutrients passively from their environment make it sensitive against environmental perturbation. The potential areas for carrying out climate change studies based on the availability of herbarium records in India belongs to a number of localities in Indian Himalayan regions (IHRs), such as Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh and hill areas of Assam and Darjeeling district of West Bengal. These areas were well explored for their lichen specimens in the past and the specimens from these localities are preserved in different Indian herbaria can be utilized for such studies. From the lichen herbarium records the foot hills of Darjeeling in eastern Himalaya represents, 151 species of lichen belonging to 61 genera of 29 families from 11 localities. The same localities revisited after a gap of 48 years revealed the occurrence of only 126 species belonging to 45 genera of 22 families, out of which only 26 species were common in both past and present study while 100 species found in the recent survey were entirely different species reported in the year 1966. The present survey revealed a significant change in growth form, habitat and community structure of lichens as compared to past. The lichen herbarium specimen records, not only helps in reconstructing historical trend in atmospheric deposition but also exhibit the temporal variation in the community structure of lichens due to changes in climate. The observation in shift of lichen communities/species in response to climatic conditions and environmental pollutants warrant its use as a model to study the global climate and/or local microclimate change.

**Key words:** Lichens, Climate change, Herbarium records, Air pollutants.



SII/P-17

## Assessment of Bryophyte Diversity at Tiger Hill (Darjeeling, Eastern Himalaya) and its Importance in Context of Anthropogenic Activities

Reesa Gupta\* and A.K. Asthana

Bryology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: guptareesa44@gmail.com; draksthana@rediffmail.com

Bryophyte diversity of Tiger Hill (Darjeeling, Eastern Himalaya) has been elucidated and documented in the present study. This place is celebrated as the highest point of Darjeeling city and is a well-known tourist place of the region. A total of 48 species under 36 genera and 22 families of bryophytes are being reported presently. Mosses were more abundant than liverworts and hornworts. The bryophyte distribution was studied across six selected habitats. The overall trend in the bryophyte distribution here suggests that maximum number of bryophytes were present on wet rocks whereas tree barks also showed substantial bryophyte distribution. The trend of Similarity Indices calculated for different habitats indicates towards rich diversity of bryophytes. At Tiger Hill bryophytes inhabiting soil covered rocks and wet rocks were more similar in species composition whereas, soil and corticolous habitats showed least similar bryophyte flora as compared to other habitats. The site witnesses substantial anthropogenic activities that include vehicular movement, construction work, clearing of forest area for space creation, manmade pollutants such as waste and garbage and regular influx of people. Some species of bryophytes which were present nearly 50 years ago and have been re-collected from this site indicate that these are very well adapted to the habitat and abiotic conditions of this area. Further some taxa such as *Porella plumosa* (Mitt.) Parihar, *Crysocladium horridum* Dixon, *Symphiodon oblongifolius* (Ren. et. Card.), *Rhynchostegium celebicum* (Lac.) A. Jeager etc. were present at Tiger Hill nearly five decades ago but have not been recorded in recent times. On the other hand, very few species such as *Plagiochila sciophila* Nees, and *Cyathophorella hookeriana* (Griff.) Fleisch. have been retained here through the span of five decades,

possibly due to their habitat preservation over the time. Interestingly, nearly ten species of mosses family Pottiaceae and four species of liverwort genus *Jungermannia* L. have been recorded in the recent surveys which were previously not documented from this site. These bryophytes are known to be less habitat specific and well adapted to the harsh environmental conditions, therefore their presence at Tiger Hill suggests that the bryophyte flora here has undergone changes owing to continuous anthropogenic disturbances and habitat modifications.

**Key words:** Darjeeling, Bryophytes, Diversity.

SII/P-18

## Current Taxonomic Status of Caesalpinoideae-Leguminosae in Uttar Pradesh

Shivaraman Pandey<sup>1\*</sup>, Gauri Saxena<sup>2</sup>, Rameshwar Prasad<sup>1</sup> and Lal Babu Chaudhary<sup>1</sup>

<sup>1</sup>Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Department of Botany, Lucknow University, Lucknow, INDIA, Email: pandeyshivaraman@gmail.com, gaurigupta72@yahoo.com, rameshwar.nbri@gmail.com, dr\_lbchaudhary@rediffmail.com

Leguminosae (*nom. alt.* Fabaceae) is the third largest family of flowering plants after Orchidaceae and Asteraceae with approximately 750 genera and 19,400 species in the world. It is distributed throughout the world in almost all habitats ranging from wetlands to dry and cold deserts, from tropical forests to alpine habitats and from sea level to 7000 m in the Himalaya. According to recent classification, the family has been divided into six subfamilies: Cercidoideae, Detarioideae, Duparquetioideae, Dialioideae, Caesalpinoideae and Papilionoideae. The old subfamily Mimosoideae has been placed under Caesalpinoideae as a separate clade. In the present study, the taxonomy and diversity of the subfamily Caesalpinoideae found in Uttar Pradesh have been dealt elaborately based on extensive field and herbarium studies. Caesalpinoideae is represented by about 2251 species under 171 genera across the world. In India, it is represented by about 169 species under 31 genera and largely distributed in

the moist tropics. The present study revealed 45 species under 12 genera in Caesalpinioideae from Uttar Pradesh, including 13 cultivated species. Among different genera, *Senna* is the dominant ones with 12 species which constitutes about 26% of total Caesalpinioideae occurring in Uttar Pradesh. The genera *Bauhinia* and *Caesalpinia* hold second and third position with 9 (20%) and 6 (13%) species respectively in the state. Out of 45 species, 10 species are commonly occurring throughout the state in different biogeographic regions like Terai Region, Gangetic Plain, Vindhyan Region and Semiarid Region. While, some of the species are area specific, that occurs only in very restricted pockets. Each species has been dealt with detailed taxonomic information such as correct nomenclature, description, distribution, phenology and line drawing illustrations or photographs.

**Key words:** Caesalpinioideae, Diversity, Uttar Pradesh, Taxonomy.

SII/P-19

## **Biodiversity Conservation and Ecosystem Carbon Storage in Traditional Homegardens in Mizoram, Northeast India**

*Soibam Lanabir Singh and Uttam Kumar Sahoo\**

Department of Forestry, School of Earth Sciences and Natural Resource Management, Mizoram University, Aizawl-796004, Mizoram, INDIA, Email: uksahoo\_2003@rediffmail.com, uttams64@gmail.com

The study was conducted to document species composition, their utilization and carbon storage in traditionally practiced homegardens in Mizoram, Northeast India. A stratified sample of 42 homegardens classified on the basis of size as small (0.02 to 0.05 ha), medium (0.05 to 0.75 ha) and large (> 0.75 ha) with 14 homegardens each were surveyed in 2017-18. A total of 198 species (82 trees, 31 shrubs and 79 herbs) belonging to 69 families and 169 genera were recorded, being most of them perennials (78 %). Overall highest plant species was recorded in small (157 species) followed by medium (141 species) and large (141 species) homegardens. Diversity index for trees was maximum in medium ( $H' = 3.780$ ) followed by small

( $H' = 3.325$ ) and large ( $H' = 3.185$ ) homegardens. Tree density was found to be higher in the large homegardens (249 trees ha<sup>-1</sup>) and followed by medium (216 trees ha<sup>-1</sup>) and small homegardens (195 trees ha<sup>-1</sup>). The study shows that vegetables are the major component of the homegardens followed by fruit, medicinal, firewood and ornamental plants. The households recorded most species as useful for vegetable (24%) followed by fruit (18%), firewood (12%), medicine (11%), ornamental (9.8%), fodder (9.2%), timber (6.7%) and others (9.3%). Higher values of biomass were recorded in small followed by medium and large homegardens, and thus biomass carbon stock amongst the homegardens was in the order: small (122.3 Mg C ha<sup>-1</sup>) > medium (109.0 Mg C ha<sup>-1</sup>) > large (90.6 Mg C ha<sup>-1</sup>). Soil organic carbon (SOC) stock upto 1 m soil depth was also recorded maximum in small (229.5 Mg C ha<sup>-1</sup>) followed by medium (176.2 Mg C ha<sup>-1</sup>) and large (144.6 Mg C ha<sup>-1</sup>) homegardens. The study results indicate that traditional homegarden agroforestry systems mimics forest ecosystems and thus qualify as potential carbon sinks through sustainable management practices.

**Key words:** Homegardens, Species diversity, Biomass carbon stock, SOC stock

SII/P-20

## **Algal Diversity with Special Reference to Chlorophyceae of Shershah Suri Pond, Kanpur, U.P.**

*Vishal Saxena\* and R.K. Khare*

Department of Botany, Govt. Model Science College (Jiwaji University), Gwalior, M.P., INDIA, Email: vishsaxena@rediffmail.com, rakesh.khare1965@gmail.com

Fresh water is natural source of fundamental importance to all living beings on earth. Natural water is rich in bacteria, algae, protozoa, worms and other organisms. Algae, carbon fixing and oxygenating organism, and their diversity is the key parameter to determine the productive nature of the pond ecosystem. The limnological survey and the algal diversity of Shershah Suri freshwater pond in Kanpur (26° 24' 29" N latitude and 80° 23' 34" E longitude) district, Kanpur Nagar (U.P.) was undertaken. Water samples were analysed for the concentration of various physico-chemical parameters. Phytoplankton of all the sides of

pond were collected for analysis. Detailed examination shows that algae exhibit a high degree of qualitative and quantitative variance throughout stretch of Shersah Suri Pond. The aquatic system have shown existences of 34 algal forms and out of them 12 belongs cyanobacteria, 4 to Euglenophyceae, 7 to Bacillariophyceae and 11 to chlorophyceae. There are certain algae occur in all the season. The present paper deals with the study of members of chlorophyceae e.g. Cladophora, Oedogonium, Spirogyra, Vaucheria and Zygnema.

**Key words:** Algal diversity, Chlorophyceae, Aquatic system, Shersah Suri Pond.

**SII/P-21**

### **Conservation Strategies in *Selinum*: A Himalayan Medicinal and Aromatic Herb**

**Ravi Prakash Srivastava\* and Gauri Saxena**

Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: ravisrivastava02@gmail.com, gaurigupta72@yahoo.com

Medicinal plants and herbal medicines form an important part of the treatment in the Indian medicine systems. One such Himalayan medicinal herb is *Selinum* that belongs to Apiaceae family. The plants are also widely distributed over the temperate zones of both the hemispheres. The genus commonly referred to as Bhutkeshi in India, is known for its medicinal and aromatic properties and has been used as an alternative source and adulterant of compounds obtained from *Nardostachys jatamansi*. All the plant parts including leaf, stem and root are utilized for medicinal uses such as nervine sedative in hypertension, aphrodisiac with analgesic properties and in common ailments like cold, cough, fever, wounds, stomachache and toothache etc. It is also used for aromatic purposes such as incense. These plants have been locally as well as globally exploited that is why the current status of plant is now near threatened. According to the IUCN Red List 2001, the species *Selinum carvifolia*, was designated as endangered in the United Kingdom. Furthermore, another Red List by the IUCN in 2009 indicated *Selinum vaginatum* as threatened species and was considered to be in low risk category. Several species

of *Selinum* also fall under the Catalogue of Life list by Catalogue of Life Indexing. Since the plant has principal constituents (alkaloids as well as essential oils) mainly in the root, the plant is completely destroyed while being put to use. To avoid mass destruction of this high altitude medicinal plant, several conservation strategies need to be under taken such as cultivation, germplasm conservation, seed bank procurement etc. Conservation of plants can be tackled by scientific techniques such as *in situ* conservation to secure genetic variation and also conserve population of *Selinum*; *ex situ* conservation or biodiversity management for human utilization; local action such as Legislation, to give sustainable benefit to the present generation while retaining its potential to meet the requirements and aspirations of future generations as well.

**Key words:** Conservation, Threatened, Medicinal, Bhutkeshi, *Selinum*, Apiaceae.

**SII/P-22**

### **A Preliminary Diversity Analysis of Dicotyledonous Plants of Dima Hasao District of Assam, India**

**R.K. Verma<sup>1\*</sup>, B.A. Khan<sup>1</sup>, V.V. Wagh<sup>1</sup>, Baleshwar<sup>1</sup>, S.K. Behera<sup>1</sup>, S. Tamta<sup>2</sup> and L.B. Chaudhary<sup>1</sup>**

<sup>1</sup>Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Botany, DSB Campus Kumaun University, Nainital-263001, Uttarakhand, INDIA, Email: dr\_lbchaudhary@rediffmail.com

The study enumerates the dicotyledonous plants found in the district Dima Hasao in Assam with their important taxonomic information. This is the outcome of the several botanical tours conducted to different parts of the district during 2017–2018. Dima Hasao district, formerly known as North Cachar Hills district, is located in the southern part of Assam between 24° 58'2" to 25°47'2" N latitudes and 92°27'2" to 93°43'2" E longitudes at elevations ranging from 140 to 1866 m. The entire district comprises about 89 % forest cover of its total geographical area of 4,888 sq. km. with evergreen, semi-evergreen and deciduous types of forest. The Jhoom cultivation is the major agricultural practice in the area while the settled agricultural land

is only 1.29 % of the total geographical area of the district. After conducting several tours, about 436 species belonging to 307 genera and 87 families have so far been collected and identified from the study area. All voucher specimens have been deposited in CSIR-National Botanical Research Institute, Lucknow (LWG). Based on life forms 184 species have been identified in herbs, 70 in shrubs, 146 species in trees and 39 species in climbers. Among all families, Fabaceae with 92 species, and among genera, *Crotalaria* with 9 species were found largest in the study area. Some of the other dominant families are Asteraceae (34 spp.), Euphorbiaceae (21 spp.), Amaranthaceae (20 spp.), Malvaceae (14 spp.), Acanthaceae (12 spp.) and Convolvulaceae (10 spp.) Similarly, *Ficus* (8 spp.), *Desmodium* (6 spp.) and *Senna* (5 spp.) are frequently occurring genera. One of the interesting plants *Nepenthes khasiana* has also been relocated from the area. During the present study, about 47 highly medicinally important and useful plants were also recorded from the study area based on the information gathered by locals.

**Key words:** Diversity, Dima Hasao District, Dicotyledon, Assam.

SII/P-23

### ***Pedaliium murex* L. from Wild to Commercial Production: An Understanding with Issues and Challenges**

***Sujata Shekhar\**, *Akhilesh Kumar* and *J.N. Shrivastava***

Department of Botany, Dayalbagh Educational Institute (Deemed University), Agra-282005, Uttar Pradesh, INDIA  
Email: akhilpbh@rediffmail.com

*Pedaliium murex* (Pedaliaceae), commonly known as Large Calatrops in English and Bada Gokharu in Hindi. It is a mucilaginous medicinal herb having multiple uses in traditional medicine system. It is mainly used to cure reproductive disorders, like impotency in men, nocturnal emissions, gonorrhoea as well as leucorrhoea in women. It is also useful in the treatment of urinary and gastrointestinal tract disorders. The present paper deals with botanical description, origin, diffusion and distribution, usages in traditional and modern system of medicine, phytochemical and

pharmacological aspects, ecology, growth condition and environment needed; products and by-products, international and local market and current scenario about demand and supply, current issues and challenges for conservation, domestication and commercial cultivation, future prospect and recommendations and need of policy support etc.

**Key words:** *Pedaliium murex*, Bada Gokharu, Large Calatrops, Medicinal plant.

SII/P-24

### **Checklist of Green Algae (Chlorophyceae) of Uttar Pradesh, India**

***Sushma Verma\**, *Kiran Toppo* and *Sanjeeva Nayaka***

Algology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: creation.sanju@gmail.com

Algae are predominantly aquatic photosynthetic organisms and are the major primary producers of freshwater ecosystem. The class chlorophyceae are diverse group of green algae comprising of various forms distributed widely in freshwater bodies and terrestrial habitats. They include some of the most common species as well as several members that are ecologically significant. Thallus organization of this group varies from microscopic unicellular to multicellular macroscopic forms, may be colonial, coccoid, palmelloid, sarcinoid, syphonaceous, filamentous, thalloid and or pseudoparenchymatus. In India the total algal taxa are 7396, with class chlorophyceae representing approximately 2592 taxa. The present checklist of class chlorophyceae is the first compilation of the freshwater algal flora of Uttar Pradesh based on the updated literature records and bibliographic data intending to contribute towards the knowledge and information on the algal biodiversity of the state. The list summarizes the bibliographic database from approximately 120 scientific research papers, 6 books and 20 theses from libraries of various Research Institutes and Universities in Uttar Pradesh. The taxonomic identity of the taxa is checked by www.algaebase.org designed by M. Guiry. The present list records 973 taxa of class chlorophyceae pertaining to 9 orders, 35 families and 115 genera from 24 different aquatic and terrestrial habitats of

approximately 65 districts of Uttar Pradesh. The genus *Cosmarium* was recorded to be the dominant taxa with approximately 142 species followed by the genus *Oedogonium* with approximately 100 species. The least number of taxa recorded are from the genus *Papenfussiomonas*, *Trochiscia*, *Sphaeroplea* and *Protosiphon* represented with single species each. The present study could be considered as a baseline data for further exploration on the algal biodiversity from the state of Uttar Pradesh.

**Key words:** Green algae, Freshwater Chlorophyceae, Checklist, Uttar Pradesh

SII/P-25

### **Application of Macro and Micromorphological Characters of Seeds in Diversity Analysis of *Astragalus* L. (Leguminosae) in India**

*Shivani Kashyap and L.B. Chaudhary*

Plant Diversity, Systematics and herbarium Division, CSIR-national Botanical Research Institute, Lucknow-226001, INDIA, Email: dr\_ibchaudhary@rediffmail.com

*Astragalus* L. is the largest angiospermic genus in the world with about 2900 species. In India the genus which is chiefly found in the Himalaya, is represented by about 79 species. Due to its large size and enormous morphological plasticity, the taxonomy of the genus is very complex and challenging. The identification of species only based on macro morphological characters is tedious in the genus. In the present study, therefore, both macro and micro morphological features of seeds like shape, size, colour and spermoderm pattern under Scanning Electron Microscope (SEM) have been examined to evaluate their role in the identification and classification. The seeds of 30 species belonging to about 14 sections have been analysed for the study of variations among them in the present study. The overall size of the seeds ranges from 1.5-3.2 x 0.8-2.2 mm. The shape of the seeds, observed in the investigated species, are reniform, ovoid, oblong, discoid, suborbicular and deltoid. In the majority of the cases the seeds are brown or blackish-brown. The spermoderm pattern showed great variability in ornamentations which exhibit variation from rugulate,

reticulate, foveolate, reticulately-rugulate, reticulately-foveolate, stellate papillate, irregularly thickened cell walls, irregularly ribbed to faintly tuberculate. Although, these characters may not be utilized to classify the genus at subgeneric or sectional, but definitely they add an additional features to the individual taxon, which tremendously help in the identification.

**Key words:** Diversity, Seeds, SEM, Identification, *Astragalus*.

SII/P-26

### **Distribution and Diversity of Lichens in Dima Hasao district, Assam with Special Reference to Forest Health**

*Gaurav K. Mishra, Sanjeeva Nayaka and Dalip Kumar Upreti*

Lichenology Laboratory, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, U.P., INDIA, Email: gmishrak@gmail.com

The Indian Himalayan region exhibit rich diversity of lichens in India. The Western Himalayan region has luxuriance of lichens due to its unique topography and climatic condition, however, the Eastern Himalayan region showed rich diversity of lichens due to its warmer and moist climate condition. The rich moist and warmer climate in Eastern Himalayan region supports forest with dominance of evergreen tree vegetation. The Dima Hasao district of Assam is situated at higher altitudes between 500 to 1500 m having a suitable condition for many lichen taxa belonging to family Graphidaceae, Pertusariaceae, Pyrenulaceae and Thelotremaaceaeas the micro lichens together with macro-lichens families such as Parmeliaceae, Physciaceae, Collomataceae and Cladoniaceae. The district is represented by occurrence of 125 species belonging to 54 genera and 16 families. Among the different genera of lichens, *Graphis* showed its maximum diversity represented by 20 species followed by lichen genera *Parmotrema* and *Pyrenula* with 10 and 9 species respectively. The study area has dominance of crustose lichens represented by 91 species followed by 27 species of foliose lichens. Based on the occurrence of lichen bio-indicator communities the study area can be mapped in to different zones having different levels of environmental conditions and forest health. The *Lobariantaxa* considered as sensitive

to micro climatic condition and air quality are reliable indicators of species rich old forest with long forest continuity. The rich diversity of all the growth forms of lichens clearly indicates that most of the forest within the district of Dima Hasao has good health. The forest in Ethenic village area of Halflong and Umranso are considered as forest having good health and rich old forest having ecological continuity. The fast pace of urbanization and other developmental activities within the district will definitely have adverse effects on the diversity and distribution of lichens in different forest type and the present distribution pattern will act as base line data for carrying out future bio-monitoring studies in the area.

**Key words:** Biodiversity, Eastern Himalaya, Climate change, Bio-monitoring.

SII/P-27

### **Comparative Study of Microbiota (Bacteria and Fungi) Diversity and Physico-Chemical Analysis of Budhatalab and Ranisagar Ponds of Rajnandgaon District, C.G.**

*Shama Afroze Baig<sup>1\*</sup> and Anita Mahishwar<sup>2</sup>*

<sup>1</sup>Department of Microbiology, Swami Shri Swaroopanand Saraswati Mahavidyalaya, Aamdi Nagar, Hudco, Bhilai, C.G., INDIA; <sup>2</sup>Department of Botany, Govt. Digvijay Autonomous College, Rajnandgaon, C.G., INDIA, Email: shamaabaig@gmail.com, anitamahishwar@gmail.com

The present study was aimed to compare the microbiota (Bacteria & Fungi) in Budhatalab and Ranisagar of Rajnandgaon District, Chhattisgarh. This study includes isolation and characterization of Bacteria and Fungi present, their biodiversity in both the ponds, its correlation with physicochemical properties of water and seasons. In order to avail this we carried our study from July 2015 to June 2016. Aquatic fungi were isolated in different seasons by baiting techniques, and Bacterial estimation was done by SPC method. Pure culture was obtained and identified in lab. MPN test was performed. Water samples were analyzed for various physico-chemical characters like temperature, colour, turbidity, pH, Chloride, TDS, Dissolved oxygen, BOD. Ranisagar showed a rich diversity in Fungi as

well as Bacteria. Fungi isolated were mostly from the group *Basidiomycetes*, *Ascomycetes*, *Deuteromycetes* and *Phycomycetes*. Bacterial isolates include *Staphylococcus sp.*, *Streptococcus sp.*, *Micrococcus sp.*, *Pseudomonas sp.* The Bacterial identification was done with reference to Bergey's Manual of Determinative Bacteriology and that of fungus by Book for Fungal Identification. The results and comparative study revealed that both the ponds are highly polluted with diverse microorganisms, some are harmful for health and the water not safe for the domestic use. There has been great impact on physicochemical parameter like DO, BOD, COD that affects the every component of ecosystems. The details and effect of seasons are discussed in detail in paper.

**Key words:** Microbiota, Biodiversity, Bacteria, Fungi, Water.

SII/P-28

### **Diversity of Macrophytes and Microphytes in Budhatalab and Ranisagar of Rajnandgaon District, C.G.**

*Anita Mahishwar<sup>1\*</sup> and Shama Afroze Baig<sup>2</sup>*

<sup>1</sup>Department of Botany, Govt. Digvijay Autonomous College, Rajnandgaon, C.G., INDIA; <sup>2</sup>Department of Microbiology, Swami Shri Swaroopanand Saraswati Mahavidyalaya, Aamdi Nagar, Hudco, Bhilai, C.G., INDIA, Email: anitamahishwar@gmail.com, shamaabaig@gmail.com

The present study deals with the aquatic macrophytes and microphytes in Budhatalab and Ranisagar of Rajnandgaon District, C.G. The goal of this study is to understand the importance of microphytes and macrophytes in the preservation and restoration of the aquatic ecosystems and suggesting the remedial measures in accumulation of toxic metals. Macrophytes and microphytes are used as ecological determinants and for phytoremediation. In order to avail this we studied the diversity of two ponds in the vicinity of Digvijay College campus, Rajnandgaon. Macrophytes and Microphytes are well known biological filters and they carry out purification of the water bodies by accumulating dissolved metals and toxins in their tissues. The study on diversity, abundance and distribution of microphyte and macrophyte species provides indicative information of environmental effect on ecosystem. This work is the study survey undertaken

from August, 2015 to January 2017, which shows the occurrence and distribution of the aquatic macrophytes in the selected ponds, and were classified according to their habit. Both the ponds are filled with water all the year round, its vegetation which includes 53 different species of aquatic macrophytes were found from the two ponds, species distribution and seasonal variation are discussed in paper. 36 Algal genera were recorded from the class Chlorophyceae, Cyanophyceae and Bacillariophyceae. *Oscillatoria* was found throughout the year. Chlorophycean microphytes dominated during the monsoon season and Cyanophycean microphytes after monsoon. Bacillariophycean microphytes have no relation with the season. The high algal population could be due to equal exposure of aquatic surface to sun and pH.

**Key words:** Macrophytes, Microphytes, Diversity, Phytoremediation, Aquatic ecosystem.

SII/P-29

## Carbon Accumulation Pattern in Different Forest Types of Northwestern Himalaya, India: the Role of Tree Structural and Species Diversity

*Shiekh Marifatul Haq<sup>1\*</sup>, Maroof Hamid<sup>2</sup>, Anzar A. Khuro<sup>2</sup> and Irfan Rashid<sup>1</sup>*

<sup>1</sup>Department of Botany, University of Kashmir Srinagar-190006, J&K, INDIA; <sup>2</sup>Centre for Biodiversity & Taxonomy, Department of Botany, University of Kashmir, Srinagar-190006, J&K, INDIA, Email: snaryan17@gmail.com

Forests are considered as the important sinks for atmospheric carbon (C), yet C uptake and accumulation rates are highly uncertain, and the mechanisms remain poorly understood. The aim of the study was to assess the tree structural attributes such as (basal area and height), diversity, stem density, biomass and C stocks in different forests of Northwestern Himalaya and to make recommendations for forest management and conservation based on priorities for biodiversity protection and C sequestration. Eleven forest types in sub-tropical to temperate zones (400-2900 masl) of the region were studied during the study. The results of the present study revealed that stem density ranged between 140 and 357  $\text{Nha}^{-1}$ , while total biomass ranged

from 36.3 to 201.8  $\text{Mgha}^{-1}$ . Total C storage ranged between 16.3 and 92.8  $\text{Mgha}^{-1}$ . The range of Shannon–Wiener diversity index was between 0.31 and 1.08. Furthermore most of the conifer-dominated forest types had higher C accumulation potential than broadleaf-dominated forest types. Protection of the conifer-dominated forest stands from deforestation especially *Cedrus deodara*, *Abies pindrow*, *Pinus wallichiana* and *Pinus roxburghii* would have the largest per-unit-area-impact on reducing human-induced C emission. The results also showed that the forest biomass is a multipart property that integrates diverse ecological functional and structural attributes, thereby linking growing stock volume density (GSVD), basal area, height, and wood density and hence plays a significant role in C accumulation, but not the tree diversity. The results of the present study help in filling the knowledge gaps in scientific studies on the forest ecosystems in this eco-fragile part of the Himalayan region and hopefully would help in mitigating the regional climate change by minimizing the anthropogenic impacts within these forest ecosystems in the region.

**Key words:** C accumulation, Diversity, Forest ecosystems, Northwestern Himalaya.

SII/P-30

## Assessment of Plant Growth and Physiological Performance among Eight Varieties of Chickpeas in Indo-Gangetic Plains of Uttar Pradesh

*Shiv Naresh Singh<sup>1\*</sup>, Shruti Mishra<sup>1</sup>, N. Manika<sup>1</sup>, Bilal A. Khan<sup>1</sup>, Nayan Sahu<sup>1</sup>, Nalini Pandey<sup>2</sup> and Soumit K. Behera<sup>1</sup>*

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR - National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Botany, Lucknow University, Lucknow-226007, INDIA, Email: 777shivlko@gmail.com

Chickpeas are the most popular pulse crop of India, popularly known as Gram or Bengal gram, mainly grown in Rabi season. Chickpeas are a rich source of highly digestible dietary protein. There is as such no detailed study available on growth, biomass and yield of different varieties in Chickpeas, *Cicer arietinum* L. with special reference to Indo-Gangetic plains (IGP)

of Uttar Pradesh. We compared the plant growth and yield among 08 varieties of chickpea under farmer's field and screened the high yielding variety for Indo-Gangetic region. Eight different varieties of Chickpeas viz. HK94-134, JG -11, PANT-G -186, Radhey, Avarodhi, Shubhra, Ujjwal and DCP-92-3 were analyzed in terms of growth, physiological attributes and yield in order to screen the best adaptive variety with highest yield under rain fed conditions of IGP of Uttar Pradesh. Field evaluation on the basis of phenological traits, physiological performance, leaf area index and yield were carried out in randomized plots with three replicates for each variety in Banda district of Uttar Pradesh. The measurements were made in three growth stages i.e. vegetative phase, reproductive phase and senescence. We observed significant differences in majority of evaluated traits among the 08 varieties. Although, the morphological traits were better in the variety 'Ujjwal' among all, but altogether, 'Avarodhi' observed the highest yield with maximum photosynthesis rate. The above ground biomass was highest in Radhey variety with an average of  $39.76 \pm 3.38$  g plant<sup>-1</sup> followed by Avarodhi (average  $30.33 \pm 2.64$  g plant<sup>-1</sup>) and Shubhra. Highest total biomass was observed in Radhey (average  $45.16 \pm 4.07$  g plant<sup>-1</sup>) among all targeted varieties. From the present findings, it may be concluded that Avarodhi has highest carbon sequestration potential with highest yield in the IGP of Uttar Pradesh in rain fed condition, which further needs to be revalidated with more field trials at multiple locations.

**Key words:** Chickpea, Indo-Gangetic plains, Uttar Pradesh.

SII/P-31

## **Invasive Alien Flora of Parvati Aranga Wildlife Sanctuary and Adjacent Tikri Forest Area, Gonda District Uttar Pradesh, India**

*Vineet Singh*

Botanical Survey of India, Central regional Centre, Allahabad-211002, Uttar Pradesh, INDIA, Email: vineet.singh332@gmail.com

Convention of Biological Diversity (1992) visualizes that "biological invasion of alien species as the second worst threat after habitat destruction". The

loss caused by these species may soon surpass the damage done by other anthropogenic activities. According to IUCN, Alien Invasive Species are those alien species which become established in natural or semi-natural ecosystems or habitats, outside their natural distributional range and act as an agent of change causing threats to native biological diversity. The opportunity of inadvertent introductions will may become more with rapidly increasing global trade. During the course of floristic exploration of the Parvati Aranga Wildlife Sanctuary and adjacent Tikri Forest Area, Gonda district, Uttar Pradesh, the author has recorded 381 species of flowering plants; out of these 64 species belonging to 31 families analyzed as invasive alien species. The species with American nativity (Tropical America, Central America and South America) were most dominant alien invasive, followed by African, Asian, European and Mediterranean species which hold the probability of their introduction through other agents along with the food grains, mainly by human beings. Further, the family Asteraceae dominated over all others with 09 taxa followed by Convolvulaceae, with 05 taxa, Euphorbiaceae and Papilionaceae with 04 taxa each. Invasive alien species of the area and their impact on the wetland ecosystem have been also discussed. A better planning is needed for early forecasting and reporting of infestation of spread of these invasive weeds by creating plant detection network by collaborative links between taxonomist, ecologist and other stakeholders related to this field.

**Key words:** Alien species, Parvati Aranga Wildlife Sanctuary, Tikri forest, Gonda.

SII/P-32

## **Aroma Yielding Grasses of India; A Potential Resource for Bioprospection**

*Shailja Tripathi<sup>1,2\*</sup>, Abhai K Srivastava<sup>1</sup>, Priyanka Agnihotri<sup>1,2</sup> and Tariq Hussain<sup>1,2</sup>*

<sup>1</sup>Plant Diversity, Systematics & Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Academy of Scientific and Innovative Research (AcSIR), Ghaziabad-201002, INDIA, Email: tripathishailja16@gmail.com

Aromatic compounds have always been of great significance due to a variety of chemical constituents



and have a diverse range of uses. Plant-based aroma is of major choice for development of essential oil-based products whether it is pharmaceuticals, cosmeceuticals or perfumery industries. Moreover, nowadays aromatherapy has become the main line medication system for various health disorders. However, despite the vast range of uses, extraction of aromatic compounds has been limited to only a few plant species resulting in the use of synthetic aromatic compounds which in turn leads to the health side effects. Poaceae, the largest plant family in India comprising 1300 species belonging to 268 genera is of vital significance useful in different economical aspects but its use is limited to only few species. In the present paper, 14 grass species belonging to eight genera have been documented for their aroma yielding properties. *Cymbopogon* is found to be the most widely used grass for aromatic properties, followed by *Chrysopogon zizanioides*, *Eleusine indica*, *Eragrostis tremula*, *Thelopogon elegans*, *Sorghum arundinaceum*, *Andropogon gayanus* and *Dicanthium* sp. distributed in different parts of the country. The study is designed with an idea of bioprospecting Indian grasses for their aromatic and essential oil yielding properties on the basis of their traditional uses.

**Key words:** Aroma, Grasses, India, Bioprospection.

SII/P-33

## SSR Marker based Genetic Diversity Analysis in *Tinospora cordifolia*

*Suchita Lade*<sup>1,2\*</sup>, *Hemant Kumar Yadav*<sup>1</sup> and *Veena Pande*<sup>2</sup>

<sup>1</sup>CSIR- National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Kumaun University, Nainital, INDIA, Email: suchitalade.sl@gmail.com

The nature and extent of diversity in *Tinospora cordifolia*, a dioecious climber, widely distributed in India, and one of the most important medicinal plants has remained under explored. The present investigation aimed to explore the level of genetic diversity in a larger set of germplasm of *T. cordifolia* using microsatellite marker. A total of 96 accessions of *T. cordifolia* were evaluated for diversity analysis and SSRs markers developed for diversity assessment. A total of 77 alleles were amplified by 10 SSRs ranging from 4 to 12 with

an average of 0.40±0.17 alleles per loci. The neighbor joining (NJ) based clustering grouped all the accessions into three major clustering grouped were also confirmed by scatter plot of PCoA. Several potential accessions have been identified which could be of potential for future *T. cordifolia* genetic improvement program. Additionally, the grouping of various *T. cordifolia* accessions in three different clusters, as analyzed with SSR markers, indicates that *T. cordifolia* has potential inherent diversity that can be exploited towards genetic enhancement program.

**Key words:** *Tinospora cordifolia*, microsatellite, genetic diversity, NJ tree, PCoA.

SII/P-34

## Distribution and Current Status of *Thalictrum* (Ranunculaceae) from India

*Harsh Singh and Dibyendu Adhikari*

Department of Botany, North-Eastern Hill University, Shillong-760002, Meghalaya, INDIA, Email: harshchamlegi@gmail.com

The genus *Thalictrum* L. (meadow rue) belongs to the family Ranunculaceae and comprises 200 species mainly distributed in temperate regions of the world of which twenty species with five varieties are found in India. The genus shows great complexities in its morphological characters and is therefore a difficult and complicated genus for the identification. Throughout the world, plants of this genus have been used as a general tonic, purgative, stimulant, aperient and for the treatment of snake-bite, jaundice, rheumatism, wounds, swellings, uterine tumours, paralysis, joints pain, nervous disorders, toothache, diarrhea, piles, fever, peptic ulcers, ophthalmic problems, headaches, as a tonic, diuretic, etc. in all systems of medicine. Ecological niche characterization and modeling potential distribution area should help in developing strategies for its conservation. In the present study, we used Maxent modeling to characterize the environmental niche of the genus *Thalictrum* and also assess the inter-specific niche differentiation. The finding of the study should be useful in population survey and should be helpful in identification of sites for reintroduction and cultivation.

**Key words:** *Thalictrum*, Ranunculaceae, Maxent, Meadow rue.

SII/P-35

## Invasive Alien Plants of Balasore District in Odisha

*Sandeep Kumar Nayak*<sup>1\*</sup> and *Kunja Bihari Satapathy*<sup>2</sup>

<sup>1</sup>P.G. Department of Botany, Utkal University, Vani Vihar, Bhubaneswar, Odisha, INDIA; <sup>2</sup>P.G. Department of Botany, School of Applied Sciences, Centurion University of Technology and Management, Bhubaneswar, Odisha, INDIA  
Email: sandeepnayak75@gmail.com, kbsbotuu@gmail.com

An exhaustive floristic survey was carried out during August to December, 2015 in the Balasore district to assess the diversity of invasive alien plants. From the study it was found that 93 species were invasive alien plants belonging to 71 genera and under 39 different angiospermic families. Analysis of habit revealed that the herbs were dominant with 80 species (86.02%) followed by shrubs (9), climbers (03) and trees (1). The dominant family was Asteraceae with 17(18.27%) species followed by Convolvulaceae (07), Amaranthaceae (04), Caesalpiniaceae (04), Fabaceae (04), Poaceae (04), Solanaceae (04), Lamiaceae (03), Malvaceae (03) and Onagraceae (03) etc. The important invasive species documented in the area under study were *Chromolaena odorata*, *Lantana camara*, *Hyptis suaveolens*, *Ageratum conyzoides*, *Parthenium hysterophorus*, *Eichhornia crassipes*, *Alternanthera philoxeroides*, *Mikania micrantha* etc. The dominance of the members of *Asteraceae* species among all IAPS found in the district was resulted due to their higher potential for adaptability and rapid growth. It was found from the literature that different native places of IAPS found from Balasore district were Tropical America (54), Tropical Africa (11), Tropical South America (8), Mediterranean (3), West Indies (3), Tropical North America (3), Tropical Central South America (1), Tropical Central America (1), Tropical East Africa (1), Peru(1), Mascarene Islands (1), Temperate South America (1), Europe (1), Brazil (1), and Tropical West Asia (1). The prevalence in large scale of IAPS in the district indicated the threat to indigenous plant species and needs urgent measures to protect them.

**Key words:** Invasive alien plants, Balasore, Odisha

SII/P-36

## Studies on Invasive Plants in Central India with Reference to *Cassia uniflora* Mill.

*Vijay Kumar\** and *P.K. Khare*

Department of Botany, Dr. Hari Singh Gour University, Sagar-470003, M.P., INDIA, Email: vijaykumarju@gmail.com

Invasive species are those that occur outside their natural range, and cause negative effect on the environment, ecosystems, habitats, native biodiversity and even human health. Invasive species are also known by other several names such as non-natives, introduced, exotic, non-indigenous and foreign species. Invasive alien species are plants, animals, pathogens and other organisms that are non-native to an ecosystem, and which may cause environmental harm or adversely impact biodiversity. All non-natives are not harmful. At least, 18% of the Indian flora constitutes adventives aliens, of which 55% are American, 10% Asian, 20% Asian and Malaysian and 15% European and Central Asian species. Although a large numbers of exotics are naturalized in India and have affected the distribution of native flora to some extent, only a few have conspicuously altered the vegetation patterns of the country. Present work deals with the occurrence and distribution of *Cassia uniflora* and its role in the extant communities. *C. uniflora* Mill. is a herbaceous invasive alien weed belongs to family Caesalpiniaceae. This plant is native of Tropical South America and widely distributed in West Indies, Brazil and Mexico. In India, it was first reported from Eastern Karnataka in 1980 by Raghavan, subsequently from Pune-Maharashtra, Andhra Pradesh, Kerala, Tamilnadu, Madhya Pradesh and Rajasthan. In Madhya Pradesh, it is widely distributed in Guna, Sagar, Dhar, Jhabua and other places. *C. uniflora* is an aggressive weed occupying large area of road sides, railway tracks and waste places. This species is spreading through road and railway transports, water drains and transport of various agricultural products. *Cassia uniflora* has been found as a dominant invasive species affecting the native flora by altering the habitat. It competed through secreting phytoallelochemicals that affect the seed germination, seedling growth and biomass production of other plants. Field observations indicate that

*Parthenium hysterophorus* decline at places dominated by *Cassia uniflora* and *Cassia tora*. Therefore, *C. uniflora* and *C. tora* could be a potential species for the biological control of *Parthenium hysterophorus*.

**Key words:** Invasive species, Ecosystem, Phytoallelochemicals, *Cassia uniflora*, Biodiversity, *Parthenium hysterophorus*.

SII/P-37

## Do Invasive Alien Species Pose a Threat to Rich Phyto-Diversity of Kinnaur District of Himachal Pradesh?

P. Sharma<sup>1</sup>, H.P. Singh<sup>1\*</sup> and D.R. Batish<sup>2</sup>

<sup>1</sup>Department of Environment Studies, Panjab University, Chandigarh, INDIA; <sup>2</sup>Department of Botany, Panjab University, Chandigarh, INDIA, Email: hpsingh\_01@yahoo.com

Kinnaur is a mountainous area and one of the most challenging terrains of India due to its geographical location. It has not only great scenic beauty but is also rich in biodiversity. A preliminary survey was conducted in Kinnaur district of Himachal Pradesh to study its flora and to find out the possible threat posed by invasive alien species, if any. During the survey, rich flora of the area including economically important plants was assessed. Some of the prominent species of the area encountered were *Angelica sinensis*, *Plantago ovata*, *Pinus gerardiana*, *Prunus armeniaca*, *Cedrus deodara*, *Juniperus recurva* and *Betula utilis* etc. Some of the plants such as *Robinia pseudoacacia* and *Artemisia* species were found exhibiting tendency to spread in the area. Although, as of today, the area is relatively safer from the invasive alien species but a few as mentioned above may pose threat to the local species owing to the increasing temperature and changing environment. Therefore, it is important to continuously monitor such species, assess their possible risks and give early warning to the local people to manage them before it is too late. The study bears importance since the invasive alien species are fast spreading in the higher reaches of Himalayas and pose a threat to the culturally and economically important species of the region.

**Key words:** Floral biodiversity, Invasive species, Risk assessment, Early warning, Himalayas.

SII/P-38

## Lectotypification of *Boehmeria densiflora* Hook. & Arn. (Urticaceae) and Hooker and Arnott's Sets of Duplicates from Captain Beechey's Expedition

Imtiyaz Ahmad Hurrah<sup>1\*</sup>, Vijay Vishnu Wagh<sup>1</sup> and Avinash Tiwari<sup>2</sup>

<sup>1</sup>Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, INDIA; <sup>2</sup>S.O.S. Botany Jiwaji University, Gwalior-474011, Madhya Pradesh, INDIA, Email: saithimtiyaz18@gmail.com

The genus *Boehmeria* was named after Georg Rudolph Bohmer, a German botanist and physician. Weddelt recognized a total of 47 species in 1869 relying on the collections held at G, GDC, K and P. Willmott-Dear and Friis in 1996 recognized 33 species from old world and 14 from new world with no species occurring in both old and new world. *Boehmeria densiflora* distributed from south-western and southern China, Philippines and Japanese island group of Ryukyu and Bonin with doubtful occurrence in Assam and Sikkim in India (confused with *B. penduliflora*). Hooker and Arnott (1838) while describing *Boehmeria densiflora* cited Loo Choo as the collecting locality for this species, relating to Captain Beechey's expedition from Ryukyu Is, without providing information about collectors, collection number or any other information which could help to identify the herbarium material collected and where the material was deposited. Willmott-dear and Friis had cited as type of *B. densiflora*: Voyage of Capt. Beechey, Lay and Collie in herb Arnott s.n. (holo E, n.v. [not see]). But two specimens with such criteria were found each in E and K. However the specimens that most closely associated with the work of Hooker and Arnott, seems to be the one deposited at K [K000741331]. Therefore the Herbarium sheet of *B. densiflora* with bar code no. K000741331 is to be chosen as the lectotype of this species.

**Key words:** *Boehmeria densiflora*, K000741331, Urticaceae.

SII/P-39

## Hemi Synthesis, Computational and Molecular Docking Studies of Novel Nitrogen containing steroidal Aromatase Inhibitors; Testolactum and Testololactum

Rayees Ahmad Lone\*, Shabir Hassan Lone and Vijay Vishnu Wagh

Plant Diversity, systematic and Herbarium Division, CSIR-National Botanical Research Institute Lucknow-226001, Uttar Pradesh, INDIA, Email: isaarhyder18@gmail.com

Testolactone and testolactone represent aromatase inhibitors containing lactone rings. Hemisynthesis of these compounds reported from the most common phytosterols, which are highly abundant in nature. Herein, we report the synthesis of their nitrogen congeners: testolactum and testololactum. The reaction process involves the conversion of 4-androstene-3,17-dione to its corresponding oxime using hydroxylamine hydrochloride, whose Beckmann rearrangement under acid conditions yielded the desired testolactum. However, testolactam was formed by the Beckmann rearrangement of the oxime of 1-4-androstene-3,17-dienone. This expeditious reaction scheme may be for the bulk production of testololactum and testolactum. Theoretical DFT studies concerning the structural and electronic properties of all the end products carrying out using the three parameter Lee-Yang-Parr function (B3LYP) and 6-31g (DP) level of theory. Molecular electrostatic potential map and further orbital analysis were carried out. The HOMO-LUMO energy gap was calculated, which allowed the calculation of relative reactivity descriptors like chemical hardness, chemical inertness, chemical potential, nucleophilicity and electrophilicity index of the synthesized products. The molecular docking studies testololactum, testolactum and testolactone with aromatase (CYP19) revealed binding free energies of ( $\Delta G_b$ ) = -9.885, -9.62 and -10.14 kcal mol<sup>-1</sup> respectively. Compared to the standard testolactone, a well-known aromatase inhibitor sold under the brand name TESLAC, which exhibited a binding energy ( $\Delta G_b$  of -10.29 kcal mol<sup>-1</sup>) with an inhibition constant  $K_i$  of 28.87 nm. The docking study revealed that the

nitrogen congeners exhibit a relatively lower but appreciable therapeutic efficiency to be used as aromatase inhibitors.

**Key words:** Hemisynthesis, Nitrogen, CYP19, TESLAC

SII/P-40

## Preliminary Studies on Algal Flora of Suhelwa Wildlife Sanctuary in Uttar Pradesh with Special Reference to Morphotaxonomy

Kiran Toppo\* Sushma Verma and Sanjeeva Nayaka

Algalogy Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA Email: toppokiran@yahoo.co.in

Suhelwa wildlife sanctuary in Shravasti district of Uttar Pradesh lies in proximity to India's border with lush forest of Mahadevpur in Nepal. The beautiful sanctuary stretched over an area of approximately 452 sq km is endowed with dense forest exhibiting rich flora with diverse habitats. Though the sanctuary encompasses favorable ecological conditions for algal growth, the area remains unexplored until date. Therefore, the present work is the first attempt to explore the algal flora of this sanctuary. Total number of 8 algal samples from different habitats were collected in the first phase of exploration. A detailed account of morphotaxonomic description of all the identified taxa was made. The identification resulted in altogether 25 taxa (11 genera) belonging to 4 classes. Within the Chlorophyceae Desmids were dominant and represented by *Cosmarium pachydermum* P. Lundell, *C. phaseolus* Brebisson ex Ralfs, *C. dubium* O. Borge, *C. blyttii* Wille, *C. margaritatum* (P. Lundell) Roy & Bisset, *C. hammeri* (Reinsch), *C. dubium* O. Borge, *C. cyclicum* P. Lundell, *C. awadhense* B.N. Prasad & R.K. Mehrotra, *Closterium parvulum* Nageli, *Euastrum insulare* (Wittrock) Roy. Class Cyanophyceae represented 5 taxa namely *Geitlernema jasorvense* (Vouk) Anagnostidis, *Glaucospira laxissima* (G.S. West) Simic, Komarek & Dordevic, *Oscillatoria limosa* Agardh ex Gomont, *Nostoc commune* Vaucher and *Anabaena doleolum* Bharadwaja. Similarly class Bacillariophyceae also

represented 5 taxa namely *Spicaticribra kodaikanaliana* Karthick & Kociolek, *Hantzschia amphioxys* (Ehrenberg) Grunow, *Pinnularia joculata* (Manguin) Krammer, *Nitzschia palea* (Kuetzing) Smith and *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg. *Phacus pleuronectis* (O.F. Muller) Nitzsch ex Dujardin, *Phacus orbicularis* K Hubner, *Trachelomonas hispida* (Perty) F. Stein and *Euglena spirogyra* Ehrenberg were represented by the class Euglenophyceae. The dominance of the desmid flora indicates the specific type of habitats and may act as indicators of pH change or the nutrient supply in the above said sanctuary.

**Key words:** Suhelwa Wildlife Sanctuary, Chlorophyceae, Cyanophyceae, Biodiversity.

SII/P-41

## **Pataalkot: A Treasure of Medicinal Plants and Biodiversity is under Danger, Needs Conservation of Plants**

*Neelima Ratti\**

RRG Township, Bhojpur Road, Bhopal-462047, M.P., INDIA,  
Email: neelimaratti2010@gmail.com

Pataalkot, a valley in Chhindwara district of Madhya Pradesh State, is known for its richness of medicinal flora. This valley is covered with tropical forests, which are rich in biodiversity. It is the home of about 200 rare medicinal plants and herbs. Few important and highly effective medicinal plants of this valley includes: Addhajira (Chaff Tree), Bach (Sweet Flag), Adusa (Malabar nut), Bel (Bail fruit tree), Ajgandha, Lahsun (Garlic), Gwarpatha (Indian Aloe), Choulai (Amaranth), Soorankand (Corm), Kalmegh (Andrographis), Sarifa (Custard apple), Pili kateri (Mexican poppy), Narbod/ Satavar (Wild Asperagus), Kachnaar (Variegated mount in ebony), Punarnava (Spreading Hogweed), Shivlingi, Khatua (Sprout leaf plant), Palas (Flame of Forest), Akona (Madar), Papita (Papaya), Van Karonda, Ajwain (Bishop's weed), Teeti (Feted casia), Amaltaas (Pudding pipe tree), Brahmi (Indian pennywort), Safed musli, Hadjori, Neebu (Lemon), Jangali Piyaz (Indian squill), Jaljamani, Sankhpusphi, Dhania (Coriander), Kalimusli, Kalihaldi, Amarbel (Dodder), Gautichai (Lemon grass), Doob

grass (Doggrass/creeping cynodon), Nagarmotha, Shisam (Indian red wood), Dhatura (Thorn-apple), Gulmohar (Gold mohur), Karanj, Baichandi (Wild Yam), Amla (Emblic-myrobalam/Amla), Safeda (Eucalyptus), Dudhi, Bargad, Bad (Banyan), Gular, Peepal (Pipal tree), Anantmul ( Indian sarparilla), Chandrajot, Narangi (Lantana), Musakani, Mahua, Aam (Mango), Pudina (Mint), Chuimui (Sensitive plant), Gulbans (4'O clock plant) Ban Karela (Bitter gourd), Munga (Horse redish tree), Bach (Cowhage), Meethi Neem, Van kela, Kaner (Oleander), Tulsi (Basil), Bhuiaonla, Chitavar (Rove colour leadwort), Amrud (Guava), Sarpagandha, Arandi (Castor), Shitaab, Semul (Silk Cotton tree), Patharchata (Indian rockfoil), Bhilwa, Cheeval, Pithkarenti, Makoy (Black night shade), Bhatkataiyen, Sahdehi, Chiraita (Chiretta), Jamun (Jambol), Imli (Tamrind), Sagon (Teak tree), Arjun (Arjuna), Baheda (Beleric-myrobalam), Harra (Myrobalam), Giloy/ Guduchi, Banda (Vanda/orchid), Sahadehi, Adrak (Ginger), Ber (Plum), etc. Some very rare medicinal plants like *Siegesbeckia* sp are also found in this valley. It is used in traditional medicine for syphilis, leprosy and other skin illnesses. Some of the highly important medicinal plants, either are already extinct or are on the verge of extinction from this valley. Over exploitation of plants like safed musli, chironji, sarpagandha and bach has already made them endangered species. During my survey of the valley, it was observed that the tribal (local) people of the area are using the plants of the valley for many diseases, as the medicine. Plants are also used as the wood, to make their homes, also for making their food, by burning the wood etc. In this way, the treasure of herbal wealth of the valley is on the verge of extinction. People from other places are also uprooting the herbal flora of the valley for their own selfish interests. Due to this extreme situation, the medicinal flora of the valley is in danger. Due to this scenario, it becomes very essential to make the local people aware of conservation of the plants used extensively, by cultivating, propagating and multiplying the plants, they are uprooting. The vast knowledge possessed by the local people, about the plants, their uses & the herbal preparations they make, and dose of the medicine, should be documented as records for future generation.

**Key words:** Pataalkot, Conservation, Medicinal Plants, Extinction, Biodiversity



**Session III**  
**Environmental Biotechnology**  
**and Microbiology**





SIII/KN-1

## Regulation of Submergence Tolerance in Rice by a Mitogen Activated Protein Kinase

*Alok Krishna Sinha\**

National Institute of Plant Genome Research, Aruna Asaf Ali Road, New Delhi 110067, India, Email: alok@nipgr.ac.in

Mitogen activated protein kinase (MAPK/MPK) cascade are known to regulate several stress responses and developmental processes in eukaryotes. They usually consist of three tier components comprising of a MAPK, MAPK kinase (MAPKK/ MAP2K/ MKK) and MAPKK kinase (MAPKKK/ MAP3K/ MKKK) connected to each other with an event of phosphorylation. In the present talk, the role of this important cascade will be discussed in light signal transduction pathways during seedling development in *Arabidopsis* and submergence tolerance in rice. The activation and interaction of AtMPK6 with MYC2 transcription factor in a light dependent manner will be discussed. AtMKK3 was identified as upstream kinase of AtMPK6. The role of MYC2 has been deciphered as a negative regulator of blue light signaling in *Arabidopsis*. In rice we identified regulation of SUB1A1, a transcription factor identified as an important molecule in conferring submergence tolerance in rice to be regulated by a MAP kinase, OsMPK3. SUB1A1 was specifically identified as a interacting partner as well as phosphorylation target of OsMPK3 in a submergence dependent manner. In both the above mentioned signalling pathways we have conducted series of physiological, biochemical, molecular and genetics related experiments to emphasize the pleiotropic roles of MAP kinase cascade in plants.

**Key words:** Rice, Mitogen activate protein kinase, *Arabidopsis*, light signaling.

SIII/L-1

## Application of Beneficial Rhizospheric Bacteria for Increasing Crop Productivity of Saline Soils

*Naveen Kumar Arora*

Department of Environmental Science, School for Environmental Sciences, BBA University, Lucknow-226025, INDIA, Email: nkarora\_net@rediffmail.com

Soil salinity is a major abiotic stress that reduces crop yields by affecting approximately 20% of irrigated land at global level. Soil salinity also causes the reduction of soil quality along with crop production. To overcome this problem application of salt tolerant plant growth promoting rhizobacteria (PGPR) as bio-inoculants can be a very beneficial technique. Salt tolerant beneficial rhizospheric bacteria mainly fluorescent pseudomonads and rhizobia were isolated and identified from diverse host plants growing in saline regions. Some potent salt tolerant PGPR (exhibiting various PGP attributes such as phosphate and zinc solubilisation, production of siderophore, indole acetic acid and exopolysaccharides) were selected for field applications. Selected bacterial strains were applied as bio-inoculants on various crops such as sunflower, chickpea and lettuce in saline soils of farmer's fields. On application of bio-inoculants productivity and quality of crops (sunflower, chickpea and lettuce) was significantly improved in comparison to control. Beneficial rhizospheric bacteria based bio-inoculants were also very effective to enhance the crop productivity even in presence of phytopathogens (*Macrophomina phaseolina*) in field conditions. These strains/bio-inoculants can be used for enhancing crop productivity in saline soil along with combating phytopathogens in beneficial way for safe and sustainable agriculture. This will also help in remediation of saline soils.

**Key words:** Salinity, PGPR, Bio-inoculant, Fluorescent pseudomonads, Rhizobia.

SIII/L-2

## Biotechnological Approaches for Reducing Grain Arsenic Accumulation in Rice

*Debasis Chakrabarty*

Biotechnology & Molecular Biology, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: debasis1972@rediffmail.com

Rice (*Oryza sativa* L.) is amidst the great essential food crop that offers a staple food for most of the world's population. Arsenic (As) is a carcinogenic heavy metal, which harms human health. In Asian countries, a major source of human As-intake is rice grains and; contamination of paddy soils and As accumulation in rice grains is one of the serious agricultural issues. Hence, it is important to mitigate the effects of As toxicity as much as possible. The main objective of our research is to provide an overview of various biotechnological methods exploited for reducing As accumulation in rice grain. To restrict As in the rice roots as a detoxification mechanism, a transgenic approach has been followed through the expression of phytochelatin synthase from *Ceratophyllum demersum* (*CdPCS1*), an aquatic plant. Transgenic lines showed enhanced accumulation of As in root and shoot but less in grains. We also describe a glutaredoxins (Grx) family protein designated as OsGrx\_C7, and investigate the mechanism of glutaredoxin mediated arsenic tolerance and accumulation in rice grains. Overexpression of OsGrx\_C7 conferred a markedly enhanced tolerance to arsenite and reduces arsenite accumulation in seeds and shoots of rice. Recently, we showed that OsPRX38 transgenics accumulate less As due to high lignification in root which acts as a barrier for As entry in transgenic plants. Another potential strategy is to generation of genetically engineer plants with arsenic methyltransferase gene capable of methylating and volatilizing arsenic. Arsenic methyltransferase (*WaarsM*) gene from *Westerdykella aurantiaca* was cloned and demonstrated that the resulting transgenic plant acquired the potential for methylating inorganic arsenic to a variety of innocuous organic species, including volatile arsenicals, providing a potential strategy for potent transgenic rice capable of low

arsenic accumulation not only in grain but also in straw, feed for livestock.

**Key words:** Arsenic, Growth, Rice, *Ceratophyllum demersum*, *Westerdykella aurantiaca*.

SIII/L-3

## Heavy Metals Phytoextraction Potential of Native Plants and their Histological Observation Growing on Stabilized Distillery Sludge: A Prospective Tool for *in situ* Phytoremediation of Hazardous Industrial Waste

*Ram Chandra*

Department of Microbiology, School for Environmental Sciences, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow-226025, Uttar Pradesh, INDIA Email: rc\_microitrc@yahoo.co.in

The sugarcane molasses based distillery waste contains significant amount of different heavy metals along with organometallic Compounds. The maillard products present in distillery waste strongly bind with heavy metals and other cationic molecules. This makes more complex and hazardous nature of waste. Due to complexity of sludge it causes the toxicity to environment at different and makes irreparable damage to ecosystem. Therefore, the study has been focused to analysis metallic and organic contents of sludge. This study revealed that distillery sludge contains not only mixture of complex organic pollutants but also retains high quantity of Fe (5264.49), Zn (43.47), Cu (847.46), Mn (238.47), Ni (15.60), and Pb (31.22 mg kg<sup>-1</sup>) which enhances the toxicity of sludge to the environment. The major identified organic compounds were benzene, 1-ethyl-2-methyl, benzene, 1-ethyl-4-methyl benzoic acid, 3,4,5-tris(TMS oxy), TMS ester; hexanedioic acid, dioctyl ester; stigmasterol TMS ether; 5 $\alpha$ -cholestane, 4-methylene; campesterol TMS;  $\beta$ -sitosterol and lanosterol. These compounds are listed under the EDCs also as per U.S. Environmental Protection Agency. However, the phytoextraction potential of growing native weeds and grasses i.e. *Argemone mexicana*, *Saccharum munja*, *Cynodon dactylon*, *Pennisetum*

*purpureum*, *Chenopodium album*, *Rumex dentatus*, *Tinospora cordifolia*, *Calotropis procera* and *Basella alba* revealed the high accumulation of Fe, Zn, Cu, Mn, Ni, and Pb in their root and leaves compared to shoot. This indicated high accumulation and translocation capabilities of these plants. Further, the bioaccumulation coefficient factor (BCF) and translocation factor (TF) was found >1 for majority of plants for various metals. Thus, this given strong evidence for hyperaccumulation tendency of these native weeds and grasses from complex polluted sites. Furthermore, the ultrastructural observations of root tissues also revealed the deposition of heavy metals at various cellular components without any apparent toxic effects. This indicated the variable adaptive characteristics of these plants growing at a hazardous waste polluted site. Thus, the study given a strong evidence for application of these weeds and grasses as tools for *in-situ* phytoremediation and eco-restoration of polluted sites contaminated site and distillery sludge after phytoremediation showed a sustainable development of ecosystem.

**Keywords:** Native weeds; Endocrine-disrupting chemicals; Distillery sludge; In-situ phytoremediation,  $\beta$ -Sitosterol

### SIII/O-1

## Cultural Studies and Biochemical Characterization in High Yielding Carotenoids and Exopolysaccharides Producing Cyanobacteria

**O.N. Tiwari**

Centre for Conservation and Utilisation of Blue Green Algae, Division of Microbiology, ICAR-Indian Agricultural Research Institute, New Delhi, 110012, INDIA, Email: [ontiwari1968@gmail.com](mailto:ontiwari1968@gmail.com)

Blue green algae or cyanobacteria have been emerged as a sustainable bioresource of novel bioactive secondary metabolites. Bioactive secondary metabolites include value added pigments, food colorants, cosmetics, feed additives, polyunsaturated fatty acids, exopolysaccharides, vitamins, lipids, proteins and therapeutic agents i.e. antioxidants, anti-inflammatory etc. EPSs of cyanobacteria are anionic high molecular weight heteropolymeric extracellular

constituent which consists of polysaccharides, lipids, protein and DNA especially uronic acids, pyruvate, and O-methyl, Oacetyl, and sulfate groups. Cyanobacteria is one of the most efficient microbial community platform to naturally synthesize diverse range of therapeutics biomolecules. In the present study, six fast growing nitrogen fixing filamentous cyanobacteria representing the genus of *Nostoc*, *Anabaena* and *Plectonema* having EPS production in the range of 1.01-1.58  $\mu\text{g ml}^{-1}$  were identified, biochemically characterized and observed their flocculating activities. Highest levels of EPS were produced by *Nostoc* sp. when nitrogenase activity was very low. Maximum EPS production occurred at pH 8.0 in the absence of any combined nitrogen source. The cyanobacterial EPS consisted of soluble proteins and polysaccharides that included substantial amounts of neutral sugars and uronic acid. Another set of twelve nitrogen fixing cyanobacteria represent the genus of *Nostoc* and *Anabaena* having EPS production in the range of 0.80-1.66  $\mu\text{g ml}^{-1}$  were characterized. The EPS isolated from *Anabaena* sp. and *Nostoc* sp. demonstrated high flocculation capacity. There was a positive correlation between uronic acid content and flocculation activity. These strains were executed for production of EPS, PBS, Chl a and bioflocculant activity. Based on this current global scenario, the main purpose of this study is to identify diverse cyanobacterial regime for its biophysicochemical characterization and screening high yielding EPS and carotenoid producing cyanobacterial communities towards commercial exploitation of suitable candidate.

**Key words:** Carotenoids, Exopolysaccharide, Cyanobacteria, Ammonia Excretion, Phycobiliproteins.

### SIII/O-2

## Beneficial Microbial Services in Management of Agro-Environmental Problems

**Jay Shankar Singh**

Department of Environmental Microbiology, Babasaheb Bhimrao University, Lucknow-226025, Uttar Pradesh, INDIA  
Email address: [jayshankar\\_1@yahoo.co.in](mailto:jayshankar_1@yahoo.co.in)

Land use/cover changes, amongst the most influential environmental issues, are negatively

impacting the soil quality and sustainability. Currently it is uncertain how the soil microbial communities and biomass, the foundation of soil fertility support system will be influenced by anthropogenic mediated land use disturbances. It is also not clear how land cover changes may influence the soil microbial biomass levels and fertility relevance across different soil depths in a given forest or agro-ecosystem. The changes in soil microbial biomass levels due land use changes may also adversely affect the soil physico-chemical properties, fertility and ecosystem stability. The increasing disturbances in agriculture and environmental resources due to urbanization and over exploitation of natural resources create a great concern to the peoples of all over the world. The anthropogenic activities led to climate changes such as drought, flood, and irregular rainfall, forest fires, habitat loss, water scarcity, poor agricultural productivity, soil and environment degradation, etc. These disturbances ultimately impact the sustainability of agriculture, environment, economy and health. Although global climate change due to increase in green house gases such as atmospheric methane ( $\text{CH}_4$ ), affect all over the world, it becomes more vulnerable to developing countries which mainly depend upon agriculture and agriculture based economy. Management of agricultural yields is a major concern for agricultural sustainability, however, until now synthetic chemicals have played a fundamental role in suppressing pests and maintaining high crop yields but also responsible for soil degradation and pollution. Soil pollution not only affects the area where it applied but also creates pollution to nearby water bodies, streams and rivers. They also disrupt the natural ecosystem and soil microbial diversity, which plays a vital role to keep up soil sustainability and health. Bio-agents are primarily living microorganisms like fungi, bacteria and cyanobacteria which is used for the controlling of many ecosystem services. These bio-agents provide good agricultural productivity and also enhance soil fertility through improving natural agro-ecosystem. Some of the bio-agents like cyanobacteria, mycorrhizae, methanotrophs, etc., are widely used in restoration of degraded lands and green house gas  $-\text{CH}_4$  mitigation. Microbial agents are not in optimum use in most developing countries due to technical, social and institutional constraints. The effectiveness and efficacy of microbial agents and their resources have yet to be explored to become alternate of agro-chemicals.

**Key words:** Agro-environmental sustainability, Ecosystem services, Microbial agents, Methanotrophs.

SIII/O-3

## Isolation, Growth and Identification of Chlorpyrifos Degrading Bacteria from Agricultural Soil

*Sonal Suman, Satyamvadaswayamprabha and Tanuja Singh\**

Department of Botany and Biotechnology, TPS College, Kankarbag, Patna-80001, INDIA, Email: sonal.micro89@gmail.com, tanujasinghbotany@gmail.com

Pesticides are a large and varied group of substances that are specifically designed to kill organisms including of weeds, insects, and the indiscriminate use of pesticides in agricultural field resulted into contamination of soil environment leading to toxicity. India is an agriculture based country and maximum portion of it's economy is dependent on agriculture. The promotion of high yielding varieties of crops has led to large scale use of chemicals as pesticides. Chlorpyrifos, is one of the most commonly and widely used commercial organophosphate pesticide. It is a broad-spectrum, moderately toxic pesticide that has been widely used in the prevention of both agricultural pests and urban public health pests. It was introduced in 1965 by Dow Chemical Company India. It has large blights on public health and environment resulting from its long residual period in soil and water. The microbial action in the environment causes the natural degradation of the pesticides which might convert parent compounds to intermediates or comparatively less toxic compounds. The adaptability of microorganisms during bioremediation releases certain enzymes, which metabolizes wide spectrum of anthropogenic chemicals. The current method for removing such contaminants from the environment through biodegradation has been shown to be more effective than any other method. In the present study, soil sample was collected having history of Chlorpyrifos from four different soil sample (rice, wheat, maize and vegetable). Nine Chlorpyrifos pesticide utilizing bacteria were isolated and identified through cultural and biochemical tests as strains of *Bacillus* sp., *Staphylococcus* sp. and *Coccus* sps. Their growth in

minimal salt medium supplemented with 200 and 250  $\mu\text{g ml}^{-1}$  of Chlorpyrifos was monitored at optical density 600 nm. The result showed that *Staphylococcus* sp., *Streptococcus* sp. and *Bacillus* sp. had maximum growth at twelve days, while *Coccus* sp. Gram-ive *Bacillus* sp. shows highest growth upto four days of incubation at 200  $\mu\text{g ml}^{-1}$  and upto eight days of incubation at 250  $\mu\text{g ml}^{-1}$  of Chlorpyrifos. The results of this research indicated that the isolated bacteria can be used for bioremediation of Chlorpyrifos contaminated soil.

**Key words:** Isolation, Bacteria, Chlorpyrifos, Contaminated, Agricultural soil.

### SIII/O-4

## Potential of Phosphorous Solubilizing Bacteria (PSB) in Improving the Palatability of Vegetable Crops Grown in Heavy Metal Contaminated Environments

*Sushmita Barua*<sup>1\*</sup>, *Dibyendu Adhikari*<sup>1</sup>, *Saroj K. Barik*<sup>1,2</sup> and *Nikhil K. Chrungoo*<sup>1</sup>

<sup>1</sup>Department of Botany, North-Eastern Hill University, INDIA;

<sup>2</sup>Present address: National Botanical Research Institute, Lucknow, INDIA, Email: nchrungoo@gmail.com

Heavy metal contamination of terrestrial and aquatic systems is a serious environmental issue. Irrigation of agricultural land with contaminated water often leads to heavy metal accumulation in the vegetables and crops growing on such sites. Vegetable crops such as spinach can accumulate heavy metal without any visual indication of stress. Consumption of such contaminated vegetables might lead to serious health issues in human beings. Therefore, it is essential to find a solution to this problem. Phosphorus solubilizing bacteria (PSB) has been reported to influence the uptake of such contaminants. We tested this hypothesis using spinach as a model species and cadmium as a contaminant. Cadmium (Cd) - a highly toxic heavy metal which attracts attention because of its widespread occurrence and its carcinogenic property. We studied the oxidative stress and biochemical responses of spinach grown in three concentrations of cadmium i.e., 0.1 mM, 0.3 mM, and 0.5 mM, and in combination of

0.5 mM Cd + PSB. Spinach grown with Cadmium showed a decrease in biomass, chlorophyll content and increase in MDA indicating a dysfunction in photosynthetic apparatus. Nutrient analysis in spinach showed a decrease in sodium (59%), potassium (24%), calcium (42%), iron (21%), magnesium (67%), manganese (32%), copper (22%), nitrogen (18%) and phosphorus (16%). With higher exposition time, the plant was observed to have accumulated 20  $\text{mg kg}^{-1}$  in shoots and 5  $\text{mg kg}^{-1}$  in roots. The plant showed a strong defense mechanism against the oxidative stress with the activation of CAT, GPOX and GR indicating the active involvement of glutathione in the plant tolerance mechanism. While in the plants treated with Cadmium + PSB, there was a decrease in metal accumulation by 20-25% and increase in phosphorus content by 30% as compared to the plants treated with only Cadmium. Our study indicates that PSBs can influence the bioavailability of heavy metals in soil, thereby decreasing the bioaccumulation in plants.

**Key words:** Antioxidative enzyme, Cadmium, Oxidative stress, PSB, Spinach.

### SIII/O-5

## Production of Novel Antibacterial Polyhydroxyalkanoates (PHAs) Incorporating Medicinal Plant Extract

*Tanushree Halder*<sup>1</sup>, *Sheila Azim Piarali*<sup>2</sup>, *Pooja Basnett*<sup>2</sup> and *Ipsita Roy*<sup>2</sup>

<sup>1</sup>Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, BANGLADESH; <sup>2</sup>Department of Life Science, University of Westminster, 101 New Cavendish Street, London W1W6XH, UK, Email: tanushree.halder01@gmail.com, S.Azimpiarali@westminster.ac.uk, p.basnett@my.westminster.ac.uk, I.Roy01@westminster.ac.uk

Polyhydroxyalkanoates (PHAs), a group of polymers have become potential candidates in biomedical, agriculture and industry due to its biocompatibility, biodegradability and wide range of mechanical properties. However, multidrug resistant (MDR) bacterial infections spread through polymer fabricated devices and tools used in various sectors as bacteria adhere and breed on its surface resulting high morbidity, mortality and environmental pollution. To

prevent this ongoing threat, it is essential to develop polymer having inherent antibacterial properties. Novel antibacterial Poly(3-hydroxybutyrate), P(3HB): a short chain length PHA was produced by direct incorporation of *Eucalyptus globulus* oil (EO). P(3HB) was produced by batch fermentation of *Bacillus subtilis* OK2. Identification of the polymer was done by fourier transform infrared spectroscopy (FTIR), gas chromatography-mass spectrometry (GC-MS) and nuclear magnetic resonance (NMR). Agar disc diffusion assay, minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were performed as antibacterial assays against *Staphylococcus aureus* ATCC 6538 and *Escherichia coli* ATCC 8739. Oil incorporated P(3HB) exhibited 2.4 cm and 1.1 cm halo against *S. aureus* and *E. coli*, respectively. Liquid FTIR confirmed the presence of oil into the polymer. Thermal and mechanical analysis of neat and oil incorporated P(3HB) were done by differential scanning calorimetry (DSC) and tensile testing, respectively. Oil incorporated P(3HB) exhibited 5.6% decreased crystallinity and reduced thermal temperature. The elongation at break increased from 6.9±1.7 to 27.9±3.5% while Young's modulus and tensile strength decreased drastically. Therefore, developed antibacterial polymer exhibited elastomeric properties. Scanning electron microscopy (SEM) and contact angle exhibited hydrophobic and rougher surface of the novel polymer. However, non-significant protein adsorption, higher cytotoxicity against C<sub>2</sub>C<sub>12</sub> cell line and lower biodegradability were exhibited and thereby suggesting optimisation of oil concentration into the polymer. Indeed, EO incorporated P(3HB) film exhibited diverse application options not only because of its antibacterial properties but also for excellent thermo-mechanical properties.

**Key words:** Poly(3-hydroxybutyrate) [P(3HB)], *Bacillus subtilis* OK2, *Eucalyptus globulus*, Multidrug resistant bacteria, Minimum Inhibitory Concentration.

SIII/O-6

## Therapeutic Role of Aqueous Leaf Extract of *Phyllanthus niruri* on Plasticizer Induced Renal Toxicity in Mice Model

*Anjali Singh<sup>1\*</sup>, Tanuja Singh<sup>1</sup>, Ravish Kumar<sup>2</sup> and Jitendra Kumar Singh<sup>2</sup>*

<sup>1</sup>Department of Botany, Thakur Prasad Smriti College, Patliputra University, Patna, Bihar, INDIA; <sup>2</sup>S.S. Hospital and Research Institute, Patna, Bihar, INDIA, Email: dranjalisingh04@gmail.com, tanujasinghbotany@gmail.com, kumardrravish@gmail.com

The major part of the population in both developed and developing countries as well as in rural and urban areas are getting exposed to plasticizer which are reported to dissolve (by leaching) with the contents (medicines, edibles etc.) present therein. Plasticizer exposure is a major health problem due to its toxic effect in animal model as well as human. Oral administration of plasticizer at environmentally significant dose for a period of six weeks showed signs of renal toxicity in mice model. Significant alterations in biochemical markers of renal function as well as in cyto-architectural structure of nephrocytes was observed. The alterations were found to be statistically significant (P<0.01). *Phyllanthus niruri* is a common herb that is widely used for its therapeutic effects. Curative properties of this medicinal plant are due to the presence of bioactive phytochemicals, among which polyphenols are reported to be most potent. *P. niruri* is popularly known as stone breaker. The plasticizer treated mice were therapeutically administered aqueous leaf extract for four weeks period. Therapeutic treatment of *P. niruri* on plasticizer exposed mice revealed marked improvement in cyto- architectural structure of nephrocytes and in renal biochemical markers.

**Key words:** *Phyllanthus*, Renal, Toxicity, Antioxidant, Therapeutic, Biochemical markers.

SIII/O-7

## Pharmaceutical Product in Environment-Sources, Potential Human Health Impacts, Emergence of Antibiotic Resistance Gene (ARGs) and Current Remediation Technologies

**Hemen Sarma**

Department of Botany, N.N.S. College (Dibrugarh University), Titabar-785630, Assam, INDIA, Email: hemens02@yahoo.co.in

The multiple uses of pharmaceutical products in healthcare, livestock's and agriculture, leading to their infiltration into the environment have received a great attention. In recent years adverse effects of pharmaceutical products specifically antibiotics on animal and human health has been reported worldwide; this is because of the development of antibiotic-resistant and multi-drug resistant bacterial strains. Furthermore, these emerging pollutants also have lethal effect for normal microbiota beneficial for environment. Antibiotics are most extensively administered drug as therapeutic for precaution, safeguard and treat humans and animal diseases. There is a worst-case scenario reported in developing worlds; it was estimate, 700,000 people currently succumb to antibiotic-resistant infections every year. The antibiotics residues present in the environment contribute to the development and dissemination of antibiotic resistance genes (ARGs) in bacteria through selection. Most of these contaminants remain persistent in soil aqueous phase and in waste water. There is growing evidence that antibiotics along with other pharmaceutical products confer selection pressure in favour of antibiotic resistant bacteria. The removal or degradation of these contaminants from environment is one of the biggest challenges.

**Key words:** Pharmaceutical products, Emerging Pollutants, Antibiotic Resistance Genes, Solutions.

SIII/O-8

## Identification of Endophytic Fungal Biodiversity Isolated from Critically Endangered Endemic Medicinal Plant, *Artemisia amygdalina* Decne. of Kashmir Himalayas

**Humeera Nisa<sup>1</sup> and Azra N. Kamili<sup>2</sup>**

<sup>1</sup>Department of Environmental Sciences/Centre of Research for Development, University of Kashmir, Srinagar-190006, J&K, INDIA; <sup>2</sup>Department of Environmental Sciences/Centre of Research for Development, University of Kashmir, Srinagar-190006, J&K, INDIA, Email: humeranissa2@gmail.com, azrakamili@gmail.com

The literal meaning of the word endophyte means 'in the plant' (endon Gr., within; phyton, plant). The usage of this term is as broad as its literal meaning and has a broad spectrum of potential plant hosts and inhabitants, including bacteria, fungi, algae, and insects. An endophytic fungus can be defined as an organism which lives in mycelial form in biological association with living plant at least for some time. The minimum requirement before a fungus to be termed as an endophyte should be the demonstration of its hyphae in the living tissue. Fungi are key resources for exploiting bioactive metabolites. Among fungi, endophytes are important to screen biologically active metabolites. The genus *Artemisia* L. (Asteraceae) containing 500 species is the largest genus in the tribe Anthemideae. Several *Artemisia* species have medicinal importance and are used in traditional medicine. This endemic and critically endangered medicinal plant grows in the subalpine region of Kashmir Himalayas and is also found in the North-West Frontier Province of Pakistan. The plants are locally used for the treatment of a number of diseases like epilepsy, piles, nervous disorders, cough, cold, fever and pain. This important medicinal plant of Kashmir valley was chosen for this study because of its pharmacological and therapeutic importance in the folkloric medicines. Fresh plant material was used for isolation work using surface-sterilization technique. The fungi have been identified on the basis of their morphological and cultural characteristics using standard taxonomic keys and monographs. A total of twenty-seven (27) fungal

endophytes were isolated from this medicinal plant belonged to twenty-four (24) different species.

**Key words:** Fungi, Endophytes, Endemic, *Artemisia amygdalina*, Kashmir Himalayas.

SIII/O-9

## Identification and Functional Analysis of Phosphate Transporters in Phosphate and Arsenate Absorption and Transport in *Pteris vittata*

**Yue Cao\***, Dan Sun, Yanshan Chen and Lena Q. Ma

State Key Lab of Pollution Control and Resource Reuse, School of the Environment, Nanjing University, Nanjing, Jiangsu 210023, CHINA, Email: caoyue@nju.edu.cn

*Pteris vittata*, the first arsenic hyperaccumulator identified, has very strong ability to absorb the arsenic, so it is widely used in phytoremediation of arsenic contaminated soil. However, the molecular mechanism of arsenic uptake efficiency of *Pteris vittata* is not clear. As a phosphorous analog, arsenate is absorbed mainly by the phosphate transporter Pht1. Using the transcriptome sequencing and gene cloning, five members of *Pteris vittata* Pht1, have been identified. We determined their arsenic transport capacity through the analysis of arsenic content in different Pht1 strains of yeast transformation lines. By qRT-PCR, expression pattern of PvPht1 protein have been identified, PvPht1;2 and PvPht1;5 transcripts were induced to Pi starvation and PvPht1;4 expression level was increased in response to As exposure. PvPht1;2-PvPht1;5 were all localized to plasma membrane, by expression in tobacco leaves with GFP fusion protein, respectively. Further, PvPht1 transporters were transformed into tobacco (*Nicotiana tabacum*), respectively. In hydroponic experiments, all PvPht1;2-Ox lines displayed markedly higher P content and better growth than wild type plants, suggesting that PvPht1;2 mediated P uptake in plants. In addition, expressing PvPht1;2 also increased the shoot/root <sup>32</sup>P ratio by 69-92% and enhanced xylem sap P by 46-62%, indicating that PvPht1;2 also mediated P translocation in plants. Unlike many Phts permeable to AsV, PvPht1;2 showed little ability to transport AsV. In soil experiments, PvPht1;2

also significantly increased shoot biomass without elevating As accumulation in PvPht1;2 transgenic tobacco. Taken together, our results demonstrated that PvPht1;2 is a specific P transporter responsible for P acquisition and translocation in plants. On the other hand, enhancing PvPht1;3 increased arsenate uptake and translocation in tobacco plants. As concentrations in shoots of PvPht1;3-Ox were 29-38% higher after AsV exposure for 1 day than that of WT, respectively. AsV uptake rate, As concentration in xylem sap and translocation factor were increased compared to wild type plants with different degree, respectively. It's suggested that PvPht1;3 played key role in efficient absorption and transport of arsenic in *Pteris vittata*. In this study, diverse functions of *Pteris vittata* PHT transporter in arsenate and phosphate uptake pathway were preliminarily identified. We expect to use the key gene, PvPHTs, to improve the efficiency of phytoremediation in future.

**Key words:** *Pteris vittata*, *Nicotiana tabacum*, Phytoremediation, Transcriptome, Hyperaccumulator.

SIII/O-10

## Sustainable Solutions for Arsenic Stress Mitigation and Arsenic Reduction in Rice

**Sudhakar Srivastava**

Plant Stress Biology Laboratory, Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: sudhakar.srivastava@gmail.com

The problem of geogenic arsenic contamination is widespread in Gangetic plains in Indian states of Uttar Pradesh, Bihar and West Bengal. In this region, arsenic concentration of groundwater is several folds higher over the safe limit and toxic levels of arsenic have been reported in crop plants, vegetables, fruits and fish and meat products. In the affected states, rice is the main crop and staple food for humans. Rice is more efficient in arsenic accumulation in its grains than other cereal crops. The problem can be tackled either through remediation of contaminated water or through management of agronomic practices for growing safe rice. Further, there are known variations in rice genotypes in terms of arsenic accumulation in their



grains. The grains of these contrasting genotypes show variations in accumulation of other mineral elements as well as in amino acid contents. Hence, genotype screening and selection and development of suitable genotype for cultivation in affected regions are promising approaches. With respect to agronomic practices, supplementation of rice crops with redox active chemical, thiourea, has been proved to be a promising approach in lab conditions. In addition, other chemical (nitrogen) and biological (microbial consortia) amendments could pave way for reducing arsenic in rice grains. Hence there lies possibility of its application in field conditions for safe rice cultivation. The presentation highlights key findings in the direction of suggested possible approaches to tackle the issue of arsenic contamination of rice.

**Key words:** Arsenic, Genotype, Nitrogen, Microbial consortia, Rice.

SIII/O-11

### **Zinc-*Funneliformis* *mosseae* Composite Application Attenuates Cadmium Toxicity in Pigeonpea via Modulating ROS Generation and Enhanced Production of Glutathione and Phytochelatins**

**Harmanjit Kaur<sup>1\*</sup> and Neera Garg<sup>2</sup>**

<sup>1</sup>Department of Botany, Akal University, Talwandi Sabo, District: Bathinda, Punjab-151302, INDIA; <sup>2</sup>Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: harmanjit.garcha@yahoo.com, garg\_neera@yahoo.com

Cadmium (Cd) is a widespread toxic trace element, non-essential for plant growth and is found in agricultural soils due to various anthropogenic activities. However, Zinc (Zn) is an essential micronutrient at low concentrations but toxic to plants at higher concentrations along with Cd. Zn interferes with Cd transport by competing with Cd for binding sites of a common transport protein on root plasma membrane. Arbuscular mycorrhizal (AM) symbiosis is considered a potential biotechnological approach for increasing plant tolerance to heavy metal contamination. Composite application of excess Zn and AM fungi can increase plant resistance to Cd toxicity, nevertheless,

their relationship and the underlying mechanisms have not been investigated. From this backdrop, pot experiments were carried out to determine interplay between Zn (500 and 1000 mg kg<sup>-1</sup> dry soil) and AM fungus (*Funneliformis mosseae*) on growth, nutrient acquisition, oxidative stress and non enzymatic antioxidants in two pigeonpea [*Cajanus cajan* (L.) Millsp.] genotypes (Tolerant- Sel 85N and Sensitive-P792) exposed to Cd stress (25 and 50 mg kg<sup>-1</sup> dry soil). Results revealed that accumulation of Cd and Zn reduced plant biomass, disrupted ionic balance by interfering with the uptake and translocation of various nutrients (N, P, K, Mg, Ca, Fe), induced membrane destabilization, hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) accumulation and increased non-protein thiols (NP-SH) [glutathione (GSH), glutathione disulphide (GSSG) and phytochelatins (PCs)], with Cd being more toxic in P792 than Sel 85N. Zn supplementation reduced the uptake of Cd which further declined when plants were co-inoculated with *F. mosseae* that resulted in increased nutrient pool, decreased reactive oxygen species (ROS) generation via enhanced production of GSH and PCs, ultimately improving growth. These findings suggested the integrated application of Zn and AM as a promising management strategy to ameliorate Cd toxicity in pigeonpea.

**Key words:** Arbuscular mycorrhiza, Cadmium, Glutathione, Pigeonpea, Phytochelatins, Zinc.

SIII/O-12

### **Prospectives of *Trichoderma* sp. in Amelioration of Arsenic Induced Phyto-Toxicity**

**Pratibha Tripathi<sup>1,2\*</sup>, R.D. Tripathi<sup>2</sup> and Alok Kalra<sup>1</sup>**

<sup>1</sup>CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow-226001, INDIA; <sup>2</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: pratibhaa25686@gmail.com

Arsenic (As), a toxic metalloid, is a food chain contaminant and is threat to all living forms. Irrigation with As-contaminated groundwater has increased As accumulation in agricultural soils which is a potential health risk for humans. Plant-microbe interaction is a promising eco-friendly strategy for conventional and

organic agriculture. Microorganisms have developed different mechanisms to transform toxic forms of As to less toxic forms. In present study, role of As tolerant *Trichoderma reesei* NBRI 0716 in countering the As induced stress in chickpea (*Cicer arietinum*) plants was studied. Arsenic exposure significantly hampered the growth, uptake of mineral nutrients and antioxidant activity in chickpea resulting in poor pod setting and limited seed yield. Inoculation of chickpea with *T. reesei* significantly promoted plant growth, yield and mineral nutrients both in absence and presence of As. *Trichoderma* inoculation also helps in restoration of stem anomalies like reduced trichome turgidity and density, deformed sclerenchymatous and collenchymatous cells induced by As stress. Upregulation of drought responsive genes, enhanced proline content and shranked cortex cells in presence of As were modulated by *T. reesei*. In addition, inoculation of *T. reesei* lead to three fold reduction of inorganic As and enhanced dimethylarsinic acid and mono-methylarsonic acid content in soil and seed as well, indicated that *T. reesei* probably has a role in methylation of As as the possible mechanism for maneuvering As stress in chickpea. Therefore, bioremediation and PGP potential of *T. reesei* makes it a promising bio-inoculant for application in As affected sites and production of safe farm produce.

**Key words:** Arsenic, Bioremediation, Chickpea, *Trichoderma*, Stress.

SIII/O-13

### **Formulation of an Organic Potting Medium Incorporated with *Trichoderma* spp. to Enhance Growth and Disease Suppression of *Abelmoschus esculentus***

*N. Hewavitharana\**, *S.D.P. Kannangara*, *L.R. Jayasekera* and *S.P. Senanayake*

Department of Botany, Faculty of Science, University of Kelaniya, SRI LANKA, Email: nalakahewavitharana@gmail.com

Organic potting media is an important source for

growth and development of vegetable and ornamental plants. Use of *Trichoderma* spp. as bio control agents as well as growth promoters in agricultural systems has been identified as an effective methodology to minimize the use of agrochemicals. Use of problematic invasive plants together with agricultural wastes as organic materials facilitates proper recycling under sustainable agriculture. Three *Trichoderma* spp. (*T. virens*, *T. harzianum* and *T. asperillum*) were selected and mass produced separately, using 250 g of sawdust as the carrier material. Four different potting media (coir + invasive plants + poultry manure with rice husk; T-1, coir + invasive plants; T-2, coir + compost; T-3 and compost + field soil; T-4) were prepared. Next, all the potting media were divided into two parts and one set was treated with *Trichoderma* spp. while the other set was used as controls, without adding *Trichoderma*. Physical and chemical properties of the four potting media were analyzed following standard methods. Effect of *Trichoderma* amended potting media on plant growth was evaluated using *Abelmoschus esculentus* by measuring several growth parameters (plant height, number of flowers and fruits yield) and disease incidence under greenhouse conditions. Of the four potting media, T-1 exhibited optimum physical properties i.e; porosity (45.2%), bulk density (0.34 gcm<sup>-3</sup>) and water saturation capacity (52.4%); as well as chemical properties i.e. pH (6.8), EC (0.89 ds m<sup>-1</sup>), organic carbon (17.2%), N (1.35%), P<sub>2</sub>O<sub>5</sub> (1.23%), K<sub>2</sub>O (1.48%) and C/N ratio (15.8). The highest mean plant height (85.8±2.5 cm), number of flowers per plant (18±2) and fruits yield (125.5±3.5 g) were observed in plants treated T-1 medium with *Trichoderma* amendments. *A. esculentus* planted without *Trichoderma* treatment in T-4 showed significantly lower (p<0.05) growth than T-1 and T-3 media. *A. esculentus* grown in *Trichoderma* amended T-1 medium showed a significantly lower (p<0.05) disease incidence (5%) compared with untreated controls. Based on the results (T-1) was selected as most effective medium and was prepared as a brick to facilitate the easy handling as well as for and commercialization of the product in order to introduce to both local and export markets.

**Key words:** Agriculture, Invasive plants, Coir dust, *Trichoderma*, *Abelmoschus esculentus*.

SIII/O-14

## Does Conversion of Forest to Cropland is a Sufficient Cause to Make Over Soil Microbes? An Important Discussion

**Meenakshi Kushwaha<sup>1,2,\*</sup>, Naina Marwa<sup>2,3</sup>, Vivek Pandey<sup>1,2</sup> and Nandita Singh<sup>1,2,\*</sup>**

<sup>1</sup>Academy of Scientific and Innovative Research (AcSIR), CSIR-National Botanical Research Institute (CSIR-NBRI) Campus, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Plant Ecology and Environmental Sciences Division, CSIR-National Botanical Research Institute, Lucknow 226001, INDIA; <sup>3</sup>Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: meena.abc7@gmail.com

In the race of modernization, deforestation and agriculture intensification has become the top threat to the nature worldwide. As a result of deforestation, soil qualities get modified and subsequently affect the soil microbiota in different ways. Bacteria and fungi, the key soil microbes are the drivers of the soil biology and biogeochemistry. They are drastically affected by the deforestation activities in various aspects. Previous research articles described about these aspects in their own ways; for example, loss, gain, modification or no effect on their diversity and composition separately. Some researchers also focused that these different aspects of bacterial and fungal diversity modification following deforestation are also influenced by the environmental factors like plant community, edaphic factors (pH, water holding capacity, and soil nutrients), climatic conditions (micro and macro) and man-made factors like fertilizer, cropping pattern, and crop plant type. The study about the combined effect of all environmental and man-made factors may result in the more valuable information to hit upon the knowledge of microbial alteration following deforestation and cropping practices in a single platform.

**Key words:** Deforestation, Microbial community, Environmental, Bacteria, Fungi

SIII/O-15

## Reduced Arsenic Accumulation in Rice Grain by Heterologous Expression of Phytochelatin Synthase of *Ceratophyllum demersum*, *CdPCS1*

**Manju Shri<sup>1,2,\*</sup>, R.D. Tripathi<sup>1,3</sup>, Prabodh Kumar Trivedi<sup>1,3</sup> and Debasis Chakrabarty<sup>1,3</sup>**

<sup>1</sup>AcSIR-Academy of Scientific & Innovative Research, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Present address: School of Life Sciences, Central University of Gujarat, Gandhinagar-382030, INDIA; <sup>3</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: manjubiochem20@gmail.com

Rice (*Oryza sativa* L.) is amidst the great essential food crop that offers a staple food for most of the world's populace. Arsenic (As) is a carcinogenic heavy metal, which harms human health. In Asian countries, a major source of human As-intake is rice grains and; contamination of paddy soils by As and accumulation of As in rice grains is one of the serious agricultural issue. The predominant model for plant detoxification of heavy metals is complexation of heavy metals with phytochelatin (PCs), synthesized non-translationally by PC synthase (PCS) and compartmentalized in vacuoles. In this study, in order to restrict As in the rice roots as a detoxification mechanism, a transgenic approach has been followed through expression of *phytochelatin synthase*, *CdPCS1*, from *Ceratophyllum demersum*, an aquatic As-accumulator plant. *CdPCS1* expressing rice transgenic lines showed marked increase in PCS activity and enhanced synthesis of PCs in comparison to non-transgenic plant. Transgenic lines showed enhanced accumulation of As in root and shoot thereby restricting its accumulation in grain. This enhanced metal accumulation potential of transgenic lines was positively correlated to the content of PCs, which also increased several-fold higher in transgenic lines. The higher level of PCs in transgenic plants relative to non-transgenic presumably allowed sequestering and detoxification of higher amounts of As in roots and shoots, thereby restricting its accumulation in grain.

**Key words:** Rice, Arsenic, Phytochelatin, Transgenic, *Ceratophyllum demersum*.

SIII/O-16

## Selenium Linked Arsenic Tolerance Entails Induction of Phytochelatins and Amino Acids and Promotes Reduction of Arsenic Phytotoxicity and Uptake in Rice

Preeti Tripathi<sup>1,2\*</sup>, Reshu Chauhan<sup>1</sup>, Surabhi Awasthi<sup>1</sup> and R.D. Tripathi<sup>1</sup>

<sup>1</sup>CSIR-National Botanical Research Institute, Council of Scientific and Industrial Research, Lucknow-226001, INDIA; <sup>2</sup>Ministry of Environment, Forest and Climate Change, New Delhi-110003, INDIA, Email: preeti71985@gmail.com

Exposure of population through consumption of arsenic (As) tainted rice is a major problem over the world especially in South and South East Asia. To overcome the As induced phytotoxicity in rice, selenium (Se) was supplied as selenate (SeVI) during arsenate (AsV) stress in rice during hydroponics. Se(VI) addition exhibited markedly ( $p < 0.05$ ) reduced level of As and oxidative stress in roots and shoots as well as induced growth suggesting its beneficial role either in the presence of As. For the first time, different species of phytochelatins (PC<sub>2</sub>, PC<sub>3</sub> and PC<sub>4</sub>) were analyzed during Se(VI) and As(V) interaction. Total PCs in roots were in the order of control < Se < As < As+Se suggesting the role of thiols for As tolerance and detoxification during As/Se interaction. The phytochelatin synthase (PCS) activity respond according to PCs contents along with serine acetyl transferase (SAT), cysteine synthase (CS),  $\alpha$ -glutamyl cysteine synthase ( $\alpha$ -ECS) and  $\alpha$ -glutathione transferase ( $\alpha$ -GT) exhibiting their maximum activities at Se(VI) added As(V) stressed plants. Arsenic distorted the essential amino acids (EAAs), however Se(IV) improved their (isoleucine, lysine, leucine, threonine and phenylalanine) level during As(V) stress. Some stress responsive non-essential amino acids (proline, cysteine, glutamic acid and glycine) increased during Se(VI) and As(V) exposure and some (arginine, serine and aspartic acid) recovered to the level of control implying the role of Se(VI) for oxidative stress removal, which probably leading to lower peroxidation of amino acids due to lesser free radicals. Thus, Se(VI) imparts As(V) tolerance through

modulation of amino acids and phytochelatins in rice plant.

**Key word:** Arsenate, Amino acids, Antioxidants, Selenate, ROS staining, Phytochelatins.

SIII/O-17

## Phylogenetic Analysis of HKT Homologs in Grasses Identified Conserved Domains and Potential Functional Sites

P.R. Weerasinghe<sup>1\*</sup>, M.H.M.M.N. Mapa<sup>2</sup> and H.A.C.K. Ariyaratna<sup>3</sup>

<sup>1</sup>Coconut Research Institute, Bandirippuwa Estate, Lunuwila, Sri LANKA; <sup>2</sup>Sara Bhumi Lanka Bio Products (Pvt.) Ltd., Dambarawa, Pilawala, SRI LANKA; <sup>3</sup>Department of Botany, Faculty of Science, University of Peradeniya, SRI LANKA Email: pabasaraweerasinghe@yahoo.com, nisansala.mapa1@gmail.com, ckariyaratna@yahoo.com

Salinity of soil is a global issue affecting more than 40% of the irrigated lands worldwide that causes adverse effects on crop production. The High Affinity K<sup>+</sup> Transporters (HKT) play a key role in salinity tolerance in plants by regulating ion transport in tissues and therefore can be used as targets to improve salinity tolerance. This study utilizes available sequence information and plant genome databases to predict the evolution of *HKT* genes and the potential functional sites of the respective transporters. Eight *HKT* genes previously identified in rice were used as queries to predict 51 orthologous *HKTs* from six species in the Graminae family using genome databases and BLAST analysis. Rice genes *OsHKT1;1* and *OsHKT1;4* were adjacent gene pairs on chromosome 1 and similarly *OsHKT2;1* and *OsHKT2;4* are adjacently located on chromosome 6 providing evidence for ancient tandem gene duplication events. Similarly, in each species studied, orthologs of *OsHKT1;1* and *OsHKT1;4* *OsHKT2;1* and *OsHKT2;4* were found as neighboring gene pairs forming syntenic blocks with rice. Phylogenetic trees constructed using protein sequences with 1000 bootstrap replications predicted three main clusters of HKT transporters (bootstrap > 65). Each of these main clusters were further separated in to two sub clusters. Thereby main cluster 1 included the

orthologs of rice OsHKT1;4 and OsHKT1;5. Orthologs of OsHKT1;1 and OsHKT 1;3 were included in the main cluster II and the third main cluster included orthologs of OsHKT2;1 and OsHKT2;4. Interestingly the genes that exist as neighboring pairs were clustered in different main clusters indicating that tandem gene duplication and subsequent divergence could be potential mechanism in the evolution of HKTs. However, G block predictions identified highly conserved sequence fragments among the HKTs, specifically in the P-loop domains identifying potential functional sites. These findings provide a basis to illuminate on the potential functional sites on HKTs.

**Key words:** Salinity, Graminae, Genome databases, BLAST, G block.

SIII/O-18

## Intellectual Property Rights and Biotechnology Issues

*Saurabh Yadav*

Department of Biotechnology, Hemvati Nandan Bahuguna Garhwal (Central) University, Srinagar Garhwal-246174, Uttarakhand, INDIA, Email: saurabhyadav40@rediffmail.com

Everyone desires to acquire a property, mostly tangible ones. But intangible property have also much value, since it is having long term effect. One of the intangible property is *Intellectual property*. Intellectual property is generated by the application of human intellect. '*Intellectual property*' is the dynamic area due to the emergence of new knowledge and technologies. The '*brick and mortar economy*' deals with all the properties such as land, house etc. The '*Knowledge economy*' is the focus of the worldwide economy, in current scenario. IP protection is mainly by patents, copyrights, geographical indications, trademarks, trade secrets, know-how etc. '*Biotechnology*' deals with living forms and inventions related to biotechnology must be dealt with extra care to avoid legal issues and needs to be protected by intellectual property rights. Inventions related to biotechnology seems to be promising for industrial productivity. The legal battle related to turmeric, basmati rice and neem are examples of strict IPR laws. Non-patentable biotechnology inventions and also legal issues like ethics, morality etc. Protecting the intellectual

property in the area of biotechnology helps to accelerate economic and social development for a developing country like India. However, there are IP concerns in developing countries and a need for greater protection and access. Isolation of live organisms e.g. bacteria etc. simply from their habitat were not eligible for patents. Biotechnology and genetic engineering makes it possible to include such biotechnological products. Also the patenting of life forms is unlike mechanical inventions and thus poses ethical issues in biotechnology.

**Key words:** Patent, Innovation, IPR, Intellectual Property, GI, Economy.

SIII/O-19

## Analysis of HKT Homologs in Grasses by Comparative Genomics and Protein Structure Prediction

*M.H.M.M.N. Mapa<sup>1,2\*</sup>, P.R. Weerasinghe<sup>1,3</sup> and H.A.C.K. Ariyaratna<sup>1</sup>*

<sup>1</sup>Department of Botany, University of Peradeniya, Peradeniya, SRI LANKA; <sup>2</sup>Sara Bhumi Lanka Bio Products (Pvt.) Ltd, Dambrawa, Pilawala, SRI LANKA; <sup>3</sup>Coconut Research Institute, Bandirippuwa Estate, Lunuwila, SRI LANKA

Email: nisansala.mapa1@gmail.com, pabasara-weerasinghe@yahoo.com, ckariyaratna@yahoo.com

Soil salinity is a major abiotic stress that incurs economic losses in crops. High affinity K<sup>+</sup> transporters (HKTs) are a class of integral membrane proteins (IMPs) involved in Na<sup>+</sup> transport and some members of this group are candidate proteins associated with salinity tolerance. This analysis aims *in-silico* prediction of potential functional sites in this group of proteins based on evolutionary significance of the different domains. Fifty-one orthologous protein sequences from *Brachypodium distachyon*, *Sorghum bicolor* (Sorghum), *Setaria italica*, *Zea mays* (Corn), *Hordeum vulgare* (Barley), and *Triticum aestivum* (Wheat), were retrieved by quarrying genome databases using eight previously known rice (*Oryza sativa*) HKT proteins as the queries. The conserved domains in the proteins were identified by G Blocks (www.idtdna.com) prediction. Protein 3D structures were obtained by homologous protein prediction by PYRE2 and analyzed by PYMOL viewer. The

conserved domains were studied in the 3D structures. Three highly conserved domains were identified where group mean pair wise distance was 0.451. Based on structure predictions these domains were found in the first, second and third Trans- membrane domain and the P loop regions. These three domains predict the potential functional sites in HKTs that can be further studied to illuminate on mechanisms of iron transport and to identify functional variants among the proteins to enable utilizing these genes in improvement of salinity tolerance in plants specially the important cereal crops.

**Key words:** Salinity tolerance, Homology prediction, Protein 3-D structure, Functional domains.

### SIII/O-20

## **Molecular Basis of How Plants can be Used as a Potential Detector System to Analyse Environmental Hazards**

*Jasmine M. Shah\*, J. Sijila and T.J. Joyous*

Department of Plant Science, Central University Kerala, Kasaragod, Kerala-671316, INDIA, Email: jasmine@cukerala.ac.in, sijila.janardhanan@gmail.com, joyoustj@gmail.com

Plants are sessile organisms and are forced to face the injustices imposed by environment and anthropogenic activities. Stress perceived by any organism, is often evidenced by a physiological change. Changes when occur in animals, often turn out to be lethal whereas, plants can still thrive with an abnormality. For example, sterility, a phenotype which brings an end to a generation in animals, can be easily ignored by a vegetatively propagated flora. Phenotype is nothing but manifestation of the genotype. Recent research has revealed that not only genetic, but also epigenetic changes reflect into the making of a phenotype. DNA, the genetic basis of life, is highly conserved across the life forms. More importantly, the mechanisms of DNA replication, repair and epigenetic regulation are highly conserved across the eukaryotic world, from yeast to plants to mammals. Hence, plants offer an excellent system to monitor the molecular impact of environmental hazards, both genetic and epigenetic, simply because of ethical reasons and easy handling. Our group works on genomic stability, expression and epigenetic regulation of DNA repair and transgenerational memory of plant genome. We

use a set of *Arabidopsis GUS* mutation detector lines to study the impact of anthropogenic activities on genome stability. Our research has revealed that the two crop protection methods - genetic transformation and pesticide application, have opposite impact on somatic mutations like homologous recombinations, frame-shift and point mutations. Both the stresses caused epigenetic changes, as analysed by methylation-sensitive restriction digestion PCR, in the promoters of certain DNA repair genes involved in recombination, base-excision repair or nucleotide-excision repair pathways. To the best of our knowledge, there are no previous studies on such an epigenetic analysis of DNA repair system. Our approach provides an excellent platform to study transgenerational memory of other environmental hazards as well.

**Key words:** Transgenerational memory, Epigenetics, Mutation, Methylation, DNA repair.

### SIII/O-21

## **Effect of Fly Ash on Growth of Cellulolytic Bacteria**

*M.S. Dhanya\* and P. Ashoka Chakravarthy*

Department of Environmental Sciences and Technology, Central University of Punjab, Bathinda-151001, Punjab, INDIA, Email: dhanyasubramanian@gmail.com, ashokachakravarthy987@gmail.com

The cellulose is the most abundant material on the earth. This is the major component of organic wastes such as kitchen waste and requires waste management. The cellulolytic bacteria play an important role in maintaining the ecosystem balance by means of decomposition. The hydrolysis depends on cellulolytic microbes which is overall rate limiting step in composting and anaerobic digestion. The fly ash is an inorganic waste that is generated from thermal power plants as a major pollutant. The disposal of food waste and fly ash are of great concern. The focus of the study was to evaluate the effect of fly ash on the growth of cellulolytic bacteria involved inorganic waste digestion. The fly ash addition to food wastes enhanced the cellulase activity and biomass growth of cellulolytic bacteria. The fly ash addition to rice wastes increased cellulase production by cellulolytic bacteria than roti wastes. The fly ash improved the manorial efficiency

of food wastes and helps in production of nutrient rich manure that can be used for plant growth.

**Key words:** Fly ash, Cellulolytic bacteria, Rice waste, Roti wastes, Sustainable waste management.

SIII/O-22

### **Silicon Fertilization and Arbuscular Mycorrhizal Fungi Alleviate Salinity by Regulating Proline and Carbohydrate Metabolism in *Cicer arietinum* L.**

**Purnima Bhandari<sup>1</sup>\* and Neera Garg<sup>2</sup>**

<sup>1</sup>MCM DAV College for Women, Chandigarh, INDIA; <sup>2</sup>Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: purnima3320@gmail.com, garg\_neera@yahoo.com

Soil salinity is recognised as a major threat to legume productivity by causing osmotic and ionic stress. Chickpea (*Cicer arietinum* L.) is considered highly sensitive to salt stress. Various studies have highlighted the promising role of silicon (Si) and arbuscular mycorrhizal (AM) fungi in alleviating salt induced osmotic stress *via* regulating osmolyte accrual especially proline (Pro) as well as soluble sugars (SS). However, the exact mechanism(s) *via* which both modulate solute levels is still lacking. Moreover, very few studies have highlighted the promising role of Si in regulating Pro and SS biosynthesis in otherwise low Si accumulating legumes. To address this issue, pot trials were conducted in two differentially tolerant chickpea genotypes which were supplemented with NaCl (0, 60, 80 and 100 mM), Si ( $K_2SiO_3$  - 0 and 4 mM), with or without *Funneliformis mosseae* inoculations. Exogenous Si and/or AM fungus counteracted the negative effects of osmotic stress by significantly reducing  $Na^+$  uptake and upgrading the activities of enzyme involved in Pro and SS biosynthesis, ultimately, leading to better growth performance under salinity. Comparatively, mycorrhizal inoculations were more efficient in boosting P5CS, OAT and GDH activities with a concomitant decline in ProDH. Benefits of Si were directed more towards accumulation of SS that led to improved shoot growth. Mycorrhizal inoculations were used along with Si nutrition as a multidisciplinary

approach in order to enhance the beneficial effects of Si in chickpea. Conclusively, these results support usage of Si along with AM as potent candidates for alleviating salt-induced osmotic stress.

**Key words:** Chickpea, Mechanism(s), Salinity, Silicon, Proline, Soluble sugars.

SIII/O-23

### **Study on Behaviour of *Tylophora indica* *in vivo* and *in vitro* with Special Reference to its Fungicidal Activity**

**Suman Das<sup>1,2\*</sup>, Shibasis Mukharjee<sup>1</sup>, Alok Hazra<sup>1</sup> and Maitreyi Banerjee<sup>3</sup>**

<sup>1</sup>Department of Agricultural Biotechnology, Ramakrishna Mission Vivekananda Educational and Research Institute, Narendrapur, Kolkata-700103, INDIA; <sup>2</sup>Department of Handloom Handicrafts and Sericulture, Sericulture Training Institute, Tripura, INDIA; <sup>3</sup>West Bengal State Council of Science and Technology, Kolkata, INDIA, Email: suman.agribiotech@gmail.com

*Tylophora indica* is a medicinal plant which has established its importance in the recent years as observed from the increasing number of reports & diverse types of study. A number of studies have been made *in vitro* but no study has so far been made to compare their performance *in vivo* and *in vitro*. The *in vivo* and *in vitro* raised plants were compared with reference to their morphological, phytochemical characters as well as their fungicidal capacity. Micro propagation was done taking nodal explants & best obtained using BAP 3mg l<sup>-1</sup> (both establishment of explants and their multiplication). Callusing was best obtained with 2,4 D and Kinetin and grown from leaves. Callusing was frequently observed at the base of the nodal explants spontaneously. Rooting also was often spontaneous after growth of the plants were complete. This probably indicates the higher level of endogenous auxin within the plants. The phytochemical studies were made with respect to a secondary metabolite (Flavonoid). The flavonoid content was higher in case of plants raised *in vitro* than those *in vivo*. Also, the callus showed higher amount of flavonoid than that found *in vivo* plants. Extract of the plants was prepared and their performances were evaluated in respect to antifungal activities against a common fungal pathogen

(*Aspergillus niger*) and it was found that the extract of the plants grown *in vivo* was much less effective as an antifungal agent than the extract obtained from those grown *in vitro* by the Minimum Inhibitory Concentration (MIC) test. (Note: MS - Murashige and Skoog, PGR – Plant growth regulator, BAP – Benzyl amino purine, 2,4 D – 2,4 dichloro phenoxy acetic acid)

**Key words:** Nodal explants, MS, Callus, Antifungal activity, Flavonoids, MIC.

### SIII/P-1

## Plant Growth Promoting Rhizobacteria: Prospects towards Sustainable Agriculture

*Ashmita Ghosh<sup>1</sup>, Mrinal Ray<sup>1</sup>, Debnirmalya Gangopadhyay<sup>1\*</sup> and Suman Das<sup>2</sup>*

<sup>1</sup>Department of Sericulture, Raiganj University, Raiganj, Uttar Dinajpur-733134, West Bengal, INDIA; <sup>2</sup>Department of Handloom Handicrafts and Sericulture, Sericulture Training Institute, Tripura, INDIA, Email: deb\_ganguly2003@yahoo.com

The chemical fertilizers and pesticides not only create environmental and human health problems but also greatly affect the soil health. It has been reported that regular use of chemical fertilizers brings down the productive capacity of the soil. Therefore, the soil with poor productivity often results in low profit particularly for the marginal farmers who viciously tied to take loans to meet the rising cost of agrochemicals. Of late, the importance of plant growth promoting rhizobacteria (PGPR) attracted the attention of the researchers. Various studies revealed that PGPR helps in increasing crop yield by improving soil fertility, accelerating plant growth and suppressing phytopathogens etc. The physiology of plant gets affected by PGPR through various mechanisms like phytostimulation (via production of gibberellins, indole acetic acid, ethylene and cytokinins), biofertilization (through phosphate solubilization, biological fixation of atmospheric nitrogen, exopolysaccharides production and siderophores production); and bio-defense mechanisms (via systemic resistance, competition for nutrient and space, production of lytic enzymes, antibiotics, hydrogen cyanide) etc. The study illustrates the latest advances

in PGPR and its significance as an alternative of chemical fertilizers towards sustainable agriculture.

**Key words:** Crop yield, Plant growth promoting rhizobacteria (PGPR), Sustainable agriculture.

### SIII/P-2

## Indirect Organogenesis from Leaf Segments of *Solanum lycopersicum*

*Poonam Chaudhary<sup>1\*</sup>, Balwinder Singh<sup>2</sup> and Avinash Kaur Nagpal<sup>1</sup>*

<sup>1</sup>Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA; <sup>2</sup>Post Graduate Department of Biotechnology, Khalsa College, Amritsar, INDIA, Email: poonamchaudhary73@yahoo.com, bbs171@rediffmail.com, avnagpal@rediffmail.com

Series of experiments were performed to test the effect of different concentrations of 2,4-dichlorophenoxy acetic acid (0.1-1.0 mg l<sup>-1</sup>) alone and in combination with kinetin (0.5 mg l<sup>-1</sup>) on indirect organogenesis response from leaf segments of *Solanum lycopersicum*. Callus initiation was observed on leaf segments in all the treatments from 7-10 days after inoculation. Maximum callus induction (90%) was observed on MS medium supplemented with 0.1 mg l<sup>-1</sup> 2,4-dichlorophenoxy acetic acid and 0.5 mg l<sup>-1</sup> kinetin. The *in vitro* response of explants for callus induction was recorded on 28<sup>th</sup> day after inoculation and it was found that the calli were white and compact. The calli were cut into small pieces and inoculated onto regeneration medium [MS medium containing different concentrations of 6-benzylaminopurine (0.1-2.0 mg l<sup>-1</sup>)]. Maximum shoot regeneration (76%) was observed on medium supplemented with 0.25 mg l<sup>-1</sup> 6-benzylaminopurine. Shoots were healthy and achieved the length of 6.18±1.75 cm within 4 weeks. Shoot regenerated on MS medium containing 6-benzylaminopurine (0.1-0.75 mg l<sup>-1</sup>) was shown to root as well without the addition of auxins. This study reveals that transfer of calli (raised on medium containing 0.1 mg l<sup>-1</sup> 2,4-dichlorophenoxy acetic acid and 0.5 mg l<sup>-1</sup> kinetin) to MS medium with 6-benzylaminopurine 0.25 mg l<sup>-1</sup> was the best option to obtain complete plantlets. This experiment would be useful to create somaclonal



variations and also for utilizing transgenic approaches to improve tomato varieties.

**Key words:** *Solanum lycopersicum*, Somaclonal variations, MS medium.

SIII/P-3

## Notes on Bio-Indicator Lichens Enumerated from Sikandra Hill of North West Himalaya

*Monika Thakur\* and Hem Chander*

Division Botany, Department of Bio-Sciences, Career Point University Hamirpur (H.P.), INDIA, Email: thakurmonika382@gmail.com, hemchander78@gmail.com

Lichens are bio-indicator of air pollution, especially sulfur dioxide pollution. They are inexpensive to use in evaluating air pollution and are able to react to wide range of air pollutants over a period of time as compared with other physical/chemical monitors. The quality of environment in a particular area can be assessed either by monitoring changes in lichen community or through monitoring their physiological changes. The toxic elemental pollutants and radioactive metals bind with mycobiont and concentrate over time. During the lichen floristic studies, three hundred specimens of lichens were collected from Sikandra hill, which is situated in Shivalik zone of North West Himalaya and is located in district Mandi of Himachal Pradesh (India). These specimens were then investigated morpho-chemo-taxonomically and thirty species of lichens have been identified so far. Out of these, ten species of lichens (viz. *Candelaria concolor* (Dicks.) Arnold, *Dermatocarpon vellereum* Zschacke, *Heterodermia pseudospeciosa* (Kurok.) W.L. Culb, *Lecanora chlarotera* Nyl, *Parmotrema praesorediosum* (Nyl.) Hale, *Parmotrema tinctorum* (Despr. ex Nyl.) Hale, *Phaeophyscia hispidula* (Ach.) Essl, *Physcia stellaris* (L.) Nyl., *Punctelia subrudecta* (Nyl.) Krog, *Pyxine subcinerea* Stirt) act as bio-indicator. *Candelaria concolor* is a nitrophile and act as indicator of nitrogen pollution, whereas, *Punctelia subrudecta* is nitrogen tolerant. *Heterodermia pseudospeciosa* belong to physcioid lichen community and is toxi-tolerant species. The other seven lichen species act as bio-indicator of heavy metal air pollutants (iron, chromium, copper, zinc, lead and nickel. These potential bio-

indicator lichen species can be used for monitoring of environmental quality in the study area.

**Key words:** Bio-indicator, Heavy metal, Nitrophile, Pollutant, Toxi-tolerant.

SIII/P-4

## Three Auxin Response Factors Promote Hypocotyl Elongation

*Ashish Chaturvedi*

Department of Pathology, King George's Medical University, Lucknow-226007, INDIA, Email: ashishchaturvedi.jr.sc@gmail.com

The hormone auxin regulates growth largely by affecting gene expression. By studying mutants deficient in Auxin Response transcription Factors (ARFs), we have identified three ARF proteins that are required for auxin-responsive hypocotyl elongation. Plants deficient in these factors have reduced response to environmental conditions that increase auxin levels, including far-red-enriched light and high temperature. Despite having decreased auxin response, the ARF-deficient plants responded to brassinosteroid and gibberellin, indicating that different hormones can act partially independently. Aux/IAA proteins, encoded by IAA genes, interact with ARF proteins to repress auxin response. Silencing expression of multiple IAA genes increased hypocotyl elongation, suggesting that Aux/IAA proteins modulate ARF activity in hypocotyls in a potential negative feedback loop.

**Key words:** Auxin, ARFs, Hypocotyls, Negative.

SIII/P-5

## Systematic Identification and Analysis of Lysine Succinylation in Strawberry Stigmata

*Ashish Chaturvedi*

Department of Pathology, King George's Medical University, Lucknow-226007, INDIA, Email: ashishchaturvedi.jr.sc@gmail.com

The various post-translational modifications of plant proteins have important regulatory roles in development. We therefore examined various

modified proteins from strawberry stigmata and found that succinylation of lysine residues was the most abundant type of modification. We then subjected proteins from strawberry stigmata to an efficient enrichment method for succinylated peptides and identified 200 uniquely succinylated lysines in 116 proteins. A bioinformatics analysis revealed that these proteins are involved in important biological processes, including stress responses, vesicular transport, and energy metabolism. Proteomics, combined with immunoprecipitation and immunoblotting, revealed an obvious increase in succinylation of the assembly polypeptide 2 (AP2) and clathrin from 0.5 to 2 h after pollination, suggesting that succinylation is involved in the recognition of pollen-stigma signaling substances and vesicular transport. These results suggest that AP2/clathrin-mediated vesicular transport processes are regulated by lysine succinylation during pollen recognition.

**Key words:** Succinylation, Proteins, Stigmata, Polypeptide 2-AP2.

### SIII/P-6

## Proteomic Study of Somatic Embryogenesis (A Tool for Rapid Plant Development) in *Catharanthus roseus*

**Basit Gulzar\* and Abdul Mujib**

Department of Botany, Jamia Hamdard, New Delhi-110062, INDIA, Email: basit.gulzar786@gmail.com; amujib3@yahoo.co.in

Somatic embryogenesis (SE), an *in-vitro*, multistep and a model technique used for the study of plant development under the stressful micro environment and used to develop embryos/plants from single or a group of cells. The objective of the study was to identify the somatic embryogenesis related proteins via label free liquid chromatography-mass spectroscopy (LC-MS) in *Catharanthus roseus*. A comparative proteomic analysis of non embryogenic and embryogenic calli of *C. roseus* was pursued. A total of 3573 proteins were identified in both non embryogenic and embryogenic calli. 1511 proteins were found to be common in both the calli. In embryogenic

callus 1079 proteins, while in nonembryogenic callus 982 were exclusively identified. These proteins were found to be associated with varied cellular functions. The most of these proteins function in different stress responses and metabolic processes. More than seventy stress related proteins were observed exclusively in embryogenic callus including ascorbate peroxidase, glutathione S transferase, superoxide dismutase, catalase, alkylhydro peroxidase, pyridine nucleotide disulphideoxidoreductase, SOD Fe-N domain containing protein, thioredoxinreductase. The role of stress/proteins was discussed in this article.

**Key words:** Somatic embryogenesis, Stress proteins, *Catharanthus roseus*, LC-MS, Embryogenic proteins.

### SIII/P-7

## Lipase Catalyzed Biodiesel Production: A Review

**Chandra Bhan\* and Jiwan Singh**

Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, INDIA, Email: evs.bhan@gmail.com, jiwansingh95@gmail.com

The rapid growing population, fast industrialization and modernization have increased the energy demand in developing countries. The conventional energy sources are limited in nature and about to run off very fast. In this condition, alternative fuels mandatory to get rid of energy crisis. So, biodiesel is the better alternative fuel of the petro-diesel fuel Biodiesel is biodegradable and produces fewer toxic pollutants and greenhouse gases than petroleum diesel. Biodiesel have the potential to replace diesel in vehicle engines. Biodiesel produce by transesterification of vegetable oil, fat and waste cooking oil with alcohol in the presence of chemical catalyst. Chemical catalyst such as sodium hydroxide, potassium hydroxide, sulfuric acid, sodium ethoxide and potassium ethoxide are used in biodiesel production. But some disadvantages of chemical catalysts, such as require high reaction temperature, difficult purification of glycerol. Alkali catalysts are inexpensive and preferred but activity is less. Sulfuric acid is used as catalyst in biodiesel, it leads to corrosion of the reactor and large amount of wastewater generated during neutralization of mineral acid. Acid-catalyzed transesterification reaction needs higher

alcohol-to-oil molar ratio. So, these chemical catalysts may replace by lipase enzyme. Lipase have the capacity to performed transesterification reaction. Lipase produced from number of microorganisms such as bacteria, fungi etc. Lipase from fruit waste also used in biodiesel production. The use of lipase will minimize the chemical catalysts. So, the enzymatic based biodiesel production is the emerging research area for grow toward green chemistry and sustainable development.

**Key words:** Energy, Biodiesel, Transesterification, Catalyst, Lipase.

**SIII/P-8**

## **Heavy Metal(loid) Stresses in Plants and their Detoxification by Soil Microorganisms**

*Ipsa Gupta\* and Neera Garg*

Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: garg\_neera@gmail.com, ipsagupta1996@gmail.com

Heavy metal(loid) (HMs) including arsenic, lead, nickel, cadmium, chromium and mercury are important environmental pollutants that are increasing across the globe due to geologic and anthropogenic activities. Their presence in the soil leads to increase in oxidative stress, degradation of plant growth cycles (including embryogenesis, organogenesis), oxidation of protein, inactivation of enzymes, DNA damage etc. Plants respond to HM toxicity in a variety of different ways such as immobilization, exclusion, chelation and compartmentalization of the metal ions, and the expression of more general stress response mechanisms such as ethylene and stress proteins however, these mechanisms are scarcely effective under high concentrations of metals. Several physical techniques such as adsorption and chemicals like alginates, citrus pectin, flavonoids and phytic acid are being used to remove heavy metal contaminants from the environment which however are costly, mechanically complex and time consuming. Bioremediation is, therefore, an eco-friendly and efficient method of reclaiming metal(loid) contaminant environments by making use of the inherent biological mechanisms of microorganisms and plants. In this technology, microbes

such as *Pseudomonas* sp., *Aspergillus versicolor*, *Saccharomyces cerevisiae*, *Cunninghamella elegans*, *Microbacterium profundi*, *Cladosporium* are widely used (alone or in combination) for bioremediation of heavy metals from metal contaminated sites. Moreover, associations of plant roots with soil microorganisms such as rhizobium and arbuscular mycorrhizal fungi have proved to be a promising strategy for imparting metal stress tolerance in crop plants for sustainable agriculture. In this review poster, we explore the difference mechanisms undertaken by plants and microbes in response to heavy metal stresses.

**Key words:** Heavy metals, Bioremediation, Rhizobium, Arbuscular mycorrhizal fungi.

**SIII/P-9**

## **Trichoderma Mediated Modulations of Chickpea Rhizospheric Activities in Presence of Organic Amendments and Inorganic Fertilizers**

*Anshu\*, Ashmita Tandon, Udit Uadav, Pankaj Kumar Srivastava, Kumkum Mishra and Poonam C. Singh*

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: anshugautam1808@gmail.com

Interaction of plant growth promoting microorganisms (PGPMs) with plants interchanges signals at physical, physiological and molecular levels. Proliferation and root colonization of PGPMs contribute in improving plant functions by manipulating the rhizosphere. They benefit plants through different mechanisms like nutrient enrichment and induction of plant vigor and defence system. The present work aims to decipher the rhizosphere modulations by an organic acid producing *Trichoderma* strain (NBRI-PR5) under different fertilization regimes. Chickpea reciprocates thoroughly to the application of organic amendments, inorganic fertilizers, and NBRI-PR5. The determining factor in the study was the microbial communities associated with the plant rhizosphere which was determined by culturable populations of heterogeneous microflora (Bacteria, fungi, and Actinomycetes) .The

rhizospheric functions were studied by determining the soil enzyme activities and HPLC profiles of organic acids in root exudates. The application of NBRI-PR5 strain induced favourable changes in rhizosphere upon the application of amendments. The minimum bacterial CFU noticed in the NPK treatment alone ( $4.18 \text{ Log}_{10} \text{ CFU g}^{-1}$ ) confirming the inhibitory effects of chemical fertilizers on rhizosphere microflora compared to the unamended control ( $6.71 \text{ Log}_{10} \text{ CFU g}^{-1}$ ). Application of NBRI-PR5, with organic amendments or inorganic fertilizers lower the pH of the rhizosphere causing inhibition of alkaline phosphatase activity in the treatments compared to the unamended control ( $0.5 \mu\text{g NP.g}^{-1} \text{ soil.h}^{-1}$ ). NBRI-PR5 had refurbished microbial activities to facilitate nutrient uptake in plants rather than fix in the microbes which is demonstrated by an opposite trend in DHA and protease enzyme activities in the rhizosphere of FYM and FYM+PR5 treated plants. The conclusion of the study is that NBRI-PR5 momentarily regulates rhizosphere activities in terms of enzymatic and microbial activities of the rhizosphere, distinct to different fertilization regimes by varying the enzyme activities to maximize the utilization of available nutrients.

**Key words:** Soil enzymes, Organic acids, Rhizosphere remodelling, Chickpea, *Trichoderma*.

### SIII/P-10

## Draft Genome Sequencing, Functional Gene Annotation, Reconstruction of Lipid Metabolic Pathways and Comparative Evaluation of Oleaginous Microalgae *Scenedesmus quadricauda* LWG002611

**Chitralkha Nag Dasgupta\***, Sanjeeva Nayaka, Kiran Toppo and Atul Kumar Singh

Algology Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: chitralkha.dasgupta@gmail.com

The oleaginous microalgae have huge potential as an alternative source of energy. The present study reveals that the high biomass ( $1.41 \pm 0.13 \text{ gL}^{-1}$ ) and lipid ( $404 \pm 30 \text{ mgL}^{-1}$ ) yielding *Scenedesmus quadricauda*

LWG002611 possesses suitable biodiesel properties as per the range defined by the European biodiesel standard EN14214 and petro-diesel standard EN590:2013. The whole genome sequencing (WGS) predicted a total of 13514 genes from *de novo* and 16739 genes from reference guided assembly. The genome size was estimated at 65.35 Mb. Metabolic pathways including lipid metabolic pathways were reconstructed and a total of 283 genes were identified in lipid metabolism. Multiple gene homologs were identified in triacylglycerol (TAG) biosynthesis pathway. The phylogenetic analysis from WGS revealed that the strain belongs to class Chlorophyceae and order Sphaeropleales. Molecular identification was carried out by sequence of small subunit ribosomal RNA gene (18S rRNA) and validated through morpho-taxonomy. Taken together, this first report on WGS of *S. quadricauda* and an insight into the lipid biosynthesis pathway could identify the targets for genetic and metabolic engineering to further improvement of the strain and use it as a sustainable source of biodiesel.

**Key words:** *Scenedesmus quadricauda*, Biodiesel properties, Whole genome sequencing, Lipid biosynthesis pathway, Phylogenetic analysis.

### SIII/P-11

## Insilco Studies of Mango Genome Cultivars and Development of Analysis Tool

**Rabia Faizan\***, Tayyaba Qamar-ul-Islam, Muhammad Ahmed and Uzma Mehmood

Sir Syed University of Engineering and Technology, Karachi 75300, PAKISTAN, Email: rabiatabassumkhi@gmail.com

Mango known as king of all fruits and fifth most important subtropical/tropical fruit crops worldwide with the production centered in India and South-East Asia. Recently, there has been a worldwide interest in mango genomics to produce tools for marker annotations and trait information. There are no online analyzed genomic tools available for mango specially. Moreover a complete mango genomic resource was required for improvement in research and annotations of mango germplasm. In this paper, we have done comparative analysis of four mango cultivars i.e. cv.

*Langra*, *cv. Zill*, *cv. Shelly* and *cv. Kent* from Pakistan, China, Israel, and Mexico respectively. There are 30,953-85,036 unigenes identified from RNA-Seq datasets of mango cultivars in De-novo sequence assembly. The significance of this specific tools is to provide the scientific community and general public a mango genomic resource and allow the user to examine their data against our analyzed mango genome databases of four cultivars (*cv. Langra*, *cv. Zill*, *cv. Shelly* and *cv. Kent*). A mango web genomic resource MGdb, is based on 3-tier architecture, developed using Python, flat file database, and JavaScript. MGdb is a website which contains the information of predicted genes of the whole genome and the unigenes annotated by homologous genes in other species, GO (Gene Ontology) terms which provide a quick look of the traits in which they are involved. This web based portal belonging to different mango cultivars could be a millstone in the assessment of the research, development of the medicines, understanding genetics and provides useful bioinformatics solution for analysis of nucleotide sequence data. We report here world's first web-based genomic resource particularly of mango for analysis and comparative studies of different mango cultivars.

**Key words:** RNA-seq, Annotation, Gene Ontology, Phylogeny.

SIII/P-12

## **Synthesis of Bioengineered Gold Nanoparticles for Enhancing Catalytic Activity**

**Ashutosh Tripathi\***, **Shipra Pandey**, **Ved Prakash Giri**, **Vivek Pandey** and **Aradhana Mishra**

Division of Plant Microbe Interactions, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: mishramyco@yahoo.com

Biosynthesis of nanoparticles is an emerging technology that is green, cost-effective and eco-friendly but the optimization for its maximum activity is doubtful thus there is a need of improvisation for maximum catalytic activity. The main aim of our work is to synthesize gold nanoparticles by cell free extract of *Trichoderma viride*, a reducing and stabilizing agent with effective potency and improved catalytic

properties through the modulation in physico-chemical parameters viz. pH, time, temperature, concentration of cell free extract, and gold salt during biosynthesis of gold nanoparticles. A varying size ranges from 2–500 nm with different shapes i.e. spherical, triangular, nanoprisms, pentagon/hexagon and nanosheets were synthesized. Catalytic activity of these gold nanoparticles were evaluated by UV-visible spectroscopy followed by gas chromatography-mass spectrometric analysis. Spherical nanoparticles of size 3-10 nm were showing highest catalytic activity among different shape and size nanoparticles. Decreases in size and spherical shape strongly affect the adsorption and activation of the reactants. An attempt has been made to obtain unique balance of physical parameters to set a strategy for selection of specific structures of gold nanoparticles for enhancing catalytic properties in degradation of organic pollutants.

**Key words:** Gold nanoparticles, Green technology, Trichoderma.

SIII/P-13

## **Histopathological Studies of Drought Tolerant and Sensitive Rice Varieties in Presence of Endophytes under Drought Condition**

**Touseef Fatima\***, **Isha Verma**, **Sanjeev Kumar** and **Poonam C. Singh**

CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: taus.fatima@gmail.com

There exists a large variability in root system architecture in cultivated rice varieties which consequently determines its drought tolerance ability. Roots are sensitive to abiotic and biotic stresses and respond at all levels of plants' structure and function including morphological and anatomical traits. The drought tolerance or avoidance in rice is largely considered to be dependent on the deep rooting seminal and primary roots and are the targets for breeding varieties better adapted to drought. To understand the morphological plasticity, which affect the water harvesting property we studied the morphological and anatomical differences induced by PEG6000 in two contrasting rice varieties, Heena (drought resistant) and

Kiran (drought sensitive), in both absence and presence of rice endophytes. The Morphological and Anatomical features of Heena and Kiran varieties were studied in presence of 20% PEG6000. The sampling was carried out 1, 3, 5, 7 and 10 days after PEG6000 treatment. The sensitive variety appears to give a spontaneous response and immediately starts increasing the root length similar to hydrotropism to explore deeper water while the tolerant one is more planned to first increase the root numbers which are structurally and physiologically adapted to drought and then grow in size to get maximum benefit. Increased prevalence of tight packing of cells in the exodermis and lignified sclerenchyma layer which improves its effectiveness as a barrier and prevent loss of water was observed in presence of the microbial intervention. Increased lignification and thickened walls in presence of bacteria make large negative pressures possible and help in water uptake.

**Key words:** Rice, Drought, Endophyte, Heena, Kiran.

SIII/P-14

### **Modulation in Nutritional Value and Defence Activity of Chickpea by Supplementation of a Novel *Trichoderma* Fusant**

**Pratibha Verma\*, Nishtha Mishra, Priyanka Chauhan and Aradhana Mishra**

CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: mishramyco@yahoo.com

Due to rise in global population and food consumption, yield of agricultural crops has to be increased substantially in the coming years. To fulfill the dietary requirements diminishing nutritional value of the grains has to be maintained by improving the agricultural practices. Legumes and cereal crops are important staple food crops with high nutritional values in amino acids content, carbohydrate content etc. In the present study we have used a protoplast fusant (H. lixii MTCC 5659) for enhancing the nutritional value and defence activity in chickpea. Essential amino acids; methionine (9.82 mg kg<sup>-1</sup> dw), cysteine (2.61 mg kg<sup>-1</sup> dw), glycine (11.34 mg kg<sup>-1</sup> dw), valine (9.26 mg kg<sup>-1</sup> dw), and non-essential amino acids; aspartic acid (39.19

mg kg<sup>-1</sup> dw) and serine (17.53 mg kg<sup>-1</sup> dw) were significantly higher in seeds of fusant inoculated chickpea. Mineral contents like i.e. Cu (157.73 mg kg<sup>-1</sup> dw), Co (0.06 mg kg<sup>-1</sup> dw), Ni (1.85 mg kg<sup>-1</sup> dw), Zn (157.73 mg kg<sup>-1</sup> dw) and S (16.29 mg kg<sup>-1</sup> dw) were significantly improved. Fusant inoculated plants showed better biocontrol and defence activities in chickpea from 20 to 35% during biotic stress. This is one of the first report on increase in amino acids and mineral content of chickpea by fusant inoculation.

**Key words:** Protoplast fusant, *Trichoderma*, Amino acids, Nutritional value, Biocontrol.

SIII/P-15

### **Molecular Diversity and Characterization of Indigenous Salt Tolerant Plant Growth Promoting Rhizobacteria Isolated from Different Agro-Climatic Zones of Uttar Pradesh**

**Sankalp Misra, Shashank Kumar Mishra, Vijay Kant Dixit, Swati Gupta and Puneet Singh Chauhan\***

Division of Plant Microbe Interactions, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: puneetnbri@gmail.com

A extensive study for 9 agro-climatic zones of Uttar Pradesh, India was conducted for the isolation and characterization of salt tolerant 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase possessing plant growth promoting (PGP) rhizobacteria for salt stress amelioration in rice. For this study, we have isolated 1125 bacteria having the ability to tolerate 1M NaCl and screened for utilizing ACC as sole nitrogen source. The resultant 77 isolates were further evaluated for seed germination assay, PGP and abiotic stress tolerance ability *in vitro*. This evaluation revealed 15 potent rhizobacteria representing each agro-climatic zone and salt stress mitigation *in vitro*. In particular, the biomass obtained for bacteria coated rice seedlings were corroborated with the performance of isolates exhibiting maximum IAA production. Surprisingly based on 16S rRNA, much of the propitious isolates belonged to same specific epithet exhibited variedly in their characteristics. Overall,

*Bacillus* spp. was explored as dominant genera *in toto* with highest distribution in Western plain zone followed by Central zone. Therefore, this study provides a counter-intuitive perspective of selection of native microflora for their multifarious PGP and abiotic stress tolerance abilities based on the agro-climatic zones to empower the establishment and development of more suitable inoculants for their application in agriculture under local stress environments.

**Key words:** Molecular Diversity, Salt, Rhizobacteria, Agro-Climatic Zones.

SIII/P-16

### **Assessment of Bacterial Community as Fertility Indicators in Response to Heavy Metal Contamination in Paddy Fields Soil**

*Nikita Bisht, Shashank Kumar Mishra, Swapnil Pandey, Sankalp Misra, Vijaykant Dixit and Puneet S. Chauhan\**

Division of Plant Microbe Interactions, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: puneetnbri@gmail.com

Heavy metal contamination especially arsenic is a huge problem worldwide. Environmental issues related to heavy metal contamination draw a great concern about the soil quality of crop cultivating lands. Therefore, it is essential to know the status of soil quality or fertility of the areas having high amount of heavy metal, especially As. It is also necessary to evaluate the impact of microbial community structure in those areas. The present work was done to examine the soil physico-chemical properties, functional, and uncultivable microbial diversity of As contaminated paddy field soil from West Bengal, India. The result revealed that the fertility indicators and growth-limiting factors were negatively correlated with the heavy metal stress except the soil total organic content which demonstrated significant positive correlation with the heavy metals. In case of functional diversity of soil, all the considered diversity indices exhibited no specific pattern along with the availability of heavy metals. Moreover, we observed a very complex and indifferent pattern of bacterial community composition in the heavy

metal contamination sites.  $\alpha$ -Proteobacteria was found to be the most abundant bacterial community followed by Actinobacteria, Firmicutes,  $\beta$ -Proteobacteria and  $\gamma$ -Proteobacteria. Overall, the present study leads to a better understanding of the interactions between soil variables, soil enzyme activity, functional diversity, and complex bacterial communities in As-contaminated paddy soils, and provides useful information of indigenous populations with potential application to improvement in soil remediation processes and explore the deep insight of microbiological imbalance in soil ecosystem.

**Key words:** Heavy metal, Paddy, Actinobacteria, Firmicutes, Proteobacteria.

SIII/P-17

### **Characterization of Potential Microbes for Arsenic Stress Amelioration in Rice**

*Vandana Anand, Salil Kumar Arkvanshi\*, Sonal Srivastava and Suchi Srivastava*

Division of Plant Microbes Interaction, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: saliltheredeemer@gmail.com, s.srivastava@nbri.res.in

Arsenic (As), a ubiquitous metalloid frequently present in most environmental samples like soil, water, etc. The contamination of this toxic element has become a menace for the human health and natural ecosystems worldwide. Millions of people are affected by the "As" poisoning. Rice is popular for more efficient As accumulation as compared to other crops due to its high water requirement. Presence of As mainly in the form of arsenite As(III) in anaerobic rice field conditions and its transportation *via* over-expressed silicic acid transporters has added to the adversity. Microbes are known to play significant role in detoxification of this metalloid. Microbial activity is linked to the biogeochemistry of arsenic and is involved in its biotransformation. Several bacteria, archaea, and fungi have developed different detoxification mechanisms, which include the reduction of arsenate to arsenite; oxidation of arsenite to the arsenate; immobilization, complexation, vacuolar sequestration and its methylation to less toxic organic form. The present study deals with the identification, characterization and elucidation of detoxification

mechanisms of different bacterial isolates from different parts of India. In addition to this, the strains were also characterized for different plant growth promoting traits viz. indole-3-acetic acid and siderophore production, and phosphate solubilization. Three strains from Bulandshahr, U.P., India NBRIB4.14 (*Bacillus tequilensis*), NBRIB5.12 (*Bacillus* sp.) and NBRIB5.12 (*Lysinibacillus xylanilyticus*) with arsenate reductase, methyl transferase and arsenite oxidase activity has been selected as best “As” tolerant strains. Assessment of arsenic stress amelioration using rice as a host plant under greenhouse condition is under progress.

**Key words:** Arsenic, Abiotic stress, Methyl transferase, Arsenite oxidase, Arsenate reductase.

SIII/P-18

## Alleviation of Micronutrient Malnutrition through Biofortification

**Kriti<sup>1,2\*</sup>, Shekhar Mallick<sup>2</sup>, Suchi Srivastava<sup>2</sup>, Vandana Anand<sup>1</sup> and Kumkum Mishra<sup>1</sup>**

<sup>1</sup>Department of Botany, Lucknow University, Lucknow-226007, INDIA; <sup>2</sup>Plant Ecology & Climate Change Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: kriti.v02@gmail.com

In developing country like India most of the population depends upon staple food (cereal grains like, rice, wheat, maize, barely) to fulfill their daily energy requirement. The majority of people who live in poverty, suffer from MN deficiency (hidden hunger as well as malnutrition). The main reason for MN deficiency is due to dependency upon monotonous diet that contain of cereal grains despite having enough MN (Fe, Zn and Mn). As known when these foods grown in MN deficient soil, there will be automatically decrease in grain. Anemia (Fe deficiency), growth retardant, immune dysfunction, cognitive impairment (Zn deficiency) and Asthma, severe birth defects (Mn deficiency) are some example of malnutrition. Biofortification approaches as agronomic, breeding, generating cultivars that effectively solublize, uptake and translocate nutrient to edible part. Biofortification through microbes could be inexpensive, sustainable and eco-friendly practice. Microorganisms those have ability to solublize insoluble form of minerals with

production of siderophore, redox system on cell membrane, chelated ligands and acidification of nearby soil by organic acid synthesis. The plant growth promotion activity is beneficial to this approach. Thus, very small increases in bioavailable MN in edible crop mainly staple food implement effective impact on human health.

**Key words:** Malnutrition, Micronutrient, Biofortification.

SIII/P-19

## Isolation, Production and Reaction Conditions Optimization of Amidase of *Bacillus* sp. MNB-1

**Monica Sharma<sup>1\*</sup> and Monika Geetanjali<sup>2</sup>**

<sup>1</sup>Department of Biotechnology, School of Life Sciences, Babasaheb Bhimrao Ambedkar University, Vidya Vihar, Lucknow-226025, Uttar Pradesh, INDIA; <sup>2</sup>Department of Biotechnology, Delhi Technological University, Main Bawana Road, Delhi-110048, INDIA, Email: monashimla@gmail.com

Amidase (EC 3.5.1.4), a nitrile metabolizing enzyme, belongs to the family of hydrolases, which acts on carbon-nitrogen bonds other than peptide bonds. It is an inducible intracellular enzyme, which is involved in nitrogen metabolism. It catalyzes hydrolysis of amide to carboxylic acid and ammonium. Amidases find wide applications in bioremediation, various industries as commodity chemicals (e.g. acrylic acid, nicotinic acid etc.) or pharmaceutically important acids (organic acids and hydroxamic acids). Here we report the isolation, production and reaction condition optimization of mesophilic amidase was undertaken. An aliphatic selective amide degrading gram positive *Bacillus* sp. MNB1 strain was isolated from thermal spring soil of Manikaran, Himachal Pradesh, India. Amidase production and reaction conditions were optimized. Amidase of *Bacillus* sp. MNB1 exhibited maximum activity in M2 medium at temperature 37°C, pH 7.0 in the presence of acetamide as inducer. The enzyme showed maximum activity at pH 7.0, temperature 37°C and 40-50 mM of acetamide as substrate.

**Key words:** Amidase, Hydroxamic acids, Nitrile metabolizing enzyme, *Bacillus* sp.



SIII/P-20

## **Influence of Heavy Metal on the Soil Microbial Community Structure and Root Exudates**

***Naina Marwa<sup>1,2\*</sup>, Meenakshi Khushwaha<sup>1</sup>, Gauri Saxena<sup>2</sup> and Nandita Singh<sup>1</sup>***

<sup>1</sup>Plant Ecology and Environmental Sciences, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: naina.marwa@gmail.com

The aim of the study was to observe the soil-microbial and root exudates cross-talk under the influence of Arsenic, a heavy metal. To detect the effect of two Ashyper-tolerant, plant growth promoting rhizobacteria (PGPR) strains isolated from the As polluted site of West Bengal, India, on the rhizospheric microbial community, their respective richness, diversity was assessed. Shannon, McIntosh and Simpson diversity and their related evenness were estimated for microbial substrate utilization pattern on Biolog MT plates. The first two components, PC1 and PC2 cumulatively accounted for 75.81% variance in 120 hr of average well colour development (AWCD) normalized data. Individually PC1 showed 40% variance whereas 35.7% variance by PC2. The PCA plot on the basis of carbon source utilization pattern displayed significant changes in microbial dynamics in inoculated samples. Furthermore, the root exudates profiling was done in the rhizospheric soil through GC-MS to investigate the role of heavy metal in its regulation. The detection of compounds like glycine, sucrose, d-glucosamine, etc. in bacteria inoculated samples reveal the constructive contribution of the strains in maintaining the rhizospheric environment conducive for plant growth. Our findings reveal that the heavy metal influences the microbial community thus adversely affects the root exudates secretion which is essential for maintaining plant-microbe interaction and root expansion. Loss of microbial diversity due to heavy metal can be restored through inoculation of efficient microbes. The maintenance of rhizospheric microbial balance is important for better remediation results.

**Key words:** Heavy metal, Arsenic, Microbial diversity, Plant growth promoting rhizobacteria.

**Abstracts** 27-30 November, 2018, NBRI, Lucknow

SIII/P-21

## **Development of an Algal Consortium for Arsenic Removal from Water**

***Anurakti Shukla and Sudhakar Srivastava\****

Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: sudhakar.iesd@bhu.ac.in, sudhakar.srivastava@gmail.com

Arsenic (As) presence in groundwater at higher than recommended levels is a serious problem in India and Bangladesh. The presence of As has been reported mainly in Gangetic plains in the states of West Bengal, Bihar, and Uttar Pradesh. It causes serious health concerns ranging from skin disorder to cancer. Therefore, As remediation in a cost-effective, practical and feasible manner is necessary. In this study, different algal strains (green algae, blue green algae, diatoms) were collected from water bodies in Varanasi as well as As affected regions of Kolkata and Nadia, West Bengal. The arsenic tolerance behaviour of different algal strains and diatom species (*Gloeotrichia*, *Oscillatoria*, *Phormedium*, *Navicula*, *Gyrosigma*, *Nitzschia*, etc.) was assessed and selected algal strains of *Phormedium* and *Oscillatoria* were used for consortia formation. The growth of algae in consortium was standardized with respect to pH, As concentration and algal biomass. The consortia in optimal conditions was used for As removal from BG-11 medium containing 200 µM, 400 µM, 600 µM arsenite [As(III)] for 15 d and samples were analyzed for As content. The consortium was found to show significant As removal potential.

**Key words:** Algae, Arsenic, *Oscillatoria*, *Phormedium*, Removal.

SIII/P-22

## **Use of Bioinoculants to Augment Growth and Yield of Soybean (*Glycine max*) under Drought Stress Condition**

***Anamika Dubey and Ashwani Kumar\****

Metagenomics & Secretomics Research laboratory, Department of Botany, Dr. Harisingh Gour Central University, Sagar-470003, MP, INDIA, Email: ashwaniitd@hotmail.com

Soybean is the important crop of Madhya Pradesh and largely harvested for production of vegetable oil. There are different types of abiotic and biotic stress faced by the plants from seedling to production stage. Drought stress adversely affects the plant growth and yield of soybean. The present study investigated the effect of inoculation of plant-growth promoting rhizobacteria (PGPR) strains AKAD 1-2 (*Pantoea agglomerans*), AKAD 1-3, (*Bacillus subtilis*), and AKAD3-5 (*Micrococcus luteus*) in improving drought tolerance in soybean. These PGPR strains were screened for different PGPR activities like PSB, IAA production, ammonia production, catalase, chitinase, and HCN production. Effect of PGPR inoculation on various morphological, physiological, biochemical parameters was studied under drought stress. Root colonization at the surface and interiors of roots were shown using scanning electron microscopy (SEM). Drought stress significantly affected various growth parameters, integrity of the membrane, water status, accumulation of the osmolyte, which were positively ameliorated by PGPR-inoculation in soybean. The PGPR strain AKAD 1-2 was found to be the best in terms of influencing biochemical and physiological status of the seedlings under drought stress. Our report demonstrate the role of PGPRs (*Pantoea agglomerans*, *Bacillus subtilis*, and *Micrococcus luteus*) in plant growth promotion of soybean under drought stress. The study reports the potential of PGPR in alleviating drought stress in soybean.

**Keyword:** Soybean, Bioinoculants, PGPR, Drought stress, Biofertilizer.

SIII/P-23

### **Applications and Mechanism of Plant Growth Promoting Rhizobacteria (PGPR) Containing ACC Deaminase under Water logging Conditions**

**Jyoti Prakash**

Amity Institute of Biotechnology, Amity University, Uttar Pradesh, Lucknow Campus, Lucknow-226028, INDIA, Email: jprakash@lko.amity.edu

Ethylene production in plant roots is accelerated in response to both biotic and abiotic processes. Over

production of ethylene leads to abnormal root growth, this leads to impart a visible dent on plant growth and development. ACC synthesized in root is transported to plant shoot where it is converted to ethylene by ACC oxidase. Bacteria being most abundant microorganisms in the rhizosphere influence the plants' physiology to a greater extent, especially considering their competitiveness in root colonization, hence, referred as plant growth-promoting rhizobacteria (PGPR). Several studies revealed increased health and productivity of various plant species under both normal and stressed conditions by the application of plant growth promoting rhizobacteria. PGPR containing ACC deaminase can lower the impact of various environmental stresses such as flooding, heavy metals, soil-borne phytopathogens, drought and high salt on host plant. ACC deaminase can hydrolyse the ACC, intermediate precursor of ethylene to  $\alpha$ -ketoglutaric acid and ammonia thus inhibiting the transport to shoot and thus retards the harmful effect of ethylene on plant. Inoculation of ACC deaminase-containing PGPR in association with plants subjected to a wide range of abiotic stresses results in enhanced plant tolerance against exposed stressors.

**Key words:** Plant Growth Promoting Rhizobacteria (PGPR), ACC deaminase, Rhizobacteria.

SIII/P-24

### **Biotechnological Investigation for Propagation and Conservation of Beles (*Opuntia ficus-indica* (L.) Mill in Tigrey Region of Ethiopia (Africa)**

**Shastri Prasad Shukla<sup>1\*</sup>, Zinabu Hailu<sup>2</sup> and Yemene Kehsay<sup>3</sup>**

<sup>1</sup>Department of Horticulture, College of Agriculture & Environmental Sciences (Beles Institute), Adigrat University, Adigrat, ETHIOPIA, AFRICA; <sup>2</sup>Research and Community Service, Beles Institute, Adigrat University, Adigrat, ETHIOPIA, AFRICA; <sup>3</sup>Beles Institute, Adigrat University, Adigrat, ETHIOPIA, AFRICA, Email: sp\_shukla2002@yahoo.co.in, zinishah@gmail.com, yemane02@gmail.com

Cactus having about 130 genera and 1,500 species of cactaceae family. Of these, *Opuntia ficus-indica* (L.) Mill. commonly known as prickly pear or Beles is a xerophytic, succulent, CAM (Crassulacean Acid

Metabolism) plant introduced in Ethiopia (Africa), particularly to Tigray region between 1848 and 1920. Throughout the African continents and especially in Ethiopia, prickly-pear cultivation has long had an important role both in subsistence agriculture and in the intensive fruit production. Beles is a multipurpose plant with great potential as source of livestock feed in Tigray region and Ethiopia at large. It is known as a multipurpose plant since it can be used for human food (fruits and vegetables), medicinal and ornamental plants, animal forage, natural wind break barrier, soil stabilizer, re-vegetation resource to control water and wind erosion in eroded soils. The sweet fruit of this plant is known as “Tuna” useful as human food and entire plant can be cultured as raw-industrial material to produce several sub-products such as jam, wine, candies and jellies etc. It is also source of natural-dye, carminic acid which is used for colouring fabrics, food, and cosmetics. Stem of this plant has been reported to treat diabetes and useful in the cure of hyperlipidemy (excess of lipids in the blood) and obesity. *O. ficus-indica* is well recognized for their wound healing properties and anticancer effects. Conventionally, *O. ficus-indica* is propagated by seeds but physiological limitations of the seeds, such as; low germination rate, genetic segregation, less guarantee of genetic stability, a long juvenile stage, less availability and low viability, and slow seedling growth rate are major constraints in the production of the population of this species in the nature. Therefore crop improvement programme, microcloning and *ex-situ* conservation of the species is underway which is a principal objective of the Beles Institute of Adigrat University, Adigrat, Ethiopia (Africa).

**Key words:** *Opuntia ficus-indica*, Biodiversity, Conservation, Micropropagation, CAM plant.

SIII/P-25

## Evaluation of Selected Compatible Microbial Consortia for the Growth Promotion and Increased Essential Oil Content in *Mentha arvensis* under Field Conditions

Suman Singh<sup>1\*</sup>, Arpita Tripathi<sup>1</sup>, Deepamala Maji<sup>1</sup>, Anju Yadav<sup>1</sup>, Poornima Vajpayee<sup>2</sup> and Alok Kalra<sup>1</sup>

<sup>1</sup>Microbial Technology Division, CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow-226015, INDIA; <sup>2</sup>Department of Botany, University of Lucknow-226007, INDIA, Email: biosuman14@gmail.com

Growing demand for mint oil in food and flavours requires eco-friendly agricultural practices. Plant growth promoting rhizobacteria or fungi alone or in combination become useful soil microorganisms improving production and control abiotic and biotic stresses. The present study was conducted to assess the potential of co-inoculation of *Trichoderma* spp. with the plant growth promoting rhizobacteria (PGPR) on the growth and essential oil yield of *Mentha arvensis* cv. “Kosi” under pot as well as field conditions. The results revealed that dual inoculation of *Trichoderma* spp. and *Brevibacterium* spp. increased plant growth, oil content, leaf-stem ratio, photosynthetic pigments, and nutrient uptake resulting in higher oil yields. The density (colony forming unit) of *Trichoderma*, as well as rhizobacteria, was significantly higher when compared to the single inoculations and control. Scanning electron microscopy revealed significant colonization of microbes on the root surface particularly for the best combination of *Trichoderma* and *Brevibacterium* spp. Similarly, under field conditions the synergistic association of *Brevibacterium* spp. and *Trichoderma* showed increased plant growth which provides evidence that both enhance the growth promoting abilities of each other significantly improving growth and yield of the crop. A higher number of propagules, both of *Brevibacterium* spp. and *Trichoderma* may exert similar crop growth benefits in the subsequent crops while higher the population of *Trichoderma* may protect the subsequent crops from many phytopathogens.

**Key words:** *Mentha arvensis*, *Trichoderma* spp., Plant growth promoting rhizobacteria, *Brevibacterium* spp., Scanning Electron Microscopy.

SIII/P-26

## Algal Biomass Pretreatment for Enhanced Methane Potential

Shashi Bhushan<sup>1\*</sup>, Mohit Singh Rana<sup>2</sup>, Mamta<sup>1</sup> and Sanjeev Kumar Prajapati<sup>1</sup>

<sup>1</sup>Bio-Resource Engineering Lab (BREL), Department of Chemical and Biochemical Engineering, Indian Institute of

Technology (IIT) Patna, Bihta, Patna-801106, Bihar, INDIA; <sup>2</sup>Department of Energy and Environment, National Institute of Technology (NIT) Trichy, Tiruchirappalli-620015, Tamil Nadu, INDIA, Email: shashiascientist@gmail.com

Human kind receives their major portion of energy needs from fossil fuels. These fuels are non-renewable and their reservoir is finite. Ever increase energy demands can be addressed through biofuels. Among the available biofuel substrate, algal biomass shows most promising feed stock for biodiesel, biomethane, and bioethanol. Microalgae contain chlorophyll and perform photosynthesis at higher rate as compared to the terrestrial plant. They can trap atmospheric carbon dioxide and fixed them in biomass. Their cell wall is composed of cellulose, which make them tuff and resistant to many cell disruption techniques. To enhance the biofuel potential of the algal biomass, it is advisable to perform pretreatment steps. These pretreatment steps enhance the anaerobic digestibility of cell wall and release the high value cellular content. This paper gives a brief idea about the available pretreatment modules. It also present the results of physical pretreatment (microwave, ultrasonic and thermal) performed on *Chlorella pyrenoidosa*. Among tested technique microwave seems most efficient in terms of soluble COD (Chemical oxygen demand) recovery. The released COD enhance the methane potential of algal feedstock.

**Key words:** Microalgae, Biofuel, Pretreatment, COD, Methane.

SIII/P-27

### **Characterization of Plant Growth Promoting Rhizobacteria Isolated from Extreme Environment (Volcanic Soil) with Multiple Plant Beneficial Traits along with Abiotic Stress Tolerance Capabilities**

*Shashank Kumar Mishra, Swapnil Pandey, Sankalp Misra, Vijay Kant Dixit, Nikita Bisht and Puneet Singh Chauhan\**

Division of Plant Microbe Interactions, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: puneetn bri@gmail.com

Abiotic stresses are one of the major barriers for crop productivity. The native rhizospheric soil microflora has limitations to withstand against these abiotic stresses and is mostly exclusive to plant growth promotion. In the current study, an attempt was made to evaluate soil bacteria from extreme environments of volcano soils based on plant growth promoting and abiotic stress mitigating characteristics. The screening led to 08 (NBRISH4, NBRISH6, NBRISH10, NBRISH11, NBRISH13, NBRISH14, NBRISH16 and NBRISH26) bacterial isolates capable of withstanding stress namely temperature (up to 45° C), salt (up to 2M NaCl) and drought (up to 60% PEG) *in vitro*. Further, the selected isolates were outstanding *in vitro* temporal performance with regards to their survival (in terms of colony count), auxin production, phosphate solubilization, biofilm formation, alginate and exopolysaccharide production abilities under abiotic stress (40°C temperature; 500 mMNaCl representing salt; 250 mM LiCl representing drought) conditions. *In vivo* treatments of each bacterium to maize plants resulted into significant enhancement in root and shoot length, root and shoot fresh and dry weight and no. of leaves per plant (NLPP). Overall, the plant growth promoting and abiotic stress tolerance ability was prominent for NBRISH6 bacterial isolate which was identified as *Ochromobacterium* sp. using 16S rRNA based phylogenetic analysis. Therefore, NBRISH6 having multiple plant beneficial and abiotic stress tolerance characteristics shall be considered for its application in agriculture under stress environments.

**Key words:** Rhizobacteria, *Ochromobacterium*, Abiotic stresses.

SIII/P-28

### **Somatic Embryogenesis Responsive Kinase (*OsSERK*) and *Myb* Related Gene (*OsGLK*) Improved Somatic Embryogenesis and Regeneration Potential in Rice (*Oryzasativa* L.)**

*Yuvraj Indoliya<sup>1,2\*</sup>, Poonam Tiwari<sup>1</sup> and Debasis Chakrabarty<sup>1,2</sup>*

<sup>1</sup>CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Academy of

Scientific and Innovative Research (AcSIR), Anusandhan Bhawan, 2 Rafi Marg, New Delhi-110001, INDIA, Email: yuvi\_indolia@yahoo.com

Rice (*Oryza sativa* L.), a major cereal crop for around half of the world population, also acts as a model crop for monocot plants in order to study various developmental, environmental and biochemical aspects due to its small size genome (430 Mb), better genomic identity with other cereal crops and comparatively better transformation system using agrobacterium mediated transformation. Compare to *japonica*, *indica* rice has been less responsive to *in vitro* culture. In the present study, comparative somatic embryogenesis and regeneration efficiency of two genes (*OsSERK* and *OsGLK*) was carried out using amiRNA mediated gene

silencing and overexpression analysis among *japonica* and *indica* rice subspecies. Further phenotypic analysis of *OsSERK* and *OsGLK* overexpressing lines of PB-1 variety (*Indica* subspecies) showed significant increase in somatic embryogenesis and regeneration potential compared to wild type. On the other hand, knock down lines of Nipponbare variety (*Japonica* subspecies) showed notable decrease in somatic embryogenesis and regeneration efficiency compared to wild type. Functional significance of both the genes, in terms of *in vitro* plant regeneration may be used as an efficient tool for improving agrobacterium mediated transformation, especially in cereal plants.

**Key words:** Rice, Somatic embryogenesis, *Japonica*, *Indica*.



**Session IV**  
**Environmental Impact Assessment**





SIV/L-1

## **Coal-Related Environmental Pollution has been Affecting Our Lives**

*Gordana Medunic*

University of Zagreb, Faculty of Science, Department of Geology, Horvatovac 95, 10000 Zagreb, CROATIA, Email: gmedunic@geol.pmf.hr, gordana.medunic@gfz.hr

Since 2013, my multidisciplinary environmental research has been focused on highly sulfurous (up to 4-8% total S) soil polluted by Croatian super high-organic-sulfur (SHOS) Raša coal (up to 11-14% total S). Due to coal mining, utilization, and combustion activities, large amounts of S, potentially toxic trace metals (Cd, Cr, Cu, Pb, U, V, Zn, etc.), metalloids (Se), and organic pollutants (polycyclic aromatic hydrocarbons, PAHs) have been released into acid-vulnerable, coastal karst environment (Istrian Peninsula, North Adriatic, Croatia). The area is urban, densely populated touristic region. The results are published in high IF WoS Core Collection journals (Science of the Total Environment, Chemosphere, Environmental Earth Sciences and International Journal of Coal Geology). The objectives of the studies were to determine the distributions of the mentioned pollutants and rare earth elements (REEs) in soil, ash and SHOS coal. I have, together with my colleagues from various scientific disciplines (biology, chemistry, physics, biochemistry, metallurgy, etc.), addressed the problem by applying several analytical approaches to determine toxicity potential of polluted soil for life forms (animals and plants). We have tested soil samples by cytotoxicity, genotoxicity, and phytotoxicity methods. We have also calculated a risk for human health posed by several routes (dermal contact as well as inhalation and ingestion). As the results were indicative of statistically significant toxicity potential, our work has warranted further research on this environmental topic. Therefore, latest/ongoing research is involving collaboration with leading US, Chinese, Indian, Italian, Spanish, and Slovenian coal geochemistry, clean-coal technology, chemistry, physics and environmental scientists. The talk will summarize most important findings of this comprehensive multidisciplinary research. At the same

time, it will introduce conference audience to future international collaborations aimed at detailed examinations of pollutant cycles in the environment, and applications of clean-up bioremediation strategies.

**Key words:** Coal mining, Toxic trace metals, Organic pollutants, Human health risk.

SIV/L-2

## **Some Insights into Strategies for Size Fractionated Phytomonitoring of Airborne Particulate Matter (PM) and Associated Metals**

*Sudhir Kumar Pandey*

Department of Botany, School of Studies in Life Sciences, Guru Ghasidas Vishwavidyalaya (A central University), Bilaspur-495009, C.G., INDIA, Email: skpbhu@gmail.com

The presentation discusses about the advances in phytomonitoring strategies for PM and associated toxic metals in strong source environments (e.g., urban roadside environments). To this end, the plant species naturally growing in the affected areas were chosen and PM samples were collected in different environmental matrices. For quantification of PM in different size fractions, plant leaves were chosen, and an effective quantification method was developed through scanning electron microscopy-based imaging and image-based counting method. For monitoring of PM bound toxic metals, the conventional atomic absorption method was employed in combination with SEM-electron dispersive spectroscopy (EDS). The SEM-EDS was effective enough to screen the maximum number of toxic metals present in PM of urban air. The strategies adopted in these studies have two-fold implications: (1) rapid phytomonitoring of PM and PM bound toxic metals in air and (2) comparative evaluation of plant species for their suitability in phytoremediation of PM and PM bound metals. The study further highlights the status and prospects of size fractionated phytomonitoring of PM and PM bound metals in air.

**Key words:** Toxic metals, SEM-EDS, Urban roadside, Image based quantification, Phytomonitoring.

SIV/O-1

## **Impact Assessment of Conservation Agriculture Systems on Environment, Rural Community and Economy of Farmers in Indo-Gangetic Plains of India**

*Anjali<sup>1\*</sup>, Ajay Kumar Mishra<sup>2</sup> and V. Venkat Ramanan<sup>1</sup>*

<sup>1</sup>School of Inter-Disciplinary and Trans-Disciplinary Studies, Indira Gandhi National Open University, New Delhi, INDIA; <sup>2</sup>Terrestrial Ecosystem Management Laboratory, Graduate School of Global Environmental Studies, Kyoto University, Kyoto, JAPAN, Email: anjali0666@gmail.com

India is an agrarian economy and conservation agriculture (CA) is one of the emerging practices that play a pivotal role in ensuring productivity, improving soil health and mitigating climate change. The principal CA technologies involve minimum soil disturbance, permanent soil cover through crop residues or cover crops, and crop rotations that offer multiple benefits in resource conservation. Implementation of CA in Indo-Gangetic plains (IGP) not only offset straw burning but also contributes towards sustainable agriculture. The technologies of CA provide opportunities to reduce the cost of production, save water and nutrients, increase yields, increase crop diversification, improve efficient use of resources, and benefit the environment. Efforts for nearly two decades have been made in India to develop, refine and disseminate CA technologies to different agro-ecology of IGP. As a result, significant progress has been made since then but still, there are several constraints like conventional mindset of farmers, lack of reach of viable technologies to farmers of eastern IGP compared to western IGP etc. that affect the adoption of CA. Present agriculture urges a paradigm shift from extensive to intensive agriculture in the IGP. Therefore, this study was conducted with the objectives 1) to quantify the impact of CA on socio-economic constraints and prospects in the IGP of India, 2) to assess the key factors governing the adoption of CA on regional and local scale, 3) to develop a linkage between all working groups that influences CA adoption 4) to propose remedy measures and alternatives based on local modifications that would enhance the CA

adoption by farmers. Seeing is believing strategy can be used to change the mindset of farmers in different regions with locally modified CA package of practices. CA insights a way forward scenario of agriculture in Indian IGP that promises to increase the farmer's income and diversify the agriculture with its multifaceted ecosystem services.

**Key words:** Conservation agriculture, Constraints in CA, Prospects of CA, Farmer's Perspective, IGP zero tillage.

SIV/O-2

## **Prioritizing Invasive Aquatic Macrophytes using a Comprehensive Risk Assessment (CRA) Approach for their Control and Management in Tropical Floodplains**

*Tapati Das<sup>1\*</sup>, Nami Prasad<sup>1</sup> and Dibyendu Adhikari<sup>2</sup>*

<sup>1</sup>Department of Ecology and Environmental Science, Assam University, Silchar-788011, INDIA; <sup>2</sup>Department of Botany, North-Eastern Hill University, Shillong-793022, INDIA, Email: das.tapati@gmail.com, namip1386@gmail.com, dibyenduadhikari@gmail.com

The tropical floodplain located in the Barak river basin of Assam in northeast India, a part of the Indo-Burma biodiversity hotspot, is dominated by varied aquatic systems. These systems play a vital role in sustenance of life of the local communities, particularly the poor, through various aquatic resources. However, most of these systems are infested by aquatic macrophytes (AMs) some of which have been reported as invasive in the Global invasive species database of the IUCN Species Survival Commission and Environmental Information Systems (ENVIS) database of Ministry of Environment, Forest and Climate Change, Government of India. As invasive species often profoundly affect the environment, economy, human health and the overall flow of various ecosystem services it is important to assess the invasiveness potential of these species for prioritizing them under various levels of threat for their suitable management options. In the present study we categorized the dominant AMs in tropical floodplain located in Barak river basin of Assam under different risk classes using

the CRA approach. This involved scoring of five major attributes/aspects of species invasion through direct measurements in the field, deductions from field observations, and inferences based on information available in the literature. The attributes were (i) species morphological features, (ii) biological characteristics & dispersal ability, (iii) distribution potential, (iv) ecological impact, and (v) difficulty to control. The study revealed that as more risk of invasion has been observed for *Eichhornia crassipes*, *Ipomoea carnea*, *Alternanthera philoxeroides*, *Ipomoea aquatica*, *Lemna minor*, *Pistia stratiotes*, and *Trapa natans*, these species should be prioritized for suitable remedial measures to control their further spread in the study area. The present study therefore showed that through CRA approach it is possible to identify the AMs with greater invasion potential which in turn would help the scientists and policy makers in prioritizing such species for their control and management in a suitable way.

**Key words:** Invasion potential, Scoring technique, Aquatic macrophytes, Tropical floodplains, Barak basin.

SIV/O-3

## Effect of Religious Rituals on the Water Quality of Jaipur Ghat of Pushkar Sarovar (Rajasthan)

*Anita Sharma*

Samrat Prithviraj Chouhan Government College, Ajmer, Rajasthan, INDIA, Email: anitasharma9339@gmail.com

The Pushkar Sarovar, situated in the lap of the Central Aravalli Ranges in the State of Rajasthan, is perhaps one of the most revered holy lake. It is supposed to have originated at the point where Lord Brahma's lotus struck the land. Thousands of devotees visit the Sarovar to take holy bath and worship it. Over the years, this resulted in enhancement of pollution level in the water body accompanied with accelerated eutrophication. Steps have been taken by the local administration and various local groups to combat the problem. One of the common decision taken was not to immerse idols, flowers and ashes into the Lake. A part of the lake has been delimited at the Jaipur Ghat for the purpose. The concrete tank built for the purpose is cleaned of the debris, thus preventing the Lake from receiving the pollutants directly and that too on a regular

basis. Water quality of the Ghat has been assessed on a regular basis during the summer, winter and rainy season, in the course of the present study. Parameters like turbidity, temperature, pH and EC were measured on spot by thermometric and potentiometric method, respectively. Water samples were collected in BOD bottles as well as pearl pet bottles for investigating various parameters including Alkalinity, Hardness, Chlorides, Nitrate, total dissolved solids, BOD (5-day), Phosphate etc. National Environmental Engineering Research Institute and the American Public Health Association protocols were followed for investigating various physico-chemical parameters. Significant seasonal variation has been observed in the physico-chemical characteristics of the study site. These variations were also very obvious in accordance with the Hindu festive calendar. An increase in values of EC, pH, TDS, turbidity, alkalinity, chloride, BOD, phosphate etc. have been recorded particularly during the winter months and after Kartik and Maagh months of the Hindu calendar. Same is true for the period following the immersion of idols after the two Navratras and Ganesh festival.

**Key words:** Jaipur Ghat, Physico-chemical analysis, Pollution, Pushkar Sarovar, Religious Rites, Seasonal variations.

SIV/O-4

## Assessment of Soil Pollution using Multivariate Techniques and Indexing Approach

*Vinod Kumar*

Department of Botany, DAV University, Jalandhar-144012, INDIA, Email: vinodverma507@gmail.com

Soil pollution is one of the most important issues throughout the globe and increasing urbanization, industrialization and application of pesticides, fertilizers etc. on agricultural activities are responsible for soil pollution. The present work was designed to study the soil properties (pH, conductivity, soil organic matter, phosphorus, calcium and magnesium) and heavy metals (Cr, Cu, Pb and Co) in soils of Jalandhar District. Cluster analysis (CA) and principal component analysis (PCA) showed that anthropogenic activities have great influence on the soil properties and heavy metal content in the soil. The various indices such as contamination

factor, geoaccumulation index, potential contamination index, enrichment factor (%), pollution index and potential ecological index showed that soils are moderately polluted by the heavy metals. This is the first such baseline study in the area and further research needed in order to monitor the soil pollution status of Jalandhar, District.

**Key words:** Heavy metals, Soil pollution, Jalandhar.

SIV/O-5

## Potential Distribution and Invasion Risk Assessment of *Parthenium hysterophorus* in India under Climate Change

Rameez Ahmad<sup>1\*</sup>, Anzar A. Khuroo<sup>1</sup>, Maroof Hamid<sup>1</sup>, Bipin Charles<sup>2</sup> and Zubair A. Rather<sup>1</sup>

<sup>1</sup>Centre for Biodiversity and Taxonomy, Department of Botany, University of Kashmir, Srinagar-190006, J&K, INDIA;

<sup>2</sup>Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Srirampura, Jakkur PO, Bengaluru-560064, INDIA, Email: rameezkhuroo929@gmail.com

Congress grass (*Parthenium hysterophorus* L.), native to Tropical America, is one of the world's worst weeds with deleterious ecological and economic impacts. In India, the weed was accidentally introduced from Central America about a century ago and since then it has invaded most of the regions across the country. The present study using ensemble modelling approach implemented in *biomod2* package has mapped the current and future distribution of *P. hysterophorus* in India and assessed its invasion risk in different biogeographic zones under climate change scenarios. The modelling results revealed that about 65% of the total area in the country is suitable for potential invasion of this species under current climatic conditions. The model predicted a decrease in overall habitat suitability for this species under future climate change with more than half of suitable habitat reduced under RCP 8.5-2070. Nonetheless, some of the currently invaded areas will become highly vulnerable to invasion under climate change. On downscaling to different biogeographic zones, North-east and coastal areas in the country remained as high and moderate risk regions respectively to the potential invasion of

this species under both current and future climate change scenarios. Also, the Himalayas is predicted to be at moderate invasion risk under climate change. The research findings of the present study have practical applications in predicting invasion hotspots and developing region-specific management strategies in the country.

**Key words:** Biogeographic zones, Climate change, Distributional modelling, Habitat suitability, Invasion.

SIV/O-6

## ICT Promotes Environmental Awareness through ENVIS activities under a National Programs

Sunil Tripathi\*, Diwakar Saini, Vineeta Yadav, Amrita Awasthi and Pankaj Kumar Srivastava

Environmental Technologies, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: sunil9351@gmail.com

Environmental information plays a vital role not only in formulating environmental management policies, but also in the decision making process aiming at environmental protection and improvement of the environment for sustaining a good quality of life of the living beings. Realizing this need of information system, Ministry set up an Environmental Information System (ENVIS) in 1983 to establish a comprehensive network in environmental information collection, collation, storage, retrieval and dissemination to users. Presently, The ENVIS network consists of 66 network partners, out of which 35 are subject-specific and 31 State/UT. These network partners are called ENVIS Centers that are located in the notable organizations/institutions/State/UT Government Departments/Universities throughout the country. ENVIS centre at CSIR-National Botanical Research Institute has started in January 2004 and focusing on the specific theme of "Plants and Pollution". ENVIS Resource Partner-NBRI systematically collects, compiles and disseminates data on all the diverse aspects of "Plants and Pollution" viz; effects of different pollutants on plant kingdom and plant resources for mitigation of specific pollutants. The centre is publishing theme based Newsletters (Quarterly), Subjective News (monthly), thematic bulletins (twice

a month), maintaining Databases (34), Case Studies, Latest news based on theme, Upcoming Events, Glossary, Bibliography, technical reports, etc. The ENVIS RP-NBRI website is designed and fully devoted on the latest information about the specific theme “Plants and Pollution” and it helps to the scientists, researches, students etc. Those are involved in the research area of the same. Besides these, ENVIS also provides Discussion Forum and a mobile app viz; “Green Planner” (Android and itunes app). Further, ENVIS centre is do various outreach activities to spread environmental awareness among the people. The national and international scientific data present on ENVIS RP-NBRI website are of immensely use to several research organizations, town planners, policy makers, teachers, students including kids and others stakeholders to aware about Environmental status especially related to the plants and pollution.

**Key words:** ENVIS, Environmental Information System, Plants and pollution, Pollutants, Green planner.

#### SIV/O-7

### Open Cast Mining and Impact of Dust on Roadside Plant Species at Jhansi-Allahabad National Highway

*Priyanka Singh and Amit Pal\**

Institute of Environment & Development Studies, Bundelkhand University, Jhansi-284128, INDIA, Email: apu13@rediffmail.com, spriyanka680@gmail.com

Deposition of dust on roadside plant and its impact on leaf i.e. leaf pigment concentration, the carotenoid and protein has been investigated on fifteen selected roadside plants species namely *Allianthus excelsa*, *Azadirachta indica*, *Butea monosperma*, *Calotropis procera*, *Cassia fistula*, *Datura metel*, *Ficus benghalensis*, *Ficus hispida*, *Ficus infectoria*, *Ficus religiosa*, *Holoptela integrifolia*, *Millettia pinnata*, *Nerium oleander*, *Phoenix dactylifera* and *Psidium guajava* respectively at Jhansi-Allahabad National Highway – 76. The variation in terms of dust deposition with species specific result observed during the entire period of study. Declination of leaf pigment concentration, carotenoid content and protein content indicate the positive impact of dust pollution. Above findings may be helpful to find out some species which

is resistant or to cope with open cast mining generated dust pollution in and around mining areas as well as beautification of adjacent highways. Maximum deposition was recorded in *Ficus hispida* and followed by *Calotropis procera*, *Butea monosperma*, *Ficus benghalensis*, *Allianthus excelsa*, *Azadirachta indica*.

**Key words:** Dust pollution, Chlorophyll content, *Ficus* spp., National highway.

#### SIV/O-8

### Determination of Geochemical Properties and Temporal Variation of Ground Water in Kanchipuram District, Tamilnadu, India

*A. Chandrasekaran<sup>1\*</sup> and R. Ravisankar<sup>2</sup>*

<sup>1</sup>Department of Physics, SSN College of Engineering, Kalavakkam, Chennai-603110, Tamilnadu, INDIA;

<sup>2</sup>Department of Physics, Government Arts College, Tiruvanmalai-606603, Tamilnadu, INDIA, Email: chandrasekaran@ssn.edu.in

Water is essential for all living organisms for their existence and metabolic process. The aim of the present study is to assess the quality and temporal variations of ground water in Kanchipuram district, Tamilnadu, India. In order to assess the water quality, water samples were collected from 20 different locations in pre-monsoon season and geo-chemical properties such as pH, Total Dissolved Solids (TDS), Electrical conductivity (EC) Chloride (Cl<sup>-</sup>), Sulfate (SO<sub>4</sub><sup>2-</sup>), Calcium (Ca<sup>2+</sup>), Magnesium (Mg<sup>2+</sup>), Nitrate (NO<sub>3</sub><sup>-</sup>), Sodium (Na<sup>+</sup>), Potassium (K<sup>+</sup>), Carbonate (CO<sub>3</sub>), Hydrogen Carbonate (HCO<sub>3</sub><sup>-</sup>) were determined using different analytical methods. The measured geo-chemical properties are compared with prescribed limits given by world health organisation (WHO, 2004). The results of geochemical properties indicates that average of Ca, Cl, NO<sub>3</sub> and pH slightly higher than WHO, 2004 permissible limit whereas other measured properties are lower. Multivariate statistical techniques like Pearson correlation, factor and cluster analysis were applied to water quality variable for evaluation of temporal variations in the study area.

**Key words:** Ground water, Temporal variations, Multivariate statistical techniques.

SIV/O-9

## **Comparative Evaluation of Hydrogeochemical Processes and Chemometrics of the Groundwater in Vijaypur Block of Samba District and Bharderwah Tehsil of Doda District, J&K**

*Anjali Bala<sup>1\*</sup>, Pankaj Mehta<sup>1</sup> and Anu Ramotra<sup>2</sup>*

<sup>1</sup>Department of Environmental Sciences, Central University of Jammu, District Samba-181143, J&K, INDIA; <sup>2</sup>Government Higher Secondary School, Kalakote, District Rajouri, J&K, INDIA

Groundwater is one of the most precious natural freshwater source, which is accessible to human beings. Approximately, 56 % rural Indian access potable water from tube wells, about 14% from open wells and about 25% supplied water system depend on groundwater, which is on average 90% of total rural water supply (NSSO 2006). The quality of groundwater is generally controlled by geology, climate, topography, surface activities and mineralogical composition of soil. The present study is focused on the comparative and comprehensive assessment of hydrogeology and geochemistry to examine pathways and chemometrics of the groundwater in the study area. Geochemical indices and multivariate techniques were applied to assess the groundwater chemistry and potability of the water present in the study area. Groundwater samples were collected in two seasons (Pre-monsoon and Post-monsoon) and all the samples were analysed for the physico-chemical parameters and major ions. Majority of the parameters were found well within the permissible limit except few chemical parameters such as pH, TDS and Total alkalinity at certain locations of Vijaypur block of Samba district however all the groundwater samples analyzed from Bharderwah tehsil of Doda district reflects the values of chemical parameters well within the acceptable limits as per the IS10500. Carbonate weathering and cation exchange capacity is important geochemical process responsible for controlling the major ion distribution in the study area. The present study reveals that Groundwater quality of Vijaypur block is suitable for drinking and

irrigational purposes after conventional treatment, making it unsafe for drinking and irrigation purposes however no chemical treatment is needed for the groundwater samples analyzed from Doda district as most part of the Bharderwah Tehsil is free from agricultural, industrial and domestic contamination as reflected in the groundwater chemistry.

**Key words:** Groundwater, Hydro geochemistry, Carbonate Weathering, Cation Exchange Capacity, TDS.

SIV/P-1

## **Impact of Conversion of Grassland to Agroecosystem on Soil Organic Carbon Content in Dry Tropics**

*Priyanka Soni<sup>\*</sup>, Chandra Mohan Kumar and Nandita Ghoshal*

Centre of Advanced Study in Botany, Department of Botany, Institute of Science, Banaras Hindu University, Varanasi-221005, INDIA, Email: sonipriyanka840@gmail.com, cmbhu05@gmail.com, nghoshal14@gmail.com

The conversion of grassland to agroecosystem leading to loss of soil organic carbon is a major global challenge. Although the tropical soils are known to be vulnerable to the loss of carbon due to land use change yet, limited information is available, especially in the dry tropics. The present study was aimed to analyze the impact of conversion of grassland to agroecosystem in the dry tropics on the content of soil organic carbon, soil carbon stock, bulk density and porosity. This study was conducted in the experimental plots of department of botany, Banaras Hindu University. The soil organic carbon content was higher in the grassland (0.81%) than the agroecosystem (0.57%). Same trend was observed in the case of soil carbon stock and soil porosity whereas the trend of the bulk density was reverse. It may be suggested that to increase the soil organic carbon and soil carbon stock in agroecosystems, management practices involving higher organic matter input to the soil should be recommended so that the agroecosystem would lead not only to long term sustenance of soil fertility and productivity but also sequester atmospheric carbon into the soil of dry tropics.

**Key words:** Carbon stock, Carbon sequestration, Dry tropics, Porosity, Soil organic carbon.

SIV/P-2

## Lead and Cadmium in Indian Herbal Medicines: Health Risk Assessment

*Debika Chakraborty, Arindam Nath, Parmita Bhattacharjee, Shamim Sultana Choudhury and Suchismita Das\**

*Aquatic Toxicology and Remediation Laboratory, Department of Life Science and Bioinformatics, Assam University, Silchar-788011, INDIA, Email: drsuchismita9@gmail.com*

Around 70-80% world populations depended on non-conventional, herbal medicine for their primary healthcare. From the cultivation of these herbs to the final herbal product, there are many factors which influence the quality of herbal medicines. Often, trace elements, such lead (Pb) and cadmium (Cd) are reported in them. With the increased dependence and use of herbal medicines, there is a growing concern regarding the adverse health effects of long term consumption of these medicines. With this aim, we estimated Pb and Cd levels in 25 commonly used marketed herbal medicines available with Ayurvedic medicine sellers as well as 30 tribal medicines collected from Dimasa, *Riang* and *Khasia* tribes of North East India. In marketed products Pb levels ranged from  $0.46 \pm 0.07$  to  $15.64 \pm 0.72$  mg kg<sup>-1</sup> and Cd levels ranged from  $0.41 \pm 0.06$  to  $4.5 \pm 0.68$  mg kg<sup>-1</sup>. There was significantly less Pb ( $0.68 \pm 0.001$  to  $5.96 \pm 0.01$  mg kg<sup>-1</sup>) and Cd ( $0.1 \pm 0.0001$  to  $0.84 \pm 0.005$  mg kg<sup>-1</sup>) in tribal medicines, presumably due to the collection of samples from pristine environment. The chronic daily intake (CDI) values of each medicine were calculated based on predictive risk assessment modelling; the tribal medicines posed no imminent threats. However, the CDI of Pb from marketed herbal medicines ranged from  $0.00005$ - $0.001$  mg kg<sup>-1</sup>bw/day, and  $0.00007$ - $0.0003$  mg kg<sup>-1</sup> bw/day for Cd, some of which were above permissible limits set by WHO. Consequently, high hazard quotient and hazard index (both more than 1) were observed for these metals in some samples, which might impart individual as well as cumulative effects on the health. Thus, apart from other dietary as well as inhalation sources of contaminants (which were not studied here), regular consumption of marketed

herbal medicines containing spurious amounts of Pb and Cd was predicted to cause health hazards in human.

**Key words:** Cadmium, Lead, Herbal medicine, Hazard assessment.

SIV/P-3

## Environmental Impact Assessment of Proposed Residential Project: A Case Study of Agra

*Manjul Gupta<sup>1\*</sup>, Pankaj Kumar Srivastava<sup>1</sup> and Akash Kumar<sup>2\*</sup>*

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>PARAMARSH, Servicing Environment and Development, Lucknow, INDIA, Email: manjulnbri@gmail.com, drpankajk@gmail.com

Environmental Impact Assessment (EIA) is a planning tool generally accepted as an integral component of sound decision-making. EIA is to give the environment its due place in the decision-making process by clearly evaluating the environmental consequences of the proposed project activity before the action is taken. Early identification and characterization of critical environmental impacts allow to assess the environmental acceptability of a proposed developmental project and conditions which should be applied to mitigate those impacts. Today we know that the building sector is developing very fast and responsible for various environmental problems: pollution, waste, resource depletion, land use, biological degradation etc. In India, building industry is growing rapidly at a rate of 9.2% as against the world average of 5.5%. The EIA study in this context is preparing a detailed account of environmental impacts of proposed activity so that appropriate interventions could be taken. An attempt has been made in the study for assessing environmental impacts of proposed residential project in Agra city of UP, India by using checklist methodology. The findings of the EIA Study have identified the nature and extent of environmental impacts arising from construction and operation of the project. The results demonstrated that 'Transportation Resources', 'Noise Pollution', 'Waste Generation', 'Sewage Pollution', 'Dust Generation with Construction Machinery' are the most risky environmental impacts

may arise due to the proposed residential project. Environment Management Plan is a practical and achievable plan of management to ensure that any environmental impact during all the phases is minimized and lead in the direction of sustainable development. EMP for the above mentioned impacts are; provide separate entry & exit points and driveways, site barricading, installed organic waste converter, frequent water sprinkling. In conclusion, results from EIA study showed that the proposed residential development project has significant impacts on the environment. Implementation of an effective EMP will minimize the environmental issues occur during the project cycle.

**Key words:** Building, Construction, Environment, EIA, Impact.

SIV/P-4

## **Heavy Metals (Pb, Cd, Hg) and Organochlorine Pesticides in Freshwater Fishes: Risk Evaluation for Consumers**

**Geeta Singh**

DDU Gorakhpur University, Gorakhpur-273009, Uttar Pradesh, INDIA, Email: geetasanger@gmail.com

Fishes are a valuable source of high-grade protein and nutritious component of the human diet. Heavy metals and OCPs from natural and anthropogenic sources are released into aquatic ecosystems, where they pose a serious threat because of toxicity, long persistence, bioaccumulation, and biomagnifications in the food chain. Fishes are badly affected because they are top consumers in aquatic life. Five most commercially important fresh water fish species were collected, digested and analyzed for organochlorine pesticide and toxic metals. The metal concentrations ranges of Pb, Cd and Hg detected were 0.02-18.0, 0.05- 21.0 and 0.01-26.0 ppb respectively. Among the three metals, concentration of mercury was detected highest. The fish samples were contaminated with one or more DDT analogue and HCH isomer residues respectively. pp-DDT and gamma-HCH was the most frequently occurring residues in fish samples. The level of contamination with pp-DDT ranged ND-48.0 ppb and gamma-HCH from ND-68.2 ppb. Delta-HCH isomer was not detected in any of the fish sample analyzed. Concentration of total DDT is higher than total HCH. The level of pesticides observed in the

current study reveals that the trend of organochlorine pesticides is decreasing in comparison to the past. The study concluded that the levels of metals and pesticide residues are variable in different fish species but within the maximum residue levels recommended at National and International standards.

**Key words:** Accumulation, Fish species, Heavy metals, Pesticides

SIV/P-5

## **Tree Falling Risk Assessment of IOCL Campus New Bongaigaon, Assam and their Control Measures**

**Rehanuddin, Priyanka Agnihotri, P.S. Chauhan and S.K. Tewari**

CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: rehanfaruqui2117@gmail.com

Trees are important natural resources; they provide us food, cloth, medicine, firewood, timber wood, beauty and shade also. An overall assessment of trees present near at IOCL sites in Bongaigaon, Assam has been done in order to identify the risk of falling associated with them. In order to carry out the study, grouping of trees depending on their position, angle of inclination and ageing were done. Few of them were found to be infected with different microbes, which weakens them and makes them prone to fall. Several approaches have been made to manage the risks from trees which involved assessment of trees according to the risk of their falling and causing injury, and further cutting of vulnerable trees alleviating the danger. Total 72 trees are observed/studied at the study site, some of which pose direct threat on pipeline of IOCL which probably leads to bursting of the pipeline causing several hazards. Therefore “Tree Falling Risk Assessment” has been undertaken emphasizing the prevention of any hazard. The parameters under consideration involve girth of the trees, their height, angle of inclination, number of trees infected by pests, termites, pathogen followed by their age. Biological treatment (Basically *Trichoderma* and PSB) has been provided to eradicate infection, while the trees carrying high potential of damage due to major degree of infection need to be cut for the safety purposes.

**Key words:** *Trichoderma*, PSB, Tree Falling Risk Assessment, IOCL.



**Session V**  
**Sub-tropical and Tropical Oak under**  
**Global Change**



SV/KN-1

## Regeneration Ecology of Oaks

*Albert Reif\**

Albert-Ludwigs-University, Tennenbacher Str. 4, D-79085 Freiburg, GERMANY, Email: albert.reif@waldbau.uni-freiburg.de

Deciduous oaks are important components of temperate forests, providing many ecosystem goods and services, including timber and firewood, acorns for feeding, tannins from bark, and others. Several factors are influencing the regeneration of oaks. The literature mentions light supply, predation of acorns by rodents, wild pigs and other acorn eating animals, browsing pressure by wild and domestic animals, infection of leaves with the mildew fungus *Microsphaera alphitoides*, competition with ground vegetation, late frost, and water supply. All these factors are interrelated in a complex way. In terms of their life form strategy, many deciduous oaks can be classified as stress-tolerating pioneers. It seems that germination and successful establishment of these oaks depend on an open canopy and a low ground vegetation. In European cultural landscapes with closed forest cover and intensive farming, this can be facilitated through wood pasture with cattle and sheep. Browsing is tolerated by the young oaks, when light supply is high. Under browsing pressure, oaks on open sites are able to survive, forming “bonsai-like” dwarfed deeply rooting treelets. However, height growth only can start after the end of grazing. This can be achieved by temporal and spatial fluctuations of browsing pressure. It seems that deciduous oaks are best adapted to transitional habitats, i.e. along forest edges, in hedges and shrubland. In such habitats, establishment is successful even under presence of browsing wildlife. Today, arguments of nature conservation and climate change recommend an increased effort to facilitate oak regeneration. For that, periods of grazing changing with periods of succession can be a successful approach, which was well known in the past, but is nearly forgotten today.

**Key words:** Deciduous oak, Temperate climate, Wood pasture.

SV/KN-2

## Managing Regeneration Potential to Sustain Oak Forests in North America

*Daniel C. Dey\**

US Forest Service, Columbia, Missouri, USA, Email: ddey@fs.fed.us

Historical disturbance regimes, primarily fire-driven, promoted oak dominance and widespread distribution for thousands of years throughout eastern North America and along the west coast of the USA. Aboriginal populations used fire for subsistence living and in doing so increased oak abundance. Colonial settlement in the early Industrial Era intensified land use practices across broad landscapes, including frequent burning, which promoted oak dominance along a gradient of site qualities from xeric, low productivity to mesic, high productivity sites. For the better part of 100 years, fires have been suppressed and practically eliminated across the range of oak in North America. Initially, oaks dominated forest recovery following colonial exploitation, but changing land use practices and modern disturbance regimes are accelerating the replacement of oak by competing species that are better adapted to current conditions, especially on the more productive sites. Today, there is a well-accepted recognition of oak regeneration failure and the widespread loss of oak forests. Similar observations are being reported around the world. Regeneration potential of a species is the probability that the species will be competitive through regeneration and stand development to prevail in the mature stand. It is the summation of a species regeneration potential from all modes of reproduction, including current seed, seed bank, new seedlings that establish after a regeneration disturbance, advance reproduction, and vegetative reproduction from stump sprouting, root sprouting and layering. Regeneration potential has been quantified for some oak species. Large, competitive oak advance reproduction and stump sprouts are essential to sustain oak forests. Regeneration potential is influenced by initial floristics, site quality, competing vegetation, herbivores, and level of management. Oak regeneration potential in modern forests is commonly too low to sustain oak stocking at current levels. Recommendations are given for silvicultural

prescriptions designed to increase oak regeneration potential to sustain oak forests.

**Key words:** Quercus, Silviculture, Ecology, Regeneration, Succession.

SV/KN-3

## Genetic Diversity, Hybridization and Conservation of Mexican Oaks (Fagaceae: *Quercus*)

**Ken Oyama\***

Universidad Nacional Autónoma de México (UNAM), National Autonomous University of Mexico, MEXICO, Email: kenoyama@enesmorelia.unam.mx

Mexican oaks (Fagaceae: *Quercus*) are one of the richest genera of trees with more than 160 species described including 109 endemics. Mexico is considered one of the main centres of oak diversification in the world. Oaks are distributed in temperate and subtropical forests in heterogeneous environments along an altitudinal gradient of 0 to more than 2500 m asl. Oaks are considered key species in the ecosystems where they are distributed with an intricate net of interactions with ectomycorrhizal fungi, insects, epiphytes, among others. A comparative analysis of population genetic diversity between selected oak species distributed in Mexico and other parts of the world indicated that Mexican oaks harbor higher levels of genetic diversity but low genetic differentiation. Hybridization between different oak species can explain in part this high levels of genetic diversity. Patterns of oak hybridization are presented in order to show the different modes and number of oak species involved. Conservation of oak forests in Mexico is urgent due to the high deforestation rates and the fragmentation of remnant natural forests.

**Key words:** Genetic differentiation, Mexican Oak, Population genetic diversity.

SV/O-1

## Assessing Restoration Potential of Fragmented and Degraded Fagaceae Forests in Meghalaya, Northeast India

**Prem Prakash Singh\*<sup>1</sup>, Anna Dermann<sup>2</sup>, Florian Dermann<sup>2</sup>, Dibeyndu Adhikari<sup>1</sup>, Tamalika Chakraborty<sup>3</sup>, Purna B. Gurung<sup>1</sup>, Saroj Kanta Barik<sup>1,4</sup>, Jürgen Bauhus<sup>2</sup> and Somidh Saha<sup>2,5</sup>**

<sup>1</sup>Department of Botany, North-Eastern Hill University, INDIA, <sup>2</sup>Chair of Silviculture, University of Freiburg, Freiburg, GERMANY, <sup>3</sup>Chair of Site Classification and Vegetation Science, University of Freiburg, GERMANY, <sup>4</sup>National Botanical Research Institute, Lucknow, INDIA, <sup>5</sup>Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology, Karlsruhe, GERMANY, Email: prem12flyhigh@gmail.com

The montane subtropical broadleaved wet hill forests of Meghalaya are part of megadiverse biome. It is situated at the transition zones between the Himalayas and Indo-Burma biodiversity hotspots. Ten tree species of Fagaceae family dominate these forests. Fagaceae tree species are important for sustenance of the local tribal populations. These forests are highly degraded and fragmented due to anthropogenic disturbances such as mining, unsustainable forest utilization, shifting cultivation, and browsing. In past, these forests originally formed large continuous areas in the landscape. Today, numerous degraded and fragmented forest patches are scattered over the entire landscape. In this study, we assessed for the first time, the restoration potential i.e. capacity of natural regeneration and state of vitality of Fagaceae species in Meghalaya. The main objective was to understand how different biotic factors, abiotic factors, and anthropogenic disturbances influence restoration potential of Fagaceae species. We selected two *Lithocarpus*, four *Castinoopsis*, four *Quercus* species and fragmented forest patches in six locations on an elevational gradient between 800 - 2000m asl along the south-facing slope of Khasi Hills, Meghalaya. We found the degraded forests still harbour high tree species richness (143 species). Additionally, our study showed that the plant community was heterogeneous in composition, structure, and distribution. We found a general trend that the Fagaceae family had high natural

regeneration potential i.e. a high number of seedlings and saplings but low recruitment of adult trees. The vitality of Fagaceae species was poorer than non-Fagaceae species because of high anthropogenic disturbance to Fagaceae species. This case study will help us in enhancing our understanding of the status of these forests and possible restoration strategies for these degraded and fragmented forests patches of Meghalaya.

**Key words:** Forest Landscape Restoration, *Quercus*, *Castanopsis*, *Lithocarpus*, Forest, Regeneration, Anthropogenic Disturbances.

SV/O-2

## Assessing the Impacts of Climate Vulnerability on *Quercus* Habitats in Central Himalayas: Future Implications

Shalini Dhyani\* and Rakesh Kadaverugu

CSIR-National Environmental Engineering Research Institute, Nagpur-440020, Maharashtra, INDIA, Email: s\_dhyani@neeri.res.in

Oak forests in Central Himalayas represent climax between 1000-3500 m amsl. Five species of oaks viz. *Quercus glauca*, *Q. leucotrichophora*, *Q. floribunda*, *Q. lanata* and *Q. semecarpifolia* grow naturally and successively replace other species along the increasing elevation in stated order. Oak dominated mixed broadleaved forests not only provide efficient provisioning ecosystem services but are also source of regulating, supporting and cultural ecosystem services in the region. Oak forests are proven for their high water holding capacity, sustaining healthy watersheds and spring sheds. Deforestation in last few decades has led to change in succession patterns and biodiversity loss due to accelerated invasion of *Chir Pine* (*Pinus roxburghii*) in oak forests. Cumulative impact of human interferences coupled with climate change has been significant on oak dominated forests. Conservation of oak forests is a socio-ecological challenge that requires an interdisciplinary approach. The present study focuses on assessing the climatic niche of *Quercus* species and understanding its shift in the future distributions due to climate change. The Maximum

entropy (MaxEnt) model using field observations and literature generated occurrence locations and CMIP5 (Couple Model Inter-comparison Project) derived bioclimatic variables were used for the study. The predictions were done on the geographic area of Uttarakhand according to four IPCC RCPs for the future periods 2050 and 2070. Our results show that the estimated potential area of the species is likely to have mixed results in future for all climate change scenarios for *Quercus* in its actual habitats. Shifts in geographic distributions of climatic niches reflect unusual patterns, implying the need for climate adaptive habitat restoration. Solutions intended need to be climate resilient restoration of degraded patches using *in-situ* conservation measures.

**Keywords:** Oak forests, Central Himalayas, Uttarakhand, Climate Change, Species Distribution Models

SV/O-3

## Status of Oaks and Related Species for Management and Conservation Strategies

Yangchenla Bhutia<sup>1,2\*</sup>

<sup>1</sup>Suri Sehgal Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment, Jakkur Post, Royal Enclave, Srirampura, Bangalore-560064; Karnataka, INDIA; <sup>2</sup>Manipal Academy of Higher Education (MAHE), Manipal-576104, INDIA, Email: yangchenla.bhutia@atree.org

The oaks and its related tree species form the dominant composition of temperate forests. They contribute significantly to overall functioning of forest ecosystem. Besides, they also have an intricate history with humans for its different uses. But, these species are globally threatened, and the Himalayan oaks are no exception. Recent studies from the Eastern Himalayan region of Sikkim reported forest degradation particularly concentrated in the oak forests. In the current study we evaluated the diversity, structure, forest composition of tree species, including the regeneration status of oaks and their related species along the altitudinal gradient. We covered three forest types ranging from 900m to 3200m above sea level, the potential distributions zone of oak and its related species. Our result reported oaks and its related species

as the major contributor to the overall forest ecosystem with highest Importance Index Value. However, an exhaustive analysis showed a more nuanced condition. One of the major concerns was the size class distribution. Overall the oaks and the related species were predominantly of large diameter. However, the low elevation forests completely lacked trees above 80cm diameter. It is feared under current situation the oak forests will disappear with unsustainable loss. We suggest conservation strategies focusing on different stages of plant growth to ensure perpetual functioning of forest ecosystem.

**Key words:** Forest composition, Conservation strategies, Regeneration status.

SV/O-4

## Effect of Microsite Characteristics on Seed Germination, and Survival and Growth of Seedlings of Two Species of *Quercus* Growing on the Hills of Northeast India

*M.L. Khan<sup>1\*</sup> and R.S. Tripathi<sup>2</sup>*

<sup>1</sup>Department of Botany, Dr. Harisingh Gour Vishwavidyalaya (A Central University), Sagar-70003, MP, INDIA; <sup>2</sup>Ex-INSA Senior Scientist, CSIR - National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: khanml61@gmail.com

The genus *Quercus* (oak) is native to the northern hemisphere and extends from cold latitudes to tropical Asia and the Americas. Oaks are considered as keystone species in a wide range of habitats from Mediterranean semi-desert to subtropical rainforest. *Quercus* species are considered humus-creating machines, house for many animals, source of free livestock feed and creator of microclimates. However, many species of oaks are under threat of extinction in the wild due to destruction of their natural habitats,

over-exploitation and growth of invasive species. About 78 species of oaks are listed as threatened. Himalayan oak forests are under serious threat and are being invaded by pine forests due to the increase in temperature. The species growing as associates of pine may cross the frontiers of pine forests, and become new elements of the oak forests. In most of the oak species, seed (acorn) germination and seedling survival are very poor. It is reported that only one in 10,000 acorns results in an eventual tree. This critical issue prompted us to study the seed germination, seedling survival and growth in two species of *Quercus* (*Q. dealbata* and *Q. griffithii*) growing in northeast India. Seeds of these two species vary widely in mass and can be categorized into light-, medium- and heavy-weight classes. Protein, carbohydrate, lipid and energy contents were greater in heavy seeds than in the medium-weight and small seeds. The heavy seeds emerged earlier and showed higher germination percentage than small seeds. Further, the seedlings emerged from heavy seeds performed better in terms of survival and growth. Of the four substratum microsites tested ( $T_1$  - herbaceous vegetation was allowed to grow and litter was left undisturbed;  $T_2$  - herbaceous vegetation was allowed to grow, but litter was removed;  $T_3$  - herbaceous vegetation was cleared but litter was left intact;  $T_4$  - both litter and herbaceous vegetation were removed), emergence, survival and growth of seedlings were highest in the  $T_4$  plots and lowest in  $T_1$  plots. Further, seedling emergence, survival and growth were more adversely affected by the herbaceous cover than the litter. The occurrence of seeds of different weights showing large variation in food reserves and energy content in two studied oak species, and differential response of these seeds and seedlings produced by them to microsite characteristics may be viewed as an important regenerative strategy. The findings of this study have considerable implication for the silviculture and management of oak forests.

**Key words:** *Quercus* spp., Seed mass variability, Seed germination, Seedling survival and growth, Microsite characteristics.

SV/O-5

## A Taxonomic Study of *Lithocarpus* (Fagaceae) in Vietnam Based on Molecular Phylogeny and Morphological Observations

Nguyen Van Ngoc<sup>1,2\*</sup>, Hoang Thi Binh<sup>1,2</sup>, Shuichiro Tagane<sup>1</sup>, Hironori Toyama<sup>1</sup>, Keiko Mase<sup>1</sup>, Chika Mitsuyuki<sup>3</sup>, Joeri Sergej Strijk<sup>4</sup>, Yoshihisa Suyama<sup>3</sup> and Tetsukazu Yahara<sup>1</sup>

<sup>1</sup>Kyushu University, Fukuoka, JAPAN; <sup>2</sup>Dalat University, Dalat City, VIETNAM; <sup>3</sup>Tohoku University, Osaki, Miyagi, JAPAN; <sup>4</sup>Guangxi University, Nanning, Guangxi, CHINA, Email: ngocnv@dlu.edu.vn

*Lithocarpus* Blume is the second largest genus of the family Fagaceae, with approximately 350 species in the world. The centre of species diversity is mainly in continental Southeast Asia, especially in China (123 spp.) and Vietnam (117 spp.). In Vietnam, almost all the species of *Lithocarpus* (Fagaceae) were described by French botanists until 1920s and some others were until 1950s. Since then, the taxonomic inventories of *Lithocarpus* in Vietnam were disrupted until recently. In this study, our morphological observations and molecular phylogenetic analyses based on both classic DNA sequencing of two cpDNA (*rbcL* and *matK*) and one nrDNA (ITS) regions and multiplexed inter-simple sequence repeat genotyping by sequencing (MIG-seq) were employed to revise three complexes of *Lithocarpus* in Vietnam: *L. elegans* complex, *L. hancei* complex, and *L. vestitus* complex. The NJ tree based on MIG-seq data clearly provide the evidence of species delamination. After a careful examination based on both these phylogenetic data and morphological comparison using our newly collected specimens, taxonomic literature, type specimen images available on the website, we distinguished five species in the *L. elegans* complex, three species in the *L. hancei* complex, 13 species in the *L. vestitus* complex. Keys to the species of each three complex are provided. Through our study, nine new species are recognized and described: *L. bidoupensis*, sp. nov., *L. chinhi*, sp. nov., *L. dahuoaiensis* sp. nov., *L. hongiaoensis*, sp. nov., *L. pseudoannamensis*, sp. nov., and *L. vuquangensis*, sp. nov. from Vietnam, and *L. bokorensis*, sp. nov. *L. monoromensis*, sp. nov.,

and *L. pierreioides*, sp. nov. from Cambodia. The photographs, illustrations, DNA barcode sequences, and the description of preliminary conservation status are also provided for the new species. Additionally, eight species are lectotypified in this study.

**Key words:** Fagaceae, *Lithocarpus*, MIG-seq, Phylogeny, Taxonomy, Vietnam.

SV/O-6

## Forecasting Climate Change Impact on Distribution Range of Fagaceae Members in Meghalaya using Open Source Data

Dibyendu Adhikari<sup>1\*</sup>, Prem Prakash Singh<sup>1</sup>, Raghuvir Tiwary<sup>1</sup> and Saroj Kanta Barik<sup>1,2</sup>

<sup>1</sup>Department of Botany, North-Eastern Hill University, Shillong-793022, INDIA; <sup>2</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: dibyenduadhikari@gmail.com

Members of Fagaceae with 8 genera have important functional roles in forest ecosystems. The economic value of oaks and beech are well recognized since ages, which are used as edible nuts, timber, floor wood, furniture, fodder and wine barrels as well as corks from bark. They are found in a range of climatic conditions in the northern hemisphere. The growing anthropogenic and climatic impacts are bound to influence their distribution range. Therefore, estimating their climatic niches and predicting the current as well as future geographic distribution should help in developing appropriate strategies for their long-term conservation and management. We attempted to reconstruct the climatic niche of 10 Fagaceae species in Meghalaya using population survey and ecological niche modelling. The climatic niches of these species were estimated using the data on current climatic conditions. The reconstructed niches were then projected to various climate change scenarios represented by different climate models pertaining to the time frames of 2050 and 2080. The bioclimatic data for current conditions as well as change scenarios with a spatial resolution of ~ 1 km were downloaded from www.worldclim.org. The modelled climatic niches and predicted geographic range of the selected species in the present study conform to the information available

in the literature in respect of a few species. Future distributional ranges as predicted under different climate change scenarios show that some species will lose climatic suitability, while in case of some other species, previously less suitable areas will become more conducive for species persistence. However, certain areas will retain climatic suitability. We suggest that such areas may be useful for long-term conservation of oaks. Appropriate silvicultural practices should be developed in these areas to counter the climate and anthropogenic pressure.

**Key words:** Fagaceae, Ecological niche, Climate change, Geographic distribution.

SV/O-7

## Temperate Broadleaved European Beech (*Fagus sylvatica* L.) Trees are Showing High Ecological Plasticity under Multiple Drought Events

*Tamalika Chakraborty*<sup>1\*</sup>, *Somidh Saha*<sup>2,3</sup>, *Andreas Matzarakis*<sup>4</sup> and *Albert Reif*<sup>1</sup>

<sup>1</sup>Chair of Site Classification and Vegetation Science, Faculty of Environment and Natural Resources, University of Freiburg, Tennenbacherstr. 4, D-79106 Freiburg, GERMANY; <sup>2</sup>Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology, Karlstr. 11, D-76133 Karlsruhe, GERMANY; <sup>3</sup>Chair of Silviculture, Faculty of Environment and Natural Resources, University of Freiburg, Tennenbacherstr. 4, D-79106 Freiburg, GERMANY; <sup>4</sup>Centre for Medical Meteorological Research, German Weather Service, Stefan-Meier-str. 4, D-79104 Freiburg, GERMANY, Email: tamalika.chakraborty@waldbau.uni-freiburg.de, chakraborty.tamalika@gmail.com

Droughts in central Europe have been increasing due to rising temperature and shifting precipitation. We studied the cause and threshold of drought-driven mortality and survival strategies of beech trees, which is the most important broadleaved tree species of central Europe. The study was conducted in five near-natural dry forests in Germany and Switzerland. Tree-level mortality (as a percentage of dead aboveground-biomass) and available soil water storage capacity (AWC) were quantified. Influences of biotic (plant-plant interactions, tree species, structural diversity) and abiotic (light, AWC, soil pH, bulk density) factors were

assessed on the mortality of the trees. Climate-growth relations (fifty years), resistance, recovery, and resilience (for multiple droughts) were quantified. The retrospective ecophysiological analysis was performed by using stable C and O isotopic signatures of the tree rings. We found, increasing AWC, light, plant-plant interactions, and tree species diversity reduced mortality. Beech trees died when the dead aboveground-biomass crossed a threshold of 58%. The dependency of tree growth to AWC became higher with increasing magnitude of drought. Recovery and resilience were higher in trees with higher AWC, but, opposite for resistance. Dual isotopic analyses revealed that beech trees growing in lower AWC plots showed a higher response to drought, climatic dependency, and higher stomatal resistance compared to those growing in higher AWC; later showed higher stomatal conductance. We conclude that: 1) beech trees growing on dry sites have a high ecological plasticity to drought; however, died after crossing a threshold of dead aboveground-biomass; 2) high tree species diversity in dry sites could mitigate drought stress in beech trees; and 3) changes in soil water condition even at microsite level could alter the growth and survival strategies of beech trees. This study will enrich the state of the knowledge about the ongoing debate on the vulnerability of beech trees to drought in Europe.

**Keywords:** Available Soil Water Storage Capacity, Biomass, C and O Stable Isotopes in Tree Rings, Dendroecology, Plant-plant interactions, Tree mortality.

SV/O-8

## Mapping of Ecosystem Services as Sustainable Management Tool – A Case from Oak Forests in Western Himalayas, India

*Sabyasachi Dasgupta*<sup>1,2\*</sup>, *Subhasis Mahato*<sup>1</sup> and *N.P.Todaria*<sup>1</sup>

<sup>1</sup>Department of Forestry and NR, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand-246174, INDIA; <sup>2</sup> Department of Forestry and Biodiversity, Tripura University, Agartala, Tripura-799022, INDIA, Email: sdhnbgu@gmail.com

Through out the world oak species have considerable economic and conservation significance.



However, the Garhwal Himalayan Oak forests provide various ecosystem services and are not considered for their timber value. The present study was desired to explore the spatial mismatch in the delivery of ecosystem services by oak forest ecosystems and also to understand the dynamics and future of oak in the Himalayas. An oak dominated forest site was selected in Rudraprayag district of Uttarakhand, India with an average elevation of 2400m above sea level. The stock and flow data were mapped using polygon approach with the help of GIS techniques. Contribution of different species to total forest biomass significantly varied. The biomass extraction was disproportionate to availability of *Quercus semecarpifolia* and *Quercus leucotrichophora* in that particular forest. Flow of ecosystem services in the form of fuel wood and green fodder was variable in spatio-temporal scale. In flow and stock map, it was clearly visible that the flow of fuel was more in lower altitudinal zone whereas fodder flow was high in the mid and high altitudinal zones. The availability of fodder was less near the village area because of more fuel and fodder extraction in the past. Therefore, if extraction is not controlled, the mid and upper elevation oak forest will be soon degraded. Spatial dynamics showed that as we move away from the settlement, the realization of ecosystem services by the people also decreases. It is likely that extraction in a planned manner with the help of stock and flow map will drastically reduce the unsustainable extraction pattern and help in sustainable measure of a natural oak forest.

**Key words:** Flow and stock map, Ecosystem Services, Oak forest, Biomass, Himalaya.

SV/O-9

## A Review of Forest Decline with a Special Focus on the Oak Forests in Iran

*Elham Shafeian*<sup>1\*</sup>, *Fabian Ewald Fassnacht*<sup>2</sup> and *Hooman Latifi*<sup>3</sup>

<sup>1</sup>DAAD awardee and future PhD student at Karlsruhe

Institute of Technology (KIT), Karlsruhe, GERMANY; <sup>2</sup>Institute of Geography and Geoecology (IfGG), Karlsruhe Institute of Technology (KIT), Karlsruhe, GERMANY, <sup>3</sup>Hooman Latifi, Khajeh Nasir University, Tehran, IRAN, Email: e.shafeian90@gmail.com, fabian.fassnacht@kit.edu, Hooman.Latifi@kntu.ac.ir

An alarming decrease in oak forest habitats has been recently reported throughout the world. Oak decline has also been observed in the Zagros mountain area in Iran. Identifying and mapping declining trees is an important step to manage the spread of infestations. Several earlier studies have demonstrated the potential of remote sensing for such purposes, however, there are still open questions concerning why certain declining areas can be detected with remote sensing and others not. Moreover, mapping declined areas is just the first step towards understanding the reasons for forest decline. Once the affected areas have been identified, it is necessary to understand the underlying drivers that have caused the decline. In this paper, we will review the current literature on oak dieback, with a specific focus on Iranian Oak forests and the current status on the application of remote sensing data to understand and map patterns and processes related to oak decline. This review will provide the basis for a subsequent remote sensing study consisting of four steps: Initially, the minimum size of declined forest patches that are detectable with current multi-spectral satellite data, will be identified. Next, the influence of co-occurring land-cover classes on these results will be assessed by applying a multi-scale remote sensing approach (including very high-resolution drone imagery and multi-spectral satellite data). Then, the derived spatial patterns of declined forest areas will be analyzed in relation to a range of explanatory variables. Ultimately, dendro-chronological time-series of stress events will be compared to spectral information available from historic Landsat datasets to check the potential of reconstructing stress events over time using satellite data.

**Key words:** Oak Decline Review, Multi-scale Remote Sensing, Dendro-chronology, Persian Oak, Forest vitality.

SV/O-10

## ITS and cpDNA Loci Based Molecular Phylogeny of Fagaceae Failed to Resolve the Backbone Topology

**Babita Joshi<sup>1\*</sup>, Gopal Ji Tiwari<sup>1</sup>, Kiran<sup>1</sup>, Prem Singh<sup>2</sup>, Dibyendu Adhikari<sup>2</sup>, Satya Narayan Jena<sup>1</sup> and Saroj K. Barik<sup>1,2</sup>**

<sup>1</sup>Plant Molecular Genetics Lab, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Department of Botany, North-Eastern Hill University, Umshing Mawkynroh, Shillong-793022, Meghalaya, INDIA, Email: babitajoshi051991@gmail.com

The family Fagaceae is one of the largest groups within Fagales, with a total of nine genera and approximately 900 species occurring in diverse habitats throughout the northern hemisphere. The temperate and semi-arid flora of north and central America is rich in *Quercus* while warmer and mesic forest of south-east Asia is diverse in *Lithocarpus* and *Castanopsis*. The wind-pollinated genus, *Quercus* has been extensively studied from its population genetics perspective. However very little study has been done on broader phylogenetic relationship of *Quercus* as well as the tropical and subtropical insect-pollinated members of Fagaceae such as *Lithocarpus*, *Castanopsis*, *Castanea*, and *Chrysolepis*. In taxonomy, the latter four insect-pollinated members of Fagaceae have similar flowers with same number of stamens and nectariferous pistillode. This makes it difficult considering the rest of the Fagaceae and its sister group with wind pollinated flowers for phylogeny evaluation. In *Quercus*, natural hybridization and introgression is also an important aspect with respect to the formation of new species or increasing genetic variation within species. Besides these, many species of *Quercus* exhibit variable phenotypes that overlap with other species. Thus, the whole broader phylogenetic lineage in Fagaceae remains to be resolved. In India, Fagaceae is represented by four genera viz., *Quercus*, *Lithocarpus*, *Castanea* and *Castanopsis*. These are distributed mostly in Indo-Burma and Himalyan region. With an aim to understand the molecular phylogenetic lineage of the four major genera of Fagaceae including 10 species collected from the state of Meghalaya, India, the sequence analysis

of nuclear ITS and seven cpDNA loci was undertaken. The sequence analysis revealed that although much sequence variations existed in various studied loci. However, the complete tree topology was not successfully resolved in maximum parsimony, maximum likelihood and Bayesian method of inference used in phylogenetic analysis. Therefore, a few loci based phylogeny will not end up with clear cut species delimitation with correct backbone topology in Fagaceae. This necessitates a novel standalone approach to resolve the topology issues in phylogenetic lineage.

**Key words:** Fagaceae, ITS, cpDNA, Phylogenetic relationship, Topology, Meghalaya.

SV/O-11

## Oak Decline and the Changing Face of the Central Himalayan Forests

**Rajesh Thadani, Anvita Pandey\* and Vishal Singh**

Centre for Ecology, Development and Research (CEDAR), 201/1 Vasant Vihar, Dehradun-248006, Uttarakhand, INDIA, Emails: rajesh@cedarhimalaya.org, anvita@cedarhimalaya.org, cedarhimalaya@gmail.com

The decline of oak forests of the central Himalaya has for long been flagged as a major environmental problem in the region. Forests of Banj oak (*Quercus leucotrichophora*) in particular have seen a significant reduction in area and degradation of quality. A result of this decline has been the increase in extent of chir pine (*Pinus roxburghii*), particularly in the oak zone. Pine has lower socioeconomic value and supports lower biodiversity and ecosystem services compared to oak. While oak decline is largely the consequence of excessive anthropogenic disturbance, the mechanism remains poorly studied. This paper focuses on lopping and litter removal and their impacts on *Quercus leucotrichophora*. Data from 40 permanent plots of 400m<sup>2</sup> each, and across a disturbance gradient, indicate that diameter growth is adversely impacted by human disturbance. The annual growth in basal area of oaks is almost five times higher in undisturbed plots as compared to degraded plots. Undisturbed oak forests had over three times the Leaf Area Index (LAI) compared to degraded forests. The opening up of the canopy also gives an opportunity for chir pine, a light

demanding species, to establish. Litter removal leads to poor acorn germination as exposed acorns get desiccated and become unviable. Understory disturbance is also evidenced in soil nutrient levels, and soil carbon was over 3% in undisturbed stands but under 1% in disturbed and degraded forests. Collection of biomass from oak forests through an opening of canopy, and changes in regeneration patterns encourage the ingress of pine at the expense of oak. This is further exacerbated by climate change which leads to increased drought period and thereby vulnerability to fire. An increased frequency of fire further benefits the fire tolerant pines thereby accelerating oak decline.

**Key words:** Oak-decline, Central Himalaya, Lopping, Litter removal.

SV/O-12

## Nitrogen Resorption Efficiency of Two Oak Species in a Montane Sub-Tropical Forest of Meghalaya

*Namita Thapa<sup>1</sup> \* and Saroj Kanta Barik<sup>1,2</sup>*

<sup>1</sup>Department of Botany, North-Eastern Hill University, Shillong-793022, Meghalaya, INDIA; <sup>2</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: namita\_2424@yahoo.in, sarojkbarik@gmail.com

Leaf nutrient resorption before senescence is considered an important mechanism for survival and growth of plants in low nutrient environment. The process is important as it directly influences the leaf litter quality, thereby affecting the overall forest productivity. In the present study, N- resorption in two oak species belonging to two different functional groups, viz. *Lithocarpus dealbatus*, an evergreen tree species, and *Quercus griffithi*, a deciduous tree species was studied in a montane subtropical forest of Meghalaya. Labelled nitrogen (<sup>15</sup>N) was used to understand the pattern of nitrogen uptake and resorption in the two oak species. N- resorption efficiency of *Q. griffithi* was 44.73±0.63 %, while that of *L. dealbatus* was 32.21 ±0.37 %. A higher foliar resorption efficiency of labelled nitrogen (<sup>15</sup>N) was also observed in *Q. griffithi* (65.61 ±1.55 %) than in *L. dealbatus* (54.53±1.21%). These results suggest that N- resorption was better in the deciduous oak species than the evergreen species.

**Key words:** Oaks, *Lithocarpus dealbatus*, *Quercus griffithi*, nitrogen resorption.

SV/O-13

## How Important are Oaks and Other Fagaceae Members in Undisturbed Sacred Subtropical Wethill Broadleaved Forests of Meghalaya, India?

*S. Kharbhi<sup>1</sup>\*, R.R. Gogoi<sup>1</sup>, B.R. Suchiang<sup>1</sup>, I.M. Nonghuloo<sup>1</sup>, K. Upadhaya<sup>1</sup> and S.K. Barik<sup>2</sup>*

<sup>1</sup>Centre for Advanced Studies in Botany, North-Eastern Hill University, Umshing, Shillong-793022, INDIA; <sup>2</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: serrada2020@gmail.com

Most oak (belonging to genus *Quercus*) and other Fagaceae (belonging to the genera *Lithocarpus* and *Castanopsis*) species of north-eastern India are now confined to subtropical wet hill broadleaved forests of the region. The members of Fagaceae are best represented in the undisturbed sacred forests of Meghalaya, India. These species provide a number of ecosystem services such as checking soil erosion and nutrient leaching, providing natural habitat and feeds to wild animals, and maintaining nutrient cycling in the forest and adjacent agroecosystems. The seeds of many Fagaceae members are one of the most important feeds for wildlife as well as human being. In addition, oaks with their large crown, bole and deep root system, play an important role in regulating the water cycle and carbon sequestration. Fagaceae contributes significantly to the tree diversity of subtropical and temperate forests. The present article quantifies the relative contribution of various oak and other Fagaceae species to total tree diversity in three undisturbed sacred forest stands of Meghalaya. In the study sacred forests viz, Nongbah, Ialong and Mawnai, a total of 10 oak and other Fagaceae species were recorded belonging to the genera of *Castanopsis*, *Lithocarpus* and *Quercus*. In Nongbah sacred forest, *Castanopsis tribuloides* contributed about 30% to the total tree importance value (IVI 87.05), followed by *Castanopsis purperella* (IVI 19.97). The dominant species in terms of IVI value in Ialong sacred forest were *Castanopsis*

*tribuloides* (13.63), *Quercus serrata* (6.36) and *Quercus griffithii* (5.71). In Mawnai sacred forest, *Quercus griffithii* (IVI 6.60), *Castanopsis kurzii* (4.46) and *Quercus semiserrata* (3.72) were dominant. The tree population structure in each of these stand revealed that Fagaceae members constituted more than 90% in the higher DBH class trees. The contribution of Fagaceae members to total carbon stock of the forest was very high due to their dominance in higher girth class trees. In view of their ecological and economic importance, oak forests should be prioritized for conservation.

**Key words:** Oaks, Importance Value, Sacred forests, Carbon stock.

SV/O-14

## Estimating Carbon Stock in *Lithocarpus dealbatus* by Developing Species-Specific Allometric Models

Rashmi R. Gogoi<sup>1\*</sup>, K. Upadhaya<sup>2</sup> and S.K. Barik<sup>1,3</sup>

<sup>1</sup>Department of Botany, North- Eastern Hill University, Umshing, Shillong-793022, INDIA; <sup>2</sup>Department of Basic Sciences & Social Sciences, North-Eastern Hill University, Umshing, Shillong-793022, INDIA; <sup>3</sup>CSIR-National Botanical Research Institute, Lucknow-226001, Uttar Pradesh-226001, INDIA, Email: rasrekh.aj@gmail.com

Oak forests have high potential for carbon sequestration. For carbon stock estimation both at species and ecosystem levels, it is desirable to have species-specific allometric models, since each species varies in its carbon sequestration potential. *Lithocarpus dealbatus* being one of the dominant oak species in the montane subtropical forests of north-eastern India, biomass model for the species is crucial for carbon pool assessment of these oak forests. The above ground biomass (AGB) and carbon values were estimated by harvesting 17 trees in the diameter at breast height (DBH) range of 11.0 - 34.8 cm. AGB of each tree was determined by summing the biomass values for branches, leaves and bole. The biomass for branches was determined separately for three branch diameter classes i.e. < 5 cm, 5-10 cm and > 10 cm. Three replicate samples from each diameter class having 15 cm length was oven dried till constant weight for

determining the mean biomass value for each branch diameter class. The total branch biomass under each branch diameter class was determined by multiplying the mean branch biomass value for a particular branch diameter class with the respective length of the branches. The total branch biomass value was obtained by summing the biomass of the three branch diameter classes. The mean leaf biomass was estimated for each tree by taking leaf samples from three random branches from each branch diameter class, and the total leaf biomass per tree was estimated by multiplying the total number of branches of the tree under each branch class. The bole biomass was estimated using volume equations based on the DBH. The best fit model for volume (V) estimation was of the form “ $V=a+bX$ ”, where X is DBH ( $R^2=0.96$ ). The mean bole volume per tree was 0.29 m<sup>3</sup>. The model can be applied to estimate biomass/carbon and volume of the species in the diameter range of 11-34.8 cm.

**Key words:** *Lithocarpus dealbatus*, Above ground biomass (AGB), Carbon sequestration, DBH, north-eastern India.

SV/O-15

## Conservation of Oaks: From the Perspective of a Wood Anatomist

Prachi Gupta<sup>1\*</sup> and Sangeeta Gupta<sup>2</sup>

<sup>1</sup>Wood Anatomy Discipline, FRI, Dehradun, INDIA, Email: prachi.gpta@gmail.com, sangeeta.fri@gmail.com

Natural disturbances caused by climate change, rising temperature and forest fire coupled with indiscriminate anthropogenic activities such as lopping, free grazing of cattle, litter removal, fuelwood and fodder collection have adversely affected oak forests in the Himalayas. Secondary xylem is indispensable for water conduction, storage and providing mechanical support to the tree, yet the knowledge of its microstructure is hardly taken into consideration while formulating conservation strategies. In the present study, the wood microstructure of *Quercus leucotrichophora* and *Q. acutissima* was analysed in detail as per the terminology given by the International Association of Wood Anatomists, taking samples from its naturally occurring areas as well as those planted in FRI campus. *Q. acutissima* is a deciduous oak found in the eastern Himalayas where snowline is at a higher altitude and

temperature and rainfall are high compared to the western Himalayas which is dominated by evergreen oak, *Q. leucotrichophora*. The study revealed that these two species of oak occurring in contrasting environment at higher altitudes are anatomically different and both maintained their respective wood microstructure even when planted at lower elevations in Dehradun (668 m). Since wood anatomy is a highly conservative feature and does not change in different environmental conditions, the plants are thriving well in Dehradun too. The present study suggests that these oak species have potential for ex-situ conservation at lower elevations and can be a part of botanical gardens and urban forestry as well.

**Key words:** Degradation, Wood microstructure, Lower elevations, Ex-situ conservation.

SV/P-1

## **Regeneration and Potential Distribution of Late Successional *Quercus leucotrichophora* (Banj Oak) in the Central Himalayan Forests of Uttarakhand**

*Niyati Naudiyal*<sup>1\*</sup> and *Joachim Schmerbeck*<sup>2</sup>

<sup>1</sup>School of Environment and Natural Resources, Doon University, Mothorawala Road, Kedarapuram, Dehradun-248001, INDIA; <sup>2</sup>Chair of Silviculture, Institute of Forest Sciences, Faculty of Environment and Natural Resources, University of Freiburg, Tennenbacher Str. 4, 79085 Freiburg, GERMANY, Email: [naudyal.niyati@gmail.com](mailto:naudyal.niyati@gmail.com), [joachim.schmerbeck@waldbau.uni-freiburg.de](mailto:joachim.schmerbeck@waldbau.uni-freiburg.de)

We studied the potential distribution of *Quercus leucotrichophora* (oak) and factors influencing its regeneration in mid-montane forests of Central Himalaya. Oak forests (covering 38.5% of total 57516 ha of the study area) play an important role in maintaining the local livelihoods and forest ecosystem services (FES) in the region. The potential distribution of oak in the study area was identified using the ecological niche modelling tool, MaxEnt. Presence location of oak along with bioclimatic and physiographic spatial data derived from WorldClim and digital elevation model (DEM), respectively, were used as input variables for identifying the fundamental niche of

oak. The results of the analysis reveal that potential oak cover in the absence of competition and disturbance can be 63% more than its present distribution in the study area. The regeneration pattern of oak was studied through a structured field survey in five vegetation formations (grasslands, pine, pine-oak, open oak, and dense oak), representing a theoretical successional sequence from early- to late-successional stages. Uniformly distributed sampling plots were used to gather information about the vegetation communities. The proportion of oak regeneration was substantially higher in sites which had not witnessed forest fires in the recent past. Our results show that the density of oak seedlings regenerating in early successional pine forests was close to 900 seedlings per hectare, however more than 75% of these regenerating seedlings were grazed. Additionally, overexploitation of existing oak trees via lopping affected the structural complexity of the forest canopy, thereby increasing light availability on the ground and supporting the regeneration of light-demanding early successional pine species, as opposed to the desired oak. We conclude that with strategic management that restricts the current anthropogenic disturbances, the extent of oak forest in the study area can be increased.

**Key words:** Himalaya, Succession, Oak, Regeneration, Distribution.

SV/P-2

## **Altitudinal Distribution of Oak Species in Three Wildlife Sanctuaries in Sikkim, India**

*Arun Chettri* and *Subhankar Gurung*\*

Department of Botany, Sikkim University, 6th mile, Tadong, Gangtok, INDIA, Email: [achettri01@cus.ac.in](mailto:achettri01@cus.ac.in)

The present study aimed to understand the altitudinal distribution of oak species in Maenam Wildlife Sanctuary (2100-3300 m) in South Sikkim, Fambonglho Wildlife Sanctuary (1500 – 2200 m) in East Sikkim and Bersay Rhododendron Sanctuary (1900-3800 m) in West Sikkim. These sanctuaries are predominantly dominated by Oak species. Associated species such as *Daphniphyllum himalayense*, *Eurya japonica*, *Symplocos theifolia*, *Rhododendron arboreum*, *R.*

*griffithianum*, *Lyonia ovalifolia*, *Acer caudulatum* grows along with oak species. At least 11 species of oak have been reported from Sikkim by ENVIS, Sikkim. The present study reports the distribution of nine oak species in the study sites which fall under three genera. The distribution of genus *Castanopsis* spp. ranged from 1500 – 2400 m, *Lithocarpus* spp. from 1500- 2300 m and *Quercus* spp. between 1500 – 2600 m at all the three sites. The oak species are: *C. hystrix*, *C. lanceifolia*, *C. tribuloides*, *C. indica*, *L. pachyphyllus*, *L. elegans*, *L. fenestratus*, *Q. lamellosa* and *Q. thomsoniana*.

**Key words:** Wildlife sanctuary, Oak species, altitudinal distribution, Sikkim

SV/P-3

### Genome Size Estimation of *Castanopsis* Species (Fagaceae) from Meghalaya, India using Flow Cytometry

**Kiran\***, Babita Joshi, Gopal Ji Tiwari, Satya Narayan Jena and Saroj K. Barik

Plant Molecular Genetics Laboratory, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: kiranbhasker691992@gmail.com

*Castanopsis*, commonly known as chinkapin is one of the dominant genera of Fagaceae. In addition to the timber value, the raw acorns of most species of the genus are eaten by human and wildlife indicating ecological and economic importance of the genus. Genome size determination is a pre-requisite for calculation of coverage of any *de novo* sequencing. Many studies have shown that genome size is an important indicator for distinguishing different taxa. There are various techniques for assessing genome size i.e. 2C DNA content. Among all these, flow cytometry (FCM) is convenient, rapid and precise for detecting small variation in genome size. In the present study, the leaf samples of three species of *Castanopsis* viz., *C. purpuella*, *C. tribuloides* and *C. armata* were collected from Jarain, Sohrarim and Umsining of Meghalaya, respectively, and were analyzed for their 2C DNA content with the help of flow cytometer. The results revealed that the genome size of three species

of *Castanopsis* varied between 2.25 and 2.55 pg/2C. The genome sizes of these *Castanopsis* species are greater than that of *Quercus* species (range:- 1.88 to 2.00 pg/2C). The genome size was used for segregating the three species. The three species had significantly different genome sizes. This indicates the successful application of flow cytometry results in segregating the elements within a taxa.

**Key words:** 2C DNA content, flow cytometry (FCM), *Castanopsis*, Fagaceae, Genome size.

SV/P-4

### Patterns of Diversity and Structure of Oak Forests in Meghalaya along a Disturbance Gradient

Aabid Hussain Mir<sup>1</sup>\* and Krishna Upadhaya<sup>2</sup>

<sup>1</sup>Department of Environmental Studies, North-Eastern Hill University, Shillong-793022, Meghalaya, INDIA;

<sup>2</sup>Department of Basic Sciences and Social Sciences, North-Eastern Hill University, Shillong-793022, Meghalaya, INDIA, Email: aabidm4@gmail.com, upkri@yahoo.com

Oak dominated forests represent the subtropical broadleaved vegetation of Meghalaya and are closely linked with the livelihood of rural people. They are used for timber, fuelwood and for edible nuts. Oak species also play a major role in the maintenance of ecosystem stability, soil fertility, watershed, and local biodiversity. The current study highlights the diversity and structural patterns of Oak forests of Meghalaya. Fifteen forests, along a disturbance gradient (low, medium and high) were sampled during the study. A total of 258 woody (e<sup>2</sup>5 cm dbh), 217 shrubs and 210 herbaceous species were recorded. Tree species richness of the forests varied from 34-75, density ranged from 560-1164 individuals ha<sup>-1</sup>, and stand basal area from 7.4-77.4 m<sup>2</sup>ha<sup>-1</sup>. Shrub and herb species density varied from 2912-1008 and 109200-378000 individuals ha<sup>-1</sup> respectively. A total of 11 species of Fagaceae viz. *Quercus kurzii* Hance, *Q. armata* Roxb., *Q. indica* (Roxb. ex Lindl.) Drake, *Q. brunnea* H. Lév., *Q. tribuloides* Sm., *Q. dealbata* Hk. f. & Th. ex Miq., *Q. elegans* Bl., *Q. glauca* Thunb., *Q. griffithii* Hk. f. & Th. ex Miq., *Q. kamroopii* D. Don and *Q. semiserrata* Roxb were recorded. These species contributed 28% and 48% to the overall density and

stand basal area of the forests, respectively. Disturbance favoured the growth of Fagaceae members as evident by a positive correlation with density except for *Q. glauca*, which showed a reverse trend. Density-diameter distribution of the species showed the reverse J shaped curve, while basal area showed an irregular pattern. Forests exposed to low disturbances had a high density and basal area in large diameter (>55 cm) class. Based on the density of seedling, saplings and adult individuals, the regeneration of the oak species may be rated as good in disturbed habitats, except *Q. glauca*, which prefer to grow in undisturbed forests. Most of the Fagaceae members were heliophytic in nature, hence can be used in ecological restoration programmes.

**Key words:** Community forests, Fagaceae, Subtropical broadleaf forests, Traditional forest management

SV/P-5

## Restoring and Managing *Quercus* in Riparian Forests of the Southern USA

John A. Stanturf<sup>1\*</sup>, Emile S. Gardiner<sup>2</sup>, Daniel C. Dey<sup>3</sup>, Douglass F. Jacobs<sup>4</sup> and Brian R. Lockhart<sup>5</sup>

<sup>1</sup>Estonian University of Life Sciences, Tartu, Estonia; <sup>2</sup> US Forest Service, Stoneville Mississippi, USA; <sup>3</sup> US Forest Service, Columbia Missouri, USA; <sup>4</sup> Purdue University, West Lafayette Indiana, USA; <sup>5</sup> US Forest Service, Stoneville Mississippi, USA, Email: drdirt48@gmail.com

More than 60 broadleaved species are endemic to the riparian or floodplain forests in the southern USA. Diverse, mixed-species forests covered 10 million ha in the Lower Mississippi Alluvial Valley (LMAV) in the south-central USA but conversion to agriculture has reduced the original forest cover to only 26% of its historic extent. Efforts over the last 30 years to restore these forests have concentrated on 10 native *Quercus* species because of their value for timber and mast production for wildlife. Because these species are difficult to regenerate naturally, planting bareroot seedlings has been the primary means of afforestation. Complex inundation regimes and other site factors, in addition to variation in species adaptations to flooding, light, and soil conditions, have presented obstacles to successful restoration. In addition to afforestation on former agricultural land, regeneration of remnant forests

that have been high-graded limit choices between clearfell and regenerate naturally or underplant with *Quercus* seedlings to alter composition. In this presentation, we will review current restoration methods including innovations from improvements in planting stock and new silvicultural systems that restore ecological function more quickly than traditional afforestation with single-species stands. We also consider the challenge of managing the understocked restoration stands that have resulted from current federal policy and incentive programs. The yet unaddressed challenges to sustainable management that would come from altered climate and sea level rise have also been discussed.

**Key words:** Nuttall oak, cherrybark oak, bottomland hardwoods, functional restoration, Wetlands Reserve Program, climate change

SV/P-6

## Flow of Provisioning Services from Oak Dominated Forest of Western Himalaya

Subhasis Mahato<sup>1\*</sup>, Sabyasachi Dasgupta<sup>1,2</sup> and N.P. Todaria<sup>1</sup>

<sup>1</sup>Department of Forestry and NR, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand-246174, INDIA; <sup>2</sup>Department of Forestry and Biodiversity, Tripura University, Agartala, Tripura-799022, INDIA

Stock of provisioning services from Western Himalaya has declined significantly during the last few decades. Oak species assume considerable conservation significance in the region as they are the providers of numerous services and serve as a lifeline for the local population. This study explored forest resource-use patterns and villagers' dependency on Government managed oak forest sites. Fuel and fodder biomass stock of 74.18t ha<sup>-1</sup> was estimated in the reserved oak forest. The estimated flow of fuel wood and fodder were 4.23 t ha<sup>-1</sup> & 4.62 t ha<sup>-1</sup> respectively. Per day fuel wood consumption was estimated at 13.09±5.11 kg / family. Oak leaf fodder available in the villages constitutes the major fodder for livestock throughout the year. Average fodder consumption per household per day was 32.31 kg. The biomass flow was estimated to be 8.86 t /ha year<sup>-1</sup>. Of the total

accessible fuelwood and fodder biomass, only 11.9 % was extracted annually from the reserved forests. Though the current level of extraction from the reserved forest seems to be sustainable in short term, with the

changing social dynamics this unregulated flow would lead to unsustainable harvesting.

**Key words:** Beneficiaries, Oak forest, Flow of provisioning services, Himalaya.



**Session VI**  
**Biomonitoring and Bioremediation**



SVI/KN-1

## Phytoremediation of Arsenic-Contaminated Soils: Molecular Mechanisms and Field Application

Lena Q. Ma<sup>1,2</sup>

<sup>1</sup>College of Ecology, Southwest Forestry University, CHINA;

<sup>2</sup>Soil and Water Science Department, University of Florida, USA, Email: lqma@ufl.edu

Arsenic is of great environmental concern due to its extensive contamination and carcinogenic toxicity. Past human activities have resulted in many arsenic contaminated sites worldwide. Our group reported the first-known arsenic hyperaccumulator Chinese Brake fern (*Pteris vittata*) in Nature (2001). The plant has the potential to phytoremediate arsenic-contaminated soils. This presentation tries to show the molecular mechanisms behind the efficient arsenic uptake and detoxification by *P. vittata* and optimization of its arsenic hyperaccumulation for phytoremediation application in contaminated soils. Towards this goal, we explored the roles of phosphate transporter and ACR3 arsenite effluxer in arsenic uptake and efflux, and the role of phytate in solubilizing arsenic and phosphate from soils. In addition, we demonstrated the efficiency of *P. vittata* in remediating arsenic-contaminated soils over 5 years. Therefore, this presentation focuses not only on the mechanisms as well as application of *P. vittata* in phytoremediation.

**Key words:** Carcinogenic, Hyperaccumulator, Phytoremediation, Phosphate transporter, Arsenite effluxer.

SVI/KN-2

## Glutathione Homeostasis Plays Critical Role in Protecting Plants from Abiotic Stresses and in Heavy Metals Phytoremediation

Om Parkash Dhankher\*, Gurpal Singh, Ahmed G. Meselhy and Bibin Paulose\*

Stockbridge School of Agriculture, University of Massachusetts, Amherst, MA, USA, Email: parkash@umass.edu

Glutathione (GSH) plays important roles in protecting cells from oxidative stress caused by exposure to toxic metals, xenobiotics and other abiotic stresses. The g-glutamyl cycle maintains GSH homeostasis, which involves GSH synthesis and degradation, and the recycling of the component amino acids. Overexpression of GSH biosynthesis pathway genes increases the levels of GSH, which chelates with toxic metals and hence provides tolerance in the plant tissues. Previously, we developed a genetics-based As remediation strategy in *Arabidopsis* by tissue-specific expression of bacterial arsenate reductase, *ArsC*, gamma-glutamylcysteine synthase, *g-ECS*, genes and RNAi knockdown of an endogenous arsenate reductase *AtACR2*, which resulted in the efficient extraction and hyperaccumulation of As into the above ground plant tissues. We have transferred this technology from *Arabidopsis* to high biomass, fast growing non-food crop- *Crambe abyssinica* for the application of this strategy to the As contaminated fields. Further, we have identified a small gene family encoding  $\gamma$ -glutamyl cyclotransferases, GGCTs (GGCT1, GGCT2;1 and GGCT2;2) in *Arabidopsis*, which are involved in the g-glutamyl cycle required for maintaining GSH homeostasis via recycling Glu, a key nitrogen-storing amino acid. The recombinant GGCT2;1 protein was able to convert  $\gamma$ -glutamyl-Ala and GSH to 5-oxoproline (5-OP), a precursor of glutamate (Glu) *in vitro* conditions. Manipulation of GGCT genes in *Arabidopsis* showed enhanced tolerance to multiple abiotic stresses, produced higher levels of Glu precursor 5-oxoproline (5-OP) as a result of GSH degradation. GGCT2;1 T-DNA mutants become severely sensitive to ABA, salt, and mannitol. Our studies suggest that by efficient recycling of Glu as part of the g-glutamyl cycle, GGCT2;1 decreased the *de novo* synthesis of Glu, thereby decreasing the nitrogen requirement. Therefore, GSH homeostasis plays important roles in maintaining cellular redox for protection of plants under abiotic stresses and holds great potential for developing 'Climate Resilient Crops' as well as developing plants for phytoremediation of toxic metals and metalloids.

**Key words:** G-glutamyl cycle, GSH synthesis, Glutamate recycling, Oxidative stress.

SVI/L-1

## Economic Valuation of Ecosystem Ecological Services

*Mir Mehrdad Mirsanjari*

Department of Environmental Sciences, Faculty of Natural Resources and Environment, Malayer University, Malayer, IRAN, Email: mmmirsanjari@malayeru.ac.ir

Each ecosystem is a dynamic set of variables, each of which plays an essential role in the formation of an ecosystem. In order to determine the economic value of each ecosystem, it is necessary to pay attention to all variables and their role, otherwise the value stated does not indicate the true value of the ecosystem and in the long run, due to miscalculations and less economic value, the space to destroy the creation It turns out. The United Nations, the IMF, the World Bank, and the Organization for Economic Co-operation and Development (ICECD) have developed a “integrated accounting system for the environment and economy”, based on the results of previous studies on environmental asset valuation. In the recipe, environmental assets consist of ecosystem goods and services. Valuation, the ecosystem of two aspects, one of the values of use and the other non-usable values will be examined. Usage values are divided into two groups: consumable (such as wood products) and non-consumable. Non-consumable values include direct values (such as outing) and indirect values (such as the value of water, soil and gas conservation). The ecosystem’s non-use values can also be seen as the conservation value of forests and the value of wildlife conservation. In this research, we intend to determine the economic value of the ecosystem based on the ecological services function.

**Key words:** Ecosystem, Economic value.

SVI/O-1

## Speciation and Compartmentation of Arsenic in Plants and Mechanism of its Sub-Lethal Toxicity

*Seema Mishra<sup>1,2,3,4</sup>, Sanjay Dwivedi<sup>1</sup>, Rudra D. Tripathi<sup>1</sup>, Gerald Falkenberg<sup>5</sup>, Jürgen Mattusch<sup>3</sup> and Hendrik Küpper<sup>4</sup>*

<sup>1</sup>Deen Dayal Upadhyay Gorakhpur University, Gorakhpur, INDIA; <sup>2</sup>CSIR-National Botanical Research Institute, Lucknow, INDIA; <sup>3</sup>UFZ-Helmholtz Centre for Environmental Research, Leipzig, GERMANY; <sup>4</sup>Universität Konstanz, GERMANY; <sup>5</sup>Deutsches Elektronen-Synchrotron (DESY), Hamburg, GERMANY, Email: seema\_mishra2003@yahoo.co.in

Toxic metals and metalloids not only restrict plant growth and productivity, but also cause food chain contamination resulting in risk to human health. One of the most relevant examples is the contamination of ground water with arsenic (As) in the Indian subcontinent. It affects health of millions through drinking water and food chain contamination and threatens the sustainability of food production. Understanding the mechanism of As toxicity is crucial for finding a sustainable solution to the problem, and determining the in planta distribution and speciation of As are important steps in this process. Speciation and compartmentation of arsenic (As) in *Ceratophyllum demersum*, a good laboratory model for shoot, and rice, the most As affected crop, was performed to explore the mechanism of As toxicity. Speciation was analyzed chromatographically (high performance liquid chromatography-[inductively coupled plasma-mass spectrometry]-[electrospray ionization-mass spectrometry]) in whole-plant extracts and by tissue-resolution confocal  $\mu$ -X-ray absorption near-edge spectroscopy (i-XANES) in intact shock-frozen hydrated root and leaves. The sub-cellular element distribution (compartmentation) was analyzed through  $\mu$ -X-ray fluorescence (i-XRF). Speciation through chromatography revealed that in *C. demersum*, up to 60% accumulated As was in the form of thiol complexed-AsIII. Most of which was in epidermis of mature leaves as revealed by tissue resolved i-XANES of intact hydrated leaves. At sublethal concentration, As predominantly accumulated in the nucleus of the epidermal cells, as revealed by i-XRF analysis, indicating replacement of P by As in DNA molecules, providing first *in vivo* evidence for arsenic induced DNA damage. While at lethal concentration, vacuole was the main storage site of As, yet a significant increase of unbound AsIII in mesophylls of young mature leaves occurred. This small amount of As reaching chloroplasts caused a strong and specific inhibition of tetrapyrrole biosynthesis and severe growth retardation. In rice plant, exposed to inorganic arsenate

(AsV) and methylated As, most of the AsV and methylarsonate (MAV) were efficiently reduced to arsenite (AsIII) and MAIII respectively, but dimethylarsinate (DMAV) did not transformed. A large proportion of AsIII and MAIII were complexed with thiols showing up to 20 and 16 As species respectively in the roots. Many of them were identified as new As-thiol species. Despite high complexation in root, more MA was translocated to shoot, with shoot/root transfer factor being in order DMA>MA>inorganic As in rice. Further, the distribution study of As in frozen hydrated roots (both the root tip and the root hair zone) of rice revealed that in the main root, As was mostly confined to the endodermis. Whereas, in the young root branches apart from endodermis arsenic was also spread into the cortex, particularly in younger, not fully differentiated tissue including root tip. This shows that As is taken up inadvertently by young tissues without proper control. In conclusion at a concentration that can be easily attained in shoots of crop plants, As is already toxic to plants, i.e. it can inhibit pigment biosynthesis and cause DNA damage leading to hampered growth and reported yield loss. This knowledge can be a starting point for targeted breeding of more resistant plants.

**Key words:** Arsenic, *Ceratophyllum demersum*, Compartmentation of arsenic, Rice, Speciation of arsenic, i-XANES, i-XRF.

SVI/O-2

## **A Study of Heavy Metal Pollution from Motor Vehicle Emissions using Human Hair as Biomarkers**

**Krishna Mishra**

Samrat Prithviraj Chouhan Government College, Ajmer, Rajasthan, INDIA, Email: drkrishnamishra@gmail.com

The fuel combustion by the vehicles on the road emit complex mixtures of air pollutants, including heavy metals like Cd, Cu, Cr, Ni, Pb and Zn. Of all of these pollutants, fine particulate matter has the greatest effect on human health. Heavy metals represent a class of omnipresent pollutants, with toxic potential, in some cases even at low exposure levels. In most of the cases, heavy metals pollution problem is associated with intense industrialization. However, high vehicle traffic

was proven to be one of the important heavy metals emissions sources in the present day urban scenario. Using biological markers can potentially improve the way in which exposure to environmental factors is assessed. At present, however, only a few valid biological markers are available that can be effectively used in epidemiological studies. The use of human hair analysis technique can be used as a tool for monitoring exposures to environmental pollutants. Of late, this technique has proved to be a well-suited biological marker of occupational and environmental exposure of man. During the past three decades the determination of trace elements levels in hair has been the subject of continual interest in the biomedical and environmental sciences (Arnold 1994 and Ciszewski 1997). In the present study concentration of four toxic metals Pb, Cu, Cr and Zn was determined, using standard methods, in human scalp hair residing near heavy traffic areas of Ajmer city (Rajasthan). Sample were collected, decontaminated and digested before analysis using Atomic Absorption Spectrophotometer. The aim of the present study was to determine the concentration of the chosen metals in hair of subjects residing near the sites of study and assess the comparative burden of vehicular pollution in the selected areas.

**Key words:** Biomarkers, Vehicular pollution, Heavy metals, Scalp hairs.

SVI/O-3

## **Bioremediation Potential of Macrophytes from Jakkur Wetland, Bangalore**

**P. Sudarshan<sup>1,2\*</sup>, Mahesh M.K.<sup>1</sup> and Ramachandra T.V.<sup>2</sup>**

<sup>1</sup>Department of Botany, Yuvaraja's College, Mysore-570005, Karnataka, INDIA; <sup>2</sup>Energy and Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore-560012, Karnataka, INDIA, Email: bhat.sudarshanp@gmail.com; mkmahesh44@yahoo.com, tvr@iisc.ac.in

Macrophytes are important components of lake ecosystem. They have the ability to remove organic, inorganic nutrients and heavy metals from environment and act as bioremediators. The present study was done

to assess biomass, nutrient and metal accumulation ability of macrophytes from Jakkur Lake, Bangalore and use it as bioindicator. Macrophytes and water samples were taken from inlet and outlet of the lake. After identifying species, they were washed thoroughly to remove adhering sediments and periphytons. They were dried to constant weight using hot air oven and the dry weight was determined. The dried samples were powdered to get fine powders and were analysed for nutrient and heavy metals using standard procedures. *Polygonum glabrum* and *Typha angustata* had higher biomass in inlet and outlet respectively. In inlet *Polygonum*, *Alternanthera philoxeroides* and *Typha angustata* had higher concentration of Carbon, Nitrogen and Phosphorus respectively. Carbon content was higher in *Typha angustata*, Nitrogen and Phosphorus was highest in *Eichhornia crassipes* in the outlet of the Lake. Cadmium concentration was within normal range with *Alternanthera philoxeroides* and *Pistia stratiotes* accumulating highest in inlet and outlet. *Typha angustata* in inlet had Copper concentration in critical range whereas in outlet all species had normal range. Lead, Zinc, Nickel and Chromium was in higher concentration in *Typha angustata* than other species in inlet. Nickel was above normal range in *Typha angustata* in inlet and in all species in outlet. In the outlet *Typha angustata* (Lead), *Eichhornia crassipes* (Zinc and Nickel) and *Alternanthera philoxeroides* (Chromium) had higher concentrations. The heavy metals in the water samples were as follows Zn>Cu>Pb>Cr>Cd>Ni. The bioconcentration factor was in the following order Cd>Cr>Ni>Pb>Cu>Zn. Thus the study highlighted the bioremediation potential of Macrophytes from Jakkur Lake.

**Key words:** Macrophytes, Bengaluru, Jakkur Lake, Heavy metal, Bioremediation.

SVI/O-4

## Two-Pronged Approach to Ascertain Cadmium Phytoremediation Ability of *Pistia stratiotes*: Biochemical and SEM-EDX Analysis along with Catfish Bioassay using *Clarias batrachus*

Sunayana Goswami<sup>1</sup> and Suchismita Das<sup>2\*</sup>

<sup>1</sup>Centre for Soft Matter, Department of Chemistry, Assam University, Silchar-788011, INDIA; <sup>2</sup>Aquatic Toxicology and Remediation Laboratory, Department of Life Science and Bioinformatics, Assam University, Silchar-788011, INDIA, Email: drsuchismita9@gmail.com

Aquatic macrophytes have tremendous potential for remediation of the heavy metal cadmium (Cd) and can be used as an alternative way of reducing aquatic metal burden. Although studies on phytoremediation are abundant, often there is a lack of validation of the process by suitable bioassay. Thus, we investigated the remediation potential of *Pistia stratiotes* exposed to 5, 10, 15 and 20 mg Cd L<sup>-1</sup> in 0.1 × Hoagland solution for 21 d in hydroponics and estimated the efficacy of this endeavour with catfish bioassay. The uptake maxima of 11670 µg Cd g<sup>-1</sup> dry wt. in root and 5750 µg Cd g<sup>-1</sup> dry wt. in shoot of *Pistia* was observed. Antioxidant enzyme activities, such as, superoxide dismutase, peroxidase, catalase and ascorbylperoxidase were estimated to ascertain stress tolerances. Our findings support that the bioaccumulation of Cd in *P. stratiotes* was accompanied by augmentation of cellular antioxidants enzyme activities to protect itself against Cd-induced toxicity. Cd induced alterations in morphology, growth, as well as the localization of Cd with the Scanning electron microscopic (SEM) coupled with energy-dispersive X-ray microanalysis (EDX) on *P. stratiotes* root and leaf were estimated. For catfish bioassay with *Clarias batrachus*, 5 and 10 mg Cd L<sup>-1</sup> *Pistia* remediated water was used to rear the catfish for 7 days after which Cd uptake in various tissues of fish, as well as analysis of biochemical responses, and antioxidant enzyme profiling of the gill and liver tissues were performed. Fish muscle accumulated 28.8-39.8 µg Cd g<sup>-1</sup> dry wt. when reared in Cd only doses, however, in fish reared in *Pistia* remediated water, muscle accumulated 9.2-14.2 µg Cd g<sup>-1</sup> dry wt. which

was within the safe levels of Cd in edible tissues. The results pointed towards the efficacy of Cd phytoextraction by *P. stratiotes* and suitability of this plant for the large scale remediation purposes.

**Key words:** Cadmium, Phytoremediation, Antioxidants, Uptake, Catfish bioassay.

SVI/O-5

## **Role of Grasses in Monitoring Global Warming and its Mitigation through Carbon Sequestration**

*Amarjit Singh Soodan*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: assoodan@gmail.com

The uncontrolled burning of fossil fuels has led to tremendous increase in green house gases (GHG's), mainly carbon dioxide and the resultant global warming and its harmful effects. Scientists are looking for model organisms that could help monitor the pace, quantum and direction of climate changes taking place at regional, national and global levels as also to reduce the concentration of GHG's in the atmosphere and mitigate their harmful effects. Grasses meet all the requirements of environmental monitors including a cosmopolitan distribution, high species diversity, habitat specificity and climatic zonation from tropical through subtropical, temperate, alpine and the polar regions. Grasses display a closely coordinated cycle of well defined phenophases in the vegetative and reproductive phenology that could be utilized for assessing the impact of climatic factors such as temperature, precipitation and duration of sunshine. Grasses show special leaf anatomy correlated with carbon assimilation cycles in cold and dry (C<sub>3</sub>) and hot and humid (C<sub>4</sub>) conditions. India is home to several cultivated (cereals and millets) and wild grasses that dominate the cultivated fields and vast ecosystems (grasslands) of the country. One only needs to earmark permanent environmental monitoring plots in natural grasslands in different climate zones and select grass species for experimental observations on phenological changes. Some such grass species have been identified during our investigations in the North-West Himalayan region. Apart from possessing a well defined phenology, accumulation of silica in the form of silica bodies

(phytolith) within and around the cells by grasses has emerged as a feature of tremendous potential in environmental monitoring and mitigation. As phytoliths show variations in size in relation to changes in the ambient growth temperatures, they have proved to be ideal markers for monitoring global warming and climate change. As phytoliths occlude organic carbon of the cytoplasm and stay unchanged in the soil for millenia, they have tremendous potential in carbon sequestration. Also, persistence of biogenic silica in the soil converts the simple geochemical weathering of silica into a biogeochemical cycle within which operates the shorter biological silica cycle. Owing to excellent preservation down the millenia and diagnostic variations in morphotypes, phytoliths have found an ever-increasing role in understanding palaeoecology and palaeoclimatology of the planet besides playing a role in contemporary environmental mitigation. The dynamics of phytolith accumulation in grasses with special emphasis on their role in carbon sequestration shall be discussed in the lecture.

**Key words:** Carbon sequestration, Environmental monitors, Grasses, Palaeoecology, Phenology, Phytoliths.

SVI/O-6

## **Rhizo-Remediation of Hazardous Waste: A Sustainable Approach for Environment Clean-up**

*Bhawana Pathak*

School of Environment and Sustainable Development, Central University of Gujarat, Gandhinagar-382030, INDIA, Email: bhawana.pathak@cug.ac.in

Industrial and technological revolution is an economic indicator for consideration as the principle criteria for measuring progress. Technological revolution has led to changes in the industrial product and processes. The development of product and processes in the industries has generated wastes; enhanced environmental pollution and cause threat to human life. The present treatment technologies - laboratory scale are insufficient to treat pollutants to acceptable level (contaminated land). Treatment technologies also resulted in the release of large number of natural and synthetic hazardous compounds (organic and inorganic chemicals) due to lack of effective waste

treatment especially in industries like chemical, dyes, textile, printing, construction and metal manufacturing sectors. Considering all these flaws of physicochemical treatment processes for remediation of hazardous compounds present in the industrial effluent, biotechnological approaches i.e bioremediation and phytoremediation are the emerging areas to remediate the environmental contaminants and are cost effective, eco-friendly and produce less toxic compounds and an alternative method offers the possibility to destroy harmful contaminants with the help of natural biological activity. Rhizoremediation is the superior biodegradation of organic pollutants/ hazardous waste by root-associated bacteria and fungi under the influence of plant species. The use of plants and native microorganisms to degrade or remove pollutants has established as an effective technology for *in situ* remediation. The potential role of plants and associated rhizomicrobial population for *in situ* bioremediation of hazardous organic compounds is significant. The present paper focuses on the rhizoremediation of dye compound and pesticides as case studies. The different factors influencing the plant-microbe-toxicant interaction in soils is also highlighted. Rhizoremediation is a promising technology for the removal of different hazardous compounds from soil, and the developed technology in the laboratory is helpful for transfer of technology from lab to land - a green technology for sustainable environment.

**Key words:** Environmental pollution, Hazardous waste, Treatment technology, Rhizoremediation, Technology transfer - lab to land.

SVI/O-7

### **A 4 Stage Setup for Phytoremediation of Arsenic Contaminated Water with *Phragmites australis* and *Vetiveria zizanioides***

**Ashish Praveen<sup>1,2</sup> and Nandita Singh<sup>1</sup>**

<sup>1</sup>Plant Ecology and Environmental Science Division, National Botanical Research Institute, Lucknow-226001, INDIA;

<sup>2</sup>Academy of Scientific and Innovative Research (AcSIR), Plant Ecology and Environmental Science Division, National Botanical Research Institute, Lucknow-226001, INDIA, Email: aashishpraveen45@gmail.com, nanditasingh8@yahoo.co.in

The arsenic contamination in soil and water has increased up to levels that are unsafe for humans as well as plants and animals. The problem of arsenic contamination in ground water is severe in Bangladesh and in the state West Bengal of India. The release of industrial wastes, sewage waste and solid waste dumping has alleviated the problem of water contamination. Phytoremediation has been the cheap and environmental friendly method to reduce contamination, and thus, a hydroponic experiment with *Phragmites australis* (Ph) and *Vetiveria zizanioides* (Vt) was designed. The study was carried out using different densities of accumulator (12 and 24 Ph, and Vt) in trays with arsenic concentration of 1 ppm, and remediation was observed with time duration (20 days). Sampling of water was done after every 2 days. It was found that arsenic concentration in water decreased with time duration and density of the accumulators. Complete remediation of arsenic was achieved after 20 days with 24 Ph and 24 Vt, and the arsenic remaining in the medium was 0.04 and 0.25 ppb respectively. With these observations a 4 stage setup was made with 24 Ph and 24 Vt with same concentration of arsenic and sampling of water after every 5 days. The arsenic concentration in water after 20 days was reduced, and was within the safe limit set by WHO with both accumulators. The 4 stage setup can be applied to arsenic contaminated irrigation water, reducing the further contamination of soil and toxic effects on plants.

**Key words:** Arsenic, Hydroponic, *Phragmites australis*, *Vetiveria zizanioides*, 4 stage setup.

SVI/O-8

### **Physiological and Biochemical Assessment of Five Varieties of *Helianthus annuus* for Phytoextraction of Lead**

**Jyoti Mathur**

Department of Bioscience and Biotechnology, Banasthali University, Banasthali Rajasthan, INDIA, Email: jyotijnp21@yahoo.co.in

Heavy metal contamination in the soil as well as water is becoming an irresolvable problem. Lead (Pb) is one of the most toxic heavy metal contaminant in the environment. Pb has no specific biological function



but can cause morphological, physiological and biochemical dysfunctions in plants, animals and humans. Phytoextraction is one of the possible method for mitigation of heavy metals from the environment. *Helianthus annuus* has been identified as a good metal hyperaccumulating plant. Therefore, the present study has been carried out for screening of lead hyperaccumulation potential of five varieties of *H. annuus* (DRSF-108, DRSF-113, Phule Bhaskar, LSFH-171 and KBSH-44). Seedlings of sunflower were treated with different concentrations (0, 50, 100, 300, 500, 700 and 1000 ppm) of  $Pb(NO_3)_2$ . Plantlets were harvested at 20, 40 and 60 days of time intervals. Physiological studies such as root length and shoot length, fresh and dry weight of shoot and root of plants performed. Concentration of Pb in various plant parts were estimated by atomic absorption spectrophotometer. This study showed maximum accumulation (693.69 ppm) of Pb in Phule Bhaskar and minimum accumulation (333.16 ppm) in KBSH-44 at 1000 ppm after 60 days. Phule Bhaskar accumulated maximum (394.32 ppm) Pb in the roots. Level of proline and polyphenol increased with increasing Pb concentration was reported in treated leaves of all varieties. The maximum proline and polyphenol contents were  $31.16 \mu\text{mol g}^{-1}$  and  $7.15 \text{ mg g}^{-1}$  respectively at 60 days. Thus, the results from this study showed that among the five varieties, Phule Bhaskar had a greater survivability and ability for lead accumulation than rest of other varieties proving as good hyperaccumulating variety.

**Key words:** *Helianthus annuus*, Lead, Phytoextraction, Heavy metals.

#### SVI/O-9

### Physico-Chemical and Biological Characteristics of Godavari River Water at Sripada Yellampalli Project, Mancherial Dist., Telangana, India

**B. Lalitha Kumari**

Department of Botany, Kakatiya University, Warangal, Telangana, INDIA, Email: lalitha21prasad@gmail.com

Sripada Yellampalli Project foundation was laid on 28<sup>th</sup> July, 2004. It started in 2005, Andhra Pradesh.

Telangana state was formed on 2<sup>nd</sup> June, 2014 and project opening date was on 4<sup>th</sup> August 2016. It is situated in Yellampalli village, Ramagundam, Mancherial District (old Adilabad District) in Telangana State, India. The project is fourth largest one on Godavari river in Telangana. The project would supply water for 6tmc to NTPC Ramagundam city and Hyderabad City. After the flood gates are installed, the project would store about 20tmc of water. Barrage type of Dam height 263m, length 1180.7m, spillways 62. Construction cost 5400 crore rupees. Its geographical coordinates 18°50'45" North and 79°22'05" East.

The water samples were collected at 9 stations for analysis of physico-chemical and biological parameters in three different seasons (rainy, winter, summer) during 2017-18. Physical parameters like appearance, color, odor, temperature, electrical conductivity, turbidity, etc.; chemically characteristics such as dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total alkalinity, total hardness, calcium, magnesium, chloride, free carbon-dioxide, phosphates were analyzed. Biological parameters like algae, fungal, bacterial, actinomycetes population were analyzed and compared with IBS (10800) 2012. The total values indicate that river water belongs to the category of excellence to good water quality as per IBS (10800) 2012.

**Key words:** Physical, Chemical, Biological parameter, BOD, COD.

#### SVI/O-10

### Characterization of Iron Infused Activated Carbon Developed from *Citrus limetta* Biomass: An Application for Theremoval of Fluoride from Aqueous Solution

**Lata Verma\*, Mohd. Ibrahim and Jiwan Singh**

Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, INDIA, Email: lataverma2501@gmail.com, mohdibra1144@gmail.com, jiwansingh95@gmail.com

In this study, a low cost adsorbent was prepared at 500°C temperatures from pulp of *Citrus limetta* and

applied for the treatment of fluoride contaminated water. Prepared bioadsorbent was characterized through X-ray diffraction, Fourier transform infrared spectroscopy,  $\text{pH}_{\text{zpc}}$  and scanning electron microscopy. This bioadsorbent shows very effective removal of fluoride as observed in batch adsorption study which was performed at different temperature (298K, 308K, 318K and 328K), pH (4-10), dose (0.5, 1.0, 2.0, and 3.0 g L<sup>-1</sup>) and concentrations (1-30 mg L<sup>-1</sup>). The result shows maximum removal of 86% with ACP-500. Adsorption isotherm, intraparticle diffusion, thermodynamics and kinetics reaction were also studied. For kinetic study, pseudo-second-order kinetics was best fitted and in adsorption study it was observed that Langmuir isotherm model well fitted. Adsorption process was found to be exothermic, it represents removal percentage decreased with increasing temperature. Regeneration study revealed that the bioadsorbent can be reused three to four times. The authors are grateful to the SERB-DST, Government of India (Project No. ECR/2016/001924) for providing financial support for this work.

**Key words:** Adsorption, Isotherm, Kinetics, Fluoride, Characterization.

SVI/O-11

## Monitoring and Assessment of Pollution Load in Terms of Heavy Metals in Surface Water of River Ganga around Kanpur: A Study for Suitability of this Water for Different Utilities

**Vandana Singh,\* Nem Kumar Nagpoore, Jai Chand and Alok Lehri**

Central Instrumentation Facility, National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: singh\_vini02@yahoo.in

A study was conducted during April, 2016–March, 2017 to evaluate the surface water quality of river Ganga around Kanpur. The samples were analyzed for a number of physico-chemical parameters using standard laboratory procedures and giving prime plunge to determine the heavy metal concentrations of surface water at five different locations of the river Ganga

around Kanpur from two points (middle of the river stream and a discharge point) at each location. Metals: Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, Cd, Se and Pb were detected in all the samples. The metals showed no noteworthy disparity with respect to sampling locations as well as discharge points. However, the concentration of the metals varied with season, being higher in summer and lower in rainy season. Out of all the metals found in the study site, Cr, Fe Cu, As and Pb concentration in all the sample during each season at all the study sites are higher than the prescribed limit by Bureau of Indian Standard (BIS) and World Health Organization (WHO) for drinking, aquatic life and irrigation. Result of pollution indices shows that river water is not suitable for drinking and aquatic life but suitable for irrigation purpose only.

**Key words:** Metals, Seasonal variation, River Ganga, Pollution indices.

SVI/O-12

## Role of Bacteria in Remediation of Indoor Pollution with the Help of *Aglaonema commutatum* Schott

**Seemaa Ghate**

Know How Foundation, C-602, Vaidehi Enclave, Bavdhan, Pune, Maharashtra, INDIA, Email: drseemaaghat@gmail.com

Role of *Sphingomonas*, gram negative bacteria was examined in remediation of Indoor pollution with help of *Aglaonema commutatum*. *Sphingomonas* was isolated and inoculated in the medium in which experimental plants were grown. *Aglaonema* was tested against pollutants released from household products like mosquito coil and incense sticks. It was found that *Sphingomonas* helped plant in the activity of phytoremediation. Exposure to Incense sticks showed no absorption of any pollutant under consideration. Exposure to smoke from mosquito coil showed that levels of allethrin absorbed by plant, were very high, up to 20-30 ppb as tested on GCMS. When GCMS analysis of same plant was done after 20 days it was observed that levels of allethrin reduced to 0. Allethrin may be digested by *Aglaonema* plant with help of *Sphingomonas*, as this bacteria helps phytoremediation activity. Further research on this line is in the channel.

**Key words:** Sphingomonas, Aglaonema, Indoor pollution, Mosquito coil, Incense sticks, Phytoremediation.

SVI/O-13

## Phytoextraction of Lead from Soil using Biodegradable Chelant (Nitrilotriacetic Acid) by *Coronopus didymus*

Riya Raina<sup>1\*</sup>, Harminder Pal Singh<sup>1</sup> and Daizy R. Batish<sup>2</sup>

<sup>1</sup>Department of Environmental Studies, Panjab University, Chandigarh-160014, INDIA; <sup>2</sup>Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: riyaraina997@gmail.com, hpsingh\_01@pu.ac.in, daizybatish@yahoo.com

Lead (Pb) is one of the most persistent and widespread heavy metals of major environmental concern. Its contamination in soil represents a major threat to human health. Chelate assisted phytoremediation has gained attention as a potential alternative to traditional remediation methods because of lower cost and minimal soil disruption. In our study, we have targeted the South American Native (*Coronopus didymus*) because of its ability to produce high biomass, good tolerance and accumulation of metals from soil. Nitrilotriacetic acid (NTA) has been used as a chelant to solubilize Pb and to enhance its uptake by *Coronopus didymus*. Because of its short half-life of 2 to 7 days and fast degradation rate in soil, it does not pose any serious threat to the environment. Pot experiments were conducted for 4 to 12 weeks under completely randomized controlled conditions using 1000 to 3000 mg kg<sup>-1</sup> of Pb in soil with or without NTA (4 mMol). Growth, biomass, photosynthetic efficiency, lead uptake and accumulation by the plant were compared. Results showed a good accumulation and tolerance of Pb in the treated plants as compared to the controlled plants thus, proving it, as a good hyperaccumulator. Further, a comparison was done between the plants treated with different concentrations of lead alone and the plants treated with lead+NTA. Results have shown that the addition of NTA has increased the uptake and accumulation of Pb in roots and shoots of *C. didymus*, hence, it has a good efficacy in mobilizing and remediating Pb from the contaminated soils. The results

strongly suggest that greater phytoextraction can be accomplished by the application of environment friendly and biodegradable chelant NTA.

**Key words:** NTA, Chelant, Phytoextraction, Hyperaccumulator.

SVI/O-14

## Silicon: A Source of Mitigator to Heavy Metal (Arsenic) Stress in Rice Grains

Vinod Goyal<sup>1\*</sup>, Sanjay Dwivedi<sup>2</sup>, Seema Mishra<sup>2,3</sup>, Neeru Jain<sup>4</sup> and R.D. Tripathi<sup>2</sup>

<sup>1</sup>Department of Botany & Plant Physiology, CCS HAU, Hisar-125001, INDIA; <sup>2</sup>Plant Ecology and Environment Science Division, CSIR-National Botanical Research Institute, Lucknow -226001, INDIA; <sup>3</sup>DDU University, Gorakhpur, INDIA; <sup>4</sup>Privi Life Sciences Pvt. Ltd., Mumbai, INDIA, Email:goyal2973@gmail.com

Indian soils are mostly contaminated with heavy metals and among the heavy metals arsenic (As) is most common and toxic metalloid affecting the human health. It is continuously being added in the food chain due to excessive use of fertilizers and changing of cation exchange capacity of soils that cause its preferred uptake by the plants. Present study is an attempt to study the interaction of silicon, a micronutrient and uptake of arsenic/accumulations in rice grains. The source of silicon used is the commercially available ortho silicic acid (OSA), which is the only bioavailable form. Application of arsenic in the form of arsenate and arsenite significantly reduced the growth of plants in dose dependent manner. Arsenate<sup>v</sup> significantly reduced the crop yield, by affecting the yield and its attributes more than arsenite<sup>iii</sup>. Independently accumulation of arsenic was seen in rice grains, when treated with different concentration of arsenic [arsenate<sup>v</sup> (25 and 50 mg l<sup>-1</sup>) and arsenite<sup>iii</sup> (20 and 25 mg l<sup>-1</sup>)] along with other trace elements, where as when arsenic was applied along with silicon, the significant reduction in arsenic accumulation in rice grains was observed over control (No treatment/ arsenic alone). Significantly lower accumulation of zinc and cobalt was observed in grains of arsenic exposed plants, whereas increased accumulation was observed for copper, manganese and selenium ions. It was observed

application of silicon (soil/foiar), enhanced the growth and yield of rice plants by increasing the activity of antioxidants enzymes and simultaneously leading to reduced accumulation of arsenic in grains. Parallel studies revealed that foliar application of silicon is more beneficial to the plants rather than soil based application. The study concludes that the silicon application in the form OSA had a significant contribution in increasing the quality and quantity of the rice produce from the heavy metal affected areas.

**Key words:** Rice, Arsenic, Silicon, Heavy metal stress.

**SVI/O-15**

### **Assessment on Environmental Issues Related to Water Pollution Associated with Textile Processing Industries Indehiwala-Mt. Lavinia and Moratuwa Municipal Council Areas in Sri Lanka**

*M.R. Namalie<sup>1</sup> and T.K. Weerasinghe<sup>2</sup>*

<sup>1</sup>Central Environmental Authority, Denzil Kobbekaduwa Mawatha, Battaramulla, SRI LANKA; <sup>2</sup>Centre for Environmental Studies and Sustainable Development, The Open University of Sri Lanka, Nawala, Nugegoda, SRI LANKA, Email:namalie44@gmail.com

The textile processing and garment industry is one of the most important industrial sectors in Sri Lanka. This study mainly focused on assessment of environmental issues related to water pollution during textile processing while introducing appropriate mitigatory measures. During the study, existing pollution control measures to obtain Environmental Protection License from the Central Environmental Authority of 16 industries with different scales (large/medium and small) were investigated. A detailed study was carried out in 07 industries including wastewater treatment systems, volume of discharge or consumption of water, work force, production capacity and mode of discharge of treated waste water to the environment while analyzing the treated effluent. The obtained results were statistically analyzed to find out suitable relationships and possible significant differences. Seven critical parameters such as temperature, colour, pH, BOD, COD, TSS and oil and grease content were measured for a period of six months. According to the

results, physicochemical treatment combined with biological treatment showed some sort of efficiency rather than physicochemical treatment with sophisticated techniques like electro coagulation with chemical coagulation. However, it is very clear from the study that industries have made significant efforts to comply with tolerance limits of industrial discharges to inland surface waters with high organic waste load. Further, it was evident that combined system of physical, chemical and biological treatment facilities has shown a remarkable efficiency in achieving the expected targets.

**Key words:** Wastewater, Pollution, Industrial discharges, Textile processing, Electro coagulation.

**SVI/O-16**

### **Heavy Metal and Prospects of Phytoremediation in India**

*Jamshed Zaidi and Amit Pal\**

Institute of Environment & Development Studies, Bundelkhand University, Jhansi-284128, INDIA, Email: apu13@rediffmail.com, jamshedphd@gmail.com

Many fold increase of population and the pace of industrialization and urbanization have caused the widespread dissemination of heavy metals in our environment. Heavy metals are among the most hazardous contaminants that may be present within the aquatic ecosystem. They pose a serious threat to aquatic biodiversity, and severe health risk for humans due to the intake of contaminated water. Several existing technologies have been used to reduce aquatic pollution, but they are generally not cost-effective, are labor-intensive and generate secondary waste. It is an intriguing option which is an eco-friendly and affordable technique. Phytoremediation, which is growing to be the most attractive innovation in this area, utilizes plants for the evacuation or alteration of ecological contaminants, causing them to become innocuous. In this chapter, we summarize use of this technique, which may play a strong role in the elimination of heavy metals from our aquatic environment using some existing macrophytes available in Bundelkhand region of Uttar Pradesh.

**Key words:** Heavy metal, Phytoremediation, Aquatic macrophytes.

SVI/O-17

## Assessment of Lukha River (Wah Lukha) with Emphasis on the Coloration Phenomena during Winter Months

*Vivek Kumar*

Department of Environmental Studies, North-Eastern Hill University, Shillong-793022, INDIA, Email: naturevivek001@gmail.com; naturevivek001@nehu.ac.in

Lukha River (Wah Lukha) is one of the most important rivers flowing in the Jaintia Hills region in Meghalaya, India. It has been a source of livelihood for the local people through the provision of fish resources. In 2007, during winter the river turned sky-blue in colour and fishes were found dead and floating on the water surface. Since then, every year the river turns turquoise to sky-blue during the winter months and along with this phenomenon of color change, fishes are found dead and floating on the water surface. During the period that the river retains this turquoise to sky-blue coloration, no fish species have been sighted in the river. Effluents from coal and limestone mining and also from the nearby cement industries have been blamed for the change in color of the river, but no clear explanation has emerged as yet. The present study focused on finding out the reason for turquoise to sky-blue color of river during winter months, to examine water quality by testing physicochemical properties of river water, and also to check if any macro-aquatic life is surviving in the colored stretch of river during coloration period. The study revealed that the turquoise to sky-blue appearance of Lukha River is due to the scattering of sunlight by the suspended aluminosilicate particles in the river water. The study also revealed that water quality of the river is deteriorated and is not fit for domestic use. One glassy fish species was found surviving in a remote pocket of the colored stretch of the river.

**Key words:** Water pollution, Lukha River, Aluminosilicate particles, Sky-blue river, Mining pollution, Meghalaya.

SVI/O-18

## River Water Quality in Relation to Alluvial Deposition and Ecological Approach

*Brajesh K. Dwivedi*

Environmental Sciences, Botany Department, University of Allahabad, Allahabad-211002, INDIA

Email: drbkdwivedi2@gmail.com, brajesh\_env@rediffmail.com

Alluvial is a natural and essential component of river systems and plays a major role in the hydrological, geo-morphological and ecological functioning of rivers. In many areas of the world, the level of anthropogenic activity is such that fine-grained sediment fluxes have been, or are being, modified at a magnitude and rate that cause profound, and sometimes irreversible, changes in the way that river systems function. This paper examines how anthropogenic activity has caused significant changes in the quantity and quality of alluvials and their deposition/ influx in the river terrain of Ganga at whole stretch of Allahabad. Heavy metals namely Co, Cu, Cr, Ni, Cd, Zn, and Pb were examined from the freshly deposited river bed sediment on a seasonal basis for the assessment of two consecutive years 2014-2015 and 2015-2016. The heavy metal concentration ranged between 09.37-26.12, 2.16-09.14, 41.25-67.08, 13.29-23.59, 0.19-0.28, 11.26-15.59 and 08.71-11.26 mg kg<sup>-1</sup> for Co, Cu, Cr, Cd, Ni, Zn and Pb, respectively in different seasons. The highest contamination degree of the sediment was noticed as 5.23. Geo-accumulation index was noted between (0 and 2, class 2) which showed that sediment was contaminated to moderately contaminated and may have adverse affects on fresh water ecology of the river. Pollution load index (PLI) was found highest (01.25), which indicates that the river alluvial/ sediment has a moderate level of contamination. The amounts of nutrient were dynamically influenced with time periods, water availability and their flow. These running water quality deterioration which may be due to insufficient water availability, flow, alluvials deposition and pollution. Various pollution indicators revealed that the river bed sediment is less contaminated by toxic metals during the study but the alluvials/ sediment

quality may degrade in the near future due to increasing anthropogenic inputs in the river basin may cause irreparable ecological approach.

**Key words:** Hydrological status of river, Alluvials/ sediment transport, Potential heavy metal, Ecological approach.

SVI/O-19

## **Arsenic Hazard Assessment in Groundwater-Soil-Rice System in Two Villages of Bengal Delta Basin, West Bengal, India**

*Munish Kumar Upadhyay<sup>1\*</sup>, Arnab Majumdar<sup>2</sup>, Anil Barla<sup>2</sup>, Sutapa Bose<sup>2</sup> and Sudhakar Srivastava<sup>1</sup>*

<sup>1</sup>Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, INDIA; <sup>2</sup>Earth and Environmental Science Research Laboratory, Department of Earth Sciences, Indian Institute of Science Education and Research, Mohanpur-741246, West Bengal, INDIA, Emails: munish007up@gmail.com, arnabmajumdar891@gmail.com, barla.neal@gmail.com, sutaparai@gmail.com, sudhakar.srivastava@gmail.com

Arsenic (As) problem in groundwater is a global menace since last three decade. Arsenic can also be build up in soil and crop plant through irrigation process. West Bengal is an important As pollution hotspot in India. To understand the actual reality about As problem, present study conducted and demonstrated As concentrations in soil, groundwater and rice grain samples of two remote villages, Sarapur and Chinili, Nadia district, West Bengal, India. The study was conducted in Sarapur and Chinili villages of Dewali Gram panchayat in Nadia district, West Bengal, India. The study also comprised a survey among people residing in these two villages to correlate the knowledge among villagers about the problem with the observed results. The data of consumption of rice per day in the survey was used for the measurement of average daily dose (ADD) and hazard quotient (HQ). The results revealed the presence of As in high concentrations in groundwater [124.50  $\mu\text{g L}^{-1}$  (Sarapur) and 138.20  $\mu\text{g L}^{-1}$  (Chinili)] and soil [47.7 to 49.3  $\text{mg Kg}^{-1}$  (Sarapur) and 57.5 to 62.5  $\text{mg Kg}^{-1}$  (Chinili)]. So, people with skin related As toxicity symptoms were also stated in

the two villages. Apart from that, analysis of As in rice grains of five popular varieties, collected from residents of two villages, presented occurrence of high As concentrations in rice grains viz- Gosai (0.95  $\text{mg kg}^{-1}$ ), Satabdi (0.79  $\text{mg kg}^{-1}$ ), Banskathi (0.60  $\text{mg kg}^{-1}$ ), Kunti (0.47  $\text{mg kg}^{-1}$ ) and Ranjit (0.29  $\text{mg kg}^{-1}$ ). Furthermore, Gosai and Satabdi were found the most popular varieties being consumed by local people. This survey based assessment is a primary observation needed to be further immediate action for arsenic remediation.

**Key words:** Average daily dose, Arsenic, Groundwater, Hazard quotient, Rice, Soil.

SVI/O-20

## **Relative Effectiveness of Different Iron Complexes in Functional Iron Availability in the Rapseed Plants**

*Rajesh K. Tewari*

Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: rktewari\_bot@yahoo.com

Iron (10  $\mu\text{M}$ ) in complex with aromatic ligands (10  $\mu\text{M}$ ) such as salicylic acid, 8-hydroxyquinoline, (+)-catechin did not provide enough Fe to plants, which was indicated by decreases in the concentrations of chlorophyll and carotenoids, activities of catalase and ascorbate peroxidase in the leaves and activated ferric chelate reductase activity in the roots. These plants exhibited cell death and accumulated ROS. Moreover, they also enhanced DNase, protease and caspase-3-like activity. Iron (10  $\mu\text{M}$ ) in complex with juglone (10  $\mu\text{M}$ ) was highly toxic as *Brassica napus* plants collapsed within an hour of treatment. However, at 10  $\mu\text{M}$  Fe and 2  $\mu\text{M}$  juglone supply plants did not show any toxic effect. While *B. napus* plants treated with aromatic organic ligands accumulated enough Fe to support normal metabolic function, they exhibited Fe deficiency-like effects. Iron (10  $\mu\text{M}$ ) in complex with non-aromatic organic ligands (10  $\mu\text{M}$ ) such as EDTA, citrate and deferoxamine supplied sufficient functional Fe to the plants for their metabolic function and growth. These plants did not produce any visible toxic effect.

**Key words:** Iron complexes, EDTA, Citrate, 8-hydroxyquinoline, (+)-catechin, Juglone, salicylic acid.

SVI/O-21

## **Industrial Water Pollution in Bangladesh and its Mitigation using the Catalyst under Ambient Condition**

*Md. Kamal Hossain\*, Umme Sarmeen Akhtar and Mohammad Moniruzzaman*

Bangladesh Council of Scientific and Industrial Research (BCSIR), Dr. Qudrat-i-Khuda Road, Dhanmondi, Dhaka - 1205, Bangladesh, Email: kamalbcsir@gmail.com

Bangladesh is one of the most populous countries in the world, facing challenges in its every aspect. Industrialization has accelerated in more recent years. Industrial sector now contributes more than 28% of the Gross Domestic Product (GDP), from around 11 per cent in the mid-1970s. Bangladesh Economic Review, manufacturing remained the largest sub-sector contributing to 17.78% of the GDP in 2009-10. Among them more than 58% are concentrated in and around Dhaka city. Textile industry uses large quantity of water in its production processes and highly polluted and toxic waste waters are discharged into sewers and drains without any kind of treatment. The textile dyeing industries of generate large amount of effluents, sewage sludge and solid waste materials everyday which are being directly discharged into the surrounding channel, agricultural fields, irrigation channels, surface water and these finally enter in to water bodies and ultimately goes to food change and living life various severe including carcinogenic disease. Extensive research is urgently need to treat this waste water for recycling and re storing and reusing this water for agricultural and fisheries sector as well as many other sector. Among the various treatment technique catalytic decomposition of industrial waste water is very important. Recently various polymorph of  $TiO_2$  is play vital role for degradation of waste water as well as reduction  $CO_2$  which is ultimately impact on climate change as well as global warming. In this experiment we chose methylene blue and 4CP as a model dye. As synthesis  $TiO_2$  more than 70% highly efficient compare to commercial catalyst. XRD, TEM, SEM, GC, Solar simulator are used for detailed structural characterization and application.

**Key words:** Bangladesh, Textile industries, Climate change, Catalyst, Dye degradation, Waste water.

SVI/O-22

## **A Sustainable Phycoremediation Coupled Lipid Production Efficiency in Green Algae under Point Source Contamination**

*Atul Kumar Upadhyay, Ranjan Singh and D.P. Singh\**

Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, INDIA, Email: dpsinghbau@gmail.com, upadhyay.eb@rediffmail.com

Water crisis and limited fossil fuel reserves are two major global concerns for the sustainable world. Fast globalization and population increase put a gigantic load on the environment to fulfill the demand of fresh water and energy. The water reserves are continuously polluted by different types of waste which is not safe for drinking (as well as for human health). A number of attempt and policies were set forth to tackle these problems yet failed due to high cost, unsustainable nature and ignorance. Thus, there is pressing need for development of such technology which synergistically treats waste water and satisfied the demand of fuel. In this view, algal based technology could be a protective measure. To achieve the goal, four stage constructed wetland system has been designed. The newly designed system consists of four rectangular tank (2.4 x 1.2 x 0.6 m). The tanks are made up of concrete fitted with poly vinyl chloride (PVC) sheet at the base to avoid seepage. The tanks were interconnected with pvc pipe of definite length and equipped with wood spinner for manual stirring of the algae. In the wetland algae were grown to treat the waste. The waste water collected from four different highly contaminated area of Lucknow, Unnao, Kanpur and Varanasi. Results revealed that the waste water collected from Vijaynagar, Jajmau of Kanpur, CETEP of Unnao and Kukrail Nala of Lucknow are highly polluted with zero dissolved oxygen and high concentration of solids, nitrate, phosphate, chloride and heavy metals as compared to EPA standard. The waste water collected from different sites will be treated with algae and checked the algal compatibility in the production of lipid and further their ecotoxicological analysis will also be analyzed under mono algal species and consortia of algae separately.

**Key words:** Algae, Waste water, Lipid, Constructed wetland, Phycoremediation.

SVI/P-1

## **Increasing Ground Water Arsenic Contamination in India: A Future Danger**

*Seema Mishra<sup>1,2\*</sup>, Sanjay Dwivedi<sup>2</sup>, Amit Kumar<sup>3</sup>, Reshu Chauhan<sup>2</sup>, Surabhi Awasthi<sup>2</sup>, and R.D. Tripathi<sup>2</sup>*

<sup>1</sup>Universität Konstanz, Mathematisch-Naturwissenschaftliche Sektion, Fachbereich Biologie, Postfach M665, D-78457 Konstanz, GERMANY; <sup>2</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>3</sup>Department of Botany, Lucknow University, Lucknow-226007, INDIA; <sup>4</sup>UFZ-Helmholtz Centre for Environmental Research, Department of Analytical Chemistry, Permoserstr 15, D-04318 Leipzig, GERMANY, Email: seema\_mishra2003@yahoo.co.in

India is consisting of 29 states and 7 union territories, including a national capital, Delhi. Elevated concentration ( $>10 \mu\text{g l}^{-1}$ ) of arsenic (As) in ground water of many states of India has become a major concern in recent years. Up to now about 0.2 million ground water samples have been analyzed for As contamination from all over India by various researchers and Government agencies. About 90% of these cover only the Eastern part of India while several states and union territories are still unexplored. However, from the available data, ground water of eighteen Indian states and three union territories has been found to be As contaminated to different extents through natural or anthropogenic origin. Among these, As  $>300 \mu\text{g l}^{-1}$  has been reported from at least one locality representing fourteen states. The maximum level of As ( $7350 \mu\text{g l}^{-1}$ ) in ground water has been reported from a highly industrialized area, Patancheru in Medak district of Andhra Pradesh. However, the gravity of problem is more in West Bengal followed by Bihar and Uttar Pradesh. Five out of eight North-Eastern states are also affected by As contamination. Manipur is ranked first and Assam as second followed by Arunachal Pradesh, Tripura and Nagaland. The ground water in these regions is naturally As enriched, and therefore wide spatial distribution of As has been found in these areas. In North India, Punjab and Haryana and in South

India, Andhra Pradesh and Karnataka are suffering with ground water As contamination. Low level of As (up to  $17 \mu\text{g l}^{-1}$ ) has also been reported in Tamil Nadu from South India. Many of the states like Jammu and Kashmir, Uttarakhand, Odisha, Gujrat, Kerala, Telengana, Goa etc. are still unexplored for ground water As contamination. Thus, according to current reports out of 640 districts in India, 141 districts are As affected (As  $>10 \mu\text{g l}^{-1}$ ), and 120 are above  $50 \mu\text{g l}^{-1}$ . Owing to the toxicity of As to humans as well as its impact on crop productivity As contamination in ground water present a great national challenge.

**Key words:** Arsenic, Ground water arsenic contamination, Indian states.

SVI/P-2

## **Appraisal of Heavy Metals in Roadside Soil from Surroundings of Ropar Wetland, Punjab, India**

*Sakshi<sup>1\*</sup>, Avinash Kaur Nagpal<sup>1</sup> and Inderpreet Kaur<sup>2</sup>*

<sup>1</sup>Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA; <sup>2</sup>Department of Chemistry, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: svsharma69@yahoo.com, avnagpal@rediffmail.com, inderpreet11@yahoo.co.in

In the present study, an attempt was made to determine the concentration of various heavy metals viz. cobalt, cadmium, lead, zinc, copper and chromium in roadside soil samples from the areas surrounding Ropar wetland, Punjab, India. Soil samples were collected from three locations along roadsides of the areas surrounding Ropar wetland in March, 2013. Contents of different heavy metals were assessed using flame atomic absorption spectrometer. It was observed that contents of different heavy metals in roadside soil samples ranged as  $1.14$  to  $14.20 \text{ mg kg}^{-1}$  for Co,  $0.26$  to  $1.10 \text{ mg kg}^{-1}$  for Cd,  $5.10$  to  $14.13 \text{ mg kg}^{-1}$  for Pb,  $20.76$  to  $45.07 \text{ mg kg}^{-1}$  for Zn,  $9.16$  to  $15.16 \text{ mg kg}^{-1}$  for Cu and  $1.30$  to  $16.35 \text{ mg kg}^{-1}$  for Cr. Order of different metals based on their metal contents was: Zn ( $31.36 \text{ mg kg}^{-1}$ )  $>$  Cu ( $11.82 \text{ mg kg}^{-1}$ )  $>$  Co ( $9.54 \text{ mg kg}^{-1}$ )  $>$  Pb ( $8.38 \text{ mg kg}^{-1}$ )  $>$  Cr ( $7.04 \text{ mg kg}^{-1}$ )  $>$  Cd ( $0.68 \text{ mg kg}^{-1}$ ). Further, it was found that 33% samples



showed Pb content above typical soil concentration of 10 mg kg<sup>-1</sup>, whereas 67% samples had higher concentrations of Co than the typical concentration of 8 mg kg<sup>-1</sup>. All samples showed Cd content to be much higher than the typical soil concentration of 0.06 mg kg<sup>-1</sup>. The high concentrations of these metals can be attributed to vehicular emissions.

**Key words:** Heavy metals, Flame atomic absorption spectrometer, Roadside soil samples.

### SVI/P-3

## Diatoms as an Important Indicators of Pollution, Futala Lake study, Nagpur, India

*M.P. Meshram\**, *K.J. Cherian* and *S.D. Dhyani*

CSIR-National Environmental Engineering Research Institute, Nagpur-440020, INDIA, Email: m.manisha1029@gmail.com

The rising carbon dioxide (CO<sub>2</sub>) emission leading to global climate change is one of the greatest environmental challenges that the world faces today. Most phytoplankton mainly diatom algae is one of the marine and freshwater plants having higher photosynthetic efficiencies than any terrestrial plants and is able to capture carbon more efficiently. Algae utilize bicarbonate directly or indirectly, by its disassociation into carbon dioxide and in so doing cause an increase in pH of the water and precipitation of calcium carbonate. Diatoms have the ability of to do this, that within a dense surface bloom an intense carbondioxide demand occurs. In western area of Nagpur, ancient Futala Lake exists since 200 years, spread over 60 acres and was selected as the study area. In this context an attempt was made to study the diatom diversity of Futala lake. The surface water samples were collected and monitoring was carried out seasonally during Jan. 2014 to Dec. 2014. Collected materials were mounted with Iodine solution and observations were recorded under the microscope and identified the taxa as per standard literature and encouraging results have been obtained. The 21 genus of Diatoms were recorded. Thus the Diatom population is represented with 41 species belonging to 21 genus of which 5 forms were of pollution indicators as per palmer index. However, the species belonging to *Bacillariophyceae* were more, it is clear that the diatom density was higher in the Futala Lake. Therefore

diatom studies not only help in a realistic assessment of pollution but it also assists in carbon sink potential.

**Key words:** Algae, Diatom, CO<sub>2</sub>, Pollution, Futala lake.

### SVI/P-4

## Effect of Arbuscular Mycorrhizal Fungi on Growth and Cadmium (Cd) Uptake by *Solanum nigrum* Grown in Cd Contaminated Soil

*P. Sharma*<sup>1</sup>, *H.P. Singh*<sup>1\*</sup> and *D.R. Batish*<sup>2</sup>

<sup>1</sup>Department of Environment Studies, Panjab University, Chandigarh, INDIA; <sup>2</sup>Department of Botany, Panjab University, Chandigarh, INDIA, Email: hpsingh\_01@yahoo.com

It is well known that plant–microbe interactions in the rhizosphere play an important role in soil fertility and plant health. Arbuscular mycorrhizal fungi (AMF) are the most important microbial symbioses for most plants roots that facilitate nutrient uptake, water relations and above-ground productivity in exchange for organic carbon from their host plants. They can enhance plant growth and resistance to toxicity produced by heavy metals, affect their bioavailability in soil and uptake by plants and thus have emerged as the most prominent symbiotic fungus for contribution to phytoremediation. A pot experiment was conducted in a dome to determine the effect of AMF association with the roots of *Solanum nigrum* in soils with different concentrations of cadmium (0, 10, 25, 45 mg Cd kg<sup>-1</sup> soil). Control and two experimental sets, one having different concentrations of cadmium and the other having different concentrations of cadmium and AMF (from plant roots) were set up. Growth, biomass, photosynthetic efficiency, Cd uptake and accumulation by the plants were measured after six weeks. A better accumulation and tolerance of Cd in the AMF-treated plants was seen as compared to the control plants and the experimental plants with Cd only. The results indicated that *S. nigrum* associated with AMF effectively enhanced the Cd uptake by plants and offer a novel strategy in microbe-assisted phytoremediation for Cd-contaminated soils.

**Key words:** AMF, Hyperaccumulator, Heavy metals, Rhizosphere, Toxicity.

SVI/P-5

## Assessment of Organochlorine Pesticide Residues in the Leaves of Medicinal Plants of Bathinda City, Punjab

*Prashant Singh and Puneeta Pandey\**

Department of Environmental Science and Technology, School for Environment and Earth Sciences, Central University of Punjab, City Campus, Mansa Road, Bathinda, Punjab-151001, INDIA, Email: prashantsingh1114@gmail.com, puneetapandey@gmail.com

India is an agriculture-dependent country where the use of pesticides is very common to control pest outbreak and avoid crop damage due to pests. Organochlorine pesticides (OCPs) are Persistent Organic Pollutants which are toxic in nature and have the tendency to bioaccumulate in lipids or fatty tissues. The present study reports the estimation of OCP residues in leaf samples of two endemic medicinal plants i.e. *Azadirachta indica* (Neem) and *Dalbergia sissoo* (Sheesham) in Bathinda city, Punjab. The study has shown the contamination of these leaf samples with a total of 9 pesticides i.e.  $\alpha$ -BHC,  $\beta$ -BHC,  $\gamma$ -BHC,  $\delta$ -BHC, Heptachlor, Aldrin, Heptachlor epoxide, Endosulfan I and Endrin. The concentration of pesticides residues ranged between 1580.01-22061.51 ng g<sup>-1</sup> for neem samples and 1547.41-8965.13 ng g<sup>-1</sup> for sheesham samples. The results showed maximum contamination of both the samples with Endrin followed by Aldrin. The concentrations of  $\gamma$ -BHC and  $\delta$ -BHC residues was found to be minimum in both the samples. The study highlights the importance of continuous long-term monitoring of the affected environment in the region.

**Key words:** Persistent Organic Pollutants (POPs), Organochlorine Pesticides (OCPs), Bathinda city, Leaves.

SVI/P-6

## Assessing Accumulation of Heavy Metals in the Bushehr Province Shore via Magnetic Properties of Sediment, Leaf and Root of *Avicenna marina*

*Shadi Karbalaeei Hassan<sup>1\*</sup>, Fateme Kardel<sup>2</sup>, Hamide Rashid<sup>3</sup> and Jelle Hofman<sup>4</sup>*

<sup>1</sup>Department of Marine and Ocean Sciences, University of Mazandaran, Babolsar, Mazandaran, IRAN; <sup>2</sup>Department of Environmental Sciences, Faculty of Sciences, University of Mazandaran, P.O. Box: 416, Babolsar, Mazandaran, IRAN; <sup>3</sup>Geological Survey of Iran, Azadi Square, Meraj Avenue, 13185-1494, Tehran, IRAN; <sup>4</sup>Lab of Environmental and Urban Ecology, Department of Bioscience Engineering, Faculty of Sciences, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, BELGIUM, Email: ShadiKarbalaeei@gmail.com; f.kardel@umz.ac.ir

In the present research, a magnetic measurement method which is a novel, inexpensive, reliable and fast method was used for assessing bioaccumulation of heavy metal pollution in root, bark, and leaf of *Avicenna marina* and sediment in Bushehr province shores, Iran. For assessing atmospheric deposition, the magnetic properties and heavy metals were measured for washed and unwashed leaf of *Avicenna marina*. The statistical results revealed that magnetic susceptibility of unwashed leaves for polluted area was significantly higher than reference area ( $p < 0.01$ ) which indicating a higher atmospheric deposition in the polluted area. Magnetic susceptibility of sediment was  $> \text{root} > \text{unwashed leaves} > \text{washed leaves}$  and tree bark. This result indicates that the magnetic particles did not translocate from sediment and root to bark and leaf of mangrove trees. The chemical composition of leaves showed that the concentration of B, Ba, Ca, Cr, Fe, Mg, Mn, Na, Ni, Pb, Rb, Se, Sr, Th and V in unwashed leaves were higher than washed leaves, and among these metals the concentration of Ca, Fe, Ni, Na, and Se were significantly higher in unwashed leaves compared to washed leaves ( $p < 0.05$ ). A positive and significant correlation was found between magnetic susceptibility of leaf and Fe, Ba, Mg, Ni, Rb, Se, Sr, Mn, Ca, and Na which indicate the source of metal in the area. According to results obtained in this research, it can be concluded that magnetic properties of

sediment can be applied for monitoring of heavy metal pollution in sediment, and the magnetic properties of leaf and bark for monitoring of atmospheric deposition. Moreover, the magnetic properties of sediment and mangrove organs (root, bark, leaf) can be applied for the evaluation of ecological impacts of heavy metal on mangrove trees, and for conservation of this sensitive ecosystem in the shore regions.

**Key words:** Heavy metal, Boushehr shore, Magnetic properties, Bioaccumulation, Mangrove trees.

SVI/P-7

## Biosorption of Lead and Cadmium by Cyanobacteria and Optimization of its Biosorption Potential

Sonal Dixit<sup>1\*</sup> and D.P. Singh<sup>2</sup>

<sup>1</sup>Department of Botany, University of Lucknow, Lucknow-226007, INDIA; <sup>2</sup>Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Raibareilly Road, Lucknow-226025, INDIA, Email: sonal.env@gmail.com, dpsingh\_lko@yahoo.com

The present study relates to the use of cyanobacterium *Nostoc muscorum* as a model system for removal of lead (Pb) and cadmium (Cd) from aquatic systems and influence of different factors on the biosorption process. The maximum sorption of Cd (83.2%) and Pb (90.3%) was achieved at 60 and 80  $\mu\text{g mL}^{-1}$  initial concentrations of respective metal, within 30 and 15 min, pH 5 and 6 respectively, with optimum cyanobacterial biomass (2.8  $\text{g L}^{-1}$ ) and at 40°C temperature. A significant proportion of Cd and Pb removal was mediated by surface binding of metals (79.2% Cd and 85% Pb), rather than by intracellular accumulation (4% Cd and 5.3% Pb). *N. muscorum* has maximum amounts of metal removal ( $q_{\text{max}}$ ) capacity of 833 and 666.7  $\text{mg g}^{-1}$  protein for Pb and Cd, respectively. The kinetic parameters of metal binding revealed that adsorption of Pb and Cd by *N. muscorum* followed pseudo-second-order kinetics, and the adsorption behaviour was better explained by Langmuir isotherm model. The surface binding of both the metals was apparently facilitated by the carboxylic, hydroxyl, and amino groups as evident from Fourier transform infrared spectra. The presence of anions and cations showed that existence of Ca and EDTA resulted in

decreased biosorption of Pb and Cd, while other anions and cations did not show significant effect. Maximum desorption of Pb and Cd was achieved in the presence of EDTA and  $\text{HNO}_3$ , respectively. Results also showed that the test biosorbent could be repeatedly used up to six biosorption/desorption cycles without significant loss of its initial metal adsorption capacity. An analysis of biosorption of Pb and Cd by using free living, immobilized living and non-viable forms of *N. muscorum* revealed that immobilized biomass of *N. muscorum* was able to remove more metal as compare to other forms.

**Key words:** Adsorption isotherms, FTIR spectra, Heavy metals, Kinetics, *Nostoc muscorum*.

SVI/P-8

## Role of Algae in the Assessment of Pollution Status of River Ganga at Kanpur, India

Vinod Rishi<sup>1</sup>, Bindeshwari Prasad<sup>2\*</sup> and A.K. Awasthi<sup>3</sup>

<sup>1</sup>Faculty of Science and Environment, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Satna, M.P., INDIA; <sup>2</sup>Department of Zoology, Sukdev Singh Luvkush PG College, Baberu, Banda, U.P., INDIA; <sup>3</sup>Department of Botany, Brahmanand College, Kanpur, U.P., INDIA, Email: vinod.rishi25@gmail.com, bindeshwari1456@gmail.com, ashok.awasthi15@gmail.com

Algae are the morphologically diverse group of autotrophic organisms. They are found in almost all kinds of habitats and are especially flourished in the organically polluted waters. Some algae highly tolerated to the organic pollution and also act as indicator of such kind of pollution. Algal samples were collected from two sampling sites viz. Bithoor (Upstream) and Jajmau (Downstream) of river Ganga at Kanpur during the period from March 2016 to February 2017 and total 51 genera spread over 228 species belonging to the class Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae have been identified. The most dominating group was Cyanophyceae followed by Bacillariophyceae, Chlorophyceae and Euglenophyceae. During the present investigations 34 genera and 36 species were identified as indicator of organic pollution on the basis of Palmer's Pollution Index (PPI)

for the assessment of pollution status of river. The PPI of both genus and species for Bithoor were 29, 28 and Jajmau 31, 32, respectively. Thus, the river Ganga at Kanpur was highly polluted due to the organic pollution.

**Key words:** Algae, Organic pollution, PPI.

SVI/P-9

## **Arsenic-Induced Nutrient Uptake in As-Hyperaccumulator *Pteris vittata***

*Xue Liu<sup>1</sup>, Changhong Liu<sup>1\*</sup>, Yungen Liu<sup>1</sup> and Lena Q. Ma<sup>1,2</sup>*

<sup>1</sup>Research Center for Soil Contamination and Remediation, Southwest Forestry University, Kunming, 650224, CHINA; <sup>2</sup>Soil and Water Science Department, University of Florida, Gainesville, FL, 32611, UNITED STATES OF AMERICA, Email: bairuixuege@126.com

*Pteris vittata* (PV; Chinese Brake fern) is the first-known As-hyperaccumulator. The success of phytoremediation depends on many factors including plant biomass, and soil As concentration and availability to plants. However, high biomass production of hyperaccumulators is a key factor. Therefore, it is important to explore ways to increase plant biomass to improve its phytoremediation efficiency. It is known that arsenic (As) promotes growth of As-hyperaccumulator *Pteris vittata* (PV), however, the associated mechanisms are unclear. Here we examined As-induced nutrient uptake in *P. vittata* and their potential role to enhance plant growth in sterile agar by excluding microbial effects. As hyperaccumulator *P. multifida* (PM) and non-hyperaccumulator *P. ensiformis* (PE) belonging to the *Pteris* genus were used as comparisons. The results showed that, after 40 d of growth, As induced biomass increase in hyperaccumulators PV and PM by 5.2-9.4 fold whereas it caused 63% decline in PE. The data suggested that As played a beneficial role in promoting hyperaccumulator growth. In addition, hyperaccumulators PV and PM accumulated 7.5 fold more As, Fe, and P than the non-hyperaccumulator PE. In addition, nutrient contents such as K and Zn were also increased while Ca, Mg, and Mn decreased or unaffected under As treatment. This study demonstrated that As promoted growth in

hyperaccumulators and enhanced Fe, P, K, and Zn uptake. Different plant growth responses to As among hyperaccumulators PV and PM and non-hyperaccumulator PE may help to better understand why hyperaccumulators grow better under As-stress.

**Key words:** Hyperaccumulators, *Pteris vittata*, Arsenic, Phytoremediation.

SVI/P-10

## **Accumulation and Distribution of Arsenic and Phosphorus in *Typha* under Arsenic Stress**

*Wei Ren<sup>2</sup>, Yuan Gao<sup>1\*</sup>, Wang Yan<sup>2</sup>, Yungen Liu<sup>2</sup> and Lena Q. Ma<sup>1</sup>*

<sup>1</sup>Research Center of Soil Contamination and Remediation, Southwest Forestry University, Kunming, 650224, CHINA; <sup>2</sup>College of Ecology and Soil & Water Conservation, Southwest Forestry University, Kunming, 650224, CHINA Email: greta\_17@163.com

Arsenic (As) is of environmental concern due to its toxicity and ubiquity in the environment. In soils, As is often present in its oxidized form arsenate (AsV), which is a phosphate (P) analog, sharing similar chemical properties and behavior. The *Typha orientalis* Presl is the research object. This experiment was conducted using the pot culture and indoor simulation systems with different As concentrations. Choosing seedlings with the most same conditions and keeping roots being flooded to simulate the growing environment of wetland. The As concentrations in sediment were 0, 50, 100, 150, 200, 400, 600 mg kg<sup>-1</sup>. After 45 d of cultivation, the plants height, dry-weight of above-ground and underground and As content were determined. The results show that: 1) different As concentrations affected the uptake of P and As in *Typha*. With the increase of As concentration in the sediment, plant P and As uptake were first increased and then decreased, which may relate to the biomass of plants; 2) the P accumulation by *Typha* in the shoots was significantly higher than that of the roots; and 3) the P transport coefficient in *Typha* from roots to shoots was higher than that of As.

**Key words:** Wetland pollution, Arsenic, Phosphorus, Distribution, Accumulation.

SVI/P-11

## Potential of Decentralized Approaches in Sewage Treatment

Aditi Roy and Pankaj Kumar Srivastava

Department of Environmental Sciences, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: adi.puja.roy@gmail.com

The conventional sewage treatment systems have always been considered as a successful approach in treating sewage. However, the centralized approaches are having constraints and complications like inefficient plant design, improper operation and maintenance, lack of continuous electricity supply and skilled manpower. The present scenario of sewage treatment plants require a total paradigm shift from a centralized to decentralized approaches where the sewage could be treated at source. Most of the centralized sewage treatment plants use the Activated Sludge Process (ASP) which is energy intensive and focusing on the disposal rather than reuse. Decentralized process like Soil Bio-technology (SBT) provides an eco-friendly and sustainable approach by processing both the solid organic wastes and waste-water through microbes and mineral additives. Integration of processes like sedimentation, infiltration and biodegradation with respiration, photosynthesis and mineral weathering, SBT helps in the bioconversion of sewage and 90% removal of COD and BOD. Unlike other conventional process, the SBT plant consists of an under-drain layer above which lies a layer of media housing culture where the raw sewage is pumped for treatment. Thus, it is required to have an alternative approach from a disposal based linear system to a recovery based closed system. The decentralized approaches for treating sewage allow flexibility in management and possess greater benefits in terms of technical, economical, environmental and social aspects. Being maintenance free it provides a feasible onsite treatment solution that is more reliable, cost-effective and also comply with the environmental standards having better treatment efficiency of municipal wastewater.

**Key words:** Sewage treatment system, Soil bio-technology, Centralized treatment, Bioconversion, Activated Sludge Process.

SVI/P-12

## Collegial Microbial Model for Arsenic Removal and Plant Growth Promotion: A Novel Approach

Manyata Sharma<sup>1\*</sup>, Pankaj Kumar Srivastava<sup>1</sup> and D.C. Sharma<sup>2</sup>

<sup>1</sup>Division of Environmental Technologies, CSIR-National Botanical Research Institution, Lucknow-226001, INDIA; <sup>2</sup>Department of Microbiology, Dr. Shakuntala Misra National Rehabilitation University, Lucknow, INDIA, Email: sharmamanyata01@gmail.com

The demand of safe eco-friendly agricultural practice is increasing all over the world. The microorganisms being used as biofertilizers/biopesticides not only showed the path to safer agricultural practice but also helps in improving soil fertility and crop productivity. Heavy metal toxicity including arsenic is a major concern now a days due to its serious impacts on human health. Globally, over 100 million people are at risk due to consumption of arsenic contaminated ground water and food produces. Arsenic in drinking groundwater water has emerged as a global health concern. The reports of arsenic contents in rice grains are of immediate concern due to its worldwide consumption. Soil harbors a wide array of microbes, colonizing in the rhizospheric region and promote plant growth. Microbes present in soil may help in the large scale bioremediation of contaminated soil. Many of such plant growth promoting rhizospheric (PGPR) microbes possess tolerance to heavy metals including arsenic. Such microorganisms are capable of reducing arsenic uptake in plants and also improve the crop yield. In this regard, development of a carrier based formulation of bio-inoculant to renovate a promising laboratory documented microbe to a commercially profitable field product can be a technology. Formulation characteristically contain active constituent or ingredient in a suitable carrier supported with additives that may assist in the stabilization and longer shelf-life of viable cells during storage and transportation of the formulation. Several studies were carried out to evaluate the effect of such formulations involving bacteria. But the use of fungi or fungi in conjunction with bacteria can be a novel approach for developing such formulation. Arsenic tolerant and plant growth

promoting microbial strains can be isolated for developing a carrier based consortia formulation and creating a bio-inoculant arsenic remediation product for their soil applications/field trials. This approach will serve dual purpose in reducing the arsenic uptake by the plants and promoting plant growth. Such carrier based microbial formulation will nullify/reduce arsenic toxicity and gain safe and sustainable agriculture.

**Key words:** Arsenic, Microbes, Consortia, Formulation, Plant growth promotion.

SVI/P-13

## Bioremediation as a Prospective Technology to Remove Cyanide from Coke Oven Plant Effluent of Steel Industry

**Saloni Rishi<sup>1</sup>\*, Pankaj Kumar Srivastava<sup>1</sup>, R.D. Tripathi<sup>1</sup>, R.N. Kharwar<sup>2</sup> and S.K. Verma<sup>2</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Centre of Advanced Study in Botany, Institute of Science, Banaras Hindu University, Varanasi-221005, INDIA, Email: rishi.saloni@gmail.com; drpankajk@gmail.com, tripathird@gmail.com, rnkharwar@gmail.com, skvermabhu@gmail.com

Cyanide is a poison and well-known as a metabolic inhibitor being released in large amounts (2-20 mg l<sup>-1</sup>) in wastewaters of different industrial processes related to metal plating, coke oven, and jewellery industry for gold and silver extraction. Its legal discharge limit as per MINAS is 0.2mg/l. Since cyanide is a fast acting toxin, therefore cyanide-containing effluents cannot be discharged without being subjected to treatment for its content beyond the permissible limit. Chemical treatments are often cost intensive and reckoning additional hazardous chemicals like chlorine to the environment. Bioremediation could be a felicitous alternative because of its speed, simplicity, cost effectiveness, and eco-friendly mechanisms. Certain bacteria and fungi metabolize cyanides by producing different enzymes like cyanide hydratase, monooxygenase, nitrilase etc. *Trichoderma* spp. has been demonstrated to produce two important cyanide-degrading enzymes, rhodanese and cyanide hydratase. *Fusarium solani* under alkaline conditions (pH 9.2-10.7) degraded cyanide by cyanide hydratase

and amidase pathways. Cyanide dihydratases readily convert cyanide to relatively non-toxic formate, does not require any cofactor and its activity is enhanced by the presence of heavy metal (Cr<sup>+</sup>, Fe<sub>3</sub><sup>+</sup>) ions. Native novel microbial communities can be utilised to harness these potential enzymes which degrade cyanide effectively and can further remediate cyanide from contaminated effluents. Additionally, the identified micro-organisms can be used as a source of potential genes for development of transgenic plants having enhanced cyanide detoxification capability. Bioremediation approach utilizing microbial consortium, fast metabolizing and transgenic plants will help in reducing cyanide concentration in effluents below the permissible level. As such it will result in development of a viable and effective integrated bioremediation technology for the cyanide contaminated wastewater and other matrices.

**Key words:** Cyanide, Bioremediation, Fungi, Wastewater, Steel.

SVI/P-14

## Remediation of Dyes in Water using Biogenic Nanoparticles

**Akanksha Pandey\* and Pankaj Kumar Srivastava**

Environmental Technologies, CSIR- National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: akanksha.p1995@gmail.com

With the rapid growth of population and increasing urbanization and industrialization, the environment pollution is becoming a serious concern worldwide. The inevitable and unjudicious release of various types of pollutants into water bodies from a wide range of industries and chemical factories has been the main cause of environment pollution. In order to ensure the better quality of people's living standard, how to ensure the pollutant-free water resources is one of the most difficult challenges in the 21<sup>st</sup> century. Among various contaminants, dyes are one of the most widely used chemicals that are mainly discharged from industries viz; textile, cosmetic, paper and leather, etc. Even at minute content (<1ppm), dyes are posing detrimental threat to ecosystem and human health risks. The wastewater containing dyes is one of the most difficult industrial wastewaters to treat. Recently,

Nanotechnology has emerged as an efficient technology for the remediation of different environmental pollutants from water. Green synthesis of nanoparticles can be done for rapid degrade atoms of dyes in wastewater. Various nanoparticles such as iron, palladium and cerium dioxide using *Camellia sinensis*, *Boswellia serrata*, and *Azadirachta indica* extracts have been reported successfully for the remediation of anthraquinone, azo and various synthetic dyes like Rhodamine B, methylene blue etc. Therefore, the idea of biogenic green synthesis of nanoparticles for the remediation of different hazardous dyes from wastewater may help in achieving an eco-friendly remediation technology for dyes.

**Key words:** Nanotechnology, Dye pollution, Remediation, Green synthesis.

SVI/P-15

## **Role of Root Exudates to Promote Fungal Growth in an Arsenic Remediating Consortium and Validation of Growth using MTT Assay**

*Ispreet Kaur<sup>1\*</sup>, Pankaj Kumar Srivastava<sup>1</sup> and Kavita Shah<sup>2</sup>*

<sup>1</sup>Environmental Technologies Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Institute of Environment and Sustainable Development (IESD) Banaras Hindu University Varanasi-221005, INDIA, Email: ispreetkaur50@yahoo.com

Arsenic is a widely recognized human carcinogen and declared as non-threshold toxic contaminant worldwide. Biomagnification of arsenic in edible parts of food produces, viz., rice grains is causing increased human health risks leading to cancer, etc. CSIR – National Botanical Research Institute has developed a novel fungal consortium with ability to tolerate and remove arsenic from contaminated matrices. These arsenic remediating fungal strains have been isolated from arsenic-contaminated paddy fields of West Bengal, India. The aim of the study was to find out the substances that may increase growth of these fungal strains during consortium preparation. Root exudates are being produced by plant roots in order to provide mechanical support and facilitating water and nutrient uptake. The exudation of a wide range of chemical

compounds as root exudates viz., L-arginine, DL-leucine, DL-methionine may change the chemical and biochemical properties of soils and thus, regulating the structure of soil microbial community exists in the vicinity of plant rhizosphere. Root exudates of different plant species may promote growth of fungal strains as well. There was a requirement to increase numbers of viable fungal cell counts in the pure fungal cultures for consortium preparation. Above mentioned amino acids were used to promote fungal cell counts and resulted in increased fungal growth by one fold log units. Despite conventional methods, an alternative method based on the transformation and colorimetric quantification of MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide] was used to determine the impact of amino acids on the increase of viable fungal cell counts. It was concluded that amino acids in the form of root exudates may increase viable fungal growth which was validated by the sensitive evaluation using MTT assay in their pure cultures.

**Key words:** Arsenic, Fungi, Root exudates, MTT assay, Amino acids.

SVI/P-16

## **Monitoring of Arsenic Bioavailable Fractions in Soils of West Bengal and its Relationship with Soil Properties for Reducing Arsenic Contamination**

*Suman B. Singh\* and Pankaj Kumar Srivastava*

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: summi29singh@gmail.com

Arsenic contamination has become one of the major environmental concerns due to potential health risk. The major arsenic contamination in soil is resulting from contaminated groundwater and enters to food chain system. The arsenic contamination in soil is regulated by its concentration and bioavailability. The bioavailable fraction of arsenic is also considered as the most significant fraction while assessing the potential risk arising from it. The arsenic interactions with various properties of soil would provide a better understanding of its availability. Therefore the current study was carried out for investigation of different available arsenic fractions. The study was also assessed the

correlation of different soil characteristics with fractions of bioavailable arsenic in contaminated soil. Soil samples were collected from 10 different sites of West Bengal, India. Three extractants, such as water, sodium bicarbonate ( $\text{NaHCO}_3$ ), di-hydrogen ammonium phosphate ( $\text{NH}_4\text{H}_2\text{PO}_4$ ), were used to extract the different bioavailable fractions viz water soluble, weakly adsorbed, specifically adsorbed and residual of arsenic, respectively. The results showed that the relative abundance of As fractions were in the order of water-soluble < weakly adsorbed < specifically adsorbed < residual. It has been found that the availability of arsenic in the paddy soils is highly and significantly correlated to pH, EC, available sulphur, organic matter and available phosphorus of contaminated soil. Bioavailable soil arsenic fraction increased with increasing available sulphur-sulfate, EC and organic matter contents and decreased with increasing P and Fe content. This study provides new insight to arsenic bioavailability in soil and this may lead with reference to develop an effective soil-specific remediation strategy to arsenic contaminated regions of India.

**Key words:** Arsenic, Bioavailable fractions, Soil property, Groundwater, Plant.

SVI/P-17

## Fungi: Remedey for Arsenic Menace

*Mariya Naseem\**, *Pankaj Kumar Srivastava* and *Neha Jaiswal*

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: mariyanaseem01@gmail.com

Arsenic is a metalloid belonging to group V of the periodic table. It exists in inorganic ( $\text{As}^{+3}$ ,  $\text{As}^{+5}$ ) as well as organic forms such as monomethylarsonic acid (MMA), dimethylarsinic acid (DMA), trimethylarsine oxide and trimethyl arsine (TMA). The inorganic forms of arsenic are more toxic compared to the organic forms and  $\text{As}^{+3}$  is relatively more toxic than  $\text{As}^{+5}$ . Arsenic is a threat to humans worldwide mostly in forty two countries, especially South Asian region. The sources of arsenic include both geogenic as well as anthropogenic. Arsenic being a systemic toxicant affects various organ systems and is a potent

carcinogen. Various strategies have been adopted from time to time to reduce arsenic contamination viz; use of surface water for irrigation, use of physico-chemical treatment options etc. These days bioremediation approaches to reduce the arsenic level at the contaminated sites are gaining popularity being eco-friendly and cost effective. Mycoremediation of arsenic contaminated sites has been found to be effective as fungi are predominant living microbiota in soil and exhibit various mechanisms to reduce As content of the affected sites viz. biosorption, bioaccumulation, biotransformation, biomethylation/ biovolatilization of arsenic and tend to reduce its bioavailability to crops. Biostimulation is a strategy which can be adopted to enhance the growth of these native arsenic remediating fungi under As stressed soils, which are also nutrient deficient. Within this strategy organic matter amendments are added to enhance the performance of the soil fungi leading to the better arsenic removal. Rice straw, biochar and cow dung manure are some of such amendments that have been found effective in stimulating the growth of arsenic remediating fungi leading to better removal of arsenic in contaminated matrices (water and soil) compared to unamended matrices.

**Key words:** Arsenic, Bioremediation, Biostimulation, Fungi, Nutrients.

SVI/P-18

## Mycoremediation a Potential Solution for Arsenic Remediation in Soil

*Priya Dubey\**, *Sneh Lata* and *Pankaj Kumar Srivastava*

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: priyadubeyd@gmail.com, drpankajk@gmail.com

Availability of arsenic in soil is toxic to plants. Developing countries such as Bangladesh, Cambodia, Chile, China, USA, Argentina and India are the worst arsenic affected countries. Arsenic exposure leads to serious threat to human health such as skin lesions, skin cancers, neurological, cardiovascular diseases. Arsenic contamination in soil occurred due to use of arsenic containing pesticides, mining activities, wood preservatives and irrigation with arsenic contaminated



groundwater. There are some physico-chemical methods for arsenic reduction or immobilization in soil but these methods have some limitations such as generation of highly toxic waste, as secondary source of contamination and high cost. Therefore, there is need of less expensive ecofriendly technologies like bioremediation for arsenic decontamination. Arsenic in soil should be below 20 mg kg<sup>-1</sup> as per FAO and for paddy grains it's should be below 1 mg kg<sup>-1</sup> of dry weight (WHO). Arsenic contamination in soil environment has now gained concern of scientific community because of its accumulation in rice (above its permissible limit) a major staple crop especially in Asian countries. In this review, mycoremediation (remediation by fungal biomass) has been reviewed for lowering and immobilizing arsenic concentration in soil and ultimately its accumulation by plants. Various mechanisms have been reported based on fungal activity to immobilized arsenic through bioaccumulation, redox reactions, volatilization, methylation, co-precipitation and complexation or chelation of arsenic from the contaminant sites. Among these mechanism methylation or methylation followed by volatilization have been found comparatively more effective arsenic decontamination process. Since fungi have advantage over other microbes due to having comparatively larger biomass, hyphal network, metabolic competence for metals, and longer life-cycle. Therefore, methylation of arsenic using soil fungi concluded as a potential alternative to arsenic remediation from soil.

**Key words:** Arsenic, Mechanism, Mycoremediation, Review, Soil.

SVI/P-19

## Soil Arsenic: Contamination in Uttar Pradesh

*Richa Mishra\**, *Neha Jaiswal* and *Pankaj Kumar Srivastava*

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: richa7087@gmail.com

Arsenic (As) toxicity is a global environmental, agricultural and health issues. It is generally found in trace quantities in rock, soil, water, air and get increased both due to natural as well as human activities. It occurs in both organic and inorganic forms. Among both of

them, inorganic forms of arsenic i.e. arsenate (AsV) and arsenite (AsIII) are highly toxic to living organism. These inorganic forms of arsenic are easily taken up by the plants. Arsenic contaminated water used for drinking, irrigation purpose and food preparation poses great threat to public health. In India, arsenic concentration in ground water has been found ranging from <10 ppb to as high as 3192 ppb by several authors. Environmental protection agency (EPA) has reduced the maximum contamination level for arsenic in drinking water from 50 ppb to 10 ppb. In soil background arsenic concentrations has been reported from 1 to 40 ppm with a mean value of 5 ppm. Due to emerging problem of arsenic accumulation in plants, soil contamination has gained interest. Various plants species have different mechanisms responsible for As (III) and As (V) uptake, toxicity and detoxification in plants at physiological and biochemical levels. Its chemistry is governed by oxidation-reduction process, acid-base reactions, absorption-precipitation process, plant uptake and accumulation. Ultimately, such mechanisms for reducing arsenic contamination provide the opportunity to safe agriculture practices and hence safeguarding the food supply. The use of bioremediation is a potential method to reduce arsenic concentration in contaminated areas of Gangetic plains of Uttar Pradesh. Bioremediation process in this regards in an option that offers the possibility to destroy various contaminants using plants and microbes. The aim of this article is to review arsenic contamination in soil and its mechanisms for removal from the contaminated source by the potential application of plant and microbes.

**Key words:** Acid-base reaction, Arsenic toxicity, Bioremediation, Detoxification, Soil contamination.

SVI/P-20

## An Application of Various Biogenic Nano Materials for the Remediation of Arsenic Contaminated Water

*Sampurna Nand\**, *Virendra Jaiswal* and *Pankaj Kumar Srivastava*

Department of Environmental Technologies, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: nandsam1005@gmail.com

Arsenic is a naturally occurring metalloid in the

earth's crust and is a potential human carcinogen. Geogenic arsenic contamination in groundwater is prevalent in several countries of the world viz; Bangladesh, China, USA, India etc., which is posing serious health hazards such as skin lesions, carcinogenic aliment in human beings. Several technologies have been applied for mitigation of arsenic contaminated water such as filtration, coagulation, membrane separation, ion exchange, etc. But these methods are less effective, requiring high material costs, high energy requirements, and generation of sludge. To overcome these limitations, nanotechnology has been emerged as a proficient strategy to treat arsenic contaminated water in a more specific and accurate way using biogenic nano materials. Nanomaterials (NMs) have higher surface volume due to their nano size and possessing other relevant biologically properties. NMs which are being synthesized using biological organisms (e.g. microbes and plants) are referred as biogenic nanoparticles. The biogenic synthesis of NMs mainly involves bioreduction and bioprecipitation by polyphenols, peptides, amino acids and other bioactive compounds obtained from living organisms. In the present study, promises and challenges for synthesis of biogenic nanomaterials from bacteria, fungi, yeast, algae and plants have been discussed to synthesize various size and shape of metallic nanoparticles. Of these biogenic NMs, our aim to apply the plant-mediated synthesis of biogenic nanomaterials and their potential applications in removing arsenic from contaminated water as being a feasible, efficient and ecofriendly.

**Key words:** Arsenic, Biogenic, Nanotechnology, Bioremediation, Contamination.

SVI/P-21

## **Arsenic Removal from Contaminated Water by Modified Fungal Biomass**

*Soni Chauhan\*, Snehlata and Pankaj Kumar Srivastava*

CSIR-National Botanical Research Institute (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, INDIA, Email: soni100chauhan@gmail.com

Arsenic is a toxic metalloid, exists in naturally inorganic and organic forms. Inorganic forms of arsenic

are more toxic than its organic forms, which is predominant in arsenic contaminated groundwater. The presence of arsenic in groundwater has been a major public health concern in many countries, such as Bangladesh, India, Thailand, China, USA and Nepal. Human exposure of arsenic occurs via arsenic polluted water, through ingestion of arsenic contaminated food produces. It may cause 'arsenicosis' and several carcinogenic diseases. Biosorption is a treatment process involving biological oxidation-filtration-sorption processes. Fungi have been recognized as promising low-cost adsorbents for arsenic removal from arsenic contaminated water. Arsenic removal using fungal biomass have been found effective after modification of fungal biomass by various modifying agents. There are various modifying agents such as iron oxide, ferric chloride, and surfactants (such as hexadecyl-trimethyl ammonium bromide and dodecylamine). Most of the studies using fungal biomass (*Penicillium purpurogenum*, *Aspergillus niger*, *Aspergillus fumiguts* and *Aspergillus flavus*) revealed that modification with different salts of iron have potential to remove arsenic from the drinking water as well as from waste water. Different surfactants as modifying agents have been used for arsenic removal from waste water. Fungi have a specific metal-binding proteins and peptides (such as metallothioneins). Iron oxides have been reported to have relatively high affinity for several inorganic oxyanions. Easy recovery of iron from the saturated arsenic loaded fungal biomass by magnetic separation process added the advantage of using iron modified fungal biomass.

**Key words:** Aqueous solution, Arsenic removal, Biosorption, Fungal biomass, Iron oxide.

SVI/P-22

## **Green Hydrogels: Most Promising Alternative to Remove Arsenic from Water**

*Vartika Gupta\*, Pankaj Kumar Srivastava and Neha Jaiswal*

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: vartika1292@gmail.com

Arsenic (As) contamination is a global problem

now. Arsenic is a naturally occurring toxic metalloid found in organic and inorganic forms, widely spread in the environment. It occurs due to geogenic processes and anthropogenic activities including industrial, agriculture, mining etc. Inorganic arsenic generally composed of trivalent arsenite (As III) and pentavalent arsenate (As V). In the contemporary times, one of the most accustomed problems is to provide cost effective cleaner technology to remove arsenic from contaminated water affecting human health worldwide. Numerous chemical methods (oxidation/ precipitation, coagulation, ion exchange, and membrane-based separation) have been applied to remove arsenic from water sources. These strategies are simple, but the disadvantages with these methods affiliate viz. huge amount of toxic sludge, poor settling and aggregation of metal precipitates. Among all treatments, the adsorption technique has proven to be efficient technique which requires low operating and maintenance cost and does not produce harmful byproducts. During the last few decades, potential utilization of renewable feedstock based hydrogels for heavy-metal adsorption for water remediation has been continuously rising. Several biopolymers such as chitin, starch, cellulose etc. have been used to develop hydrogels. It readily removes arsenic ions from contaminated water and may give arsenic free water. Owing to the existence of functional groups i.e. carboxylic acid, hydroxyl, sulfonic acid etc. metal ions can penetrate the porous structure of bio-based hydrogels and form stable complexes with these groups. It involves several mechanisms like electrostatic interactions, complex formation, chelation etc. Thus, utilization of green biogenic hydrogels for heavy-metal adsorption particularly arsenic should be done to gratify safe and clean drinking water to human population living in arsenic contaminated areas.

**Key words:** Arsenic contamination, Environment, Inorganic arsenic, Hydrogels, Remediation.

SVI/P-23

## Self Cleansing Properties of Ganga during Mass Ritualistic Bathing on Maha-Kumbh

*Sanjay Dwivedi<sup>1</sup>, Puneet Singh Chauhan<sup>1</sup>, Seema Mishra<sup>1</sup>, Amit Kumar<sup>1</sup>, Mohan Kamthan<sup>2</sup>, Reshu Chauhan<sup>1</sup>, Surabhi Awasthi<sup>1</sup>, Pradyumna Kumar Singh<sup>1</sup>, Sumit Yadav<sup>1</sup>, Aradhana Mishra<sup>1</sup>, GeetGovindSinam, Shekhar Mallick<sup>1</sup>, Sanjeev Kumar Ojha<sup>1</sup>, Sri Krishna Tewari<sup>1</sup>, RudraDeo Tripathi<sup>1</sup> and Chandra Shekhar Nautiyal<sup>1\*</sup>*

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Environmental Toxicology Division, CSIR-Indian Institute Toxicological Research, Lucknow-226001, INDIA, Email: drs\_dwivedi@yahoo.co.in

The aim of present study was to evaluate the changes in physicochemical properties, microbial diversity and role of bacteriophages in controlling bacterial population of Ganga water during mass ritualistic bathing on the occasion of Maha-Kumbh in 2013. The BOD, COD, hardness, TDS and the level of various ions significantly increased while DO decreased in Ganga water during Maha-Kumbh. Ganga water was more affluent in trace elements than Yamuna and their levels further increased during Maha-Kumbh which was correlated with decreased level of trace elements in the sediment. The bacterial diversity and evenness were increased and correlated with the number of devotees taking dip at various events. Despite enormous increase in bacterial diversity during mass ritualistic bathing, the core bacterial species found in pre-Kumbh Ganga water were present in all the samples taken during Kumbh and post-Kumbh. In addition, the alteration in bacterial population during mass bathing was well under the 2 log units, which can be considered negligible. Study of bacteriophages at different bathing events revealed that Ganga was richer in presence of bacteriophages in comparison to Yamuna against seven common bacteria found during the Maha-Kumbh. These bacteriophages have played role in controlling bacterial growth and thus preventing putrefaction of Ganga water. Further the abundance of trace elements in Ganga water might also be a reason for suppressing the bacterial growth.

**Key words:** Bacteriophage, Ganga River, Microbial diversity, Metal contamination.

SVI/P-24

## Ganga Water Pollution Due to Religious Activities

*Sanjay Dwivedi<sup>1</sup>, Seema Mishra<sup>1</sup>, Lalit Agrawal<sup>1</sup>, Geetgovind Sinam<sup>1</sup>, Sita Ram Taigor<sup>2</sup>, R.D. Tripathi*

<sup>1</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>UP State Ganga River Conservation Agency; Under Urban Development Department, Govt. of Uttar Pradesh, INDIA, Email: drs\_dwivedi@yahoo.co.in

River Ganga is considered as the soul purifier and Mokshdayini, means a dip in the Ganga liberates from the cycle of death and rebirth. The Ganga basin houses many historical towns like Rishikesh, Haridwar, Garhmukteswar, Kannauj, Allahabad, Mirzapur, Varanasi and Gangasagar which are important pilgrim centers where several religious activities takes place throughout the year on the bank of Ganga. During different festivals billions of people come to these places for holy dips called “Ganga snans”. Devotees offer different kinds of materials like sweets, milk, flowers, leaves, lighted earthen lamps to Ganga, and discard remains of old holy books and idols thereby contaminating the river water. Several communities in India throw dead bodies and the remains of bones, after crimation, in Ganga as a part of last ritual. More than 1000 tons of flower and garlands are thrown in the river as offering during worship of Ganga as well as those used in the temples nearby. At various places such as Haridwar, Varanasi etc. splendid evening prayer of Ganga is being held during that the devotees offers flowers and hundreds of floating lighted earthen lamps. These processes are more during mass rituals. According to an estimate of Kashi Vishwanath temple administration of Vanarasi, in normal days, over 20 quintal of floral waste was being disposed into the Ganga daily, while during special occasions like Mondays of the month of Shrawan (July-August), the quantity increased by four to five times. Further each household dispose of their religious material, including those used in daily prayer, into the Ganga. Thus, floral and other religious temple wastes continue polluting Ganga water. The impact of different religious activities

on Ganga water has been studied extensively and will be discussed during conference.

**Key words:** Devotees, Floral wastes, Holi dip, Ganga river.

SVI/P-25

## Emerging Arsenic Removal Technologies from Ground Water in India

*Sanjay Dwivedi<sup>1\*</sup>, Seema Mishra<sup>1,2</sup> and R.D. Tripathi<sup>1</sup>*

<sup>1</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Deen Dayal Upadhyay Gorakhpur University, Gorakhpur-273009, U.P., INDIA, Email: drs\_dwivedi@yahoo.co.in

Drinking water is one of the main sources of arsenic (As) exposure to humans particularly in Indian subcontinent where ground water As contamination is common phenomenon. The conventional techniques for As removal involves chemical precipitation, oxidation and coagulation which often show lower efficiency, consumption of chemicals, production of toxic sludge and thus, having many disadvantage. In recent years, various organizations have developed a number of As removal devices/ units showing good As removal efficiency from ground water (GW). These techniques are novel, eco-friendly, sorbent material based and have higher sorption capacity of As. These devices/ units vary in size, filtering mechanisms, and mechanisms of operation, therefore based on the size, the devices are of two type's: (1) Arsenic Removal Unit (ARU) and (2) Arsenic Removal Plant (ARP). Arsenic Removal Units are those, whose inlet are directly connected to a hand pump or tube well. It is normally a small domestic assembly which can filter up to 500 l of water per day and can meet requirement of water for a smaller section of people. These arsenic removal plant/units are *Ceramic micro-filtration membrane unit; AMRIT; IITB arsenic filter; DRDO arsenic removal filter; Low cost laterite based arsenic filter; ARI ground water arsenic treatment plant*. Arsenic Removal Plants (ARPs) has the capability to treat a large quantity of water and can cover a large section of general public. These technologies have demonstrated good efficiency

to remove As below WHO permissible limits for drinking water ( $10 \mu\text{g l}^{-1}$ ) under field conditions in As affected areas.

**Key words:** Arsenic, Arsenic Ground water problem, Treatments plants.

SVI/P-26

## Contamination of Arsenic in Ghaghara Basin: A Potential Threat to Local Inhabitants

*Sanjay Dwivedi<sup>1</sup>, Seema Mishra<sup>1,2</sup>, Vishnu Kumar<sup>\*1</sup>, Pragya Sharma<sup>\*1</sup>, Amit Kumar<sup>1</sup> and R.D. Tripathi<sup>1</sup>*

<sup>1</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Deen Dayal Upadhyay Gorakhpur University, Gorakhpur-273009 (U.P.), INDIA, Email: vishnukumar772@gmail.com, sharmapragya766@gmail.com

Chronic arsenic toxicity from ingestion of contaminated drinking water has been reported from many countries of the world, including India. In India, eighteen states and three union territories are facing ground water arsenic problem. Uttar Pradesh, one of the severely arsenic affected state, is located at north of India bordering Nepal. The Ghaghara, sub-basin of Ganga basin has a total catchment area of 58,634 Sq.km. where two big rivers flowing from the northwest to the south-east are Ghaghara and Sarda. Up to now the As contamination has been said to be mostly confined in Ganga basin originating from Himalaya. However, recent studies have shown that several district situated in Ghaghara basin also have higher level of As in ground water. The Terai planes of Ghaghara is particularly As contaminated. Ghaghara basin covers 5 districts of Nepal (one is arsenic affected), fifteen of Uttar Pradesh (eleven are arsenic affected) and seven of Bihar (two are arsenic affected) in India. These arsenic affected districts of Ghaghara basin having different levels of ground water arsenic contamination. In Ghaghara basin, the maximum arsenic concentration in ground water is reported from Bhojpur district of Bihar ( $1654 \mu\text{g l}^{-1}$ ) followed by Ballia ( $1310 \mu\text{g l}^{-1}$ ), Gazipur ( $531 \mu\text{g l}^{-1}$ ), Gonda ( $510 \mu\text{g l}^{-1}$ ), Faizabad ( $350 \mu\text{g l}^{-1}$ ), Basti ( $150 \mu\text{g l}^{-1}$ ) and Bahraich ( $100 \mu\text{g l}^{-1}$ ). The results of different studies revealed that the ground water of hilly

region of Ghaghara basin is less arsenic polluted being maximum ( $4.7 \mu\text{g l}^{-1}$ ) in Mugu district of Nepal. In these districts cereal crops like rice and animal based food are the main As exposure to human due to transfer of As to higher tropic level through food chain contamination. The many local inhabitants of these districts are suffering from different disease induced by arsenic accumulation in their body. The highest amount of arsenic has been detected in their nails followed by hairs and urine.

**Key words:** Ghaghara basin, Arsenic, Arsenic Ground water problem, Arsenicosis.

SVI/P-27

## Use of Plants and Animals as Bio Indicators in Ancient Indian Science of Climatology and Effect of Climate Change on it

*Navneet Shukla\* and Vinod Shukla*

<sup>1</sup>Department of Forestry, Dolphin P.G Institute of Biomedical and Natural Sciences, Chakrata Road, Dehradun-248007, Uttar Pradesh, INDIA; <sup>2</sup>Department of Geography, Munishwar Dutt Post Graduate College, Pratapgarh-230001, Uttar Pradesh, INDIA, Email: nvneet4@gmail.com, vinodshukla177@gmail.com

Like other sciences, the science of Climatology based on plant and animal behaviour was well developed in ancient India. It is unfortunate that, now a days, we do not pay proper attention to our ancient Indian sciences. Somehow ancient Indian science have lost all their utility in the face of the modern sciences. But this concept will prove false if we try to realize the real merits of the ancient Indian sciences. The main difference between the modern sciences and ancient Indian sciences is that, in modern sciences, the deeper we go the more we have to depend upon costly machines and other instruments. Thus, the earth and the atmosphere had been their laboratory wherein the plants and animals, other natural objects had to serve the purpose of instruments and equipment's. We can found some folklores by *Ghagh* and *Bhadduri* describing the relationship of phenological characters of some plants with rain forecasting. *Brihat Samhita* of *Shri Varahamihira* also contains important botanical data which is itself is an encyclopaedia of astrology.

We found some temporal variations in weather and monsoonal events, while studying present weather conditions using these bio indicators as weather forecasting tool and comparing them with pre described theories given by ancient Indian Rishis. Research need and priorities emphasized on- i. Identification and inventorization of flora as bio indicator species to promote non-destructive study of climate change. ii. Establishment of bio indicator gardens for research and educational purposes. iii. Awareness about the importance of ancient Indian sciences among young researchers.

**Key words:** Bio indicators, Ancient Indian Science, Plants and animals, Weather forecast, Climate change.

SVI/P-28

## Bioremediation of Sewage using Two Potential Microalgae

*Atul Kumar Singh\*, Chitrlekha Nag Dasgupta, Kiran Toppo and Sanjeeva Nayaka*

Algology Laboratory, CSIR- National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, INDIA, Email: atulfc2114@gmail.com

Rapid urbanization and increase of municipal sewage resulted in load on conventional sewage disposal system. The composition of municipal sewage water mostly contains natural organic and inorganic minerals as well as man-made compounds. Microalgae utilize these wastes as nutritional sources and improve the quality of sewage water. In the present study, algae belonging to Chlorophyceae family showed good and healthy growth in sewage waste water by absorbing and utilizing organic and inorganic waste. Two isolates *Scenedesmus quadricuada* and *Chlorella vulgaris* were used for treatment of sewage water of Bharwara Sewage Treatment Plant (STP) located in Gomti Nagar, Lucknow. More than 6 times improvement in dissolved oxygen (DO) concentration has been noticed. About 12.50 reductions were obtained in total dissolved solids (TDS). Chemical oxygen demand (COD) and biological oxygen demand (BOD) was reduced by 33.77% and 19.62% respectively. After treatment COD and BOD were found 50.4 and 17.2 mg L<sup>-1</sup> which are within the limits of standard specified by CPCB norms, 2015. Treatment induced progressive reduction of phosphorus

(86.90%), nitrogen (64%.16), potassium (72%), total organic carbon (202%), chlorine (35%), phenol (38.46%), hardness (51.48%) and floride (64.90%). The microalgae also demonstrated high reduction in the percentage of different heavy metals in the range between 43 to 99% in continuous system. Waste water supported algal growth which exhibit number of dependent and independent metabolism process of the uptake and accumulation of heavy metal. Thereby with recent advances in scientific knowledge, sophisticated techniques and environment awareness microalgae could offer an elegant, environment friendly solution to tertiary and quandary treatments of sewage water. Furthermore, harvested algal biomass can be utilized for several value added products development such as bioenergy, pharmaceuticals, nutraceuticals, genetically engineered products etc.

**Key words:** Phycoremediation, Biorefinery, Waste-water treatment, Chlorophyceae.

SVI/P-29

## Phytoremediation Potentiality of Four Fly Ash Tolerant Plants Grown On Fly Ash Dykes: A Case Study of Obra Thermal Power Station, Sonebhadra, India

*Ashutosh Pandey\*, Sanjay Dwivedi, Shekhar Mallick, Nandita Singh and Vivek Pandey*

Plant Ecology and Climate Change Division; CSIR-National Botanical Research Institute Lucknow-226001, INDIA, Email: apandeymsb@gmail.com

Heavy metal contamination in water and soil is a big challenge of 21<sup>th</sup> century. Due to increasing demand of electricity in India, millions of tons of fly ash is generated per annum from thermal power plants. Fly ash contains high amount of toxic elements which not only affect the local vegetation, but their accumulation in crop plants results in food chain contamination. The present study is focused on to assess the phytoremediation potentiality of four plants namely *Phragmites kraka*, *Saccharum spontaneum*, *Canna occidentalis* and *Pteris vittata*. These selected plants were transplanted on fly ash dykes in the month of September 2016 and monitored after one year in terms

of plant height, biomass and heavy metal accumulation in different plant parts. The results indicated that fly ash contains significant amounts of Mn (411 mg kg<sup>-1</sup>), Fe (11083 mg kg<sup>-1</sup>), Cu (41 mg kg<sup>-1</sup>), Zn (27 mg kg<sup>-1</sup>) and toxic Cr (61 mg kg<sup>-1</sup>), Ni (40 mg kg<sup>-1</sup>), As (8 mg kg<sup>-1</sup>), Pb (4 mg kg<sup>-1</sup>) metals. Among the plants, *Saccharum spontaneum*, accumulated highest amount of Cr (5 mg kg<sup>-1</sup>) and Ni (13 mg kg<sup>-1</sup>) in roots, while arsenic was found highest in the shoot of *Pteris vittata* (38 mg kg<sup>-1</sup>). After one year, the reduction in metal content of fly-ash was found maximum for Cu (65%) followed by As (64%), Cr (55%), Zn (46%) and Ni (35%), Fe (31%) and Mn (22%). Therefore, the study concluded that the *Saccharum spontaneum*, and *Pteris vittata* are the most suitable plants to develop phytoremediation technique for decontamination of fly ash dykes. Correlation of different parameters/results will be presented during the conference.

**Key words:** Fly-ash, Heavy metals, Food chain contamination, Phytoremediation.

SVI/P-30

## Arsenic Contamination Confines Fertility Indicators of Paddy Soil

*Vijay Kant Dixit, Shashank Kumar Mishra, Sankalp Misra, Arpita Singh, Puneet Singh Chauhan\**

Division of Plant Microbe Interactions, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: puneetn bri@gmail.com

Emerging environmental issues related to heavy metal contamination in rice draw great concern about the soil quality of paddy farming lands irrigated with groundwater. Investigating the functioning of soil microorganisms exposed to heavy metal contamination is imperative for agricultural soil manipulations. The current study accentuates the influence of heavy metals on microbial activity and community composition in arable soil of West Bengal State of India. The result revealed that the fertility indicators (activity of all soil enzymes) and growth-limiting factors (soil N and P) were negatively correlated with the heavy metal stress except the soil total organic content which demonstrated significant positive correlation with the heavy metals. In case of functional diversity of soil, all the considered diversity indices exhibited no specific pattern along with

the availability of heavy metals. Further, despite the heavy metal contamination, we observed a very complex and indifferent pattern of bacterial community composition along the heavy metal contamination sites. Overall, we found that c-Proteobacteria had been the most abundant bacterial community followed by Actinobacteria, Firmicutes, b-Proteobacteria and a-Proteobacteria. Commemorating all the results, we can infer that arsenic and other heavy metal contamination is deteriorating the soil quality and hence warrants immediate attention of concerned soil scientist and agronomists.

**Key words:** Arsenic, Paddy, Proteobacteria, Enzymes.

SVI/P-31

## A Study on Carbon Sequestration Potential of *Chlorella ellipsoidea* Isolated from Domestic Sewage Water with Inorganic Source of Carbon

*Himangshu Sharma\*, Mahdi Ahmed, Pampi Sarmah and Jayashree Rout*

Phycology and Lichenology Laboratory, Department of Ecology and Environmental Science, Assam University, Silchar, Assam (India) Pin-788011, Email: hshimangshu270@gmail.com, mahdiaahmed438@gmail.com, mailtopampi@rediffmail.com, routjaya@rediffmail.com

The potential of microalgae have been well recognized for its efficient carbon fixation and contribution in substantial biomass production. The present paper highlights the carbon sequestration efficiency of a freshwater algal species viz. *Chlorella ellipsoidea* isolated from domestic sewage water of Cachar district, Assam (India). Growth response of the aforementioned species was monitored under varying concentrations of nitrate (1.0, 1.5, 2.0 g l<sup>-1</sup>), phosphate (0.03, 0.04, 0.05 g l<sup>-1</sup>) and CO<sub>2</sub> (g) (20, 40, 60, 80, 100 ml min<sup>-1</sup>). The value of pH ranges from 5.92 to 9.93. The maximum chlorophyll *a* content and cell density in case of *Chlorella ellipsoidea* was estimated to be 4.79 µg ml<sup>-1</sup> and 984 cells/ml × 10<sup>4</sup> during study period respectively. The maximum protein and carbohydrate content was observed to be 44.99 µg ml<sup>-1</sup> and 118.97 µg ml<sup>-1</sup>, respectively. The highest biomass productivity and CO<sub>2</sub> fixation rate was found to be 64.3

(mg l<sup>-1</sup> day<sup>-1</sup>) and 120.89 (mg l<sup>-1</sup> day<sup>-1</sup>), respectively. This microalga seems to be a promising candidate for effective carbon sequestration ability and in general, this study may be advanced further for strategic optimization of higher microalgal biomass yield, lipid production and other value added products.

**Key words:** Carbon sequestration, Microalga, *Chlorella ellipsoidea*, Sewage.

SVI/P-32

## Removal of Emerging Contaminants of Municipal Wastewater through Sustainable Phytotechnologies

**Gurudatta Singh\* and Virendra Kumar Mishra**

Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: gurudatta.singh2@bhu.ac.in

This study mainly discuss the removal of emerging chemicals in wastewater through phytotechnologies. The occurrence of emerging contaminants or newly identified contaminants in municipal wastewater is of continued concern for the health and safety of public. The design parameters of the reported constructed wetlands including the physical configuration, hydraulic mode, vegetation species, and targeting pharmaceuticals were summarized. The removal efficiencies of pharmaceuticals under different conditions in the wetlands were evaluated. In addition, the importance of the three main components of constructed wetland (substrate, plants and microbes) for pharmaceutical removal was analysed to elucidate the possible removal mechanisms involved. The compounds were extracted from municipal wastewater samples by solid phase extraction and analyzed by ultra-performance liquid and gas chromatography couple with tandem mass spectrometry (UPLC, GCMS, MS). Most of the target compounds were detected with the concentration of 4.4 ng L<sup>-1</sup> to 6.6 µg L<sup>-1</sup>. Phytoremediation technology through constructed wetland was used to remove target compounds such as sulhamethoxazole and tetracycline, with the removal efficiency of 17% to 98% for sulhamethoxazole, and 12-80% for tetracycline was achieved. Constructed wetlands had better efficiency to remove emerging contaminants from wastewater.

**Key words:** Wastewater, Emerging chemicals, Phytoremediation technology, Constructed wetland.

SVI/P-33

## Strategies for Arsenic Reduction in Crops for Sustainable Environment and Agriculture

**R.D. Tripathi<sup>1\*</sup>, R. Chauhan<sup>1</sup>, S. Awasthi<sup>1</sup>, P.K. Singh, M. Shri<sup>1</sup>, P. Verma<sup>1</sup>, S. Dwivedi<sup>1</sup>, S. Mishra<sup>2</sup>, P.K. Srivastava<sup>1</sup>, B. Adhikari<sup>3</sup>, P.K. Trivedi<sup>1</sup> and D. Chakrabarty<sup>1</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Uttar Pradesh, INDIA; <sup>2</sup>DDU University, Gorakhpur, Uttar Pradesh, INDIA; <sup>3</sup>Rice Research Station, Department of Agriculture, Chinsurah, Hooghly, West Bengal, INDIA, E-mail: tripathird@gmail.com

Arsenic is a widely recognized human carcinogen and declared as non-threshold toxic pollutant worldwide. The most common routes of arsenic exposure to humans are the usages of contaminated water for drinking and irrigation in agricultural field. This leads to arsenic contamination in crops and vegetables grown on such soil eventually contaminating the food chain. In a regime where cultivation of GM crops are not encouraged, selection of low grain arsenic cultivars of crops through breeding process, needs to be extensively explored. Rice being a cereal consumed by half of world's population, needs special attention. Through breeding and selection, a rice cultivar CN1794-2-CSIR-NBRI was developed. This rice cultivar while accumulating low As maintains higher level of micronutrients such as Fe, Cu, Zn, Se and Ni. Application of arsenic tolerant bacterial strains decreased arsenic uptake in shoots and increased stabilization of arsenic in root zone of rice plants, can also be a cheap and safer strategy. In order to restrict As in the rice roots a transgenic approach has been followed through expression of phytochelatin synthase (PCS), CdPCS1, from *Ceratophyllum demersum*, an aquatic As accumulator plant. Rice transgenic lines showed enhanced accumulation of As in root and shoot. However, all the transgenic lines accumulated significantly lower As in grain and husk in comparison to non-transgenic plant. The higher level of PCs in transgenic plants relative to non-transgenic presumably allowed sequestering and detoxification of higher



amounts of As in roots thereby restricting its accumulation in grain. Another approach could be of As volatilization through genetically engineered *Arabidopsis thaliana* with arsenic methyltransferase (*WaarsM*) gene from one of the fungal strain *Westerdykella auantiaca* (MTCC10845), isolated from arsenic-contaminated sites. The *WaarsM* transgenic *A. thaliana* plant showed enhanced tolerance to AsV and AsIII, compared to wild-type (WT) plants. *WaarsM* expressing transgenic plants evolved significant amount of volatile arsenicals ( $\text{mg}^{-1}$  fresh weight) after 48 h of exposure. Further, *WaarsM* gene expressed in rice was able to convert toxic inorganic arsenicals to methylated arsenic species, therefore, reduce arsenic accumulation in rice grains. In response to arsenic treatment in hydroponics, *WaarsM* expressing transgenic lines showed a marked increase in arsenic resistance and reduced its accumulation compared to NT. Also, *WaarsM* expressing transgenic Line 1 evolved c.a. 157 ng and c.a. 43 ng volatile arsenicals ( $\text{mg}^{-1}$  fresh weight) after 72 h of exposure to 25  $\mu\text{M}$  AsIII and 250  $\mu\text{M}$  AsV, respectively. Transgenic line 1, grown in soil irrigated with arsenic-containing water accumulates about 50% and 52% lower arsenic than the NT in shoot and root, respectively; while arsenic concentration in polished seeds and husk of the transgenic line was reduced by 52% compared to NT. Thus, the present study demonstrates that the expression of *WaarsM* in rice induces arsenic methylation and volatilization, provides a potential strategy to reduce arsenic accumulation in rice grain. Suitable combined biotechnological and microbe plant interaction approaches may lead to safer levels of arsenic in the food crops grown in the arsenic contaminated soils.

**Key words:** Arsenic, Methyl transferase, Microbes, *Arabidopsis thaliana*.

SVI/P-34

## Application of Stable Isotopes in Environmental Monitoring and Pollution Studies

*Vivek Kumar\* and D. Paul*

Department of Environmental Studies, North-Eastern Hill University, Shillong-793022, INDIA, Email: naturevivek001@gmail.com; pauld97@rediffmail.com

Stable isotopes occur naturally in environment and have emerged as promising environmental tracers. They are safe and non-radioactive, and do not decay, thus are suitable natural environmental tracer in understanding various environmental processes and pollutant dynamics in environment. Stable isotopes have been used in understanding biogeochemical cycles. Stable isotopes have been used in different biological and ecological studies. It can be used to understand fundamental processes in the biology and ecology of arthropods, which range from nutrition and resource allocation to dispersal, food-web structure, predation, feeding behavior, mating, etc. Compound-specific stable isotope analysis (CSIA) has been used to study the fate of various groundwater pollutants, such as monoaromatic and polyaromatic hydrocarbons, MTBE, chlorinated ethenes, perchlorate, nitrate, and chromium (VI). CSIA has also been used in monitoring diffuse pesticide pollution in river. Metal stable isotope signatures can be used as tracers to get a deeper understanding of environmental geochemistry and to deduce information about composition and history of environmental samples and understanding other environmental processes like redox process, complexation and organic matter binding, biological cycling, etc. This paper presents a review on potential use of stable isotopes in biological, ecological and pollution studies.

**Key words:** Stable isotopes, Compound-specific stable isotope analysis (CSIA), Environmental processes, Pollutant dynamics.

SVI/P-35

## Lichen Use as a Biomonitoring Tool for Assessment of Air Quality

*Kirti Kumari\* and Sanjeeva Nayaka*

Lichenology Laboratory, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, U.P., INDIA, Email: kirtikumari64@gmail.com

Lichens are promising biomonitoring agent of atmospheric pollution as compared to any other group of plants. Lichen is a combination of an alga and a fungus which live together in symbiotic association. During association, the algal component (phycobiont or photobiont) and fungal component (mycobiont) lose

their original identity and form the composite thallus, which is both morphologically and physiologically behaves as one entity. For the growth and abundance of lichens several parameters are required like adequate amount of moisture, light and altitude, unpolluted air and undisturbed perennial substratum. Alteration in the atmosphere can bring marked changes in morphological and physiological features of lichen. Changes in chlorophyll in lichens is very sensitive to changes in environmental factors including air pollution. Lichens have been found to be very much sensitive to environmental parameters like temperature, humidity, wind and air pollutants because they don't have any vascular system and thus absorb water and nutrients passively from their surrounding environment. The changes in species composition is a very powerful tool to get information about changes in climate, air quality and biological processes. The lichens respond to the environmental changes by reflecting changes in their diversity, abundance, morphology, physiology, changes in DNA, accumulation of pollutants etc. Climate change and air pollution are two very important fields to study as they impact not only human beings but also affect flora and fauna throughout the world. Lichens are very useful indicators for long term monitoring of climate change and air pollution and their vulnerability as they are not only very much sensitive to climate change and air pollution but also measurable and thus relevant for biomonitoring studies. Their response to any change in climate or pollution is much faster than any other biota. Lichens are successfully used to monitor global warming at various places in the world. Lichens are important components of ecosystems. Lichen has been used as natural indicator of climate change and air quality monitoring worldwide including US, Britain, Canada, Netherlands, Switzerland, Italy and Israel etc. But very few such studies have been done in India.

**Key words:** Air quality, Lichen, Air pollution, Climate change, DNA damage, Lichen physiology, Bio-indicator.

SVI/P-36

## **Phytoremediation of Heavy Metal Contaminated Soils: A Potentially Promising Clean-Up Technology**

*K.K. Tiwari*

Sophisticated Instrumentation Center for Applied Research & Testing (SICART), Sardar Patel Centre for Science & Technology, Vallabh Vidyanagar-388120, Anand, Gujarat, INDIA, Email: drkktiware@hotmail.com

Environmental pollution of the biosphere with toxic heavy metals has accelerated dramatically since the beginning of the industrial revolution. Contamination of soils with toxic heavy metals is a widespread environmental problem resulting from global industrialization. Some heavy metal remediation technologies have been developed to treat contaminated soil, but a plant-based remediation technology, phytoremediation, is a new emerging technology. Phytoremediation is green technologies utilizing green plants to clean up the environment from contaminants and has been offered as a cost-effective and non-invasive alternative to the conventional engineering-based remediation technique. The advantage of the technique lie in making the living plants act as a solar-driven pump, which can extract and concentrate certain heavy metals from the environment. The process of hyperaccumulation of heavy metals by higher plants is a complex phenomenon. Phytoremediation process includes phytovolatilization, phytostabilization, and phytoextraction using hyperaccumulator plant species. Plants have a range of potential mechanisms at the cellular level that might be involved in the detoxification and tolerance to heavy metal stress. Technologies with the use of new transgenic plants have also improved the capacity of biochemical processes such as metal uptake, transport, accumulation and detoxification of metal pollutants. The recent research that certain chelating agents greatly facilitate metal accumulation by soil-grown plants can make this remediation technology a commercial in the near future. Thus the knowledge on the physiological and biochemical responses helps to adopt different strategies of purification and improvement of the environment

through use of plants, which tolerate and accumulate high levels of heavy metals.

**Key words:** Phytoremediation; heavy metals, phytoextraction, accumulation, translocation

SVI/P-37

## **Bioremediation and Monitoring of 2,4-D in Contaminated Soil of Vidarbha using Non-Invasive Geophysical Tools: A Novel Approach**

*K.S. Bramhanwade\**, *S. Dhyani<sup>1</sup>*, *P. Balwant<sup>1</sup>*, *P. Pujari<sup>1</sup>*, *F. Chiampo<sup>2</sup>* and *A. Godio<sup>3</sup>*

<sup>1</sup>CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur, INDIA; <sup>2</sup>Dipartimento di Scienza Applicata e Tecnologia - Politecnico Di Torino-Torino, ITALY; <sup>3</sup>Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture-Politecnico Di Torino-Torino, ITALY. Email: ksbramhanwade@rediffmail.com, shalini3006@gmail.com, d001940@polito.it, pandurangbalwant@gmail.com, pr\_pujari@neeri.res.in, fulvia.chiampo@polito.it,

2,4-D (2,4-dichlorophenoxyacetic acid) herbicide is an organic, selective, post-emergence systemic herbicide, prominently used for controlling weeds across India. On spraying the herbicide on weeds only 40% goes at target while, the rest goes to the soil and contaminates it. As a result it affects the beneficial soil microflora and leads to decline in soil fertility. Bioremediation is striking method due to its eco-friendly and economic character. It involves removal of contaminants with the help of microorganisms or their enzymes from environment. To decontaminate soil there is a need to remediate it by biological measures. Therefore bioaugmentation and biostimulation strategies of bioremediation were applied on soil and monitoring process. In present study 2,4-D degrading microbes were isolated from soil by regular microbiological isolation method and were further used in bioaugmentation process. Experiment of bioremediation was carried out in column to monitor it by geophysical methods. Study mainly focus on monitoring, as it is necessary to check whether bioremediation actually

takes place or not by geophysical signatures. Microorganisms alter the chemical and physical properties of soil during its metabolism process. These changes lead to altered geophysical signatures. Hence, geophysical methods being non invasive, cost effective, less time consuming and less expensive, provides an opportunity for using them as an innovative approach for getting high density spatial and temporal information. This information can be used in mapping contaminated soil and monitoring its bioremediation.

**Key words:** Bioremediation, Geophysical, 2,4-D, Bioaugmentation, Biostimulation.

SVI/P-38

## **Chelants (EDTA, Citric Acid) Induced Nickel and Chromium Accumulation in Tomato Grown on Industrially Polluted Soil**

*S.N. Pandey\** and *Sanjoli Tripathi*

Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: snpandey511@gmail.com

Industrial effluent 25% (Low) and 100% (High) irrigated soil (silty loam texture, mild calcareous, pH 7.9) evaluated for potentially toxic heavy metals (Ni and Cr). This contaminated (Low and High) soils used to grow tomato plants in clay pots (8 kg size) with application of EDTA (10 $\mu$ g) and citric acid (10  $\mu$ g) twice at the difference of 30 days. Growth, tissue accumulation of Ni and Cr and some biochemical constituents (protein and total chlorophyll contents) observed at day 90 of the growth. The application of both the chelants enhanced tissue accumulation of Ni and Cr in tomato. As compared, citric acid induced more Cr accumulation than EDTA, whereas EDTA induced more Ni accumulation than citric acid. Also, EDTA induced Cr accumulation in tomato. With respect to tissue accumulation levels of Ni and Cr, dry matter yield, protein and total chlorophyll contents was observed to be decreased in tomato.

**Key words:** Chelants, EDTA, Citric Acid, Contaminated soil, Protein, Nickel, Chromium.

SVI/P-39

## Physico-Chemical Characteristics of Surface Water nearby Industrial Areas of Balrampur

*Zaheen Hasan\* and D.D. Tewari*

Water Analysis Laboratory, Department of Botany, M.L.K. (P.G.) College, Balrampur, INDIA, Email: zaheenhasan666@gmail.com

Present paper deals about the water qualities occur near the industrial areas of Balrampur city. The industrial areas of Balrampur city has large number of small scale industries as well as one of the largest sugar factory i.e. Balrampur Chini Mill Ltd. with one distillery unit. This investigation focus mainly on the effluents released from BCM Ltd. which is running during the winter and spring season so the analysis has been done from October 2017 to March 2018. The physico-chemical characteristics of effluents shows a deteriorating trend in the quality of water occur mainly in water bodies of industrial areas of Balrampur city.

**Key words:** Balrampur, Chini Mill, BCM Ltd., Industrial areas.

SVI/P-40

## Characterisation of Groundwater Quality in the Aquifer of Indo-Nepal Border of Balrampur City

*Zaheen Hasan\* and D.D. Tewari*

Water Analysis Laboratory, Department of Botany, M.L.K. (P.G.) College, Balrampur, INDIA, Email: zaheenhasan666@gmail.com

Present investigation deals about the groundwater quality occur at aquifers found at the foothills of Shivalik at Indo-Nepal border of Balrampur. Here the water samples were collected from those areas where industrial and municipal waste water leachate and mixed with the groundwater. These ground waters are used as potable water for drinking and other purposes by humans. The analysis has been done especially during summer and winter season mainly. In this season the Groundwater quality is seriously affected by various types of pollutants which are discharged from industrial

and leached down and mixed with the groundwater after percolation. The result shows that the groundwater quality is threatening with the contamination of pollutants.

**Key words:** Balrampur, Groundwater, Indo-Nepal border.

SVI/P-41

## Physico-Chemical Characterization of Rivers in Different States of India: A Review

*Sandip Singh Bhatti<sup>1</sup>\*, Jaswinder Singh<sup>2</sup>, Vasudha Sambyal<sup>3</sup> and Avinash Kaur Nagpal<sup>1</sup>*

<sup>1</sup>Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA; <sup>2</sup>Department of Zoology, Khalsa College Amritsar, Punjab, INDIA; <sup>3</sup>Department of Human Genetics, Guru Nanak Dev University-143005, Amritsar, INDIA, Email: singh.sandip87@gmail.com; avnagpal@rediffmail.com

Rivers are one of the most important factors for development of human civilization considering their use for drinking water, irrigation, fisheries, aquaculture, transport and tourism. But, anthropogenic activities, especially industrialization, urbanization and modern agriculture have deteriorated the water quality of rivers around the world including India. The physico-chemical parameters of river water are very important indicators of their quality and also help in understanding the sources of pollution. Therefore, a review of studies published in last decade was done to summarize the physico-chemical characteristics of rivers from different states of India in order to assess their water quality. Reports from different states suggested that rivers (such as Ganga, Yamuna, Sutlej, Mahanadi etc.) and their tributaries are mostly uncontaminated or very less contaminated in the states of their origin. But when these rivers enter the states having industrial and urban development (such as Punjab, Uttar Pradesh, West Bengal, Maharashtra, Tamil Nadu, etc.) they get highly polluted due to anthropogenic activities such as discharge of untreated industrial effluents and urban sewage water, runoff from adjoining agricultural fields, domestic activities such as washing of clothes, bathing of humans and animals in water, washing of utensils etc. The water quality of some rivers such as Yamuna and Sutlej has been deteriorated to extremely low levels

in downstream states like Delhi and Punjab, respectively. Hence, adequate steps must be taken in the downstream states to ensure that anthropogenic activities must not pollute the rivers.

**Key words:** Industrialization, Physico-chemical characteristics, Rivers, States of India, Urbanization.

SVI/P-42

## Periodic Dissemination of Phthalate Esters in Pond Water of the Amritsar City, Punjab, India

*Sneh Rajput, Rajinder Kaur and Saroj Arora*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, INDIA, Email: snehrajput89@gmail.com

Phthalates are the dialkyl or alkyl aryl esters of phthalic acid and used in PVC to provide softness and flexibility. Phthalates have been identified as a priority pollutant by The United States Environmental Protection Agency. The present study was planned to envisage the seasonal dissemination and contamination of five phthalic acid ester in pond water of Amritsar, Punjab (India). The water samples were collected for a period of two years for four different seasons at eleven different sites. The highest phthalic acid esters contamination was found in the samples collected during the monsoon season (0.291-2.787 ppm) followed by post-monsoon season (0.291-1.776 ppm) and winter season (0.326-1.684 ppm) of the first year of sampling. Benzyl butyl phthalate was the most prominent phthalate found in 31.81% samples followed by di-n-butyl phthalate and dimethyl phthalate. Diallyl phthalate and diethyl phthalate was not detected in any water sample. Seasonal distribution of phthalates in water varied with the sampling site, the surrounding aquatic environment and local atmospheric deposition. Temperature and precipitation were identified as the two main governing factors for the seasonal variability of phthalates concentration in water. The study offers the first set of data on the distribution of phthalic acid esters in pond water of Amritsar district of Punjab (India). The results confirm the presence of phthalic acid esters in the water body.

**Key words:** Pond water samples, Phthalic acid, Benzyl butyl phthalate, Di-n-butyl phthalate, Dimethyl phthalate.

SVI/P-43

## Contamination of Ground Water Due to Leakage of Septic Tanks

*Lisha Taneja and Mayank\**

Amity School of Earth and Environmental Sciences, Amity University Haryana, Gurugram-122413, Haryana, INDIA, Email: lishataneja@gmail.com, mayank301095@gmail.com

Onsite disposal of waste water used by offices and household which is not connected to city disposal system is of great concern. However, the improperly designed, constructed or ill maintained septic tanks are of more concern as water percolates in the soil and reaches ground water and contaminates it. There are circumstantial evidences of septic tanks in some rural areas where bottom is not cemented therefore; wastewater has direct contact with the soil. The low cost septic tanks, especially in the rural areas under *Swatchh Bharat Mission* programme, are often constructed without proper lining at the bottom to further reduce on the cost. Wastewater seeps through the layers of soil and reaches the ground water making ground water unfit for useful purposes like irrigation, and drinking. The large scale use of such incomplete septic tanks have a long term effect on the groundwater of the region, which is evident through quality of the water drawn through pumps. The ground water contamination by sewage may lead to entrance of urea in body as well as heavy isotope of nitrogen will enter into food chain.

**Key words:** Sewage, Groundwater pollution, Low cost septic tanks, Swatchh Bharat Mission.

SVI/P-44

## Study of Physico-Chemical Analysis of Groundwater for Pre- and Post-Monsoon Variation of Gorakhpur District, Uttar Pradesh, India

*Priyanka Chaudhary*

Department of Botany, Deen Dayal Upadhyay Gorakhpur University, Gorakhpur, U.P. INDIA, Email: priyanka.chaudhary89@gmail.com

Present study deals for the analysis of physic-

chemical parameters of groundwater for pre and post monsoon variations in Gorakhpur district. For the study of groundwater total twenty samples are collected from different sampling sites during two season winter (post monsoon ) and summer (pre monsoon). The physico-chemical parameters like temperature, pH, EC, TDS, Total hardness, turbidity, chloride, alkalinity, fluoride, nitrate were analyzed. It has been found that the value of parameters is higher in pre monsoon season than post monsoon season. The purpose of this study is to verify the quality of ground water.

**Key words:** Ground water, Total Hardness, Pre monsoon, Post monsoon, Sampling sites.

SVI/P-45

## **Biomarkers based Comparative Cytogenotoxicity Assessment of Two Fertilizers**

*Sonam Verma\* and Alka Srivastava*

*In Vitro* Culture and Plant Genetics Unit, Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: sonamv529@gmail.com, alkasrivastava@hotmail.com

These days use of fertilizers has become a regular farming practice due to the food crisis emerging as a consequence of population growth and subsequent need of augmenting in the agriculture production. Within the existing agriculture system, agrochemicals are classified as one of the major chemical pollutants that are disseminated all over the planet. However, there is still little information about the effects of fertilizers on producers that occupy the first levels of high sensitivity in the trophic chain. The use of biomarkers in the evaluation of toxic effects of agrochemicals has increased significantly in the last decade. Biomarkers are sensitive and quick indicators of the presence of pollutants in the biomonitoring experiments. The present study deals with comparative assessment of cytogenotoxic effects of two commonly used fertilizers: urea and ammonium nitrate by using biomarkers *viz.* cytotoxic and genotoxic markers in the test plant *Allium cepa* L. For this, pot experiments were set up, in which both fertilizers were added separately to the sample soils and healthy onion bulbs were planted at varying day/s after treatment (DAT). Roots from onion bulbs grown in these were fixed at 3<sup>rd</sup> day after planting for

cytological analysis. The cytogenotoxicity of fertilizers was assessed by markers- mitotic index and chromosomal aberrations during the different stages of mitosis. Results will be discussed.

**Key words:** Biomarkers, Cytogenotoxicity, *Allium cepa*, Genotoxic.

SVI/P-46

## **Pyrenocarpous Lichens as an Indicator of Ecological Continuity in Forests of Manipur and Nagaland**

*Komal Kumar Ingle\*, Sanjeeva Nayaka, Vindhyeshwari Uppadhyay and D.K. Upreti*

Lichenology Laboratory, Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow, Uttar Pradesh - 226001, INDIA, Email: ingle.komal@gmail.com

The pyrenocarpous lichens are characterized by a pitcher like ascomata, carbonized laterally with the involvement of substrate bark cells, completely immersed in the thallus or covered at the base, opening by a pore at the top. Most of the Pyrenocarpous lichens comprise of green alga particularly trentepohloid while few species have blue-green alga. During a recent survey in Manipur and Nagaland state, a total of 87 localities of 5 districts were surveyed, and more than 1,800 lichen specimens were collected. All the specimens identified and resulted in 26 species of pyrenocarpous lichens. The pyrenocarpous lichens are widely distributed in the study area as the species were encountered in almost all the localities surveyed. Some of pyrenocarpous lichens are substratum specific as found growing exclusively either on trees or rocks. The species of *Verrucaria*, mostly found growing on rocks while members of Pyrenulaceae and Trypetheliaceae prefers to grow on the bark. The moist evergreen forest having smooth and moist bark mostly exhibit the rich diversity of Pyrenocarpous lichens as species of lichen genera *Anthracotheicum*, *Lithothelium* and *Pyrenula* prefers to grow on smooth bark. The species of genus *Anisomeridium* were found growing on hard, rough and dry barked tree trunk. The distribution pattern of Pyrenocarpous lichens clearly grouped the forests into distinct zones with evergreen, semi-evergreen and dry deciduous types of forests. The Mt. Saramati area

located in the Nagaland having old growth trees exhibit the rich diversity of pyrenocarpous lichen than the disturbed, thin out forest near human settlements.

**Key words:** Lichenized fungi, Pyrenocarpous, Forest types, North-East.

SVI/P-47

### **Silicon and Selenium Reduce Arsenic Uptake and Mitigate Arsenic Toxicity in Rice (*Oryza sativa*) Plants by Activation of Antioxidant Enzyme System**

**Amit Kumar<sup>1,2\*</sup>, Sanjay Dwivedi<sup>2</sup> and R. D. Tripathi<sup>2</sup>**

<sup>1</sup>Department of Botany, University of Lucknow, Lucknow-226007, INDIA; <sup>2</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: amit\_gene@yahoo.com, amit.metagene@gmail.com

Arsenic (As) is toxic to plants and animals, making it necessary to develop strategies that seek to reduce its introduction into food chains. Thus, the aim of this study was to investigate whether silicon (Si) and selenium (Se) reduce As concentrations in rice. A comprehensive study was conducted with tolerant variety of rice (BRG-12) in different combinations of As, Si and Se under hydroponic condition. Results showed that As treated rice plant with the combination of Si and Se significantly reduces the As accumulation in comparison to other treated plants. The diminish As accumulation by 64% in comparison to control in shoot clearly reflects a protective and combined positive effect of Si and Se on As toxicity. Increased growth responses, enzymatic antioxidant system (SOD, APX, GPX, GR, GST and POD) signify tolerance responses in As treated rice. Results demonstrated that supplemented with combination of Si and Se effective limit As translocation, tolerance and increase growth responses in rice which could be used as a supplements in the As affected paddy field. However, field trial must be imperative prior to application in agriculture land.

**Key words:** Antioxidants, Arsenic, Nutrients, Rice, Silica, Selenium

SVI/P-48

### **A Consortium of Alga (*Chlorella vulgaris*) and Bacterium (*Pseudomonas putida*) for Amelioration of Arsenic Toxicity in Rice: A Promising and Feasible Approach**

**Surabhi Awasthi<sup>1</sup>, Reshu Chauhan<sup>1</sup>, Suchi Srivastava<sup>1</sup>, Sudhakar Srivastava<sup>2</sup> and R.D. Tripathi<sup>1</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: surabhi.microbiology@gmail.com

In the present study, arsenic (As) toxicity amelioration potential of a consortium of plant growth promoting rhizobacterium (*Pseudomonas putida*) and alga (*Chlorella vulgaris*) was evaluated during arsenate (AsV) exposure to rice (*Oryza sativa*) plants for 15 d. The consortium mediated amelioration of As toxicity was evident through improved growth of rice plants (root and shoot length and biomass) and reduced oxidative stress [as level of superoxide radicals (O<sub>2</sub><sup>-</sup>), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) and membrane damage]. The positive responses were attributable to a significant decline in As accumulation in root (94 mg kg<sup>-1</sup> dw) and shoot (51 mg kg<sup>-1</sup> dw) in consortium (*P. putida* + *C. vulgaris*) inoculated seedlings as compared to As alone exposed plants (156 and 98mgkg<sup>-1</sup>dw, respectively). There were also significant changes in the level of various nutrient elements (Mn, Fe, Co, Zn, Mo and Cu), thiols and in the activities of antioxidant and thiol metabolism enzymes in the consortium inoculated seedlings that allowed the plants to tolerate As stress effectively and achieve better growth. The study demonstrated that consortium of *P. putida* and *C. vulgaris* may alleviate As stress and improve growth of rice seedlings along with reduction in As levels.

**Key words:** Arsenic, *Chlorella vulgaris*, *Pseudomonas putida*, Growth, Rice.

SVI/P-49

## **Diminution of Arsenic Accumulation in Rice Seedlings Co-Cultured With *Anabaena* Sp.: Modulation in the Expression of Lower Silicon Transporters, Two Nitrogen Dependent Genes and Lowering of Antioxidants Activity**

**Ruma Ranjan<sup>1,2\*</sup>, Navin Kumar<sup>1</sup>, Arvind Kumar Dubey<sup>1</sup>, Ambedkar Gautam<sup>1</sup>, Shyam Narain Pandey<sup>2</sup> and Shekhar Mallick<sup>1\*</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>University of Lucknow, Lucknow-226007, INDIA, Email: connect.ruma89@gmail.com

The present study was intended to investigate the role of algae, *Anabaena* sp. in the amelioration of As toxicity, when co-cultured with rice seedlings. The reduction of growth in rice seedlings against As(III) and As(V) was recovered with *Anabaena* sp. The *Anabaena* sp. also reduced the accumulation of As, where it was more efficient against 60  $\mu$ M As(III) (49%) than As(V) (23%) in rice shoot. Similarly, with reduction of As accumulation, lower silicon transporters (Lsi-1 and Lsi-2) was found to be suppressed against As treatments. However, the expression of two nitrogen dependent genes i.e., NR and SAMT were found to be enhanced with the *Anabaena* sp. Likewise, the activity of antioxidant enzyme, GST, was enhanced, whereas, the activity of other enzymes such as SOD, APX, GPX, GR and DHAR were decreased with As+Algae combinations. Overall, the result suggested that the *Anabaena* sp. reduces As accumulation, modulates gene expressions and antioxidants to ameliorate the As toxicity in *Oryza sativa* L.

**Keywords:** Arsenic, *Anabaena* sp., Lower silicon transporter, S-adenosylmethionine-dependent methyltransferases, *Oryza sativa* L.

SVI/P-50

## **Evaluation of Phytoremedial Potential of *Pteris vittata* through Cytogenetic Biomarker using *Vicia faba***

**Kiran Gupta\*, Alka Srivastava and Amit Kumar**

Plant Genetic Unit, Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: sunrays79@gmail.com

A study was carried out to assess the phytoremedial potential of *Pteris vittata* by employing *Vicia faba* L. test system. In that context comparative study of cyto-genotoxicity in *Vicia faba* was done in untreated and *Pteris vittata* treated As affected soil samples. The roots of *Vicia faba* L. were exposed to *Pteris vittata* treated and untreated As affected soil samples. The roots of *V. faba* analyzed in terms of mitotic activity, chromosomal aberration as well as micronuclei end point. Study revealed that inhibition of mitotic index and stimulation of mitotic depression; chromosomal aberrations and micronuclei were more in roots of *V. faba* exposed to untreated soil samples in comparison to *Pteris vittata* treated As affected soil samples. These cytogenetic biomarker like enhancement of mitotic index and decrease in mitotic depression, chromosomal aberrations as well as micronuclei endpoint in roots of *V. faba* exposed to treated soil samples *Vicia faba* revealed the phytoremediation potential of *Pteris vittata*. Therefore it can be depicted on the basis of result that *Pteris vittata* has good phytoremediation potential for Arsenic affected pollution.

**Key words:** Biomarker, *Vicia faba*, *Pteris vittata*, Arsenic, Chromosomal aberrations, Mitotic depression.

SVI/P-51

## ***In-vitro* Degradation of Fluorene by Bacteria Mediated by Catabolic Enzymes**

**Nitanshi Jauhari and S.N. Singh**

Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute Lucknow, Uttar Pradesh, INDIA, Email: nitanshijauhari27@gmail.com



Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants found in soil and sediments, groundwater and atmosphere. Many PAHs and their epoxides are toxic and mutagenic / carcinogenic in nature. This investigation evaluates the degradation ability of three bacterial strains, such as *Pseudomonas aeruginosa* PSA5, *Rhodococcus* sp. NJ2 and *Cronobacter* sp. PSM10, isolated from petroleum sludge containing 500 ppm of fluorine in mineral salt medium. A maximum degradation of 79% was attained by PSA5, followed by PSM10 (71%) and a minimum was recorded for NJ2 (68%) after 7 days of incubation. Induction of catabolic enzymes of two major pathways involved in the formation of catechol and protocatechuate as intermediates was also examined. Between the two pathways, enzymes associated with protocatechuate pathway were more induced than that of catechol pathway. Besides, degradation kinetics and half life of anthracene were also determined to find out the degradation pattern caused by bacteria. Biosurfactant production, cell surface hydrophobicity and emulsification index of anthracene, which facilitate anthracene degradation, were also determined in all bacteria to substantiate their degradation potential.

**Key words:** Fluorene contamination, Anthracene, Catabolic, Degrading microbe.

SVI/P-52

## Microplastic Pollution in River Ganges at Varanasi: A Case Study

**Vyomendra Chaturvedi\* and Kavita Shah**

Environmental Biotechnology Laboratory, Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: vyomendra.chaturvedi04@bhu.ac.in, kavitashah@bhu.ac.in

Microplastics (MPs), a manmade litter having particle size <5 mm, have recently been identified as an emerging global concern which affects aquatic organisms and human beings. The small sizes of MPs make them easily available for ingestion by a wide variety of organisms such as zooplanktons, bivalves, mussels, shrimps, oysters, copepods, worms and by organisms from higher trophic levels as fish, marine mammals etc. Ingestion of these tiny particles can

cause pathological stress, false satiation, reproductive complications, blocked enzyme production, reduced growth rate and oxidative stress in organisms. MPs can also potentially transfer chemicals adsorbed on their surface in the food chain. Currently, knowledge and data on the accumulation and effects of microplastics in freshwater and terrestrial systems is much limited than that in marine systems. In this context the occurrence of microplastic pollution was investigated in the sediment and the mussel samples from the Ganga river at twelve sites in Varanasi. The samples were processed and measured for microplastic through alkali digestion and density separation. Results suggest the presence of variety of microplastics including fibres and fragments in the sediments as well as tissues of mussels. Based on our results, it is evident that microplastic pollution in River Ganga at Varanasi is statistically significant and that freshwater mussels due to their extensive filter-feeding activity are exposed to these microplastics directly present in the water column which may thereby enter our food chain, however detailed studies are needed to prove the hypothesis.

**Key words:** Fresh water pollution, Food chain, Ganga river, Microplastics, Varanasi.

SVI/P-53

## Fluoride: Pollution and Mitigation

**Gayatri Singh<sup>1\*</sup>, Geetgovind Sinam<sup>1</sup>, Babita Kumari<sup>1</sup>, Kriti<sup>1</sup>, Mahiya Kulsoom<sup>2</sup> and Shekhar Mallick<sup>1</sup>**

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, U.P., INDIA; <sup>2</sup>Department of Environment Science, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, INDIA, Email: gayatrisingh.15@gmail.com

Fluorosis is the most prevalent groundwater-related disease in India, the most severely affected country worldwide. The desirable and the maximum permissible limits of the fluoride concentrations in the drinking water are 0.6 mg l<sup>-1</sup> and 1.0 mg l<sup>-1</sup>, respectively (WHO). In Uttar Pradesh Unnao is one of the most fluorosis affected district. Few studies have previously reported the F<sup>-</sup> level in the drinking water in Unnao region, which ranges between 0.8-13.9 mg L<sup>-1</sup>. There are various physical, chemical and biological methods

mentioned to defluoridation of drinking water. To mitigate this problem, there is an urgent need to understand the current status and brief knowledge of F.

**Key words:** Fluoride, Unnao, Defluoridation.

SVI/P-54

## **Ganga Water Pollution Management by Green Clean Technology and Outreach Programmes**

*Mridul Kumar Shukla*

Outreach Programmes, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: mridul\_shukla@rediffmail.com; mridulcsir0101@gmail.com

The Ganga river has been considered as the most sacred river of India in Ved Puran. It is called as “Ganga Maa” or Mother Ganga or Ganga Ji. People of world believe that a bath in the holy water of Ganga washes all the past sins of a person. It has a symbol of purity, and for Mokshh . It has long history of reverence in India and it is often called Holy Ganga. The total length of the river is about 2510 K.M.; one of the largest groups of human population belts on earth is built around the Ganga. Its originated from Bhagirathi from Gangotri glacier in the Uttarakhand. The basin drains eight states, H.P., Panjab, Haryana, U. P., Rajasthan, M. P., Bihar, West Bengal and Delhi. The level of pollution in the Ganga River has reached alarming proportions. Two types of point sources like, surface drains carrying municipal sewage or industrial effluent, pumping stations and sewage system from industries etc are found. The point source can be measured. Second is non point source which cannot be measured such as runoff agriculture field carrying chemical and fertilizers, run off from area used for dumping of solid waste and open defecation, mass bathing, floral offerings etc. According to study nearly 89 million liter of sewage is disposed into Ganga from 12 municipal towns that fall along its route till Haridwar, where the amount of sewage disposed in the river increase during the Char Dham Yatra season. A constructed wetland is an artificial marsh or swamp, created for anthropogenic discharge such as waste water storm water runoff or sewage treatment and as a habitat for wild life, or for land reclamation after mining or other disturbances.

Natural wetland act as a biofilter, removing sediments and pollutants such as heavy metal from water, and constructed wetland is designed to emulate these features. Constructed wetland is built by human. These constructed wetlands are primarily built to clean up waste water and create wild life habitat. Constructed wetland naturally filters and treats waste water and are often less expensive than traditional treatment plants.

**Key words:** Ganga, Water pollution, Green technology.

SVI/P-55

## **Estimation of Arsenic in Rice Grains and Rice-Based Food Products in Gangetic Region**

*Nidhi Tyagi and Sudhakar Srivastava\**

Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: sudhakar.iesd@bhu.ac.in, sudhakar.srivastava@gmail.com

Arsenic (As) is a toxic carcinogenic element which poses threat to millions of lives around the globe. The element has already entered the food web as many of the crops and animal products are reported to have As in high concentrations. The range of health impact of As is from skin disorder to cancer. In few reports, As exposure has been linked to diabetes mellitus and adverse pregnancy outcomes (APO) too. The present study was conducted to analyze As content in rice grains of market sold rice varieties and rice-based food products (laiyya, chuda, and snacks) in Gangetic region. The cities covered in Gangetic region include Kanpur, Allahabad, Varanasi, Balia, Patna and Kolkata. In addition, Jabalpur was taken as a control area which is not reported to have As contamination. The samples were oven dried, crushed and digested in nitric acid. After this, the samples were analyzed for As using Atomic Absorption Spectroscopy. The results show presence of As in the samples that varied from variety to variety, and in different areas. The results are discussed with possible health impacts considering standard As limits in rice grains, and in food products, rice consumption rates and As consumption limits for humans.

**Key words:** Arsenic, Rice, Gangetic region.

SVI/P-56

## Degradation of Diesel using Co-Culture of Bacterial and Fungal Strains

*Babita Kumari\**, Kriti, Mahiya Kulshoom, Gayatri Singh, Shekhar Mallick and Pankaj Kumar Srivastava

Environmental Technologies, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: babita.bit86@gmail.com

Diesel is one of fractionate part of crude petroleum oil that is a major source of energy for public and good transports. The use of these petroleum oils can have negative impact on Earth's biosphere by contributing pollutants and greenhouse gases into the atmosphere, hence damaging not only ecosystems but also human health viz lung and bladder cancer. It is composed of 75% of saturated and 25% of aromatic hydrocarbons. Bioremediation agents like heterogeneous bacteria and fungi are being successfully applied to degrade petroleum hydrocarbon because they completely mineralized it into CO<sub>2</sub> and H<sub>2</sub>O or transformed it into non-toxic metabolites. In the study, diesel degrading efficiency of potent petroleum hydrocarbon degrading bacterial and fungal strain i.e., *Pseudomonas* sp. BP10 and *Penicillium* sp. PS10, respectively was studied as individual or in combination. Co-culture of these strains has been found capable to degrade 65% of diesel (5%) in minimum salt media after 15 days of incubation period. Individually, only 55% and 40% degradation was recorded by bacterial and fungal strain, respectively. Compared to fungal strain, bacterial strain was found more potent in degradation of diesel. Specific activity of degradative enzymes i.e., alkane dehydrogenase and laccase and induction of biosurfactant (glycolipid) were also found higher for bacterial strain. Bioaugmentation of co-culture of these bacterial and fungal strains showed synergistic relation and induce 50 and 200% of specific activity of degradative enzymes and induction of biosurfactant, respectively. Consequently, the rate of degradation (65%) of diesel exaggerated owing co-culture of potent microbial strains. So, this study recommends the use of bacterial and fungal strain consortium for the degradation of diesel hydrocarbons compounds to decontaminate the polluted sites.

**Key words:** Diesel, Petroleum hydrocarbon, Degradation, Microbial consortium.

SVI/P-57

## Interaction of Microalgae with Engineered Nano-Materials: Possibilities for Bioremediation and Biofuel Production

*Mohit Singh Rana<sup>1,2</sup>, Shashi Bhushan<sup>1</sup>, Ruben Sudhakar<sup>2</sup> and Sanjeev Kumar Prajapati<sup>1\*</sup>*

<sup>1</sup>Bio-Resource Engineering Lab (BREL), Department of Chemical and Biochemical Engineering, Indian Institute of Technology (IIT) Patna, Bihta, Patna-801106, Bihar, INDIA; <sup>2</sup>Department of Energy and Environment, National Institute of Technology (NIT) Trichy, Tiruchirappalli-620015, Tamil Nadu, INDIA, Email: mohitrn90@gmail.com, sanjukec@iitp.ac.in; sanjukec@gmail.com

Engineered nanoparticles (ENPs) are emerging substances, being widely used in the biomedical industries, disinfectant, process engineering, surface coating, cosmetics and food packaging. By the virtue of the Advanced Oxidation Technology (AOT), inherited by nanoparticles, these materials generate highly reactive transitory species (i.e. H<sub>2</sub>O<sub>2</sub>, OH·, O<sub>2</sub>·<sup>-</sup>, O<sub>3</sub>) and mineralize various organic and inorganic molecules. Further, some selected ENPs show positive effect on microalgal growth, biochemical accumulation and biofuel yield. Hence, at the optimal concentration, the nano-materials can be exploited for bioremediation along with microalgae, leading to green sustainable technology. In the present work, effect of Fe<sub>2</sub>O<sub>3</sub> ENPs supplementation on growth and composition of *Chlorella* spp. was tested. Interestingly, the Fe<sub>2</sub>O<sub>3</sub> ENPs at a concentration of 20-30 mg L<sup>-1</sup> showed up to 40 % increase in biomass concentration during 15 days batch cultivation. Additionally, the biochemical composition was also improved. Further, pretreatment of the microalgal cells was confirmed through visual observations, when the ENP containing biomass was incubated under direct sun light (for Fenton reaction) and under UV light. Hence, the pretreated biomass, having improved biochemical composition, may result in higher biofuel yield as evident from previous reports. However, practical biofuel yield needs to be determined to assess the feasibility of the process. In future, the

ENPs may also be tested with microalgae in municipal wastewater, to assess the effect on biomass yield as well as pollutant removal. If successful, the proposed process will serve as a role model for bioremediation coupled biofuel production using microalgae.

**Key words:** Engineered nano-materials, Biofuel, Bioremediation, Microalgae, Wastewater.

SVI/P-58

## Characterization of Yeast Strains with Potential of Arsenic Stress Amelioration

Jasvinder Kaur, Vandana Anand, Sonal Srivastava, Pankaj Kumar Srivastava and Suchi Srivastava\*

Division of Microbial Technologies, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: jasvinderkaurnsc@gmail.com

Arsenic is the most common toxic substance in the environment, ranking first in the inorganic toxicants. Its distribution in environment causes serious human health issues worldwide due to its highly carcinogenic properties. Microbes play a significant role in detoxification of this metalloid. Microbial activity is linked to the biogeochemistry of arsenic and is involved in its biotransformation. Many bacteria, archaea, and fungi have developed different mechanisms to prevent themselves from arsenic stress. These mechanisms include the reduction of arsenate to arsenite; oxidation of arsenite to the arsenate; immobilization, complexation, vacuolar sequestration and its methylation to less toxic organic form. In this study we have isolated yeasts from rhizospheric soil of different regions of India. Three strains from Bulandshahr and Shillong has been selected as best As tolerant saccharo-type yeast strains. The present study deals with the identification, characterization and detoxification mechanisms in selected yeast strains. Selected yeast strains with arsenite oxidase and arsenate reductase activities were identified as *Candida tropicalis* (NBRIB3.4), (NBRIB3.5) and *Debaryomyces hansenii* (NBRISH2.11). In addition these strains were also

characterized for different plant growth promoting attributes viz. indole-3-acetic acid, phosphate solubilization, siderophore production. Assessment of arsenic stress amelioration using rice as a host plant under green house condition is under progress.

**Key words:** Arsenic, Yeast, Arsenite oxidase, Reductase activity.

SVI/P-59

## The Role of Metallothionein Gene in Abiotic Stress

Sanoj Kumar\*, Arvind Kumar Dubey and Indraneel Sanyal

Plant Transgenic Laboratory, Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: sanojyadav152@gmail.com

Metallothionein (MT) is a ubiquitous low molecular weight protein ranging from 5-14 kDa, with high cysteine content and has strong affinity for heavy metals. It was first isolated from equine kidney. The metallothionein (MT) are small, cysteine-rich heavy metal-binding proteins which participate in an array of protective stress responses. Based on the arrangement of Cys residues, plant MTs are classified into type-I, II, III and IV. MT provides protection against heavy metal toxicity, oxidative stress, and participates in the regulation of physiological metals like zinc (Zn<sup>2+</sup>) and copper (Cu). The level of the response to these inducers depends on the MT gene. These activities are regulated through intracellular metal ion modulation and free radical scavenging. MTs transcript levels in various plants alter during abiotic stress caused by salt, heat, cold, heavy metals contaminations etc. MTs are involved in maintaining homeostasis of essential metals and metal detoxification and implicated in a range of other physiological processes. We are presently working on chickpea exploring the role of MT under drought stress, using molecular approaches.

**Key words:** Metallothionein, Abiotic stress, Cysteine, Heavy metal.

SVI/P-60

## Remediation of Heavy Metal Contaminated Soils: An Innovative Technology for the Present and Future Research

*Khusboo Pandey and K.K. Tiwari*

Sophisticated Instrumentation Centre for Applied Research & Testing (SICART), Vallabh Vidyanagar, Anand-388120, Gujarat, INDIA, Email: pandeykhusboo94@yahoo.com

Contamination of lands with toxic heavy metals is a widespread environmental issue resulting from global industrialization. Heavy metal contaminants are a serious problem worldwide to human health, animals and some plants. Conventional techniques for reclamation of such soils are expensive and environmental non-friendly. Phytoremediation is an emerging group of technologies utilizing green plants to clean up the environment from contaminants and has been offered as a cost-effective and non-invasive alternative to the conventional engineering-based remediation methods. Biochemical mechanisms such as adsorption, transport, accumulation and translocation that are adopted by plants are of supreme importance in developing improved phytoremediation. Identification of suitable hyperaccumulating plants with remarkable biochemical mechanism, presents a fascinating success in the field of phytoremediation as well as other research area. There are different versions of phytoremediation viz. phytoimmobilization, phytostabilization, rhizofiltration, phytovolatilization and phytoextraction, the latter being most widely accepted for remediation of soils contaminated with toxic heavy metals. Phytoremediation includes phytovolatilization, phytostabilization, and phytoextraction using hyperaccumulator species or a chelate-enhancement strategy. Different aspects of phytoextraction and scope of this technology for remediation of heavy metal-contaminated soils are reviewed discussing challenges and opportunities in realizing phytoextraction as an economically viable remediation method.

**Key words:** Phytoremediation, Heavy metals, Rhizosphere community, Genetic engineering.

SVI/P-61

## Identification and Characterization of Multi-trait Quorum Sensing Exhibiting PGPR Isolates and Assessing their Prospective as Inoculants for *Zea mays*

*Arpita Singh\* and Puneet Singh Chauhan*

Microbial Technologies Group, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA

Email: puneetnbri@gmail.com, puneet@nbri.res.in

Development of an effective plant growth promoting rhizobacteria (PGPR) inoculant necessitates the presence of a diverse set of traits that can help its colonization of the rhizosphere and survival under varying environmental conditions. In our investigation, a set of 310 bacterial isolates from extreme environment and *Zea mays* rhizosphere of plants were screened initially on the basis of acyl homoserine lactone (AHL) production, plant growth promoting (PGP) attributes like indole acetic acid (IAA) production, Phosphate solubilization, siderophore production, abiotic stress tolerance namely drought (30%, 45% and 60% Poly Ethylene Glycol 6000), salt (8% and 12% NaCl), pH (pH5, pH9 and pH11) and temperature (37°C and 45°C) and antagonistic activity. The screening led to the selection of 13 isolates (12VPNC2, PC8, PD4, 7VP51.8, P51.9, 11VPKHP4, P51.8, P51.10, NBRI N7, NBRI N11, NBRI N12, NBRI N15, NBRI N21), proficient in AHL production, withstanding different abiotic stress conditions as drought (30%, 45% and 60% Poly Ethylene Glycol 6000), salt (8% and 12% NaCl), pH (pH5, pH9 and pH11) and temperature (37°C and 45°C), exhibiting plant growth promoting attributes along with biofilm formation, exopolysaccharide (EPS) production, alginate production, aminocyclopropane-1-carboxylic acid (ACC) deaminase activity and antagonistic activity and are also proficient in forbearing with heavy metal contamination. The plant growth promotion potential of selected thirteen bacterial strains showed significantly growth enhancement in all the parameters of *Zea mays*.

**Key words:** Quorum sensing, PGPR, *Zea mays*

SVI/P-62

## **Impact of Pyrometallurgical Slags on Sunflower Growth, Metal Accumulation and Rhizosphere Microbial Communities**

***Priya Jaiswal\*, Ana Carolina Agnello and Puneet S. Chauhan***

Microbial Technologies Group, CSIR-National Botanical Research Institute, Lucknow, 226 001

Email: puneetnbri@gmail.com, puneet@nbri.res.in

Slag, a by-product of metallurgic processes is dumped into the environment as such ignoring the hazards caused by it on the flora and fauna. Several studies have confirmed the presence of heavy metal residues left in the slag which becomes a source of heavy metal deposition in the environment. Thus, human intervention becomes imperative to resolve this environmental concern by utilising sustainable remediation methodologies. The main objectives of the current study includes- (1) investigating release of metals from slags by the influence of plants and

microbes, (2) Determining the effects of metal stress on growth of sunflower and microbes present in the rhizosphere, (3) Developing phytoremediation and phytomanagement strategies for reclamation of affected soils and focusing on safe disposal strategies for slag. Present work was designed to determine the release of metals from slag, leaching test was performed on granulated slags(GS), in presence of soil pre solution, which showed us that soil pore solution increases release of Copper from GS. Sunflower (*Helianthus annuus*) was used for investigating metal accumulation. Sunflower was grown in a 50% w/w substrate(mix of agricultural soil and GS) and it was able to accumulate metals in above ground tissues. Community level physiological profiling (CLPP) and 16S rRNA gene based denaturing gradient gel electrophoresis analyses was performed for determining shift in rhizospheric and bulk soil microbial diversity induced by presence of slag. Findings from this study suggested that metallurgical wastes should be treated before dumping in the environment to minimise the metal toxicity.

**Key words:** Metal accumulation, Rhizosphere, Microbial diversity.

**Session VII**  
**Plant Response to Environmental Pollution**





SVII/L-1

## Environmental Mercury Stress-Adaptation in Selected Macrophytes - Crosstalk on Chemical and Biological Mechanisms

Naser A. Anjum<sup>1,2</sup>

<sup>1</sup>Centre for Environmental and Marine Studies (CESAM) and Department of Chemistry, University of Aveiro, 3810-193 Aveiro, PORTUGAL; <sup>2</sup>Present address: Department of Botany, Faculty of Life Sciences, Aligarh Muslim University, Aligarh-202002, U.P., INDIA, Email: dnaanjum@gmail.com, g0216@myamu.ac.in

Salt marsh macrophytes have been recognized as the managers of pollution of varied types (including chemicals) in the coastal areas. However, the major mechanisms underlying salt marsh macrophytes-adaptation to persistent chemical contaminants (such as mercury, Hg) are least explored. This work is aimed to present a critical cross-talk on the success and failure of non-biological (chemical traits) and biological (physiological/biochemical, and polypeptide patterns) mechanisms underlying salt marsh macrophytes *Juncus maritimus* and *Halimione portulacoides* (root/rhizome/shoot) adaptive responses to Hg under environmental exposure.

**Key words:** Chemical pollution, Mercury, Coastal lagoon, Salt marsh macrophyte, Stress adaptation

SVII/L-2

## Emerging Role of Silicon, Salicylic Acid and Arbuscular Mycorrhizal Fungi in Alleviating Abiotic Stress in Legumes

Neera Garg

Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: gargneera@gmail.com, garg\_neera@yahoo.com

Soil salinization and heavy-metal contamination are the major eco-environmental factors that hamper legume production worldwide by negatively influencing plant metabolism. Among the various approaches

adopted, exogenous applications of silicon (Si), salicylic acid (SA) and arbuscular mycorrhizal (AM) propagules have emerged as potent bio-tools for alleviating stress induced effects in crop plants. However, little is known about the alleviative role of these amendments in legumes, which vary in their sensitivity towards different abiotic stresses. Studies were conducted in *Cajanus cajan* (L.) Millsp. and *Cicer arietinum* (L.) where different mechanism(s) adopted by stress alleviants were explored and identified through a series of experiments under stressful conditions. Si maintained plant growth by improving light perception, imparting hardiness to plants, reducing toxic ion uptake and maintaining nodular efficiency under salinity and metal(loid) stress. Exogenous SA positively regulated membrane stability, nutrient uptake, and modulated enzymes involved in carbohydrate metabolism thereby regulating reproductive potential. AM could impart abiotic stress tolerance by enhancing root water absorption capacity, improved nutrient status, modulated proline and trehalose biosynthesis, and by sequestering toxic ions in underground plant organs. When applied together, interactive effects were observed where mycorrhization enhanced endogenous Si content in otherwise low Si accumulating legumes that conferred enhanced stress tolerance. Similarly, exogenous SA improved root colonization ability of AM fungus, thus imparted functional complementarily by modulating carbohydrate metabolism. In addition, effects observed varied among differentially tolerant genotypes. Hence, application of exogenous amendments along with mycorrhiza could be used as a promising strategy in achieving sustainable production of economically important legumes under abiotic stresses.

**Key words:** Abiotic stress, Arbuscular mycorrhizae, Legumes, Tolerance mechanism(s), Silicon, Salicylic acid.

SVII/O-1

## Nitric Oxide Exposure Impacts on Morphology and Auxin Transport of *Oryza sativa* under Arsenic Stress

Afsana Praveen\* and Meetu Gupta

Ecotoxicogenomics Lab, Department of Biotechnology, Jamia Millia Islamia, New Delhi, INDIA, Email: afsana735@gmail.com, meetu\_gpt@yahoo.com

Nitric oxide (NO), a signal molecule play vital role to provide tolerance to abiotic stress in plants by interplay with reactive oxygen species, and thus promoting their growth and development. Arsenic (As) is a toxic metalloid and its contamination found in crop plants, mainly rice which is an important diet for millions of people. In this study 7 days old hydroponically grown rice seedlings were exposed to As<sup>(III)</sup> (150  $\mu$ M), NO (100  $\mu$ M), As<sup>(III)</sup>+NO for 48 h and control (without metal). We observed NO mediated alteration on physiological, biochemical and stress related parameters along with auxin transporter *PIN* genes (*Os PIN1a*, *Os PIN1b*, *Os PIN1c*, *Os PIN1d*, *Os PIN2*, *Os PIN5a*, *Os PIN5c*, *Os PIN8*, *Os PIN9*, *Os PIN10b*), expression under As stress. As exposure reduced the overall plant growth, formation of lateral roots, chlorophyll and protein content and enhanced the oxidative stress by increasing the level of antioxidant enzymes (SOD, CAT, APX, GR), and stress related parameters (cysteine, proline, MDA, H<sub>2</sub>O<sub>2</sub>). Supplementation of NO along with As reduced the accumulation of As in rice seedling, improved plant growth, lateral root formation, increased chlorophyll and protein content, diminished the level of antioxidant enzymes and stress related parameters by reducing the ROS generation. Addition of NO also up regulates the gene expression of auxin transporters. Overall, NO reduced the toxicity of As using various mechanism and provide tolerance to its stress in rice seedlings.

**Key words:** Arsenic, Nitric oxide, Oxidative stress, Antioxidant enzymes, ROS.

SVII/O-2

## Differential Response of Indica Rice Varieties using Biochemical and Molecular Approaches under Arsenic Stress

*Medha Panthri\* and Meetu Gupta*

Ecotoxicogenomics Lab, Department of Biotechnology, Jamia Millia Islamia, New Delhi, INDIA, Email: medhapanthri@gmail.com, meetu\_gpt@yahoo.com; mgupta@jmi.ac.in

Arsenic (As) is a carcinogenic metalloid and an environmental constraint posing harmful consequences on living beings. The negative effect of As in

agricultural areas has raised an alarming situation. Rice is an important food crop of India which feeds about half of the population, but presence of As in environment has lead to its accumulation in edible plant parts, which effects human and animal health. In this study, we have analyzed the effect of As<sup>III</sup> on two rice varieties- Varsha and Jaya. Rice seeds were exposed to As<sup>III</sup> (150iM) for 7 days to observe seed germination and relative As-injury rate while hydroponically grown 12 days old seedlings were exposed to As<sup>III</sup> (150iM) for 96 h to study the changes at biochemical and molecular levels. Changes in phenotypic characters, physiological parameters (chlorophyll, protein), stress indicators (MDA and H<sub>2</sub>O<sub>2</sub>) along with accumulation of As and macro/micro-nutrients (Na, Mg, S, Mn, Fe, Cu and Zn) constituted the biochemical approaches, while RAPD analysis was done to observe the changes at molecular level. *WRKY* TFs play a key role in plants during heavy metal stress, thus an attempt has been made in this study to observe their expression analysis in response to As<sup>III</sup> toxicity in both rice varieties. Our observations showed that seed germination, phenotypic and physiological parameters decreased, while stress indicators increased during As<sup>III</sup> exposure as compared to control. Nutrient profiling results also demonstrated the negative effect of As<sup>III</sup> on both rice varieties. Further, results obtained from RAPD band profiles and GTS were compatible to the above parameters indicating As<sup>III</sup> mediated toxicity in rice varieties. Analysis of the *WRKY* expression profile indicated that these TFs play a role in plant processes by regulating stress tolerant genes.

**Key words-** Arsenic, Rice, Nutrient profiling, RAPD, *WRKY*.

SVII/O-3

## Effect of Vehicular Pollution on Pollen Grains of some Roadside Plants: An Overview

*Mandeep Kaur\* and Avinash Kaur Nagpal*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: avnagpal@yahoo.co.in; mandeep.mandygndu@gmail.com

Air pollution has become one of the severe and most talkable issues all over the globe. Increase in

number of motor vehicles has been found to be positively correlated with increase in air pollution levels in different urban areas of the world. Vehicular pollution has resulted in various adverse and irreplaceable effects on plants, animals and human beings at various levels ranging from biochemical to ecosystem levels. Plants, being the true friends to all life on this earth have the capability to improve the quality of air by absorption of gases and particles. Various plant parts *viz.*, roots, leaves and pollen generally get exposed to different types of soil and air pollutants. The leaves show apparent symptoms like, necrosis and chlorosis and likewise pollen grains also show various symptoms that can be assessed to measure the type and extent of pollution. Pollen grains can provide important information about the biological impacts and can act as sensitive bio-indicators of air pollution. Air pollutants like suspended particulate matter (SPM), SO<sub>x</sub>, O<sub>3</sub>, NO<sub>x</sub>, HF and heavy metals (Pb and Cr) led to reduction in pollen grains germination, pollen tube length, size and viability; pollen abortiveness; distorted pollen shape and pollen tectum. The present paper is an attempt to review summary of some literature on the effects of air pollution on pollen of different plant species growing along roadsides/ traffic stressed areas.

**Key words:** Motor vehicles; pollen grain; Vehicular pollution; Bio-indicators.

SVII/O-4

## Distributional Pattern of Diatom Assemblages in the Ganga River: Impact of Nutrient Enrichment and Limitation

*Amita Yadav*<sup>1\*</sup>, *Jitendra Pandey*<sup>1</sup> and *Usha Pandey*<sup>2</sup>

<sup>1</sup>Ganga River Ecology Research Laboratory, Environmental Science Division, Centre of Advanced Study in Botany, Institute of Science, Banaras Hindu University, Varanasi-221005, INDIA; <sup>2</sup>Department of Botany, Faculty of Science and Technology, Mahatma Gandhi Kashi Vidyapith, Varanasi 221002, India, Email: amita0804@gmail.com, jiten\_pandey@rediffmail.com, usha\_pandey28@yahoo.co.in

The Ganga River still lacks systematic data evaluating point- and non-point sources of nutrient input,

their dispersal, impact on river ecology and ecosystem functions, despite the fact that such information are important on which integrated river basin management strategies can be keyed. In this study, we investigated shifts in the pattern of ecological nutrient limitation and relative diatom assemblage as influenced by a point source (Assi drain) input, and up- and downstream Varanasi urban influences along a 37 km stretch of the Ganga River for three consecutive year (March 2013 to February 2016). We found point- and non-point sources of input shifts N:P:Si stoichiometry of the river toward N and Si limitation consequently altering the relative diatom assemblages with increased abundance of P favoured species such as *Cyclotella meneghiniana*, *Cocconeis splancentula*, *Melosira varians* and *Hyalodiscus laevis* downstream city. The dynamic fit function showed significant positive correlation of *C. meneghiniana*, *C. placentula* and *Fragilaria intermedia* with N: P (R<sup>2</sup>= 0.99-0.85; p<0.001) and with Si: P ratio (R<sup>2</sup>= 0.99-0.83; p<0.001) reflecting their P favoured nature. Excessive growth of such exploitative species replaced less adapted diatoms such as *Aulacoseira granulates*, *Cymbella affinis* and *Craticula halophila*. If excessive P loading is continued, as expected in future, it will lead to high P condition and consequently a niche based shift in diatom species composition. The study has relevance in understanding interactive effect of diatom shift under N and Si limiting conditions to restore the river property as buffering agent and provides important cues for further study for river rejuvenation.

**Key words:** Diatom, N: P: Si stoichiometry, Ganga River, Land use, Point source, Water pollution.

SVII/O-5

## Effect of Marble Slurry Dust on the Proline Content of *Callistimon lanceolata* and *Albizialebbeck* Trees

*Vibha Khanna*

Samrat Prithviraj Chouhan Government College, Ajmer, Rajasthan, INDIA, Email: vibhaajmer@yahoo.co.in

Free proline accumulation in the various plant parts in Angiosperms has been considered as one of the most widespread stress induced response. So, its measurement is an excellent stress detector. Increase

in free proline contents have been recorded under water and osmotic stress. The accumulation of free proline depends on the type and intensity of stress. The *Callistimon lanceolata* and *Albizia lebbec* trees growing in the green belt developed on the embankment of the Marble Slurry Dumpyard at Kishangarh (Ajmer) are subjected to continuous suspended slurry dust which gets settled on various plant parts including the phylloplane. The texture, thickness and orientation of leaves and the canopy architecture of the tree species influence the dust holding capacity, which in turn regulates the proline content of the plant. Availability of Slurry dust in the soil also leads to osmotic stress which in general enhances during rainy season when the dust present on the trees as well as in the atmosphere is washed down into the soil. This exposes the vegetation to water stress and leads to accumulation of proline in various plant parts particularly the leaves. Proline accumulation is as an adaptive response to stress. It acts as an osmolyte and antioxidant, thus helping plants to maintain the survival of cell turgor. In the present course of study, higher level of proline has been reported during winter months as well as during the rainy season. The former may be attributed to the greater accumulation of suspended slurry dust on the arial plant parts while higher level of proline during monsoons indicates the stress induced by the soil and ground water pollution. Of the two tree species under consideration, proline content in plants exposed to pollution was higher in *Albizia lebbec* as compared to that in *Callistimon lanceolata*.

**Key words:** *Albizia lebbec*, *Callistimon lanceolata*, Marble Slurry, Seasonal variations, Stress, Pollution, Proline.

#### SVII/O-6

### **Fly Ash-Induced Thiol Synthesis and Metabolic Adaptation in Fern *Ampelopteris proliferata* (Retz.) Copel.**

*Alka Kumari*<sup>1\*</sup> and *Ashu Gulati*<sup>2</sup>

<sup>1</sup>Department of Botany, University of Lucknow, Lucknow-226007, INDIA; <sup>2</sup>NPCPD Division, CSIR-Institute of Himalayan Bioresource Technology, Palampur-176001, H.P., INDIA, Email: kumarialkasanjay@gmail.com

Thiol containing compounds have been reported to play an important role in metal detoxification and

accumulation in some higher plants as well as in arsenic hyper-accumulator *Pteris vittata* (Chinese Brake fern). During present study the formation of low molecular weight thiols were investigated in a common native fern *Ampelopteris proliferata* which was luxuriantly growing on fly ash (FA) dumping sites. In order to observe its toxic metal- induced adaptation, a pot experiment was set up in three sets of FA amendments viz. first set of 100% FA, second set of 50% FA and 50% garden soil and third set of 100% garden soil only, treated as control. In this study, the synthesis of total thiols and acid-soluble thiols in *Ampelopteris proliferata* was investigated under fly-ash exposure. The strong and positive correlation between heavy metal concentration and acid soluble thiols in leaf fronds suggests that these thiols play pivotal role in metal detoxification. In addition to cystein and glutathione, an unidentified thiol was observed in plants grown on fly ash, which was not found in the control. Our study suggests that the thiols are synthesized due to metal stress in ferns grown on fly ash and these compounds (thiols) are helpful in metal detoxification in ferns and thus provide metabolic adaptation to the plant against toxic fly ash.

**Key words:** Power plants, Fly ash, Heavy metals, Pteridophytes, Thiols, Metal detoxification.

#### SVII/O-7

### **Effects of the Desert Barriers in the Genetic Structure of Laperrine's Olive, from the Central Saharan Mountains**

*Djamel Baali-Cherif*<sup>1,2\*</sup>, *Guillaume Besnard*<sup>3</sup>, *Fabien Anthelme*<sup>4</sup> and *Med-Salah Abdellaoui*<sup>5</sup>

Searcher LRZA/USTHB BP44 16000 Algiers-Gare, ALGERIA; <sup>2</sup>Teacher ENSA (ex INA) El-Harrach, ALGERIA; <sup>3</sup>CNRS, Laboratory of Evolution and Biologic Diversity, UPS Toulouse, FRANCE; <sup>4</sup>IRD Montpellier (France), University of Bamako, NIGER; <sup>5</sup>Searcher INRF station, Tamanrasset, Hoggar, ALGERIA, Email: bacherdj@yahoo.fr

The Laperrine's olive (*Olea europaea* subsp. *laperrinei*) persists in the central Saharan mountains from Algeria, Niger and Sudan. Populations of this tree are locally threatened of extinction due to climatic changes and human activities, particularly in Niger and

Algeria. In order to study the spatial genetic structure and the dynamic of *laperrinei* populations, we sampled trees in four isolated massifs [Tassilin' Ajjer and Hoggar (Algeria), Tamgak and Bagzane (Niger)]. Two hundred and seven genets were identified based on nuclear microsatellite polymorphism. Phylogenetic reconstruction based on plastid DNA data supported a maternal origin of *laperrinei* populations in South Algeria, where a higher allelic richness (on both nuclear and plastid loci) was also observed. Based on nuclear microsatellite data, we revealed two levels of structure using a Bayesian method: the first one allowed recognition of most of individuals from Nigerien and Algerian massifs whereas the second one showed a less marked differentiation among the two populations from Niger and Algeria. These results support that desert barriers may have greatly limited long distance gene flow. Spatial genetic structure was then investigated within populations. We showed that genetic coefficients were significantly correlated to geographical distance within Nigerien populations but this was not observed within Algerian massifs. We discussed that historical factors and habitat heterogeneity may explain the differences observed for the allelic richness and the spatial structure within population. Lastly, based on our results, we discussed on possible strategies for the conservation of populations of subspecies *laperrinei*.

**Key-words:** Conservation, Microsatellites, Olive tree, Plastid DNA, Saharan mountains, Threatened species.

SVII/O-8

### **Silicon-Induced Antioxidant Defense, Methylglyoxal Detoxification and Metal Chelation Works Coordinately in Alleviating Nickel Toxicity in *Oryza sativa* L.**

*Mirza Hasanuzzaman*<sup>1\*</sup>, *Md. Mahabub Alam*<sup>2</sup>, *Kamrun Nahar*<sup>3</sup>, *Sayed Mohammad Mohsin*<sup>4,5</sup>, *M.H.M. Borhannuddin Bhuyan*<sup>1,6</sup>, *Khursheda Parvin*<sup>1,7</sup> and *Masayuki Fujita*<sup>1</sup>

<sup>1</sup>Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, BANGLADESH; <sup>2</sup>Department of Agriculture, Faculty of Science, Noakhali Science and Technology University, Noakhali-3814, BANGLADESH; <sup>3</sup>Department of Agricultural Botany, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, BANGLADESH; <sup>4</sup>Laboratory of Plant Stress Responses, Department of Applied Biological Sciences, Faculty of Agriculture, Kagawa University, Miki-Cho, Kita-Gun, Kagawa 761-0795, JAPAN; <sup>5</sup>Department of Plant Pathology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, BANGLADESH; <sup>6</sup>Citrus Research Station, Bangladesh Agricultural Research Institute, Jaintapur, Sylhet, BANGLADESH; <sup>7</sup>Department of Horticulture, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, BANGLADESH, Email: mhzsauag@yahoo.com

Nickel (Ni) is an essential plant nutrient but very toxic to plant at supra-optimal concentration and causes inhibition of seed germination, growth, and development of plants. The present study investigates the possible mechanisms of Ni tolerance in rice seedlings by exogenous application of silicon (Si). Hydroponically grown 13-day-old rice (*Oryza sativa* L. cv. BRRI dhan54) seedlings were exposed to 0.25 mM and 0.5 mM NiSO<sub>4</sub>·7H<sub>2</sub>O alone and combined with 0.50 mM Na<sub>2</sub>SiO<sub>3</sub> for 3 days to investigate the effect of Ni toxicity as well as the role of Si revoking the stress. Nickel toxicity caused oxidative stress by overproduction of reactive oxygen species and methylglyoxal in seedlings of rice that created higher lipid peroxidation, and membrane damage. Nickel stress also reduced growth and biomass, leaf relative water content, and chlorophyll content of seedlings. However, non-protein thiol (NPT) content, phytochelatin and proline content increased in Ni-stress. In contrast, the Ni-stressed seedlings supplemented with exogenous Si recovered from water loss, chlorosis, growth inhibition, and oxidative stress. Silicon up-regulated most of the antioxidant defense components as well as glyoxalase systems, which helped to improve ROS and MG detoxification respectively. Hence, these findings suggest that the exogenous application of Si can improve the tolerance of rice seedlings to Ni-toxicity.

**Key words:** Silicon, Reactive oxygen species, Methylglyoxal, Metal chelation, Nickel.

SVII/O-9

## Status and Response of *Nerium indicum* to Air Pollution in Kathmandu Valley, Nepal

*Sushila Devi Shrestha\**, *Anjana Devkota* and *Pramod Kumar Jha*

Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu, NEPAL, Email: sushilashresthab@gmail.com, devkotaa@gmail.com, pkjhaprof@gmail.com

*Nerium indicum* is an evergreen, broad-leaves shrub or small tree that is widely cultivated as an ornamental in warm areas of the world. In this investigation, the variation in coverage, dust deposition on leaves and air pollution tolerance index (APTI) along roadsides having highly polluted and less polluted with respect to sites and seasons were studied. *N. indicum* was selected for the research. This study was conducted in different seasons and in various sites which were categorized as highly polluted, less polluted and control. The plants and leaves are used in analysis for their frequency, APTI and amounts of pollutants deposition. Four physiological and biochemical parameters which are total chlorophyll content, relative water content, leaf pH and ascorbic acid were used to determine the APTI. *N. indicum* is prominently available in urban sites rather than in sub urban sites. Control site is with less availability. APTI of selected species is normal and showed tolerance in different seasons and in different sites. In winter season, the polluted sites and this species leaves were more appropriate to pollutants deposition. The species is with sometimes fragrant pink flowers are known, available in residential area and has been successfully grown in urban areas where air pollution, poor drainage, compacted soil, and drought are common. It is highly suitable for planting in capital city.

**Key words:** Air Pollution, APTI, Pollutants, Leaves, Roadsides.

SVII/O-10

## Drought-Responsive Reversible and Irreversible Changes in the Cytoplasmic Proteins: Comparative Proteomics of Rice Genotypes with Contrasting Tolerance

*Lalit Agrawal*, *Shashank Kumar Mishra*, *Swati Gupta*, *Puneet Singh Chauhan* and *Chadra Shekhar Nautiyal*

Microbial Technology Department, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: lalit.ncpgr@gmail.com

Drought is one of the common and crucial environmental conditions among abiotic factors, which adversely effects the plant growth, development, and productivity of agricultural crops worldwide. Plants have been adapting different mechanism to respond to this stress at physiological to molecular levels for their survival. Studies on genetic variations for dehydration tolerance in plants is crucial because divergent cultivars with contrasting traits aid the identification of key cellular components that confer better adaptability. The cytoplasm serves as the main repository for important signaling components including proteins for building defence system. To better understand drought tolerance mechanism, a proteomic study was performed on the cytoplasmic proteins of Kiran, drought susceptible rice genotype and compared with another contrasting Heena, a tolerant genotype. The proteome was generated using two-dimensional gel electrophoresis (2-DE). The MALDI-MS/MS analysis led to the identification of 81 drought induced proteins. Many genotype-specific differentially expressed proteins revealed their involvement in variety of cellular functions like BEM, CDR, PBS and cell signaling and differing ability to recover from drought-induced damage. Drought sensitive cultivar Kiran the largest percentage of the identified proteins was involved in bioenergy and metabolism (34%), cell defense and rescue (20%), biogenesis and storage (15%), and miscellaneous (22%). The expression patterns of some of the corresponding genes were further analyzed at the mRNA level using Real Time PCR.

**Key words:** Drought, Rice, 2-DE, mRNA.

SVII/O-11

## Nanomaterials in Agri Environment: A New Threat to Crop Plants

*Poornima Vajpayee*

Ecotoxicology, Bioremediation and Nanotoxicology Laboratory, Department of Botany University of Lucknow, Lucknow-226007, INDIA, Email: devpoornima@rediffmail.com, poornimavajpayee@gmail.com

Plants are important component of any ecosystem. Imagination of life on earth without plants is impossible. Environmental pollutants are affecting crop plants adversely. Nanoparticles are newly recognised environmental pollutants. Nanomaterials are of two types: a) natural b) engineered. Nanomaterials exhibit dimension between 1-100 nm. Engineered nanomaterials (ENMs) are either carbon based (viz., Carbon Nanotubes, fullerene) or metal based (viz., metal oxide Nanoparticles, quantum dots). The environmental release of nanomaterials during production/industrial use may affect adversely the production of staple crops. Rice (*Oryza sativa*) and wheat (*Triticum aestivum*) are global staple food for a large population. CuO NPs (size <50 nm) inhibit the root and shoot growth of rice seedlings in concentration dependent manner in comparison to control. Upward translocation of CuO NPs result in accumulation of NPs in cell wall, chloroplasts etc. Rice plants under NPs (CuO) stress combat toxicity generated by reactive oxygen species (ROS) through hyperactivity of antioxidant defense system comprised of antioxidant enzymes and cellular antioxidants. However, roots are the first plant part exposed to stress generated by CuO. Hence, they have shown toxic symptoms viz. browning of the roots and lower hyper response of the antioxidant defense system. CuO NPs induce drought like condition due to adhesion of large agglomerates on roots. Wheat plants exposed to TiO<sub>2</sub> NPs (size <25 nm) showed reduced biomass, reduced photosynthesis and transpiration. TiO<sub>2</sub> NPs accumulated in chloroplasts resulted into swirling of chloroplasts. TiO<sub>2</sub> NPs significantly affected the plant primary and secondary metabolism in wheat resulting in decreased glucose, sucrose,  $\alpha$ -sitosterol, Squalene, glutamine contents. However, an increase in the concentrations of stigmasterol, malic acid,  $\alpha$ -Linolenic Acid, Asparagine,

proline, Myo-Inositol was observed after exposure of TiO<sub>2</sub> NPs in wheat. Thus, environmental release of metal oxide Nanomaterials is potent threat to rice and wheat crops.

**Key words:** Nanomaterials, Agriculture, Crop plants, Nanotechnology.

SVII/O-12

## Transcriptional Regulation of Rice Sulphate Transporter Gene Family and Functional Characterisation of Arsenic-Responsive High Affinity Sulphate Transporter, *OsSUL1;1*

*Smita Kumar<sup>1,2\*</sup>, Ria Khare<sup>2</sup>, Debasis Chakrabarty<sup>2</sup>, R.D. Tripathi<sup>2</sup> and Prabodh Kumar Trivedi<sup>2</sup>*

<sup>1</sup>Research School of Biology, Australian National University, Canberra, ACT 0200, AUSTRALIA; <sup>2</sup>CSIR-National Botanical Research Institute, Council of Scientific and Industrial Research (CSIR-NBRI), Rana Pratap Marg, Lucknow-226001, INDIA, Email: smita.kumar@anu.edu.au, smitabiochem@gmail.com

Sulphur is an essential element required by plants for their growth and development. Plants depend on the external sulphur supply in the form of sulphate anion (SO<sub>4</sub><sup>2-</sup>) from the soil, which is taken up by a set of transporters encoded by a multigene family. Plant sulphate transporters have been implicated in various abiotic stress responses. Comprehensive analysis of the proximal promoters of rice sulphate transporters suggested the presence of various common stress-related *cis*-acting elements. In addition, the transcriptional regulation of the arsenic-responsive high affinity sulphate transporter, *OsSul1;1*, was studied through development of *Arabidopsis* transgenic lines expressing reporter gene encoding  $\beta$ -glucuronidase under the control of *OsSul1;1* promoter. The analysis of the transgenic lines suggested differential response of the *OsSul1;1* promoter to various heavy metals as well as other abiotic stresses. Also, *OsSul1;1*, was functionally characterized through complementation of *Saccharomyces cerevisiae* mutant YSD1, deficient in sulphur transport. Tolerance was observed in the yeast cells expressing *OsSul1;1* towards different heavy

metals suggesting its role in heavy metal stress response. Further, functional characterization of *OsSull;1* was carried out by developing *Arabidopsis* transgenic lines to understand its role in abiotic stress conditions including heavy metals. No significant change in the growth was observed in wild type (WT) and transgenic plants under optimum nutrient medium, however, significant increase in the germination rate, cotyledon emergence and root length was observed in the transgenic plants in comparison to WT under sulphur limiting condition. Apart from the heavy metals, transgenic lines showed resilience towards different abiotic stresses such as salt and drought under sulphur limiting conditions. Therefore, the study suggested the role of *OsSull;1* in maintaining enhanced sulphur pool inside the cell and a significant role in providing tolerance against various stress conditions.

**Key words:** *Arabidopsis*, Arsenic, Detoxification, Rice, Sulphate transporter, Sulphur.

SVII/O-13

## Urban Dustfall: Affecting Foliar Surface and Biochemical Constituents of Economically Important Plant Species of Delhi Region, India

Gyan Prakash Gupta<sup>1\*</sup> and U.C. Kulshrestha<sup>2</sup>

<sup>1</sup>Department of Botany, DAV College, CSJM University, Kanpur, INDIA; <sup>2</sup>School of Environmental Sciences, Jawaharlal Nehru University, Delhi, INDIA

Email: gyan.greet12@gmail.com, umeshkulshrestha@gmail.com

Very high loadings of atmospheric dust in Indian region contribute to remarkably higher levels of particulate matter. The dust is primarily a mixture of suspended soil, road dust and other particulate matter. During prevailing dry weather conditions, the dust is deposited onto the foliar surfaces affecting their trichome, stomata and biochemical constituents. Hence, during this study, elevated total dust fall and fluxes of  $\text{SO}_4^-$  at industrial site (Sahibabad) as compared to residential site (Jawaharlal Nehru University campus) have been recorded on foliar surfaces. These higher fluxes of  $\text{SO}_4^-$  have been attributed to the oxidation of  $\text{SO}_2$  due to which remarkable changes have been

observed in foliar morphology and biochemical constituents of an economically important plant Arjuna (*Terminalia arjuna*) and Morus (*Morus alba*). It is interesting to note that around 3-4 times higher fluxes of  $\text{SO}_4^-$  were recorded on foliar at industrial site as compared to residential site. Atmospheric dust was also characterized for other major ions ( $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{NO}_3^-$ ,  $\text{Na}^+$ ,  $\text{NH}_4^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{++}$  and  $\text{Ca}^{++}$ ). The morphology of foliar through Scanning Electron Microscope (SEM) indicated a significant difference in size of the stomatal pores and ruptured guard cells at industrial site as compared to residential site. Results of biochemical analysis showed that plant foliar at the industrial site had relatively higher values of ascorbic acid, proline amino acid and lower values of total chlorophyll.

**Key words:** Dustfall, Sulfate ( $\text{SO}_4^-$ ) flux, Ascorbic Acid, Proline amino acid, Chlorophyll, SEM.

SVII/O-14

## Study on the Effect of UV-B on Two Different Ferns

Niranjana Mishra\*, Babita Kumari and Sandip Kumar Behera

CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: niranjana.mishra5555@gmail.com, babita.bit86@gmail.com, 16.sandip@gmail.com

A preliminary study was carried out to find out whether Ultraviolet-B (UV-B) radiation influences the chlorophyll, carotenoid and protein contents of two different ferns *Nephrolepis tuberosa* (Bory ex Willd.) C. Pres land *Microsorium alternifolia* (Willd.) Copel.. For this study, the plantlets of 30 days of both the species were planted in the plastic pots filled with soil equally. The potted plants of each species were divided into 4 groups randomly. One group of plants from each species was kept in natural condition without any treatment, second groups were exposed to UV-B for 15 minutes, third groups for 20 minutes and fourth groups for 30 minutes for 3 days respectively. The results indicated that there was a reduction in chlorophyll a (Chl a), chlorophyll b (Chl b), total chlorophyll, carotenoids and protein content in UV-B irradiated plants as compared to the control. The percentage of reduction of Chl a, Chl b, total chlorophyll, carotenoids and protein content was maximum in the



plants exposed to 30 minutes of UV irradiation in both *Nephrolepis tuberosa* and *Microsorium alternifolia* than control. There was significant decrease in protein content in *Nephrolepis tuberosa* as compared to *Microsorium alternifolia* when irradiated to UV light. From the results it is suggested that *Nephrolepis tuberosa* is more susceptible to UV-B than *Microsorium alternifolia*.

**Key words:** Ultraviolet-B, Ferns, Chlorophyll, Carotenoid, Protein.

SVII/O-15

### **Ameliorative Effect of Salicylic Acid on Growth and Seedling Establishment of Corn (*Zea mays* L.) Grown under NaCl Stress**

**P.K. Singh**

Department of Botany, Udai Pratap Autonomous College, Varanasi-221002, INDIA, Email: drpksinghupc@gmail.com

In this changing environment plants have to face major threat in natural ecosystem. The major cause of stresses are heat, drought, salinity and cold stress. Among these soil salinity is one of the most devastating environmental stress which causes major reduction in productivity and quality via affecting physiological and biochemical function of plants like inhibit photosynthesis through its effect on stomatal conductance absorption of water and nutrients. Plants exhibit several mechanisms that can alleviate the deleterious effect of salinity under changing environment. The aim of the present work was to investigate the accumulation of phenolic acids in 2 weeks old maize (*Zea mays* L.) plants grown under salt stress (0, 50, 100, 150 and 200 mM NaCl) in presence and absence of 0.5 mM SA. The results showed severe reduction in plant dry weight, leaf relative water content and photosynthetic pigments. Content of total phenolics was increased by 64% in the plants after salt treatment. The exogenous application of SA significantly alleviated the growth inhibition of plants caused by NaCl, and was accompanied by higher leaf relative water contents, photosynthetic pigments, and lower total phenolics. This result shows that the presoaking application of SA was an effective way to improve the salt tolerance of maize plants.

**Key words:** Salinity stress, Salicylic acid, Phenolic profiles, NaCl stress.

SVII/O-16

### **Ganga Water Pollution: A Potential Health Threat to Inhabitants of Ganga Basin**

**Sanjay Dwivedi\*, Seema Mishra and R.D. Tripathi**

Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, India, Email: drs\_dwivedi@yahoo.co.in

The water quality of Ganga, the largest river in Indian sub-continent and life line to hundreds of million people, has severely deteriorated. Studies have indicated presence of high level of carcinogenic elements in Ganga water. We performed extensive review of sources and level of organic, inorganic pollution and microbial contamination in Ganga water to evaluate changes in the level of various pollutants in the recent decade in comparison to past and potential health risk for the population through consumption of toxicant tainted fishes in Ganga basin. The analysis of data showed that despite several Govt. plans to clean Ganga, the amount of untreated waste water discharge into Ganga has increased by many folds in past four decades resulting in high increase in microbial load and disturbed physicochemical parameters. The level of pesticides in Ganga water registered drastic reduction in last decade (i.e. after the establishment of National Ganga River Basin Authority (NGRBA) in 2009); still the levels of some organochlorines are beyond the permissible limits for drinking water. Conversely the inorganic pollutants, particularly carcinogenic elements have increased several folds. Microbial contamination has also significantly increased. These pollutants have adversely affected the unique properties, such as self-purification, antibacterial and incorruptibility of Ganga water as well as its fish fauna and fish health. The high load of pathogens and chemical toxicants in middle and lower stretch of Ganga make the water unsuitable for consumption or other domestic uses. Hazard quotient and hazard index indicated significant health risk due to metal/metalloid exposure through consumption of tainted fishes from Ganga. Target cancer risk assessment showed high carcinogenic risk from As,

Cr, Ni and Pb as well as residues of DDT and HCHs. Current data analysis showed that Ganga water quality is deteriorating day by day and at several place even in upper stretch of Ganga the water is not suitable for domestic uses. Although there is positive impact of ban on persistent pesticides with decreasing trend of pesticide residues in Ganga water, the increasing trend of trace and toxic elements is alarming and the prolong exposure to polluted Ganga water and/or consumption of Ganga water fishes may cause serious illness including cancer.

**Key words:** Ganga river, Microbial diversity, Metal and pesticides contamination.

SVII/O-17

### Ultrastructure Modification of Arsenic Stressed Rice Cultivars under Altered Irrigation Practices in Bengal Delta Basin

Arnab Majumdar<sup>1\*</sup>, Munish Kumar Upadhyay<sup>2</sup>, Anil Barla<sup>1</sup>, Sudhakar Srivastava<sup>2</sup> and Sutapa Bose<sup>1</sup>

<sup>1</sup>Earth and Environmental Science Research laboratory, Department of Earth Sciences, Indian Institute of Science Education and Research Kolkata, Mohanpur-741246, West Bengal, INDIA; <sup>2</sup>Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Emails: arnabmajumdar891@gmail.com, munish007up@gmail.com, barla.neal@gmail.com, sutaparai@gmail.com, sudhakar.srivastava@gmail.com

Rice cultivation and related agronomic practices in Bengal delta basin profoundly relies on the arsenic (As) contaminated groundwater irrigation in wintery boro production and rain water in monsoonal aman cultivation. Implication of dry-wet water regimes instead of conventional waterlog practices led to higher degree of silicon accumulation in rice plant tissues suppressing arsenic translocation and its subsequent accumulation. This practice of controlled water application also strengthens plant's shoot, nodes and leaf xylem-phloem integrity compared to conventional continuously flooded rice cultivation approach, observed under Field emission-scanning electron microscopy (FE-SEM). This study was conducted in 2017. Bio-available concentrations of soil As were

found  $28.66 \pm 0.97$ ,  $31.40 \pm 0.74$  mg Kg<sup>-1</sup> respectively in two periodically saturated fields with two selected rice cultivars, gosai and satabdi. Whereas, in continuously flooded field soil concentrations of bio-available As were  $79.24 \pm 0.78$ ,  $77.52 \pm 0.21$  mg Kg<sup>-1</sup> in gosai and satabdi fields respectively. Correlation has been made in terms of arsenic release from irrigated fields to plant uptake due to As rich groundwater by deriving two proposed seasonally justified equations. Soil microbial screening was performed where 16S rRNA analysis of the same bacterial species from the two irrigation fields showed different As tolerance. Fresh plant's parts (shoot-root) were analysed for biomass, lipid peroxidation, pigment content, protein and superoxide dismutase (SOD) enzyme in both conditions clearly indicating an alleviation of arsenic contamination from rice grain with certain sustainability and proved to be potential in reducing considerable bio-available amount of arsenic in dry-wet irrigation.

**Key words:** Arsenic stress, Periodical water cycling, Paddy plant ultrastructure, Sustainable mitigation.

SVII/O-18

### Nitric Oxide Alleviates Iron and Chromium Toxicity by Reducing Growth Inhibition and Oxidative Damage in Wheat (*Triticum aestivum* L.) Seedlings

Laxmi Verma\*, Zeenat Parveen and Nalini Pandey

Plant Nutrition and Stress Physiology Laboratory, Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: laxverma000@gmail.com, zntprvn8@gmail.com, nalini\_pandey@rediffmail.com

Nitric oxide (NO) is an important bioactive signaling molecule in plants which modulates a variety of physiological processes and responses to abiotic and biotic stresses. In this study, the effects of exogenous NO supplied as sodium nitroprusside (SNP) in wheat seedlings under Fe and Cr toxicity was investigated. In solution culture wheat seeds were grown in the control, toxic Fe (400 µM Fe) and toxic Cr (50 µM Cr) levels. These seedlings were treated with 50, 100, 200 and 500 µM sodium nitroprusside (SNP) as a source of NO. The results indicated that 400 µM Fe and 50 µM Cr

significantly decreased germination percentage, tolerance index, root lengths as well as fresh and dry weight as compared to control. Exogenous SNP attenuated the inhibition of wheat seed germination. The promoting effect was most pronounced at 100iM SNP. The concentration of Fe and Cr was significantly decreased by SNP treatment in the toxic seedlings. Toxicity of Fe and Cr caused oxidative stress by elevating hydrogen peroxide ( $H_2O_2$ ), malondialdehyde (MDA) and proline contents in roots of wheat seedlings. Treatment with 100 iM SNP counteracted Fe and Cr toxicity by reducing the  $H_2O_2$ , MDA and proline contents of toxic Fe and Cr exposed seedlings. Meanwhile, application of SNP markedly reduced the activities of superoxide dismutases (SOD), catalases (CAT), peroxidase (POD), ascorbate peroxidases (APX), glutathione reductase (GR), non protein thiols (NPT) and increased ascorbate (ASc) compared with Fe and Cr toxic treatment alone, thereby indicating the modulation of the antioxidative defense system against Fe and Cr induced oxidative stress by NO.

**Key words:** Wheat seedlings, Fe toxicity, Cr toxicity, Sodium nitropruside, Oxidative damage, Antioxidative enzymes.

#### SVII/O-19

### **$\alpha$ -Aminobutyric Acid Modulates Fatty Acids, Stress Responsive Amino Acids and Polyamines Biosynthesis in *Oryza sativa* L. to Ameliorate Arsenite Toxicity**

**Navin Kumar<sup>1,2\*</sup>, Saripella Srikrishna<sup>2</sup> and Shekhar Mallick<sup>1\*</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Biochemistry, Faculty of Science, Banaras Hindu University, Varanasi-221005, INDIA, Email: shekharm@nbri.res.in

$\alpha$ -aminobutyric acid (GABA) is a free amino acid, helps to counteract biotic and abiotic stress in plants. In the presented study, two concentrations of GABA, i.e., 0.5 [GABA(0.5 mM)] and 1 mM [GABA(1 mM)] were applied to provide tolerance against As(III) toxicity in rice seedlings through modulation of fatty acid (FA), stress responsive amino acids (AAs) and polyamines (PAs) biosynthesis. The GABA modulated FA

biosynthesis and its response against As(III) in plants remains to be explored. The GABA (0.5 mM) effectively recovered the growth parameters against As(III) stressed rice seedlings. Simultaneously, application of GABA (0.5 and 1mM) against As(III), consistently enhanced the unsaturated fatty acids (USFA) (cis-10-pentadecenoic acid, oleic acid,  $\alpha$ -linolenic acid and  $\omega$ -linolenic acid) content, which was higher than saturated fatty acid (SFA). Among the USFAs, level of linolenic acid was found to be always higher with GABA application. Similarly, the elevated level of AAs (proline, methionine, glutamic acid and cysteine) was observed with the application of GABA (0.5 and 1 mM) against As(III) treatments. Among all the PAs i.e., putrescine, spermine and spermidine, level of putrescine was found to be highest with application of GABA. Elevated level of USFAs, AAs and PAs were strongly correlated with the reduced level of hydrogen peroxide ( $H_2O_2$ ) and thiobarbituric acid reactive substances (TBARS) in seedlings. Overall, the study demonstrates that GABA plays a vital role in As(III) tolerance by enhancing the biosynthesis of USFA, AA and PA in rice seedlings.

**Keywords:** Arsenic, Amino acid, GABA, Fatty acid, Polyamines, *Oryza sativa*.

#### SVII/O-20

### **Amelioration of Salt Stress by Salicylic Acid and Arbuscular Mycorrhizal Fungi via Strengthened Antioxidant Defense Mechanisms in Chickpea**

**Amrit Bharti\* and Neera Garg**

Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: ahlbharti@gmail.com, gargneera@gmail.com

Salt stress disturbs redox homeostasis by perturbing equilibrium between generation and scavenging of reactive oxygen species (ROS), which reduces plant biomass through membrane damage, denaturation of proteins and lipid peroxidation. Exogenous salicylic acid (SA) and arbuscular mycorrhizal (AM) fungi play important roles in imparting salt tolerance in legumes by maintaining redox homeostasis. However, their relative roles in

modulating antioxidant defense mechanisms have not been investigated. The present study focused on the relative and combined roles of SA and AM fungi in scavenging ROS in chickpea genotypes (salt tolerant-PBG 5, sensitive-BG 256) subjected to NaCl (0, 4, 6 and 8 dSm<sup>-1</sup>) stress. Despite the increase in antioxidant activities, ROS such as superoxide radical (O<sub>2</sub><sup>•-</sup>) and hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) increased significantly with increasing salt concentrations and induced increased lipid peroxidation along with lipoxygenase (LOX) activity, which disrupted membrane stability, more in BG 256 than PBG 5. Salt stress also caused redox imbalance by lowering ascorbate (AsA)/dehydroascorbate (DHA) and reduced glutathione (GSH)/oxidized (GSSG) levels, which indicates that for efficient antioxidant mechanisms, maintenance of redox homeostasis is crucial. Individually, SA as well as AM reduced ROS generation and up-regulated the activities of antioxidant enzymes. Exogenous SA was more effective in reducing ROS accumulation and lipid peroxidation, which provided higher membrane stability as compared to AM fungi. Although the enzymatic antioxidant activities were found to be more in SA treated plants, yet AM fungi outperformed the increase in regenerative enzyme activities of Asada-Halliwell pathway, thereby improving AsA/DHA and GSH/GSSG ratios, which resulted in higher plant biomass in a genotype-dependent manner. SA increased percent root colonization, which provided functional complementarily by significantly strengthening the antioxidant defense mechanisms through their individual and cumulative contribution. The study suggested the use of +SA+AM as an eco-friendly tool in imparting salt tolerance in chickpea genotypes subjected to long-term salinity.

**Key words:** Arbuscular mycorrhizal (AM) fungi, Asada-Halliwell pathway, Chickpea, Redox homeostasis, Salicylic acid (SA), Salt stress.

SVII/P-1

## Screening of Genotypic Variability in Nitrogen use Efficiency of *Brassica oleracea* L. var. *capitata* on the basis of Various Morpho-Physiological and Biochemical Parameters

Peer Saffullah\*, Tinu Anand Kain, Shahid Umar and Tariq Omar Siddiqi

Department of Botany, School of Chemical and Life Sciences, Jamia Hamdard, New Delhi-110062, INDIA, Email: saif3n9@gmail.com, tinuanandkain@gmail.com, sumer@jamiahamdard.ac.in, tosiddiqi@jamiahamdard.ac.in

A marked increase in food production has occurred over the past half-century to feed the growing population, which is mainly attributed to application of chemical fertilizers. However, excess inputs of synthetic N fertilizers also results in severe environmental pollution, climate change and biodiversity loss, which are enormous environmental challenges of the 21st century. Moreover, the application of N fertilizers will keep on increasing with growing demand for food production and therefore developing crop varieties with improved NUE is crucial for sustainable development. Thus reducing N fertilizer usage but maintaining crop yield is a pressing challenge. One of the ideal ways to tackle this crisis is to improve NUE of crops and identification of new cultivars that utilize N more efficiently. In our study, variations in Nitrogen Use Efficiency (NUE) of cabbage cultivars were evaluated and accessions were screened out on the basis of genotypic differences in NUE. The 12 accessions of *Brassica oleracea* L. var. *capitata* were procured from NBPGR, New Delhi. The plants were grown under following fertilizer treatments applied to the soil pre-sowing: 120 kg ha<sup>-1</sup> of N as urea, 30 kg ha<sup>-1</sup> of P as single super phosphate, 80 kg ha<sup>-1</sup> of K as KCl, 25 kg ha<sup>-1</sup> of Zn as ZnSO<sub>4</sub> and 40 kg ha<sup>-1</sup> of S as CaSO<sub>4</sub>. Various morpho-physiological parameters like plant height, head size, head weight, fresh and dry weights were recorded at marketable yield stage. The plants were also analyzed for various biochemical characteristics, mainly associated with N metabolism, like NR activity, NiR activity, GS-GOGAT activity and nitrate content. The marketable head yield and N

content were measured by CHNS analyser and NUE was calculated. Based on the N metabolism, N utilization and N content accessions were screened out as High NUE and Low NUE varieties. Other biochemical parameters like total protein content, total soluble sugar content and total phenol content was also measured. Significant differences among genotypes and N-treatments were found.

**Key words:** NUE, cabbage, Nitrogen, NR activity, Screening, Genotypic variability.

SVII/P-2

### **Effect of Carbendazim on Mustard [*Brassica juncea* (L.) Czern & Coss.]: An *in vitro* Study**

**Monika and Mohd. Kashif Kidwai\***

Department of Energy & Environment Sciences, Chaudhary Devi Lal University, Sirsa, Haryana, INDIA, Email: kashif357313@yahoo.co.in

Mustard is one of the most important oil yielding crops and is majorly used for various purposes such as medicinal uses, condiment and industrial uses. Bavistin is a broad spectrum systemic fungicide containing 50% WP Carbendazim. Carbendazim 50%WP is popularly applied against a wide range of pathogenic fungi and is highly specific in its control of important plant pathogens on a variety of crops, ornamental plants, plantation crops etc. It is used as a seed dresser. An *In-vitro* plant study was conducted to assess the effect of Carbendazim 50%WP on growth parameters i.e. germination percentage, fresh weight, seedling vigour Index (SVI), plant length, number of roots and biochemical parameters i.e. Chlorophyll a, Chlorophyll b, Total chlorophyll and Carotenoids on Mustard [*Brassica juncea* (L.) Czern & Coss] variety Varuna. In the experiment three different doses of Carbendazim (50% WP) i.e. 1 mg.kg<sup>-1</sup> Half Recommended Dose (½RD), 2 mg kg<sup>-1</sup> Recommended Dose (RD) and 4 mg kg<sup>-1</sup> Double Recommended Dose (2RD) applied on variety Varuna. Results revealed that, RD and 2RD reduced the germination up to (25–45 %), fresh weight (20-40%), seedling vigour Index (50-70%), plant length (30-50%) and no significant difference were observed in number of roots in comparison of control. Overall results clearly indicate that excess amount of Carbendazim induced stress in the studied mustard

variety, which resulted in poor growth, and also indicated the adverse impact on biochemical parameters, Higher doses i.e. RD and 2RD reduced the Chlorophyll a (25-40%), Chlorophyll b (30-60%), Total Chlorophyll and Carotenoids (25-50%) in comparison of control plants.

**Key words:** Mustard, Bavistin, Growth parameters, Biochemical parameters.

SVII/P-3

### **An *in vitro* Study of Effect of Sugar Mill Effluent on Radish (*Raphanus sativus* L.) Varieties**

**Mohd. Kashif Kidwai\* and Kamlesh**

Department of Energy & Environmental Sciences, Chaudhary Devi Lal University, Sirsa, Haryana, INDIA, Email: kashif357313@yahoo.co.in, sainikamlesh23@gmail.com

An *in vitro* study was conducted to assess the impact of sugar mill effluent applied in different dilutions i.e. 0.5%, 1.0%, 5.0% and 10.0% along with control in duplicate on two Radish (*Raphanus sativus* L.) varieties (RD-68 and Radish Hill Queen) to investigate the effect on growth parameters i.e. germination percentage, seedling vigour, plant fresh weight, plant length and photosynthetic parameters i.e. Chl a, Chl b and total chlorophyll. The effluent samples were collected from the sugar mill situated at Rohtak (India). The results of Physico-chemical analysis of the sugar mill effluent indicated the presence of high inorganic and organic content with acidic load. Test plants of both the varieties having 0.5% and 1.0% dilutions responded better than control plants exhibiting the supply of essential nutrients needed for initial plant growth and biochemical metabolism of plants. High germination percentage was observed in RD-68 variety at lower dilution i.e. 1% where as in Radish Hill Queen variety best germination percentage was recorded at 0.5% as compared to control after 72 hrs. Early germination was recorded in RD-68 variety plants than Radish Hill Queen variety plants. Inter-varietal difference was observed as RD-68 variety plants performed better in terms of seedling vigour, fresh weight and plant length at 0.5% and 1.0% dilutions whereas least values for seedling vigour, fresh weight and plant length were recorded in plants having treatment of 10% dilution. Photosynthetic pigments such as Chl a, Chl b and total chlorophyll were also adversely

affected after 7 and 21 days at higher dilutions i.e. 10% resulted to induce stress in both the test varieties. The results indicate that the sugar mill effluent may be applied for irrigation in appropriate dilutions with judicious approach to encourage industrial waste management.

**Key words:** Sugar mill effluent, *Raphanus sativus*, Chla, Chl b, Total Chlorophyll, Germination percentage, Seedling vigour.

SVII/P-4

## Effect of Different Levels of Fertilizers on Morphological Characteristics of Two *Vigna* Species

Supriya Dixit\* and R.K. Gupta

Department of Botany, Dayanand Vedic College, Orai, Jalaun-285001, INDIA, Email: supriyadixit.dixit2@gmail.com, gupta.rk@radiffmail.com

Current soil management strategies are mainly dependent on inorganic chemical based fertilizers, which caused a serious threat to human health and environment. Today fertilizer has become essential to modern agriculture to increase yield and to feed the growing population. Increased crop production largely relies on the type of fertilizers used to supplement essential nutrients for plants. Microorganisms play an important role in soil processes that determine the plant productivity. Today most of farmers and agriculturists are turning to the use of biofertilizers, to enhance the crop production, as these are gentler on the soil as compared with the chemical fertilizers. A pot experiment carried out during two kharif seasons to study the effect of different levels of chemical fertilizer (DAP) (0.25g, 0.5g and 1.0g per kg of soil) and biofertilizer (PSB) (2.5g, 5.0g and 10g per kg of soil) separately and in combination on urd bean [*Vigna mungo* (L.) Hepper] and mung bean [*Vigna radiata* (L.) Wilczek] to observe certain morphological characteristics i.e. germination percentage, plant height, fresh and dry weights of plants, leaf area and total chlorophyll content. The study was aimed to improve the growth and obtain optimum yield of *Vigna* species with eco-friendly, non-toxic way and reduce the use of chemical fertilizer application in agricultural activities. In the present study, sixteen treatments were prepared

including control. After 60 DAS (Days after sowing) observation found that all experimental parameters were maximum in both *Vigna* crops with combined application of fertilizers as DAP (1.0 g) + PSB (10 g) per kg of soil as compared to control and separate applications of fertilizers also showed better result than control. Therefore, it can be concluded that a balanced fertilizer strategy with or without combination of chemical and biofertilizer could be used to achieve maximum crop yield without contaminating the environment.

**Key words:** Fertilizer, DAP, PSB, *Vigna* species, Morphological characters.

SVII/P-5

## Percussion of Plant Derived Smoke and Karrikinolide on Germination, Growth, Photosynthesis and Nutritional Values of Carrot

Arshiya Akeel<sup>1</sup>\*, M. Masroor A. Khan<sup>1</sup>, Hassan Jaleel<sup>1</sup> and Moin Uddin<sup>2</sup>

<sup>1</sup>Department of Botany, Aligarh Muslim University, Aligarh, INDIA; <sup>2</sup>Botany Section, Women's College, Aligarh Muslim University, Aligarh, INDIA, Email: arsh.aqeel@gmail.com, masruur@gmail.com, jaleelamu@gmail.com, moinuddin.bt@gmail.com

Plant-derived smoke has now been established as a positive regulator of seed germination and growth in many plant species. Out of several compounds present in plant-derived smoke, the major active growth-promoting compound is believed to be Karrikinolide or KAR<sub>1</sub> (3-methyl-2H-furo [2,3-c] pyran-2-one). A pot experiment was performed under the natural conditions of net house at the Department of Botany, Aligarh Muslim University, Aligarh, India. Smoke-water making apparatus was designed in the lab. This study was conducted to test the efficacy of smoke-water and KAR<sub>1</sub> on carrot (*Daucus carota* L.). Smoke-water and KAR<sub>1</sub> treatment was applied to the plants in the form of diluted aqueous solution of variable concentrations. Seeds were pre-soaked in the solutions of smoke-water and KAR<sub>1</sub>. Analyzed aspects of this study were: percent seed germination, plant growth, photosynthesis and nutritional values. The results obtained clearly indicate a significant

improvement in all the attributes studied. In case of seed germination percentage, SSW 1:500 (v/v) and  $10^{-8}$  M of  $KAR_1$  showed an increase of 58.06% and 54.39% respectively, as compared to control. The  $\beta$ -carotene content and ascorbic acid content exhibited an increment of 32.71% and 37.90% over control by 1:500 (v/v) of SSW and  $KAR_1$   $10^{-8}$  M showed enrichment of 42.03% and 48.42% respectively in comparison to control. This study provides insight into an affordable and feasible method of crop improvement.

**Key words:** 3-methyl-2H-furo [2,3-c] pyran-2-one, *Daucus carota* L., Growth promoter, Karrikinolide, Plant-derived smoke, Photosynthesis, Seed germination.

#### SVII/P-6

### Effect of Sodium Dodecyl Sulphate (SDS) to Determine the Indices of *Allium* Species Studied

Thejasenuo Julia Kirha<sup>1\*</sup>, Sanjay Kumar<sup>2</sup> and Talijungla<sup>1</sup>

<sup>1</sup>Department of Botany, Nagaland University, HQs: Lumami-798627, INDIA; <sup>2</sup>Department of Botany, Banaras Hindu University, Varanasi-221005, INDIA, Email: thejasenuokirha@gmail.com, ksanjay79@gmail.com, lkr.talijungla@gmail.com

Sodium dodecyl sulfate (SDS) is a primary alkyl sulphate denoted by molecular formula  $C_{12}H_{25}NaO_4S$  with molecular weight of 288.38 g mol<sup>-1</sup>. The tremendous use of this chemical in daily life activity prompted us to determine the Indices of this chemical in plant genetic system. The different *Allium* species (*A. hookeri*, *A. tuberosum*, *A. chinense*, *A. ascalonicum*, *A. porrum*) and concentrations (500, 1000 and 3000 ppm) was used in the present study to observe the said effects for 3 h on the genetics of this species. Different Indices such as meiotic index (MI), apoptotic index (AI), nuclear index (NI) and genetic damage index (GDI) were calculated along with frequency of chromosomal aberrations, total no. of abnormal cells, SDS tolerance were taken into consideration after the application SDS in different concentration in all the *Allium* species. The nuclear division index which indicates the division rate of a nucleus shows 100 percent division of nucleus under the meiosis after application of different concentration.

During the nuclear division, the damage of genetic material was observed from lower to higher concentrations. Genetic damage index (GDI) during nuclear division has shown a mixed response in *A. chinense* (19.7, 14.26, 21.07) and *A. tuberosum* (12.24, 39.54, 18.36) as the GDI material increase from lower to higher concentration but the apoptosis in the cells showed above 90% in all the *Allium* species. When the meiotic index decreased at higher concentration, it also indicates that the total percent of abnormal cell must increases at higher concentration. The frequency of getting abnormal cells increased from lower to higher concentration in *A. hookeri* (2.54, 1.66, 11.75) and *A. porrum* (1.90, 3.33, 6.07), which may be also suggested that *A. hookeri* and *A. porrum* are more sensitive to the applied concentration. Since the frequency of abnormal cell increased after application of SDS, *A. hookeri* and *A. porrum* may be considered more sensitive than *A. ascalonicum* (3.26, 5.06, 4.43), *A. tuberosum* (4.83, 9.04, 3.95) and *A. chinense* (16.38, 3.44, 4.34). When the concentration was applied to the *Allium* species for SDS salt tolerance the higher concentration has shown less tolerance in *A. porrum* (0.25, 0.24, 0.14) and *A. hookeri* (0.38, 0.43, 0.17). Which suggests that it involves higher number of abnormal cells at higher concentration, and it also correlates with the higher production of abnormal cells frequency, GDI, apoptotic index and meiotic index. None of the species has shown 50% of the salt tolerance which also suggested that all the species are sensitive to the applied concentration but most sensitive species is *A. hookeri* and *A. porrum*.

**Key words:** SDS, *Allium* species, Abnormalities, Genotoxicity, Toxicity.

#### SVII/P-7

### Impact of Silicon: Most Neglected Nutrient, in improving Quality and Quantity of Menthol Production in *Mentha arvensis*

Vinod Goyal<sup>1\*</sup>, Sanjay Dwivedi<sup>2</sup>, Anita Kumari<sup>1</sup>, Neeru Jain<sup>3</sup> and R.D. Tripathi<sup>2</sup>

<sup>1</sup>Department of Botany & Plant Physiology, CCS HAU, Hisar-125001, INDIA; <sup>2</sup>Plant Ecology and Environment Science Division, CSIR-NBRI, Lucknow-226001, INDIA; <sup>3</sup>Privi Life

Sciences Pvt. Ltd., Mumbai, INDIA, Email: goyal2973@gmail.com

Plants are important source of essential oils, which found varied usage in our day to day life. Cultivation of aromatic plants has been very lucrative and profitable for farmers, as they fetch good price in the market. Unlike any other crops, vagaries of climate along with deteriorating soil health are adversely hampering the production and quality of essential oils. In India, mint species are cultivated predominately in northern states (Uttar Pradesh, Utrakhand, Punjab and Haryana), occupying over 150000 hectares. Under prevailing cultural practices, plants experience various abiotic stresses (heat, water etc.), which have resulted in reduced yield and composition of menthol. Despite of ubiquitous and abundant presence of silicon in earth crust, its essentiality for plants is ambiguous. Ortho silicic acid (OSA) is the only bio available form of silicon is generated *in situ* in soil from soil silicates. However, degraded and poor soil health has limited the natural process. This warranted the need for alternative option for its supply to crop. Present field study was conducted on *Mentha arvensis* var. at three locations at Uttar Pradesh. Foliar application of Silixol (OSA 2.0%) was applied two times with standard agronomic practices. First application was done at 4-5 leave stage of crop while the second application was carried out after 4 weeks of first application. The crop was harvested after 80 days of planting. A significant increase in the plant vigour in terms of plant height (~10% increase over control) and leaf size (19% increases over control) was recorded. This increased vegetative growth has contributed to an increase in oil content, an average increment of 18%. Besides, quantitative increment a significant increase in quality of oil was also increased. No change in chemical composition of oil was recorded, though an increment in 10% increment in total menthols was recorded. Results obtained are very promising as by a mere addition of a nutrient component has a potential to improve both quality and quantity of menthol. Further studies are in progress to ascertain repeatability of the results. The present results reveal the implication of OSA technology to boost the production of essential oil for all medicinal and aromatic plants.

**Key words:** Silicon, *Mentha arvensis*, Methanol, Nutrients, Silixol.

SVII/P-8

## Impact of Cadmium Toxicity on Germination, Plant Biomass, Oxidative Stress Markers and Osmolyte Synthesis in *Cajanus cajan* (L.) Millsp. (Pigeonpea) Genotypes

*Aditi\* and Neera Garg*

Department of Botany, Panjab University Chandigarh-160014, INDIA, Email: gargneera@gmail.com, garg\_neera@yahoo.com, bishtaditi1994@gmail.com

Agricultural soils in many parts of the world are contaminated by various heavy metals (HMs) such as cadmium (Cd), nickel (Ni), cobalt (Co), lead (Pb), arsenic (As) etc. Cadmium is a potentially hazardous trace metal which induces complex changes in plants at anatomical, biochemical and physiological levels. Pot and petri-dish experiments were conducted to compare the influence of cadmium ( $\text{CdSO}_4$  - 0, 20, 30, 40 and 50  $\text{mg kg}^{-1}$  /  $\text{mg l}^{-1}$ ) on growth and metabolism in five genotypes of pigeonpea (Pusa 2001, Pusa 2002, Pusa 991, Manak, AL 882). Negative effects of cadmium stress, manifested within 3 days of petri-dish experiments in the form of reduced germination, seedling growth, vigor index, emergence percentage and seedling respiration rate in concentration dependent manner. Long term Cd stress of one month duration in pot experiments indicated significant decline in root and shoot biomass as well as their ratio and led to reduced relative water content (RWC), chlorophylls, carotenoids concentration. On the basis of all the above parameters and relative metal tolerance index (MTI), Pusa 2001 were found to be most tolerant followed by Pusa 2002 and Manak with Pusa 991, AL 882 most sensitive. A significant increase in membrane relative permeability, ROS ( $\text{H}_2\text{O}_2$ ) generation and lipid peroxidation (MDA) was recorded in the presence of Cd in rooting medium in genotype dependent manner. Significant increase in the levels of total soluble sugar (TSS) and proline indicated their roles as important stress biomarkers especially in Pusa 2001.

**Key words:** Biomarker, Cadmium, Genotype, Seedling, Pigeonpea.



SVII/P-9

## Response of *Linum usitatissimum* L. to Heavy Metal Contaminated Soil

Adnan Khan\* and Athar Ali Khan

Environmental Botany Laboratory, Department of Botany, Aligarh Muslim University, Aligarh-202002, INDIA, Email: akhan9361@gmail.com, khan\_ath@yahoo.com

Flax (*Linum usitatissimum* L.) vern. Alsi is an herb of family Lineaceae, extensively grown in cooler climate of the world. Linen fibres are used traditionally and in textile industry for 'Linen' manufacture while linseed oil is active ingredient of folk medicine and drug industry as pain reliever it is also used in paint industry and wood finishing products. Lead (Pb), copper (Cu) and cadmium (Cd) are common soil contaminants in arable lands posing ecotoxicity and shift in ecosystem structure. Flax plant was tested against these common soil contaminants for its growth responses against heavy metal accumulation. Experiment was set up under natural conditions to test the plant response grown in earthen pots filled with garden soil contaminated with chloride salts of Pb, Cu and Cd. Treatment with different concentrations of heavy metals (mg/kg of soil) had shown maximum accumulation of Pb followed by Cu and Cd. Increasing concentration of these metals led to increased phytotoxicity of these heavy metals and negative effects on visible and growth markers. As an adaptive strategy initial leaf fall and leaf burn, lesser branching and early flowering was induced in heavy metal dose dependent manner. Plant height, dry weight, number of leaves number of flowers and number of seeds were other morphological parameters tested which shown progressive reduction. Maximum accumulation of heavy metal was shown by Pb followed by Cu and Cd when treated with concentration of 750 mg kg<sup>-1</sup> soil (for Pb and Cu) and 75 mg kg<sup>-1</sup> soil (for Cd), however, phytotoxicity induced by these heavy metals were in order of Cu > Cd > Pb.

**Key words:** Cadmium, Flax, Copper, Lead, Phytotoxicity.

SVII/P-10

## Phytochemical Evaluation and Free Radical Scavenging Activity of Seeds of *Cyamopsis tetragonoloba* L. (Taub.) Genotypes

Mohd Akram Ansari<sup>1,2\*</sup>, Vivek Kumar Sharma<sup>3</sup>, Arvind Kumar Dubey<sup>2,4</sup>, B.N. Singh<sup>3</sup>, Veena Pande<sup>2</sup> and Vivek Pandey<sup>1</sup>

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-NBRI, Lucknow-226001, INDIA; <sup>2</sup>Department of Biotechnology, Bhimtal Campus, Kumaun University, Nainital, INDIA; <sup>3</sup>Pharmacognosy and Ethnopharmacology Division, CSIR-NBRI, Lucknow-226001, INDIA; <sup>4</sup>Plant Molecular Biology and Biotechnology Division, CSIR-NBRI, Lucknow-226001, INDIA. Email: akramansari1988@gmail.com

Guar or cluster bean (*Cyamopsis tetragonoloba* L. Taub.) is a drought-tolerant and sun loving annual legume crop grown in arid climatic zones. India is the world-leader for cluster bean production as it accounts for 80% of its total production. Guar bean has been extensively used in the pharmaceutical and food industries. In recent years, exploration of antioxidant and free radical scavenging potentials of fruits, vegetables and legumes have received considerable attention and is used concurrently in the development of functional foods and nutraceuticals. The aim of the present work was to assess antioxidant and free radical scavenging activities of endosperm of thirteen guar bean genotypes using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay, 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) assay, total reducing assay, total antioxidant content, total phenolics and total flavonoid content. Results revealed that the highest free radical scavenging activity in terms of IC<sub>50</sub> values for total antioxidant activity, DPPH and ABTS radicals were 54.40 µg ascorbic acid equivalent /mg extract (T4 genotype), 48.96 µg ml<sup>-1</sup> (T6 genotype) and 10.35 µg ml<sup>-1</sup> (T12 genotype), respectively. Maximum total reducing power (1.593; OD<sub>700</sub> nm at 0.4 mg extract) and total phenolic content (39.54 µg gallic acid equivalent mg<sup>-1</sup> extract) were found in T12 genotype, while total flavonoid content (10.71 µg rutin equivalent mg<sup>-1</sup> extract) was recorded highest in the T9 genotype. HPTLC analysis was employed to

determine the presence of specific polyphenols in all the genotypes and gallic acid was the detected phytochemical. Overall results suggest that guar seeds can be a good source of natural antioxidants for the development of nutraceuticals and functional foods.

**Key words:** *Cyamopsis tetragonoloba*, Genotypes, Antioxidant, Free radical-scavenging activity, Reducing power.

SVII/P-11

## Comparative Impact of Arsenate and Arsenite Toxicity on Germination, Growth, Nodulation Potential and Osmolytes Synthesis in *Cicer arietinum* L. (Chickpea) Genotypes

**Amandeep Cheema\* and Neera Garg**

Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: garg\_neera@gmail.com, khasmanya@gmail.com

Arsenic (As) with its two inorganic forms arsenite (AsIII) and arsenate (AsV) is a non-essential toxic metalloid, whose elevated concentration in plants affects productivity. Present study was conducted to compare the influence of As (Sodium arsenite;  $\text{NaAsO}_2$ -5, 10 mg  $\text{kg}^{-1}$  and Sodium arsenate;  $\text{Na}_2\text{HAsO}_4 \cdot 7\text{H}_2\text{O}$ -30, 60 mg  $\text{kg}^{-1}$ ) on germination, plant biomass, nodulation and osmolyte status of chickpea genotypes-HC5, HC3, C235 and HC1. Results indicated delayed and reduced germination in all genotypes under As stress which was more significant in AsIII than AsV treated plants in concentration dependent manner. On the basis of relative As injury rate, HC3, HC5 were found to be tolerant, C235 moderate and HC1, highly sensitive with a decline of 25, 34, 42 and 50% in case of AsIII and 30, 40, 45 and 55% in case of AsV respectively. Additionally, on the basis of relative growth, HC3 and HC5 displayed highest metal tolerance index (MTI). Negative correlations were recorded between AsIII, AsV concentrations and chlorophylls, carotenoids, total protein contents, electrolyte leakage etc. Loss in plant biomass especially roots had a negative impact on the symbiotic efficiency of all genotypes in terms of reduced nodule number as well as their dry weights under As stress. Decline in

these parameters could be correlated to their differential As uptake with sensitive varieties displaying higher As contents. Increase in the levels of total soluble sugar and proline proved to be important stress markers responsible for imparting better As tolerance in HC3 and HC5 than other genotypes.

**Key words:** Arsenic, Chickpea, Osmolytes, Nodulation potential.

SVII/P-12

## Role of Glutaredoxin in Abiotic Stress

**Anil Kumar<sup>1\*</sup>, Veena Pande<sup>2</sup> and Indraneel Sanyal<sup>1</sup>**

<sup>1</sup>Plant Transgenic Laboratory, Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Biotechnology, Bhimtal Campus, Kumaun University, Nainital, INDIA, Email: anilksp1986@gmail.com

Glutaredoxins (GRXs) are 10-15 kDa, ubiquitous, disulfide oxidoreductases and possess a typical glutathione-reducible CxxC or CxxS active site, required for their redox properties. Glutaredoxin forms a complex system, comprising of glutaredoxin (GRX), glutathione (GSH), glutathione reductase (GR) and NADPH. It consists of four-stranded  $\alpha$ -sheets and three flanking  $\alpha$ -helices, extended by additional -N or -C terminal  $\alpha$ -helix. The cellular redox is essential for maintaining the structure of proteins and other cellular activity under normal condition, which gets disturbed under oxidative stress. Among the abiotic stresses, drought is the major stress response, leading to reduction of crop yield. Drought is a multi-dimensional stress, which impairs normal growth, disturbs water relation and causes changes in the physiological, morphological, biochemical and molecular traits in plants. Drought stress causes reactive oxygen species (ROS) production, in the different cellular compartments. ROS generated during drought stress, functions as an alarm signal that triggers defense responses, to maintain homeostasis. Glutaredoxin defense system plays a major role against ROS by stimulating the antioxidant defense system. The role of GRX in metal reduction is well established in prokaryotic and mammalian systems and in few plant genera. However, under drought stress, the role of GRXs is poorly understood. In a recent study, tomato

glutaredoxin (*SIGRX1*) was found to be involved in drought stress. During our investigation, we have found that chickpea GRX (LOC101493651) was upregulated many folds under drought stress. We are presently exploring the role of different GRXs under drought stress, using molecular approaches.

**Key words:** Glutaredoxin, Drought, ROS, Abiotic stress.

SVII/P-13

## Variation of Chlorophyll Pigment and Dust fall Flux on the Foliar Surfaces of Selected Indoor Plants in Delhi

*Ankita Katoch\* and U.C. Kulshrestha*

School of Environmental Sciences, Jawaharlal Nehru University, New Delhi-110067, INDIA

Email: ankitakatoch@gmail.com, umeshkulshrestha@gmail.com

Delhi is one of the most polluted cities having poor air quality which has an adverse impact on the health of the individuals. People staying indoors for longer hours have to face various air pollution problems. Among living beings, plants are the bystanders facing pollution. They act as a natural sink for airborne pollutants. The foliar surfaces of plants act as biological filters to detoxify harmful gases and also serve as a platform to trap dust. But the deposition of dust onto the foliar surfaces affects the physiological and biochemical properties of the plants depending upon the tolerance and sensitivity of the species. The level of sensitivity varies among different plants depends on their response towards characteristic environmental stress. The present study includes three indoor plants namely, *Ficus elastica*, *Ficus lyrata* and *Schefflera*, growing at two urban localities of distinct characters in Delhi during summer season. We aim to find out the dust fall fluxes on the foliar surfaces and its effect on the chlorophyll content of these plants. The average dust fall flux for *Ficus elastica*, *Ficus lyrata* and *Schefflera* is 199, 275 and 191  $\text{mgm}^{-2}\text{d}^{-1}$  respectively at Mayapuri and 178, 192 and 130  $\text{mg m}^{-2}\text{d}^{-1}$  respectively, at Dwarka. It has been seen that higher dust fall flux at Mayapuri shows a clear reduction in the chlorophyll pigments of all the three plants at Mayapuri, as compared to Dwarka. This trend indicates

an important role played by urban dust in determining the levels of chlorophyll pigments in the foliar surfaces of indoor plants. By the end of this study, we will be able to characterise the tolerant species among the selected plants in polluted indoor environment. Such knowledge is beneficial for mitigating indoor air pollution in urban cities.

**Key words:** Dustfall flux, Chlorophyll pigments, Urban cities, Indoor plants, Foliar surface.

SVII/P-14

## Air Pollution and Plant Water Relations: An Increasingly Important Interaction

*David A. Grantz*

University of California at Riverside, Kearney Agricultural Center, Parlier, California USA, Email: dagrantz@ucanr.edu

Regions of the Earth that experience abundant sunshine and warm temperatures are conducive to plant growth and crop productivity. They are also susceptible to generation of oxidant air pollutants in the form of both gases and particles. When natural ventilation is poor, as in basins, valleys, and areas of low wind, unpleasant or dangerous levels of these pollutants may accumulate. Many of the world's mega-cities fall into this category, as does the San Joaquin Valley of California. In some areas these are also wintertime problems. Drought stress is a concern of agricultural and wild land plant biologists as global change occurs, including "global change type drought". This reflects the increase in evaporative demand due to elevated temperature, even if precipitation is stable. Ozone, the most damaging gaseous air pollutant to vegetation, reduces carbon allocation to roots, root proliferation, and water harvesting. Ozone also reduces steady state stomatal conductance and induces changes in the rate at which stomata respond to environmental variables. When slow closure leads to longer open periods in high light or dry air, water loss increases and drought hardiness declines. Particulate matter is less well-studied. Many aerosol species are hygroscopic, which increases dew deposition on leaves, increases deposition of gases such as ozone and ammonia, and penetrates the stomatal pore creating a thin liquid phase

pathway between leaf apoplast and the atmosphere. This reduces drought hardiness. These impacts of air pollutants are just beginning to be incorporated into models of regional hydrology. The accuracy of such modeling efforts is poor, due to the very preliminary understanding of mechanisms. More research on vegetative impacts of gases and particles is urgently required.

**Key words:** Ozone, Particulate matter, Plant productivity, Plant water relations, Stomata.

SVII/P-15

## **A Comparative Analysis of Plant Functional and Eco-physiological Traits between Invasive (*Prosopis juliflora*) and Native (*Acacia nilotica*) Species**

**Harman Singh\***, **Harinder Pal Singh<sup>1</sup>**, **Daizy Rani Batish<sup>2</sup>** and **Ravinder Kumar Kohli<sup>3</sup>**

<sup>1</sup>Department of Environment Studies, Panjab University, Chandigarh-160014, INDIA; <sup>2</sup>Department of Botany, Panjab University, Chandigarh 160014, INDIA; <sup>3</sup>Central University of Punjab, Mansa Road, Bathinda 151001, INDIA, Email: virkharman.86@gmail.com

Invasion is a global phenomenon which has accelerated of late, largely because of human interference. Conservation biologists have globally ranked invasive alien/exotic species as the second most important and serious threat to species diversity after habitat loss. Biological invasion occurs when species move from one geographical region to another, establish and proliferate there, and harm the native ecosystems. The present study evaluated the comparison between the traits of invasive *Prosopis juliflora* and native *Acacia nilotica* species. Both the species belong to family fabaceae and occupy same geographical areas. Different traits were studied under natural conditions as well as under experimental conditions. Significant differences were noticed different leaf, stem and root functional traits of *Prosopis juliflora* and *Acacia*

*nilotica*. Further, we investigated the allelopathic potential and soil properties of *Prosopis juliflora* in terms of pH, conductivity, phenolics and organic matter in control soil and *Prosopis* soil. Prominent alteration was observed in various above-mentioned parameters in invaded soil. The present study clearly inflicts the invasive nature of *Prosopis juliflora* as it possesses better functional traits and allelopathic potential which further inhibits the growth and germination of local species.

**Key words:** Plant functional traits, Leaf traits, Stem traits, Root traits, Allelopathy.

SVII/P-16

## **SEM Studies of Seed Surfaces in Some Members of Family Asteraceae**

**Harpreet Kaur<sup>1</sup>** and **Avinash Nagpal<sup>2</sup>**

<sup>1</sup>Dev Samaj College for Women, Ferozepur, INDIA; <sup>2</sup>Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: avnagpal@yahoo.co.in

The seeds of 12 plant species namely *Blumea mollis*, *Cosmos bipinnatus*, *Eclipta alba*, *Erigeron bonariensis*, *Helianthus annuus*, *Gillardia pulchella*, *Launaea residifolia*, *Parthenium hysterophorus*, *Sonchus oleraceus*, *Sonchus wightianus*, *Tagetes erecta* and *Zinnia multiflora* belonging to family Asteraceae of Gamopetalae were studied by using Scanning Electron Microscope. Macro and Micro morphological characters including seed shape colour and seed surface patterns were studied. The seeds could be distinguished by three principal diagnostic characters- Seed shape, color and seed surface topography. Special emphasis was given to the cypsela/seed surface characters like sculpture and anticlinal and periclinal walls. Electron micrographs of seeds of 12 plant species were taken and 6 different types of sculpture pattern *viz.* pusticulate, reticulate, rugose, striate, tuberculate and undulate were observed.

**Key words:** Macro and Micromorphology, Seed surface, Sculpture, SEM studies.

SVII/P-17

## Thiourea Supplementation Differentially Impacts on Arsenic Accumulation in Two Selected Rice (*Oryza sativa* L.) Cultivars in Bengal Delta Basin

Munish Kumar Upadhyay<sup>1\*</sup>, Arnab Majumdar<sup>2</sup>, Anil Barla<sup>2</sup>, Sutapa Bose<sup>2</sup>, Ashish Kumar Srivastava<sup>3</sup>, P. Suprasanna<sup>3</sup> and Sudhakar Srivastava<sup>1</sup>

<sup>1</sup>Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, INDIA; <sup>2</sup>Earth and Environmental Science Research Laboratory, Department of Earth Sciences, Indian Institute of Science Education and Research, Mohanpur-741246, West Bengal, INDIA; <sup>3</sup>Nuclear Agriculture and Biotechnology Division, Bhabha Atomic Research Centre, Mumbai-400085, Maharashtra, INDIA, Emails: munish007up@gmail.com, arnabmajumdar891@gmail.com, barla.neal@gmail.com, sutaparai@gmail.com, penna888@yahoo.com, ashishbarc@gmail.com, sudhakar.srivastava@gmail.com

Arsenic (As) is a carcinogenic and nonessential metalloid whose entry into rice grains is an issue of public concern worldwide especially South East Asian countries including India. As accumulates in significant concentrations in rice grains due to its favourable reducing environment. The values can exceed maximum permissible values recommended by World Health Organization (WHO) and European Union (200  $\mu\text{g kg}^{-1}$  and 100  $\mu\text{g kg}^{-1}$ , respectively). Rice, being a staple food across the world, has become a crucial factor in exposure of As to humans. Thiourea (TU) is a redox active thiol (-SH) based molecule, which is known for its ability to maintain redox homeostasis within plant system. This study was planned to assess prospective utilization of TU against As toxicity in rice to reduce its accumulation grains in natural field conditions in Bengal Delta Basin. The study was conducted in Sarapur, Dewali Gram panchayat (geopositioning 23°01'07.8"N 88°39'43.1"E to 23°01'14.3"N 88°38'24.7"E) in Nadia district of West Bengal. We choose two rice cultivars (Satabdi-*IET 4786* and Gosai), which are the local cultivar being used in the study area. The cultivation of rice was performed in BORO season (Jan-April, 2017) in three

selected fields where soil As concentration was (39.92  $\text{mg kg}^{-1}$ ), (87.53  $\text{mg kg}^{-1}$ ) and (21.06  $\text{mg kg}^{-1}$ ) referred to as Low As field, High As field and control field, respectively, with/without TU application. The concentration of As ( $\text{mg kg}^{-1}\text{dw}$ ) in rice grains in Gosai, Satabdi, Gosai (TU) and Satabdi (TU) were found 1.18, 1.04, 0.93 and 0.91, respectively in low As, 1.21, 1.14, 1.03 and 0.99, respectively in high As and 0.62, 0.47, 0.56, 0.41, respectively in control field. Several physiological (growth, tiller number etc.) and molecular (expression analysis of transporters) were also performed to delineate mechanisms associated with the observed responses. The study proposes that TU application may be useful in reducing As in rice grains.

**Key words:** Arsenic (As), Thiourea (TU), Rice, Boro, Gosai, Saabdi (*IET-4786*).

SVII/P-18

## Identifying Nutrient Regulators of Lipid and Starch Biosynthesis in *Chlamydomonas reinhardtii*

Amit K. Bajhaiya<sup>1</sup> and Jon K. Pittman<sup>2</sup>

<sup>1</sup>Chemical Biological Centre, Department of Chemistry, Umea University, SE901-87, Umea, SWEDEN; <sup>2</sup>Faculty of Life Sciences, The University of Manchester, Michael Smith Building, Oxford Road, Manchester M13 9PT, UK, Email: amit.bajhaiya@umu.se

Microalgae have potential as photosynthetic cell factories for the production of chemicals and metabolites that can be used for industrial applications, including as a source of bioenergy. To harness the full potential of microalgae for industrial biotechnology, an improved understanding of microalgae metabolism is needed, including an understanding of how primary metabolism is regulated. Many microalgae including the model unicellular green alga *Chlamydomonas reinhardtii* accumulate energy rich storage lipid and starch under nutrient-limited conditions, such as phosphorus (P) and nitrogen (N) limitation. These changes in lipid and starch production are underpinned by an altered expression of numerous genes. To dissect the transcriptional regulation of lipid and starch biosynthesis in response to nutrient limitation, we have characterized the biological role of candidate regulators: the MYB family transcription factor, PSR1 (phosphorus

starvation response 1) and putative SNRK2-type kinases, as these proteins have been previously implicated in metabolic control in algae and other organisms. Genetically modified lines were used to evaluate the role of these proteins in storage metabolite biosynthesis in response to nutrient stress. *C. reinhardtii* were grown under nutrient limiting and sufficient conditions and analysed using combinations of high-throughput metabolic profiling by Fourier transform infrared (FTIR) spectroscopy, and detailed metabolite analysis by chromatography–mass spectrometry (LC- and GC-MS), whole transcriptome analysis by RNA sequencing and validation by quantitative real-time PCR. The analysis showed specific metabolic and transcriptomic fingerprints in response to specific nutrient limitation conditions that correlate with lipid and starch biosynthesis. Furthermore, PSR1 was shown to function as a regulator of carbon metabolism specifically under P limiting conditions, by controlling the expression of specific metabolite biosynthesis enzymes.

**Key words:** Microalgae, *Chlamydomonas reinhardtii*, Lipid, Starch.

SVII/P-19

### ***In vitro* Propagation of *Rhodobryum roseum* Limpr. with Exogenous Application of 2, 4-D and Vitamin B1: A Strategy to Enhance Biomass**

**Isha Pathak\* and A.K. Asthana**

Bryology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: ishathak69@gmail.com

Present study highlights *in vitro* propagation of *Rhodobryum roseum* known as “Rose Moss” belonging to family Bryaceae. It is a cosmopolitan taxon growing at higher altitudes in cool and shady places. Reproduction of this species commonly takes place vegetatively through horizontal stems or stolons. This species is medicinally important to treat nervous prostration and cardio-vascular diseases. In spite of its potential medicinal value it cannot be fully utilized for isolation of chemical compounds due to little biomass in nature. Present work has been carried out with an

objective to propagate and enhance the biomass of this potential moss ‘in vitro’. Plants of *Rhodobryum roseum* were cultured in two different combinations of culture media: Knop’s + 2,4-D and Knop’s + vitamin B1 using stem as explant. In this study role of exogenous application of a plant growth regulator called 2,4-D (a synthetic Auxin) and vitamin B1 (as a cofactor) has been observed. Study has shown that Rose moss grown in culture media exogenously supplemented with 2,4-D have high protonemata density, while plants grown in medium with Vitamin B1, produced longer stem with wider and robust leaves as compared to plants grown simply in Knop’s medium. Subsequently use of combination of 2,4-D and Vitamin B1 in Knop’s medium has resulted into enhanced plant and leaf size with density of protonemata. Hence it is a better strategy to enhance the biomass of this medicinally important moss for bioprospection.

**Key words:** *Rhodobryum roseum*, Vitamin B1, 2,4-D, Biomass.

SVII/P-20

### **Role of Exogenous Polyamines on Plant Biomass, Nutrient Status, Osmolytes Synthesis and Yield Parameters in *Cajanus cajan* (L.) Millsp. (Pigeon pea) Genotypes under Nickel Stress**

**Kiran Saroy\* and Neera Garg**

Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: kiransaroy747@gmail.com, gargneera@gmail.com, garg\_neera@yahoo.com

Nickel (Ni) is an essential micronutrient for plants, but its excessive concentration in the soil is considered toxic for plant growth and development. Polyamines (PAs) such as putrescine (Put), spermidine (Spd) and spermine (Spm) are small aliphatic nitrogenous compounds and have been reported to play significant roles in the regulation of heavy metal (HM) induced toxic responses in plants. Experiments were conducted to investigate the relative roles of Put, Spd or Spm (0.5mM) on plant biomass, nutrient status, osmolytes synthesis and yield in two pigeonpea genotypes (Tolerant - Pusa 2001, Sensitive - AL 201) subjected

to nickel stress ( $\text{NiSO}_4$  - 100 mg  $\text{kg}^{-1}$ ). Ni stress had more negatively effects on roots as compared to shoots which led to a decline in root to shoot ratio. A significant decrease in nutrient (N, P and K) concentrations resulted in reduced productivity which had a direct correlation with increased Ni uptake in both the genotypes. Pusa 2001 had significantly greater potential to withstand Ni stress when compared with AL 201. Seed priming with polyamines reduced Ni uptake, improved plant growth, nutrient acquisition and productivity in a genotype dependent manner with higher positive effects displayed by Put followed by Spd and Spm. Although, increase in osmolytes status was recorded under Ni stress PAs treatments further boosted the osmolyte synthesis especially proline. The study concluded that Put was more effective than Spd and Spm imparting tolerance to Ni stress in Pigeonpea plants.

**Key words:** Polyamines, Nickel, Pigeonpea, Nutrient, Osmolyte.

SVII/P-21

### Functional Validation of *CAMTA* Transcription Factor in Chickpea (*Cicer arietinum* L.)

*Meenakshi*<sup>1,2\*</sup>, *Veena Pande*<sup>2</sup> and *Indraneel Sanyal*<sup>1</sup>

<sup>1</sup>Molecular Biology and Biotechnology Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Biotechnology, Kumaun University, Bhimtal Campus, Nainital, INDIA, Email: meenakshiabhi1991@gmail.com

Chickpea (*Cicer arietinum* L.) is one of the most important legume crops. It ranks third in the world in terms of production and contains high quality dietary protein. Abiotic stress is one of the major factors responsible for reduction in crop yield which includes drought, salinity, chilling and heat stress. However, drought poses a serious threat to chickpea production. Due to lack of rainfall during flowering season, chickpea suffers from terminal drought stress which results in flower drop leading to the reduction in crop yield. CAMTA (Calmodulin Binding Transcription Activator) helps in regulating many cellular responses such as drought and several abiotic and biotic stresses. CAMTA

is a transcriptional activator which contains a DNA binding domain which is a highly conserved, a TIG domain which is an immunoglobulin chain like domain, an ANK repeat which helps in protein-protein interaction and an IQ motif. In *Arabidopsis*, studies with the CAMTA gene have showed steady recovery after drought and also under different abiotic stresses. Therefore, CAMTA can play a major role during drought conditions and could open new perspective for the improvement of crops for enhancement of stress tolerance and thereby lead to enhanced crop productivity.

**Key words:** CAMTA, WUE, RWC, Drought recovery.

SVII/P-22

### Ethylene Di Urea as Ozone Protectant under High Tropospheric Ozone in Two Mung Cultivars

*Rekha Kannaujia*<sup>1,2\*</sup>, *Vivek Prasad*<sup>2</sup> and *Vivek Pandey*<sup>1</sup>

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Molecular Plant Virology Lab, Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Emails: rekha.nbri@nbri.res.in, v.pandey@nbri.res.in

Tropospheric ozone ( $\text{O}_3$ ) is considered the most hazardous secondary air pollutant that adversely affects crop yield and ecosystem. The present study was conducted to assess the impact of ethylene di urea (EDU) as an antiozonant on morphology, physiology, and antioxidative system of two mung (*Vigna radiata*) cultivars (SML-668, PDM-139) growing under high tropospheric ozone condition. Plants were sprayed with the different doses of solutions of EDU (200 ppm and 300 ppm) and water (non EDU treated) at seven day interval till the harvesting. The average ambient  $\text{O}_3$  concentration 8 h  $\text{day}^{-1}$  (from 9:00 to 17:00) during the experimental period (July to October 2016) was very high approximately 61.11 ppb. AOT 40 parameter, which represents the accumulated dose of ozone over a threshold of 40 ppb, was maximum recorded in July (11.34 ppm  $\text{h}^{-1}$ ). Foliar application of EDU provided protection by reducing lipid peroxidation (MDA content) along with significant increments in total chlorophyll,

activities of antioxidant glutathione and antioxidative enzymes in both the cultivars as compared to non EDU treated plants. However, insignificant increase was recorded in physiological parameters viz. stomatal conductance, photosynthesis, and water use efficiency in EDU treated plants. Significant increments in yield parameters like no. of pod plant<sup>-1</sup>, pod weight plant<sup>-1</sup>, no. of seeds plant<sup>-1</sup>, and hundred seed test weight were observed in both the cultivars under EDU treatments. Results revealed that EDU concentration of 300 ppm was more effective than 200 ppm in alleviating the negative effects of ozone toxicity in SML-668 cultivar. SML-668 was found to be more sensitive (EDU responsive) than PDM-139 cultivar. The present study demonstrated that EDU can be used as valuable research tool to screen sensitive/tolerant cultivars under high ambient ozone.

**Key words:** Tropospheric Ozone, EDU, Mung, Yield, *Vigna radiata*.

SVII/P-23

### **Growth, Pigments and Antioxidative Responses of *Trigonella foenum-graecum* against Excess Zinc in Soil**

**Sanjoli Tripathi\* and S.N. Pandey**

Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: sanjolitripathi@yahoo.com

Clay pot culture experiment was conducted in glass-top wire house to study the excess levels of zinc amendment viz. nil (control), 2, 4, 10 and 20 ppm Zn (as ZnSO<sub>4</sub>) in soil on growth and antioxidative responses of *Trigonella foenum-graecum*. The growth (length, dry weight yield and branching) and biochemical properties (total chlorophyll, protein content and the activity of catalase and peroxidase) were measured in *Trigonella foenum-graecum* leaves at 60 days of growth. The length and dry weight of plants increased up to 4 ppm zinc levels in soil, Thereafter decreased at its higher concentration. Total chlorophyll contents also followed similar trends. Protein content in leaves increased about two times more at elevated Zn levels in soil as compared to native soil without amendment. The activity of catalase in plants was not affected significantly with gradual increase of the Zn levels in soil. Whereas peroxidase activity showed decreasing

trend with excess Zn levels. Therefore, the above study concluded that the elevated levels of Zn in soil, showed inhibitory effects on growth and biochemical constituents as studied in *Trigonella* plants while the lower levels of Zinc (2 and 4 ppm) promoted its growth.

**Key words:** Zinc, *Trigonella*, Antioxidative enzymes, Protein, Chlorophyll.

SVII/P-24

### **Screening of *Cajanus cajan* (L.) Millsp. (Pigeonpea) Genotypes for their Arsenic Tolerance in Terms of Germination, Seedling Growth, ROS Generation and Osmotic Balance**

**Shyna Bhalla\* and Neera Garg**

Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: shynabhalla@gmail.com, gargneera@gmail.com; garg\_neera@yahoo.com

Presence of heavy metals (HMs) in the soils has become a potent threat to agriculture due to their non-degradable nature. Arsenic (As) is a non-essential toxic metalloid which gets accumulated in plants and its elevated concentration adversely affects germination and plant growth. The study was aimed to investigate the comparative effects of different concentrations of inorganic forms of As, i.e. AsV (Arsenate-0, 10, 20, 30, 40, 50 mg kg<sup>-1</sup>) and AsIII (Arsenite- 0, 2, 4, 6, 8, 10 mg kg<sup>-1</sup>), on seed germination, plant biomass, ROS production and osmolyte synthesis in four genotypes (PUSA2001, PUSA2002, AL882 and MANAK) of pigeonpea. 50 mg kg<sup>-1</sup> of AsV and 10 mg kg<sup>-1</sup> of AsIII were found to be critical concentrations that significantly delayed and reduced the seed germination, seedling growth, vigor index, emergence percentage, respiration rate etc. in all the four genotypes. On the basis of metal tolerance index (MTI), PUSA2001 was found to be more tolerant, PUSA2002 moderately tolerant, MANAK and AL882 highly sensitive to As. A significant decline in root and shoot length as well as their dry weights were recorded in concentration and genotype dependent manner with more negative impact under the combined treatments of AsV and AsIII. Decline in plant biomass had direct effect on leaf water status and photosynthetic pigment concentration. AsIII



was more toxic and induced higher oxidative stress in terms of increased hydrogen peroxide and Malondialdehyde contents. There was a significant increase in proline accumulation in the leaves which played the role of osmoprotectant and imparted relatively higher As tolerance in PUSA2001.

**Key words:** Arsenic, Pigeonpea, Photosynthetic pigments, ROS, Osmolytes.

SVII/P-25

## **Benzyl-Butyl Phthalate Induced Physiological Responses in *Hordeum vulgare* (L.) Seedlings**

*Arpna Kumari\* and Rajinder Kaur*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: arpnakumari.gndu@gmail.com, swab2002@yahoo.com

Phthalates are synthetic chemical compound known for their use as plasticizers. They possess weak bonding with the polymeric matrix or the products in which they are used and contribute toward their easy release into the environment making them ubiquitous. The agricultural soils are also reported to be polluted with phthalates up to a considerable extent. A few studies have been conducted on phthalates induced phytotoxicities in some edible/crop plants but barley is the least explored plant. Therefore, present study has been designed to investigate the impact of benzyl-butyl phthalate (BBP) on barley (*Hordeum vulgare* L.) to address biochemical, physiological and toxicological implications. After the exogenous exposure of BBP (viz. 0, 25, 50, 100, 200, 400, 800, 1600 mg L<sup>-1</sup>) for 7 days, barley seedlings were analyzed for different indices. The exposure of BBP showed significant (p<0.05, 0.01) elevation in the content of pigments, proline, soluble protein, carbohydrate, hydrogen peroxide, malondialdehyde in shoots and roots of barley seedlings. The activities of superoxide dismutase (SOD), guaiacol peroxidase (POD), catalase (CAT), ascorbate peroxidase (APX) and glutathione reductase (GR) also enhanced significantly in shoots and roots of seedlings against BBP stress except for SOD activity

which was declined in roots. The polyphenols content was also altered in all the treated concentrations as compared to control. Furthermore, the exposure of BBP induced stomatal abnormalities, cytotoxicity, and loss of plasma membrane integrity in the treated plants. Presently, BBP disturbed the normal physiology of barley which could also affect the yield of the crop under field conditions.

**Key words:** Benzyl-butyl phthalate, *Hordeum vulgare* L., Oxidative stress, Proline, Polyphenols, Cytotoxicity.

SVII/P-26

## **Diethyl Phthalate Triggered Growth and Biochemical Manifestations in *Spirodela polyrhiza* L. Schleiden**

*Ritika Sharma\* and Rajinder Kaur*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: swab2002@yahoo.com

The present study aims to evaluate the effect of diethyl phthalate (DEP) on growth and biochemical indices of *Spirodela polyrhiza*. Plants were exposed to varying concentrations of DEP (10, 20, 40, 80, 100, 200 and 400 ppm) for seven days. This led to oxidative stress in plants that was quite evident from significant decline in growth related parameters. Results depicted that DEP toxicity significantly affected the amount of photosynthetic pigments (chl a, chl b, total chl), carotenoids and anthocyanin content in treated fronds of *Spirodela polyrhiza* as compared to control. Further, decrease in carbohydrate, protein and enhancement in MDA, proline and phenolic content was also observed with increasing concentrations of DEP. Scanning electron microscopic and confocal studies also revealed oxidative stress in plants under DEP stress. Overall, the results clearly indicated the provoked oxidative burst in *S. polyrhiza* under the exposure of DEP. The study would be helpful in understanding the tolerance and detoxification of DEP by *S. polyrhiza* to cope up with the oxidative stress.

**Key words:** Diethyl phthalate, MDA, Oxidative stress, Proline, Scanning electron microscopy, *Spirodela polyrhiza*.

SVII/P-27

## miRNA156j Confers Differential Regulation under Arsenic Stress at Various Developmental Stages in Rice

Alka Srivastava<sup>1\*</sup>, Akhilesh K Pandey<sup>3</sup>, Ashok K. Verma<sup>2</sup>, Praveen C. Verma<sup>1</sup> and R.S. Dubey<sup>3</sup>

<sup>1</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>U.P. Council of Sugarcane Research, Shahjhanpur-242001, INDIA; <sup>3</sup>Department of Biochemistry, Banaras Hindu University, Varanasi-221005, INDIA, Email: nandsam1005@gmail.com

In plants, arsenic (As) stress modulates the metabolic pathways at various developmental stages of rice plants through alteration of various gene expressions. Micro-RNAs (miRNAs) are 21–24 nucleotides non-coding RNAs. They involve in a range of cellular processes, underlying plant adaptation to the oxidative stresses. To understand the functional role of miRNA156j under 25 μM As (III) stress, the expression was analyzed in various tissues and different developmental stages of rice plants. Gene expression through RT-PCR and Northern blotting were significantly down regulated within various plant tissues at different time intervals and various developmental stages. This down-regulation was more prominent in roots. The roots of plants during seedlings, tillering and flowering stages showed 15, 25 and 34 fold down regulation in gene expression e.g. of phospholipase I, squamosa promoter-binding-like protein (SPL family), from zero to 72 hours under As (III) treatments, respectively. Alterations in gene expression between different developmental stages, the down-regulation was more advanced at seedlings developmental stage followed by flowering and tillering. The results of *Osa-miRNA156j* gene in response to As (III) stress indicates that it plays important regulatory role in altering the expression of some transcription factors and enzymes (e.g. phospholipase I, acetyltransferase) in rice plants.

**Key words:** Rice, Arsenic (As), Micro-RNA, Gene expression, Developmental stage.

SVII/P-28

## Physiological Attributes Associated with Leaf Spectroscopic Alterations of Guar [*Cyamopsis tetragonoloba* (L.) Taub.] under Water Deficit Condition

Priyanka Upreti<sup>1\*</sup>, Shiv Narayan<sup>1</sup>, Lalit Mohan Tewari<sup>2</sup> and Pramod Arvind Shirke<sup>1\*</sup>

<sup>1</sup>Plant Physiology Lab, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Botany, Kumaun University, DSB Campus, Nainital, INDIA, Email: priyankaupreti1@gmail.com; pashirke@nbri.res.in

The Guar or cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.], is an annual legume and the source of guar gum. Guar is an important source of nutrition to both human being and animals, which is consumed as a vegetable and cattle feed, respectively. Guar varieties, namely RGC-1002, RGC-936 and RGC-1066, were subjected to eight days of water deficit condition. The physiological attributes of gas exchange, pigment concentrations and the spectral properties of the leaves were monitored and assessed. The physiological attributes and optical studies, showed RGC-1002 to be drought tolerant among the three varieties studied. RGC-1002 exhibited higher CO<sub>2</sub> assimilation and stomatal conductance rates, a higher percentage of RWC (relative water content) and lesser membrane damage under drought. A significant correlation was found between spectral reflectance and pigment concentration among the guar varieties. Our study suggests that leaf spectral measurements along with the photosynthetic characteristics, can be used as a tool for screening large populations to review the physiological status of the plants more easily, rapidly and in a non-destructive way.

**Keywords:** Guar, Drought, CO<sub>2</sub>, Relative water content, Photosynthesis.

SVII/P-29

## Elucidation of Complex Nature of PEG Induced Drought-Stress Response in Chickpea Root using Comparative Proteomics Approach

Swati Gupta<sup>1,2\*</sup>, Shashank Kumar Mishra<sup>1</sup>, Lalit Agrawal<sup>1</sup>, Puneet Singh Chauhan<sup>1</sup> and Chadra Shekhar Nautiyal<sup>1</sup>

<sup>1</sup>Microbial Technology Department, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Academy of Scientific and Innovative Research (AcSIR), New Delhi, INDIA, Email: swatinbri@gmail.com

Global warming reaches to an alarming situation all across the world and it leads to change in climatic condition. This situation becomes worse by irregular rainfall, drought, flood and land degradation. One of the consequences of these changes, specially abiotic stresses, is decrease in productivity of many economically important food crops. Among these abiotic stresses drought is a major player because it is also associated with the other stresses such as salinity, high temperature and nutrient deficiency. To study the effect of drought stress on root and mechanism of drought stress tolerance comparative proteomic analysis of roots of the drought tolerance chickpea cultivar was performed at different time points after drought induction using 20% PEG. 2DE analysis was performed with 4-7 pH strips from root sample of hydroponically grown three week old chickpea seedling. PD-Quest analysis revealed almost 126 differentially expressed spots which show more than 2.5 fold increase or decrease at any one of the stages. 110 differentially expressed spots were subjected to MALDI-TOF/TOF and among them 81 spots were identified with significant score. These identified proteins were classified into eight categories based on their functional annotation. Metabolism related proteins comprised 25% of the total identified proteins whereas proteins related to stress response represented 16% of the total protein spots followed by those involved in protein metabolism (15%), ROS metabolism (13%), signal transduction (9%), Secondary metabolism (5%) and N and amino acid metabolism (4%). Rest of the proteins for which no function could be assigned

grouped as unknown comprised (12%) of the identified proteins. Some of the protein was also validated using western blotting as well as Real Time PCR. Overall study represents a well-developed mechanism for drought tolerance and some proteins were further taken for characterization for their role in drought tolerance.

**Key words:** Chickpea, Proteomic, Drought, Protein.

SVII/P-30

## Combined Effects of Plant Viruses and Heavy Metals Stress in *Nicotiana tabacum*

Rashmi Raj<sup>1,2\*</sup>, Lalit Agrawal<sup>3</sup>, Susheel Kumar<sup>1</sup>, Puneet S. Chauhan<sup>3</sup> and S.K. Raj<sup>1</sup>

<sup>1</sup>Plant Molecular Virology Laboratory, CPMB Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Academy of Scientific and Innovative Research (AcSIR), New Delhi, INDIA; <sup>3</sup>Microbial Technology Department, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: rashmi.1990r@gmail.com

Plants develop specific mechanisms, which permit them to detect stress/es and respond against them. These interactions help plants to minimize damage and allow them to survive even in complex stress conditions. Stress may be abiotic or biotic which potentially damage physiological changes within plants. Abiotic stress is a physical such as heavy metals, heat, cold, drought, salinity, and nutrient stress may impose on a plant. Biotic stresses are living organisms, such as bacteria, viruses, fungi, parasites, insects, weeds etc, through which a plant may be exposed during its lifetime. In this study we focused the investigation on the relationship between host plant, virus and heavy metal interactions. For this study biotic or abiotic stresses was examined in *Nicotiana tabacum* where the *Begamovirus* strain and different concentration of metal (AsIII and AsV) in soil separately was taken under glasshouse condition. This study showed arsenic metal ion as well as virus activities enhance the defense related enzymes (ascorbate peroxidase, guaiacol peroxidase, superoxide dismutase and catalase). The simultaneous application of virus and metal attenuates the concentration of peroxidase, chlorophyll and carotenoid. The presence of high conc. of heavy metal in soil leads to various

physiological changes in plants. The results showed that the virus with heavy metals retards the growth of shoots as well as roots. Interestingly high conc. of metal inhibits the accumulation of virus. This study suggested that using non-toxic concentration of metals may protect plants from viral infection.

**Key words:** Arsenic, *Begamovirus*, Defense related enzymes, *Nicotiana tabacum*.

SVII/P-31

### Alterations in CO<sub>2</sub> Assimilation Vs Internal CO<sub>2</sub> Response Curve under Water Deficit Condition in *Cyamopsis tetragonoloba* (L.) Taub

**Komal Pandey<sup>1\*</sup>, Shiv Narayan<sup>1</sup>, Veena Pande<sup>2</sup> and Pramod Arvind Shirke<sup>1</sup>**

<sup>1</sup>Plant Physiology Lab, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Biotechnology, Kumaun University, Bhimtal Campus, Nainital, INDIA, Email: komaltiwari182@gmail.com, pashirke@nbri.res.in

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] commonly known as Guar, is a drought and high temperature tolerant deep rooted summer annual legume of high commercial significance. CO<sub>2</sub> assimilation (A) Vs Internal CO<sub>2</sub>(Ci) response in leaves of two guar varieties i.e; RGC-936 and RGC-1066 were evaluated under watered and water limiting conditions. Photosynthesis is limited by one of three processes: (i) rate of CO<sub>2</sub> assimilation by Rubisco (V<sub>cmax</sub>), (ii) the rate of ribulose-1,5-bisphosphate regeneration supported by electron transport (J<sub>max</sub>) and (iii) triose phosphate availability/utilisation (TPU). The V<sub>cmax</sub>, J<sub>max</sub> and TPU rates were determined from the A/Ci curves assessed under watered and water deficit conditions. The V<sub>cmax</sub> of variety RGC-936 declined more than that of RGC-1066 showing the decrease in carboxylation rate efficiency of the variety RGC-936. The CO<sub>2</sub> compensation point in RGC- 936 increased from 55 ppm to 82 ppm in RGC-936 and 48 ppm to 63 ppm in RGC-1066. The increase in compensation point indicates that water stress is affecting CO<sub>2</sub> assimilation significantly in RGC-936 than RGC-1066 under drought conditions. J<sub>max</sub> values from

the curve in variety RGC-936 decreased around 22% in RGC-936 then 10% in RGC-1066 under water deficit condition. The decrement in the J<sub>max</sub> values signifies shift in the maximum electron transport rate process caused by water stress. The unutilized CO<sub>2</sub> in plants at saturating CO<sub>2</sub> concentration i.e, triose phosphate utilization increased significantly in RGC-1066 than in RGC-936. At saturating CO<sub>2</sub> there is non stomatal limitation of CO<sub>2</sub> assimilation because of reduction in ATP synthesis and RuBP regeneration. The rate of CO<sub>2</sub> assimilation under drought in different photosynthesis limiting conditions is efficient in RGC-1066 than RGC-936 showing intraspecies variation and performance of the two varieties at physiological level.

**Key words:** Internal CO<sub>2</sub>, CO<sub>2</sub> assimilation, V<sub>cmax</sub>, J<sub>max</sub>, TPU, Intraspecies variation.

SVII/P-32

### Bacterial Endophytes Eliciting Physiological Performance and Withanolite Biosynthetic Pathway in *Alternaria alternata* Infected *Withania somnifera*

**Priyanka Chauhan\*, Satyendra Pratap Singh, Arpita Bhattacharya, Pratibha Verma and Aradhana Mishra**

CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: mishramyco@yahoo.com

Extensive researches on the plant growth activity of the endophytic microbes have been carried but their role in eliciting the production of therapeutically important secondary metabolites in plants remains scarce. In the present study, chitinolytic bacterial endophytes were isolated from selected medicinal plants and evaluated for their mycolytic and plant growth promoting efficiency. Among them the two most efficient bacterial endophytes *Bacillus amyloliquefaciens* (MPE20) and *Pseudomonas fluorescens* (MPE115) individually as well as in combination were able to enhance biosynthetic pathway of withanolide and inflect tolerance against *Alternaria alternata* in *Withania somnifera*. The level of withanolide biosynthetic pathway genes (1-deoxy-D-xylulose-5-phosphate reductase, 3-hydroxy-3-methylglutaryl co-enzyme A reductase, farnesyl

diphosphate synthase, cytochrome P450, squalene synthase, sterol  $\Delta$ -7 reductase, sterol glycosyl transferase and sterol desaturase) were upregulated in treated and microbial consortium plants under *A.alternata* stress. In addition, use of endophytes not only increase the content of withanolide A, withaferin A and withanolide B (3.32-5.96, 1.52-1.96 and 12.49-21.47 fold respectively) under *A. alternata* infection but also provide the resistance to host *via* improvement of their photochemical efficiency, standardizing the non-oxidized and oxidized fractions, accelerating electron transport rate and photochemical and non-photochemical quantum yield. Furthermore, depletion in passively dissipated energy of PSI and PSII in microbial combination treated plants validates the above findings. Altogether, the study provides novel insights into the application of endophytes and their ability to accelerate withanolide biosynthesis in *W. somnifera* under biotic stress caused by *A.alternata*.

**Key words:** Endophytes, *Bacillus amyloliquefaciens*, *Pseudomonas fluorescens*, *Withania somnifera*, Withanolides.

SVII/P-33

## Sulfur Nanoparticle Mediated Detoxification of Arsenic Stress in Rice (*Oryza sativa* L.)

**Garima Awasthi<sup>1,2\*</sup>, Amit Kumar<sup>2,3</sup>, Kiran Gupta<sup>2</sup>, Kumkum Mishra<sup>2</sup> and R.D. Tripathi<sup>3</sup>**

<sup>1</sup>Vivekananda Global Universit, Jaipur-302012, Rajasthan, INDIA; <sup>2</sup>University of Lucknow, Lucknow-226007, India; <sup>3</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: gariimaa21@gmail.com

Arsenic (As), a ubiquitous toxic metalloid element in earth crust and has become a global concern in many regions of the world due to geochemical weathering of rocks, microbial and human activities. Arsenic is an environmental and food chain contaminant. Indian soils are sulfur deficient making crop sulfur deficient. Sulfur is a ubiquitous and essential element for all living organisms, like its counterpart's carbon and nitrogen, plays a pivotal role in plant metabolism and development. Sulfur deficiency has considerable impact on plant growth and development, reducing crop yield and quality. Sulfur helps to detoxify As through

complexation of arsenite with thiol-rich peptides. Thus, maintaining sufficient Sulfur nutrition may be particularly important in As-contaminated environments. Arsenic contamination is a major problem in rice growing areas hence sulfur nano particles may be supplemented with the nutrients given to the plants. Due to its small size and shape, it may easily enter and translocate in to the plants and thus reduce arsenic toxicity.

**Key words:** Arsenic, Sulfur nano particles, Toxicity, Rice.

SVII/P-34

## Evaluation of Leaf Proteomics Responses during Selenium Mediated Tolerance of Arsenic Toxicity in Rice (*Oryza sativa* L.)

**Reshu Chauhan<sup>1,2\*</sup>, Surabhi Awasthi<sup>1</sup>, Sanjay Dwivedi<sup>1</sup>, Lalit Agrawal<sup>1</sup>, Shekhar Mallick<sup>1</sup>, Veena Pande<sup>2</sup> and R.D. Tripathi<sup>1</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Department of Biotechnology, Kumaun University, Bhimtal, Nainital, Uttarakhand-263001, INDIA, Email: reshu.biotech.87@gmail.com

Arsenic (As) is a toxic element, which poses significant threat to human health due to frequency of occurrence, toxicity and various routes for human exposure. Arsenic contamination of water and food, especially rice, is a serious issue. Selenium (Se) is an essential element for human and other animals and is beneficial for plants as well. Selenium has been found to antagonize the toxicity of As in plants. Importantly, rice is a good accumulator of both As and Se and hence, the application of Se to rice can be a feasible strategy to mitigate As toxicity. The present study focused on understanding proteomic responses of leaves of arsenite (AsIII) stressed rice plants under the supplementation of selenite (SeIV). Supplementation of SeIV (25 $\mu$ M) significantly decreased As accumulation in rice plants as compared to that of AsIII (25 $\mu$ M) alone treated plants. The proteomic study was also performed using 2-dimensional gel electrophoresis (2DE). By comparison of gel images of different treatments *viz.*, control, As and Se with the help of PDQuest software,

89 differentially expressed proteins were identified in rice leaves using MALDI-TOF/TOF. Functional categorization revealed that As and Se responsive differentially expressed proteins are mostly related to defense, photosynthesis, redox homeostasis, antioxidant system, amino acid metabolism, energy metabolism and transport. Protein ubiquitination and phosphorylation also might be playing important roles in Se mediated amelioration of As toxicity in rice. In conclusion, the present study provides new insights into As-Se interaction in rice leaves at the proteome level and identifies crucial proteins involved in Se mediated amelioration of As toxicity in rice.

**Key words:** Arsenic, Selenium, Rice, Protein profile.

SVII/P-35

### **Evaluation of Proteomics Responses of Rice (*Oryza sativa*) during Arsenic Toxicity Amelioration by a Potential Microbial Consortium**

**Surabhi Awasthi<sup>1,2\*</sup>, Reshu Chauhan<sup>1</sup>, Sudhakar Srivastava<sup>1</sup>, Sanjay Dwivedi<sup>1</sup>, Lalit Agrawal<sup>1</sup> and R.D. Tripathi<sup>1</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: surabhi.microbiology@gmail.com

Environmental pollution of arsenic (As) is a serious problem that is not only affecting the local people but also population throughout the world through rice and rice based food products. The scale of problem is reaching high with the discovery of new As contaminated regions. Rice accumulates As in significantly greater amounts in comparison to other cereal crops. Microbiological interventions can serve as protective agents to ameliorate As stress in rice. The present study was carried out to explore mechanistic details of a microbial consortium [plant growth promoting rhizobacterium, *Pseudomonas putida* and alga, *Chlorella vulgaris*] mediated As toxicity amelioration in rice (*Oryza sativa*) using comparative proteomic approach. The experiments were conducted in hydroponically grown rice seedlings

subjected to arsenate [As(V)] stress alone and also with microbial consortium for 15 days. The presence of consortium promoted the growth of the plants and accumulation of nutrients by reducing the toxicity of As. Two-dimensional gel electrophoresis (2DE) analysis revealed that 145 spots were significantly expressed, out of these, 79 spots were identified using MALDI-TOF-TOF. The differentially expressed proteins during supplementation of microbial consortium under As stress belonged to defense, growth promotion, energy metabolism, cellular and metabolic processes. This study revealed the expression of IAP100 (Inhibitor of Apoptosis) in the presence of microbial consortium under As stress, which has ability to regulate caspases and also influence ubiquitin (Ub)-dependent pathways that modulate innate immune signaling in plants. In conclusion, these results provide new insights about the proteins and mechanisms involved in microbial consortium mediated As toxicity amelioration in rice.

**Key words:** Arsenic, *Pseudomonas putida*, *Chlorella vulgaris*, Rice.

SVII/P-36

### **Selenium Mitigates Arsenic Toxicity by Modulation of Phenolics, Antioxidant System and Thiols in Rice (*Oryza sativa* L.)**

**Reshu Chauhan<sup>1\*</sup>, Surabhi Awasthi<sup>1</sup>, Sudhakar Srivastava<sup>2</sup>, Sanjay Dwivedi<sup>1</sup> and R.D. Tripathi<sup>1</sup>**

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: reshu.biotech.87@gmail.com

Arsenic (As) contamination of paddy rice is a serious threat all over the world particularly in South East Asia. Narrow range of selenium (Se) is beneficial to plants as well as arsenite (AsIII) and selenite (SeIV) can be biologically antagonistic to each other due to having same electronic structure and sharing the same transporter for their uptake in rice. Thus during the present study, the detoxification mechanism of As toxicity was explored by evaluating As accumulation, growth, oxidative stress, phenolic compounds, antioxidant enzymes activity and thiols during AsIII and

SeIV interaction in hydroponically grown rice seedlings. The results indicated that the presence of Se (25µM) significantly decreased As accumulation in roots and shoots as compared to As (25µM) alone treated plants. Oxidative stress was analyzed by detection of reactive oxygen species (ROS), lipid peroxidation, electrical conductivity (EC), nitric oxide (NO) and pro-oxidant enzyme (NADPH oxidase), which were in the order of As>As+Se>control>Se for both roots and shoots. Selenium combat As phytotoxicity by increased level of phenolic compounds particularly gallic acid, protocatechuic acid, ferulic acid and rutin, antioxidant enzymes, non-protein thiols (NPTs) and thiol metabolism related enzymes viz., serine acetyl transferase (SAT), cysteine synthase (CS) and glutathione-S-transferase (GST). Selenium supplementation also enhanced the uptake of nutrient elements viz., Fe, Mn, Co, Cu, Zn, Mo, resulted in improved plant growth. The results concluded that Se addition in As contaminated environment might be an important strategy to reduce As uptake and associated phytotoxicity by modulation of thiols and phenolic compounds and increased uptake of nutrient elements in rice plant.

**Keywords:** Arsenic, Nutrient elements, Phenolics, ROS staining, Selenium

SVII/P-37

## Phytotoxicity and Metabolic Adaptations in Rice Exposed to Copper Oxide Nanoparticles and Copper Ions

Archana Dwivedi<sup>1</sup>\*, Subodh Kumar<sup>1</sup>, Alok Kumar Pandey<sup>2</sup> and Poornima Vajpayee<sup>1</sup>

<sup>1</sup>Ecotoxicology, Bioremediation and Nanotoxicology Laboratory, Department of Botany University of Lucknow, Lucknow-226007, INDIA; <sup>2</sup>Nanomaterial Toxicology, CSIR-Indian Institute of Toxicology Research, Vishvighyan Bhawan, 31, Mahatma Gandhi Marg, P.O. Box No. 80, Lucknow-226001, INDIA, Email: devpoornima@rediffmail.com, poornima vajpayee@gmail.com

The increasing use of engineered metallic nanoparticles in industry and therapeutics has led to growing need for investigating their potential negative impact on human and environmental health. Metallic nanoparticles, extensively used in commercial products

are posing serious threat to biota including plants due to their release into environment. This may affect adversely the production of staple crops. Rice (*Oryza sativa*) is a global staple food for a large population. CuO NPs (size <50 nm) inhibit the root and shoot growth of rice seedlings in concentration dependent manner in comparison to control. Upward translocation of CuO NPs result in accumulation of NPs in cell wall, chloroplasts etc. Rice plants under NPs (CuO) stress combat toxicity generated by reactive oxygen species (ROS) through hyperactivity of antioxidant defense system comprised of antioxidant enzymes and cellular antioxidants. However, roots are the first plant part exposed to stress generated by CuO. Hence, they have shown toxic symptoms viz. browning of the roots and lower hyper response of the antioxidant defense system. CuO NPs induce drought like condition due to adhesion of large agglomerates on roots. One of the known marker for water stress, proline, increased dramatically in all treated samples to provide an osmoprotective function when compared to their respective controls. Transcripts of PIN-1 gene was down regulated in leaves and roots of rice. Further, expression of PIN-2 and AUX1 genes were upregulated in these plants. Auxin distribution in roots mediated by auxin efflux carriers was probably responsible for root growth inhibition in rice exposed to CuO NPs. Thus, rice plants attempt to reduce Phytotoxicity caused by NPs by metabolic adaptations.

**Keywords:** Copper oxide nanoparticles, Copper ions, Phytotoxicity, Metabolic adaptations.

SVII/P-38

## CuO Nanoparticles Affects Growth, Photosynthetic Pigments and Cellular Antioxidants in *Ocimum basilicum*

Subodh Kumar<sup>1</sup>\*, Archana Dwivedi<sup>1</sup>, Alok Kumar Pandey<sup>2</sup> and Poornima Vajpayee<sup>1</sup>

<sup>1</sup>Ecotoxicology, Bioremediation and Nanotoxicology Laboratory, Department of Botany University of Lucknow, Lucknow-226007, U.P., INDIA; <sup>2</sup>Nanomaterials Toxicology, CSIR-Indian Institute of Toxicology Research, Vishvighyan Bhawan, 31, Mahatma Gandhi Marg, P.O. Box 80, Lucknow 226001, U.P., INDIA, Email: devpoornima@rediffmail.com, poornimavajpayee@gmail.com

CuO nanoparticles (CuO-NPs) are globally used in many agricultural applications such as pesticides, herbicides, fertilizers, additives for soil remediation, and growth regulators. Copper is an essential element and is involved in several vital metabolic activities in plants. Indiscriminate use of copper nanoparticles in various applications paves gateway for these materials into the atmosphere, soil, and water. Thus, the widespread use of CuO-NPs raised concerns worldwide about the impacts that these materials might have on staple and medicinal crops. In this study plants of *Ocimum basilicum* were exposed to CuO (0.0-10 µgml<sup>-1</sup>) for 24 days in hydroponics and their impact on growth, photosynthetic pigments and cellular antioxidants was determined. Result indicates that CuO-NPs exhibit adverse impact on growth and photosynthetic pigments. Root and shoot biomass was decreased in CuO-NPs exposed plants. Chlorosis in leaves and browning of the roots was also observed in plants exposed to CuO-NPs. An increase in MDA contents and membrane permeability of CuO-NPs treated plants showed that these particles generate oxidative stress in *O. basilicum*. Hence, it can be inferred from the present study that CuO-NPs induced toxic effects in *O. Basilicum* could alter their medicinal properties.

**Keywords:** Copper oxide nanoparticles, *Ocimum basilicum*, Photosynthetic pigments, Phytotoxicity.

SVII/P-39

## Impact of Heavy Metal on the Benthic Microbial Community

*Chitra Pokharia\* and Kavita Shah*

Environmental Biotechnology Laboratory, Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, INDIA, Email: chitra.pokharia04@bhu.ac.in, kavitashah@bhu.ac.in

River Ganga, considered as one of the most sacred river in the world, is one of the largest and longest rivers in India. The Ganges basin is the most heavily populated river basin in the world, with over 400 million people and a population density of about 1,000 inhabitants per square mile (390 km<sup>2</sup>). Varanasi, situated on the bank of river Ganga, is an important industrial and religious centre in northern India. Varanasi region has about 5000 registered industries which can

be categorized into textile and fabric, carpet, Diesel Locomotive Works (DLW), wood, leather, metal, paper products, food processing, plastic-rubber and glass industries. The Industrial effluents from these industries carrying heavy metal directly or indirectly (get mixed with the city sewage system) gets discharged into the river. These effluents contain high concentration of heavy metals (HMs) ultimately polluting water, sediment and soil. Metals discharged into the river get precipitated and accumulated onto river sediments and eventually enter the food chain. Higher concentrations of heavy metals can form harmful complex compounds, which critically effect different biological functions. Heavy metals are not easily degraded by the natural processes and persist in soil and sediment. This study emphasis on the effect of heavy metal toxicity on the benthic microbiota community, as benthic microbial communities play crucial roles in ecological processes such as organic matter recycling and biomass production. Due to their functional role in aquatic ecosystems, it poses an ecological risk as it may impact ecosystem functioning.

**Key words:** River Ganga, Heavy metal, Effluents, Toxicity, Benthic microbiota.

SVII/P-40

## Temporal Development of Stomatal Traits Regulate Physiological Responses in Cotton

*Raghvendra Dubey<sup>1</sup>, Shivanand Suresh Dudhagi<sup>2</sup> and Pramod Arvind Shirke<sup>2\*</sup>*

<sup>1</sup>Plant Physiology Laboratory and Academy of Scientific and Innovative Research (AcSIR), CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA, Email: raghvendra.jnu@gmail.com, pashirke@nbri.res.in

The balance of gaseous flow between plants and their atmosphere largely depend on stomatal traits (stomatal density and size). Hence, in response to fluctuating environmental and internal stimuli, plants have to coordinate two type of regulation, a short term response regulation by opening of stomata and long term response through control of stomatal development that actively adjusts stomatal conductance,



photosynthesis and water loss. The mechanism controlling stomatal development and their physiological significance are still not well explained. Here, we demonstrate the stomatal development mediated physiological responses in three varieties of cotton grown under well watered conditions at different growth stage of life cycle (day after sowing). Stomata development indicates disparities in stomatal traits on both surfaces (lower and upper) accompanied with their physiological responses. This understanding may help to reveal as to how the long term stomatal development enable plants to adapt under climate change and manage its water use strategy. Further molecular analysis will be required for elucidation of the mechanism at multiple levels of stomatal response.

**Key words:** Cotton, Physiological responses, Stomatal traits, Temporal development.

SVII/P-41

### Screening of Sensitive and Tolerant Cultivars of Rice ( $C_3$ ) and Maize ( $C_4$ ) based upon Morphological Response against Abiotic Stress

*Ambedkar\_Gautam<sup>1,2\*</sup>, Kavita Shah<sup>2</sup> and Shekhar Mallick<sup>1</sup>*

<sup>1</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Institute of Environment and Sustainable Development (IESD), Banaras Hindu University, Varanasi-221005, INDIA, Email: shekharm@nbri.res.in

The present study was conducted to identify a pair of sensitive and tolerant cultivars of rice ( $C_3$ ) and maize ( $C_4$ ) based upon morphological response against abiotic (salinity, drought and metalloids) stress. These stresses disrupt the biochemical and physiological processes, leads to reduce growth and yields of the plants. The cereal crops such as rice, wheat, maize, barley, sorghum, millet, oat and rye crops are cultivated worldwide. Particularly, in India, maize is the third most cultivated cereal crop after rice and wheat. Rice and maize are classified as  $C_3$  and  $C_4$  plants, respectively, on the basis of their anatomy and physiology. These plants may also differ in their defense mechanism against abiotic stress. In present study, ten cultivars of maize and rice plants each were examined against

metalloid [AsIII & AsV (15 to 240  $\mu$ M)], salinity [NaCl (50 to 200 mM)] and drought stress [polyethylene glycol (PEG) (10 to 40 mM)]. Among all ten cultivars of rice and maize, Pant dhan-10 rice seedlings survived in all treatments, however, fresh weight (FW) was reduced against AsIII (120  $\mu$ M) ~21%, AsV (120  $\mu$ M) ~17%, NaCl (100 mM) ~43% and PEG (20 mM) ~47%, in comparison to control. However, rice cultivar Saryoo-52 seedlings exhibited maximum reduction in FW ~20% at As(V) (120  $\mu$ M) and ~38% with PEG (20 mM), however, rice seedlings could not survive against As(III) (120  $\mu$ M) and NaCl (100 mM). Similarly, maize cultivar Vivek QPM-9 seedlings survived against all treatments, however, FW was reduced with AsIII (240  $\mu$ M) ~51%, AsV (240  $\mu$ M) ~35%, NaCl (200 mM) ~47% and PEG (40 mM) ~63%. However, Vivek hybrid-43 maize seedlings could not survive against AsIII (240  $\mu$ M), NaCl (200 mM) and PEG (40 mM) treatments. Overall, result indicates that maximum FW reduction was observed in rice Saryoo-52 and minimum in Pant dhan-10 against AsIII & AsV (120  $\mu$ M), NaCl (100 mM) and PEG (20 mM) treatments. Similarly, maize Vivek hybrid-43 exhibited maximum FW reduction and Vivek QPM-9 showed minimum FW reduction against AsIII & AsV (240  $\mu$ M), NaCl (200 mM) and PEG (40 mM) treatments.

**Key words:** Abiotic stress, PEG, NaCl,  $C_3$  and  $C_4$  plants.

SVII/P-42

### Difference in Leaf Proteome Response of Winter Wheat to Interactive Effect of Elevated $CO_2$ and EDU against High Ambient Ozone

*Vivek K Maurya<sup>1,2\*</sup>, Nalini Pandey<sup>2</sup> and Vivek Pandey<sup>1</sup>*

<sup>1</sup>Plant Ecology and Environmental Science Division, CSIR-National Botanical Research Institute, Lucknow-2260012, INDIA; <sup>2</sup>Department of Botany, Lucknow University, Lucknow-226007, INDIA, Email: vivektheviva@gmail.com

Concentration of ground level ozone ( $[O_3]$ ) has increased twice than preindustrial times and still continuously increasing in northern hemisphere. After Bangladesh (21.3%), India (20.2%) is among the top ten most ozone populated countries worldwide during

1990-2013. Various modeling based studies of ozone risk for important crops reveals 3.5-20% loss of yield in Indian subcontinent. Many studies have shown positive impact of [CO<sub>2</sub>] on multiple crops. Similarly [CO<sub>2</sub>] negate the damaging effect of high level of ambient ozone concentration. Many researchers working on assessment of O<sub>3</sub> impact use EDU (N-[2-(2-oxo-1-imidazolidinyl) ethyl]-N'-phenylurea as a tool to mitigate O<sub>3</sub> damage upon plants. Present study was conducted on winter wheat (*Triticum aestivum L.*) variety- PBW-343. Plants were grown in FACE field and four treatments (Control, CO<sub>2</sub> (550 ppm), EDU and CO<sub>2</sub>+EDU) were given from germination till harvesting. Average concentration of CO<sub>2</sub> and O<sub>3</sub> were 532 ppm and 61ppb, respectively during the season. Total Leaf protein extraction was performed by Acetone/methanol/ phenol method at two biological stages (vegetative and flowering) separately and in triplicate. IEF was performed on 7 cm IPG strip (pH 4-7). Second dimension was done on 12% SDS-PAGE. Image master 2D Platinum software was used to perform image analysis of protein spots. Further identified proteins were characterized in functional groups. There were 28, 47, 33 spots at vegetative and 34, 34, 37 spots at flowering stage in elevated CO<sub>2</sub>, EDU and in combined treatment, respectively. Major identified carbon metabolizing protein and Photosynthesis assembly and degradation related proteins were EDU responsive and were mostly decreased in abundance. Amino acid metabolism and signal transduction related proteins were mainly observed more abundant at vegetative stage specially with EDU. Defense and energy related proteins were less abundant during flowering stage with EDU and more abundant with combined treatment of CO<sub>2</sub> and EDU.

**Key words:** Elevated CO<sub>2</sub>, High ambient ozone, FACE, *Triticum aestivum L.*

SVII/P-43

## Toxicological Effects of Silver Nanoparticles on Different Physiological Parameters of Tadpoles, *Polypedates maculatus*

Rojalin Pattanayak<sup>1\*</sup> and Priyabrata Swain<sup>2</sup>

<sup>1</sup>Department of Zoology, College of Basic Sciences and Humanities, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, INDIA; <sup>2</sup>Central Institute of Freshwater Aquaculture, Bhubaneswar, Odisha, INDIA

Email: pattanayak.rojalin@gmail.com, pswainy2k@yahoo.co.in

The effects of silver nanoparticles (Ag-NPs) on the growth, metamorphosis, innate immune parameters and enzyme profiles of tadpole, *Polypedates maculatus* were studied. Chronic exposure to Ag-NPs for 60 days at 1 mg l<sup>-1</sup> and 5 mg l<sup>-1</sup> concentrations caused 10% and 50% mortalities respectively along with slow growth and delayed metamorphosis as compared to 0.1 mg l<sup>-1</sup> treatment and control (0 mg l<sup>-1</sup>). The non-specific immune parameters and certain enzyme activities like alkaline phosphatase (ALP), superoxide dismutase (SOD) and lactate dehydrogenase (LDH) varied significantly in a dose dependent manner. The accumulation of silver in the tadpole tissues of treated groups ranged from 0.0966±0.0025 µg g<sup>-1</sup> to 0.4718±0.0126 µg g<sup>-1</sup> as compared to tissues in control group (0.0758±0.0019 µg g<sup>-1</sup>). Hence Ag-NPs had significant detrimental effects on growth and other associated physiological parameters of tadpole, *Polypedates maculatus* when administered at higher concentrations (>1 mg l<sup>-1</sup>) for longer durations. Thus the toxicity studies of Ag-NPs have to be conducted on wider ranges of target and non-target species to assess their environmental impacts. Furthermore, these results suggest that silver nanoparticles induce a dose-dependent toxicity in physiological parameters of tadpoles, which hinders normal development. This study was aimed to enhance our insight on the health and environmental impact of silver nanoparticles. This study pointed out the adverse effects of Ag-NPs in tadpole species and all applications involving silver nanoparticles should be

given special attention and promoted only after detailed studies.

**Key words:** Nanoparticles, *Polypedates maculates*, Enzyme activities.

SVII/P-44

## **Synthesis of Gold Nanoparticles from Leaf Protein of *Nicotiana tabacum* and their ROS Scavenging Responses under Stress Conditions**

*Mohammad Israil Ansari<sup>\*1</sup> and Syed Uzma Jalil<sup>2</sup>*

<sup>1</sup>Amity Institute of Biotechnology, Amity University Uttar Pradesh, Lucknow Campus, Lucknow, INDIA; <sup>2</sup>Department of Botany, University of Lucknow, Lucknow, INDIA, Email: ansari\_mi@lkouni.ac.in, ansari\_mi@hotmail.com

Heavy metals induce serious contamination because of high toxicity. This is transmitted through the food chain of ecosystem. Heavy metals are naturally occurring and industrial activities as a result drastic environmental pollution. Plants accumulate metal ions that will distribute all over plant as a result will disturb cellular ionic homeostasis. The stress condition imposed by the impact of metal and non-metal oxide nanoparticles over plant systems enhances the synthesis of reactive oxygen species (ROS), resulting in oxidative damage at cellular level. The objective of this study was to synthesize the gold nanoparticles from the leaves protein of tobacco and reactive oxygen species (ROS) scavenging activity on plant after exposure to different stresses. We have treated tobacco plants different concentrations of synthesized gold nanoparticles and examined physiological as well as biochemical changes. The biochemically synthesized gold nanoparticles exposure significantly increased the seed germination, root, shoot growth and antioxidant ability of plants depending on bioengineered gold nanoparticles concentrations. Low concentrations of gold nanoparticles boosted growth by approximately 50% and significantly increase in photosynthetic parameters such as total chlorophyll content, membrane ion leakage as well as malondialdehyde content with respect to

untreated plants under stress conditions. The high concentration of gold nanoparticles affected these parameters in negative manner.

**Key words:** Tobacco, Heavy metal, Toxicity, Gold nanoparticle, Stress conditions.

SVII/P-45

## **Identification of Arsenic Sensitive and Arsenic Tolerant Rice Varieties on the Basis of Early Seedling Growth Responses**

*Poonam Yadav<sup>1</sup>, Sudhakar Srivastava<sup>1</sup> and Madhu Babu Pulagam<sup>2</sup>*

<sup>1</sup>Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA; <sup>2</sup>Directorate of Rice Research, Rajendranagar, Hyderabad, Telangana, INDIA, Email: sudhakar.srivastava@gmail.com

The threats of arsenic (As) hazards are known globally including several states of India. Arsenic accumulation in rice (*Oryza sativa* L.) grains is a serious issue as it affects health of millions all over the world. It is known that rice varieties differ in their tolerance to As and in their ability to accumulate As in grains. Hence, identification of appropriate rice varieties showing low grain As accumulation is a feasible approach to tackle the problem. In the present work, rice screening experiments were conducted to compare the performance of 64 rice varieties against As stress (25 and 50  $\mu$ M). Control and treatments were run in parallel for each set of experiments. The performance of rice varieties was assessed on the basis of seed germination and early seedling growth. Seed germination was recorded when both plumule and radical were grown more than 2mm from the seed coat. Root-shoot length, percent change in root-shoot growth and seedling vigour, were measured after 7 d. On the basis of above data analysis, two most sensitive varieties (CO-50 and Shobhini) and tolerant varieties (Pooja and Vivek dhan) were identified. These varieties can be a basic tool for further research in future.

**Key words:** Arsenic, Rice, Sensitive, Tolerant.

SVII/P-46

## Juniper Berry (*Juniperus communis* L.) Essential Oil can Confers Stress Tolerance and Life Span Extension in Nematode *Caenorhabditis elegans*

Swapnil Pandey, Shashank Kumar Mishra, Vijay Kant Dixit, Sankalp Misra, Priya Jaiswal, Alok Lehri and Puneet Singh Chauhan\*

Division of Plant Microbe Interactions, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: puneetnbri@gmail.com

Plant and plant products including essential oils are globally acclaimed for their medicinal and therapeutic values. It's an age-old practice, owing to their safety and protective effects against reactive oxygen species (ROS)/ oxidative stresses. Aging is a global challenge and needs proper attention to check on its causative factors. The increased ROS production/ oxidative stress is one of the major contributing factors endorses aging and age-related disorders. Present work investigated the impact of different doses (0, 10, 50, 100 ppm) on lifespan and health span of *C. elegans*. The present study revealed that lower dose (10 ppm) was highly effective and enhanced the life span of *C. elegans* by 18.54% as compared to the control. Similarly, same concentration, i.e. 10 ppm was also showing potential against various oxidative and thermal stresses. The JBEO treated worms showed 30.40% more survival under thermal stress as compared to control. Besides the increased survival percent of worms, the elevated expression of SOD-3 (39.49%) and GST-4 (25.13%) was also observed, indicating oxidative stress resistance in worms. The screening studies on mutants of *C. elegans* for prediction of mechanism demonstrated the involvement of major conserved transcription factors (DAF-16, SKN-1, and HSF-1) which coordinates in the stress-induced transcription and extends longevity. Overall, here we unveiled potentials of JBEO in anti-stress activities and life span extension in *C. elegans*. Thus, in future, more studies on JBEO will pave paths for commercialization of essential oils in the formulations of anti-aging products.

**Key words:** *Juniperus communis* L., Juniper berry oil, Stress resistance, Longevity, *Caenorhabditis elegans*.

SVII/P-47

## Nitric Oxide-Mediated Modulation of Stress Tolerance Responses to Mitigate Arsenic Toxicity in Rice (*Oryza sativa* L.)

P.K. Singh<sup>1,2\*</sup>, D. Chakrabarty<sup>1,2</sup> and R.D. Tripathi<sup>1,2</sup>

<sup>1</sup>CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Academy of Scientific and Innovative Research (AcSIR), Anusandhan Bhawan, 2 Rafi Marg, New Delhi-110001, INDIA, Email: pkdk2009@gmail.com

Nitric oxide (NO) has been known ROS (reactive oxygen species) scavenging. Being an antioxidant and very active signalling molecule, it modulates various physiological processes in abiotic stressed plants. Rice is a staple crop and food chain contamination of As in rice grain may possess a serious health risk to the human. Nitric oxide mitigates the As toxicity in rice. But, the detailed mechanism related to NO-mediated mitigation of As toxicity in rice is still unknown. The transcriptomic study elucidates the role of NO in transcriptional modulation of the genes related to metal transporters, redox-regulatory pathways, hormone and amino acid metabolisms in rice during AsIII exposure during 12 days of the growth period. Sodium nitroprusside (SNP, 30  $\mu$ M) used as NO donor. SNP supplementation reduced As accumulation and maintained the cell viability in AsIII stress. This study also showed the NO-mediated modulation of stress tolerance responses such as antioxidant activity, ROS and hormone level. The lignin and jasmonic acid (JA) acid contents also varied during various treatments. The NO-mediated modulation in secondary metabolite and JA acid content further strengthens the protective role of lignin and JA in rice plant during AsIII stress.

**Key word:** Arsenic toxicity, Nitric oxide, Rice.

SVII/P-48

## An Interactive Study of UV-B Radiation on Green Algae *C. humicola* and *C. vulgaris*: Implication on Photosynthetic Performance and Nutrient Status

R. Singh, A.K. Upadhyay and D.P. Singh\*

Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, INDIA, Email: dpsinghbbau@gmail.com

Gradual depletion of the stratospheric ozone layer by environmental pollutants such as chlorofluorocarbons (CFCs), enhance the incidence of solar UV-B (280–320 nm) at the Earth's surface. This increase in UV-B radiation affects primary production and ecosystems instability. UV-B is deadlier environmental threat that has the potential to cause severe consequence in plants and animals. Microalgae are the largest producer of oxygen, essential for planet function and health. Algae with its wider distribution and tolerant nature at different extreme environment offer a range of biotechnological opportunities to produce high-value added commercial products such as biodiesel, omega-3 containing PUFA and high biomass. In present investigation, microalga *C. humicola* and *C. vulgaris* were exposed to UV-B radiation for different time period to assess its growth, biochemical responses, lipid production efficiency and physiological changes viz., photosynthetic performance, OJIP value, NPQ etc. The chlorophyll fluorescence parameters indicated that the maximum photochemical efficiency of PSII (Fv/Fm), the actual photochemical efficiency of PSII in the light (ÖPSII) and the non-photochemical quenching (NPQ) displayed minimum changes at 2h of exposure but significantly decreased at 4h as compared with the control. Moreover, UV-B stress decreases the light energy utilization of photosystem II and thus damages the photosynthetic capacity in light reaction in both the algae. The algae used in this study showed remarkable alteration in growth and tolerance behavior which was more pronounced in the case of *C. humicola* than *C. vulgaris*. The effect of UV-B on biochemical, physiological and lipid production efficiency will explain during the presentation.

**Key words:** Algae, Stress biomarker, Photosynthesis.

SVII/P-49

## Interactive Effects of Putrescine (PUT) and Arbuscular Mycorrhiza (AM) on PUT Metabolism and Rhizobial Symbiosis in *Cajanus cajan* (L.) Millsp. under Salt Stress

Neera Garg and Amrita Sharma\*

Department of Botany, Panjab University, Chandigarh-160014, INDIA, Email: garg\_neera@yahoo.com, gargneera@gmail.com, amritasharma28@yahoo.com

Soil salinisation is a global issue that affects plant growth and limits agricultural production. Putrescine (Put) and arbuscular mycorrhiza (AM) have been reported to impart salt tolerance in crop plants. However, their relative and interactive effects in modulating Put metabolism as well as rhizobial symbiosis under salinity have not been explored yet. Present study aimed to investigate the relative impacts of Put (1 mM) seed priming and AM (*Rhizophagus irregularis*) inoculations on growth, ionic homeostasis, mycorrhizal and rhizobial symbiosis as well as Put metabolism in *Cajanus cajan* (pigeonpea) genotypes (Pusa 2001-salt tolerant; Pusa 991-salt sensitive) under NaCl stress (0, 60, 80, 100 mM). Salinity reduced plant biomass, with greater detrimental effects on roots which led to significant decline in mycorrhizal colonization and nitrogen fixing efficiency in both genotypes. The decline was directly proportional to increase in sodium ion uptake, decreased  $K^+/Na^+$  and  $Ca^{2+}/Na^+$  ratios in nodules, more in Pusa 991 than Pusa 2001. Salt stress reduced Put content by decreasing activities of arginine decarboxylase (ADC) and ornithine decarboxylase (ODC) with simultaneous increase in diamine oxidase (DAO). AM was more beneficial in decreasing  $Na^+$  content and DAO activity in the nodules with a concomitant increase in ADC, ODC which led to increased endogenous Put, relative to exogenous Put treatments. Put treated AM plants significantly enhanced the symbiotic efficiency and imparted better salt tolerance especially in Pusa 2001. The study suggested use of Put in combination with AM as an effective strategy to increase functional efficiency of nodules in pigeonpea.

**Key words:** Putrescine, Arbuscular mycorrhiza, Salinity, Rhizobial symbiosis, Pigeonpea.

SVII/P-50

## Heavy Metal Pollution and Genotoxicity of Soil

*Avinash Kaur Nagpal\**

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: nagpal\_avn@yahoo.com

Soil, with its complex nature, has been considered as the most dynamic interface between biota, atmosphere and hydrosphere. Heavy metal pollution of soil (resulting from vehicular emissions; domestic and industrial wastes; metallurgical activities; application of chemical pesticides and fertilizers) is an important issue of global concern. Heavy metals in contaminated soil can reach animals and human beings through various routes such as direct intake of food crops which have accumulated heavy metals from the soil and contaminated ground/surface water; through food chain and dermal contact. Exposure of human beings to heavy metals can lead to various health issues such as cardiovascular problems, testicular damage, respiratory, neurological and renal disorders etc. Hence, it becomes necessary to evaluate heavy metal contents in soils on regular basis to avoid potential risks

associated with contaminated soils and also associated food chains. Besides being toxic, subtle danger of presence of heavy metals in soil is the fact that they can induce mutations or genotoxic effects and even cancer in the living organisms including human beings exposed to such heavy metal contaminated soils. Hence soils should be evaluated not only for the presence of heavy metals using analytical methods but also for their potential risk they pose to biological systems. In this regard, bioassays are the best alternatives as they provide a measure of biologically relevant toxicity i.e. presence of bioavailable fractions of heavy metals in the soil matrix. Among difference bioassays available for such analysis, *Allium cepa* Root Chromosomal Abberation Assay (A/RCAA) is widely accepted and has gained a great attention as it is less expensive not requiring sophisticated equipment, and has less number and relatively large size of chromosomes. It is a simple assay and its strength lies in the fact that morphology of its chromosomes is similar to that of mammals and also this system has unique adaptation for *in situ* studies. This assay has been used world over to determine genotoxic potential of different types of soil including agricultural soil.

**Key words:** Heavy metals, Soil pollution, Genotoxicity, *Allium cepa*, Root chromosomal aberration assay.

**Session VIII**  
**Contemporary Issues in Environment and Plant**





SVIII/KN-1

## Water Conservation Models for the Buildings in Indian Cities

*Jal Guru Sri Mahendraa Modi*

IPS, DGP, SE, UP and Adviser, water conservation to Govt. of UP, Lucknow, INDIA, Email: dgpmmodioffice@gmail.com

Devising and inventing new formulae in an atmosphere devoid of resources is a unique path being introduced by my group. (1) (i) one rooftop in Mumbai can supply all the domestic water needs of 12 storey flats for all the 12 months from the same rooftop after extending rooftop water catchments areas. This will be collected, filtered and distributed at and from a suitable height. (ii) By this process, India will be able to save at least 2.5 trillion KWH electricity every year. And the total citizens of the earth will save 12 trillion KWH (iii) By so doing 75 to 90 percent people of India will get all the water of domestic needs fulfilled for 12 months from rooftop rain water only at nominal cost. (iv) The benefits are manifold. (v) This set of energy free purified rooftop rain water conservation tanks have been made functional by my team at three places of India. (2) To reinforce the water conservation culture among the people, we have developed economical, time saving, non-polluting and land saving techniques and also implemented them successfully at different districts of UP, MP and Jharkhand of India and are trying to extend these techniques to other areas of India for extending them as these methods also help mitigate the problem of water logging and floods (3) In furtherance of this goal, we have started Bhartiya Sanskriti Evam Jal Sanrakshan Utsav in 07 villages with an SOP of 32 points. (4) We have started SAJAL BHARAT ABHIYAN in 15 states by training the people at 179 places by PPT. Some people from 35 states/UTs have attended my training directly. (5) We got water recharge wells, trenches or filtered rain water tanks constructed at 272 places of India. (6) Mission Maha Indraa Koop has been started to revive the dried up wells, hand pumps and other reservoirs. These have worked successfully. We have been followed successfully in a large purpose of villages and several urban areas in India. (7) We have made several innovations and upgradations in water conservation technology like (a) Filed patents of ponds to hold more

water with diminished evaporation saving water due to evaporation loss upto 75 percent. (b) Energy free Purified rooftop rain water direct to multistorey flats model. (c) On MahaIndraa Koop to catch more rain water and prevent evaporation. (d) on economical and pollution free rain water harvesting / ground water recharging model for buildings. Improved water recharge trenches for plain area and plateau areas with controlled siltation. (8) I have written and published a book on water conservation in Hindi language- (i) SAB JAN PAANI RAKHIYE and (ii) the book "Conserve Water, Prevent World War" is in the process of writing. (9) Water level has been raised in some villages.

**Key words:** Water Conservation, Cities, Rooftop, Water.

SVIII/L-1

## Pharmacological and Biological Studies on Selected Endemic Pandanaceae Species Grown in the Philippines

*G.J. Alejandro<sup>1,3,4</sup>, J. Apostol<sup>2,3,4</sup>, P. Bangcaya<sup>5</sup>, A. Castillo<sup>2,3,4</sup>, R.R. Rondilla<sup>4</sup>, C. Tan<sup>4</sup>, M. Tan<sup>1,3,4</sup>, and M.G. Nonato<sup>1,3,4\*</sup>*

<sup>1</sup>College of Science; <sup>2</sup>Faculty of Pharmacy; <sup>3</sup>Research Center for the Natural and Applied Sciences; <sup>4</sup>Graduate School University of Santo Tomas; <sup>5</sup>Antique University, PHILLIPINES, Email: pandans2001@yahoo.com, aribel.nonato@ust.edu.ph

The family Pandanaceae with about 900 known species arising from five genera namely the Pandanus, the biggest of the group, the Freycinetia, the Sararanga, the Benstonea, and the Martellidendron. The Philippines is blessed to have all the genera except the Genus Martellidendron, formerly a subgenus of the Genus Pandanus. There are 54 species of the Genus Pandanus found in the Philippines, 42 of which are endemic to the country. Most of the phytochemical and biological/pharmacological studies conducted were on the common species of the Genus Pandanus. These afforded novel/new structural group of alkaloids and new/known compounds with new/known bioactivities. These findings led to the interest to study Philippine grown endemic Pandanus species and representatives of Genera Freycinetia and Benstonea for their pharmacological and biological activities. This paper will present the results of theantidiabetic, antioxidant,

antimicrobial, cytotoxicity, anti-inflammatory, and responses against selected cell lines-of the crude alcoholic extracts of the representative species of the genera *Pandanus*, *Freycinetia*, and *Benstonea*.

**Key words:** Pharmacology, Pandanaceae species, Philippines.

SVIII/L-2

## **A Systems Biology Approach in Research on Medicinal Plants: From Phytochemistry to Metabolomics**

*Khozirah Shaari*

Laboratory of Natural Products, Institute of Bioscience, University Putra Malaysia, 43400 Serdang, Selangor, MALAYSIA, Email: khozirah@upm.edu.my

Medicinal plants have been investigated and utilized to alleviate disease since early human history. Extracts and infusions containing natural products from plants have historically been a major source of pharmaceutical ingredients, often comprising mixtures of several bioactive compounds with complex synergistic effects. Their dominant role in modern medicine is evident in the approximately 60% of anticancer compounds and 75% of drugs for infectious diseases that were either natural products or natural product derivatives. Despite a declining interest in the screening of natural products by the pharmaceutical industry, natural products have continued to be significant source of drugs and leads. The tropical rainforest is a source of unimaginable chemical diversity for drug discovery. Recognition that this valuable biological diversity is rapidly diminishing is fostering a renewal of interest in natural products research. Over the past twenty years, our group has been focusing on the isolation and identification of bioactive compounds from the tropical rainforest plants of Malaysia. For most part of our research, the emphasis has been on inflammation, cancer and diabetes mellitus. Recently, we have also adopted metabolomics approach in the hope of obtaining a more holistic understanding of the biological properties of a medicinal plant or herb. Our research endeavours which began with a mainly reductionist perspectives, in accordance with the then popular drug discovery approaches used by big pharma and academic laboratories all over the world, has now mellowed into a more holistic approach, utilizing ‘omics’

technologies. Both approaches have their merits. However it has now become increasingly clear that disturbing the inherent synergism of a plant metabolome could be one of the main reasons for loss of biological activity in previous bioassay-guided studies on medicinal plants. In this regard, systems biology, in particular metabolomics/metabonomics, will have greater promise in our efforts to gain a deeper understanding of a plant metabolome effects on a disease state or on other biological perturbations. This paper will present some of our findings and progress made using both approaches with selected examples.

**Key words:** Medicinal plants, Metabolomics, Phytochemistry.

SVIII/O-1

## **Assessment of Protein Content and Antioxidant Activity in the Waste Pupae of Mulberry, Tasar and Muga Silkworm**

*Ashmita Ghosh<sup>1</sup>, Mrinal Ray<sup>1</sup>, Debnirmalya Gangopadhyay<sup>1\*</sup>, Suchisree Jha<sup>2</sup> and Palash Mandal*

<sup>1</sup>Department of Sericulture, Raiganj University, Raiganj, Uttar Dinajpur, 733134, West Bengal, INDIA; <sup>2</sup>Department of Botany, University of North Bengal, Darjeeling, 734013, West Bengal, INDIA, Email: deb\_ganguly2003@yahoo.com

The waste pupae of the silkworm such as mulberry (*Bombyx mori*), tasar (*Antheraea mylitta*) and muga (*Antheraea assamensis*) generated from the silk reeling industry can be a substantial source of protein. In the present study, the waste pupae of mulberry, tasar, and muga collected from the silk reeling industry were defatted, crushed into powder and analyzed through different biochemical methods to assess protein content and antioxidant activity. The present study revealed highest content of protein in the pupae of tasar ( $189.4 \pm 0.5 \text{ mgg}^{-1}$ ) followed by muga ( $165.6 \pm 0.92 \text{ mgg}^{-1}$ ) and mulberry ( $158.2 \pm 0.37 \text{ mgg}^{-1}$ ). The antioxidant activities of the samples were determined by using standard antioxidant assays like DPPH, ABTS, superoxide and metal chelating assay. The methanolic pupae extract (MPE) of muga and tasar showed high DPPH and ABTS scavenging activity with

IC<sub>50</sub> value of 163.11 and 63.69  $\mu\text{g mL}^{-1}$  respectively. On the other hand, the MPE of mulberry showed high metal chelating and superoxide radical scavenging activity with IC<sub>50</sub> value of 1.01 and 0.86  $\mu\text{g mL}^{-1}$  respectively. The study demonstrates that the waste silkworm pupae rich in protein content may serve as a potential source of natural antioxidants for the development of animal feed products.

**Key words:** Antioxidant, Protein, Silkworm pupae, Animal feed product.

#### SVIII/O-2

### Product Development and Sensory Evaluation of Value Added Food Products made by Incorporating Dried *Murraya koenigii* (Curry Leaf) Powder

*Mukta Singh\* and Khushaboo Prajapati*

Department of Home Science, M.M.V Banaras Hindu University, Varanasi-221005, INDIA, Email: drmuktasingh@gmail.com

*Murraya koenigii* (Curry Leaf) is one of the most common and popular plant grown in South India but in North India still neglected by people in their consumption pattern. In view of this, an attempt was made to utilize (dried curry leaf powder) to develop Iron and Vitamin C rich value added products for people suffering from nutrient deficiency. The present study was undertaken with an aim to develop value added products (Bengal gram flour sweets) incorporating dried curry leaf powder with other ingredients. Three samples were prepared with different incorporation of dry curry leaf powder T<sub>1</sub>:5g, T<sub>2</sub>:10g, T<sub>3</sub>:15g and one control sample T<sub>0</sub> was prepared without incorporation of dry curry leaf powder. Hedonic rating was used for sensory evaluation of value added products. Incorporation of dried curry leaf powder 5 g was highly accepted in sample T<sub>1</sub> of Bengal gram flour sweets. The shelf life studies revealed that the value added products stored in glass containers covered with aluminium foil had better shelf life. Nutritional composition of value added products T<sub>1</sub> were studied in which protein, iron and Vit C content were 12.51  $\text{g}^{-100\text{g}}$ , 13.84  $\text{mg}^{-100\text{g}}$  and 33.87  $\text{mg}^{-100\text{g}}$  respectively. Nutritional compositions of control value added

products T<sub>0</sub> were studied in which Protein, Iron and Vit C, content were 11.35  $\text{g}^{-100\text{g}}$ , 10.54  $\text{mg}^{-100\text{g}}$  and 27.87  $\text{mg}^{-100\text{g}}$  respectively. Thus there was a remarkable increase in the nutritional contents of the value added products.

**Key words:** Hedonic rating, Nutrients deficiency, Value added product, Nutritional composition.

#### SVIII/O-3

### Conservation of Herpetofauna in Cachar District of Assam: Challenges and Opportunities

*Sibam Sarkar and Mithra Dey\**

Department of Ecology and Environmental Science, Assam University, Silchar -788011, Assam, INDIA, Email: mithradey@gmail.com; shibamsarkar831@gmail.com

Recent research has shown that reptilian and amphibian population worldwide are on a sharp decline with approximately 32.5% and 22% of amphibian and reptilian species being endangered. Herpetofauna are important group of vertebrates and play significant role in the ecosystem. Amphibians are biphasic in lifestyle and depend on both aquatic and terrestrial ecosystems for their larval and adult phase of life. Herpetofauna occupy an important place in food chain being both predator and prey and form important vertebrate biomass in the ecosystem. Cachar is one of the three districts of Barak Valley; the other two being Hailakandi and Karimganj, located in Southern Assam. Barak Valley Region of Northeast India is a part of the Indo-Burma hotspot, which is one of the 35 global biodiversity hot spots and has myriad freshwater ecosystems along with thick tropical vegetation which offer excellent habitats. However, herpetes have not commanded much attention and little is known about their ecology and natural history. During the present study 16 species of anurans (Class: Amphibian) and 24 species of Reptiles (23 species of Order Squamata and 1 species of Order Testudines) were recorded. The study was carried out from January, 2016 to July, 2018 in Innerline Reserve Forest (24°35'36.47"N, 92°46'57.47"E), Rosekandy Tea Estate (24°41'40.12"N, 92°41'17.34"E), Silcoorie Tea Estate (24°41'5.55"N, 92°46'18.53"E) and in Assam University, Silchar Campus (24°41'12.70"N, 92°45'4.18"E ). The economic activity is mainly tea

cultivation, agriculture and allied activities. The paper analyses the impact of urban development, changes in climatic conditions, pollution of aquatic and terrestrial systems, habitat loss and degradation due to land use changes on the herpetofaunal diversity. Although challenges for conservation are many opportunities are also available and some suggestions are put forward which would help design conservation strategies for this lesser studied group of vertebrates and help their successful survive.

**Key words:** Herpetofauna, Threats, Conservation, Habitat degradation and fragmentation, Pollution, Urbanization.

#### SVIII/O-4

### Plant Disease Diagnosis: Current and Prospective Methods and Challenges

*Sunil Kumar Srivastava\* and N.K. Singh*

Department of Botany, M.L.K.P.G. College, Balrampur, U.P., INDIA, Email: sunilmkblp@gmail.com, singh.narendra november@gmail.com

Food losses due to plant diseases from pathogens such as bacteria, viruses and fungi are persistent issues in agriculture for centuries across the globe. In order to minimize the disease induced damage in crops during growth identification and diagnosis of plant diseases are very important. In the era of climate change and globalization for prevention of the pathogens an efficient and economical management of Plant diseases accurate and specific diagnosis is necessary. Laboratory based methods such as serological techniques, polymerase chain reaction (PCR), immunofluorescence (IF), fluorescence *in situ* hybridization (FISH), enzyme-linked immunosorbent assay (ELISA), flow cytometry (FCM) are some of the direct detection methods. Indirect methods include thermography, fluorescence imaging techniques. Finally the review provides a comprehensive overview of biosensors based on highly selective bio-recognition elements as a new tool for the early identification of crop diseases and their evolution to meet the contemporary challenges.

**Key words:** Detection, Diagnosis, ELISA, Food loss, Pathogen, PCR.

#### SVIII/O-5

### Biological Activity of Rare Sugar Ester and their Potential Role as Environmental-Friendly Organic Growth Regulator

*Md. Tazul Islam Chowdhury<sup>1\*</sup> and Yasuhiro Kawanami<sup>2</sup>*

<sup>1</sup>Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka-1207, BANGLADESH; <sup>2</sup>Faculty of Agriculture, Kagawa University, Kagawa, JAPAN, Email: mticsau@yahoo.com, kawanami@ag.kagawa-u.ac.jp

Plant growth retardants (PGRs) are a diverse group of chemicals which inhibit the growth of plants. But problem is-most of them are creating hazardous problem to flora and fauna. To avoid the detrimental effects of synthetic chemicals, research on novel natural products have moved from the fringe to the mainstream for the development of ecologically acceptable, environment friendly and relatively safe natural plant growth retardants. Therefore, research on rare sugar D-Allose explores the biological activities of new rare sugar derivatives on plant growth. D-Allose, a naturally-occurring rare monosaccharide, is a C-3 epimer of D-glucose that displays various biological activities such as anti-proliferative, immunosuppressive, and inhibitory effects on plant growth. Our group has synthesized five (5) different types of rare sugar derivatives and evaluated their inhibitory activity on plant growth using lettuce, cress, Italian ryegrass, and rice seedlings. Among them, All-C10 and 2-DOAll-C10 exhibited higher inhibitory effect on four plant species. And compare to D-Allose itself, it was 6 times greater inhibitory which suggest that carbonyl group at C-6 of increased the inhibitory activity on plant growth. In addition, in our experiment we have found that co-addition of gibberellins (GAs) rescued the growth inhibition, implying that rare sugar ester inhibits the formation of active GA in a plant. Moreover, the mode of action of rare sugar ester using known growth retardants revealed that rare sugar ester might mainly inhibits the last step of GA biosynthesis similar to daminozide or dehydro-GA<sub>5</sub>. These results may contribute to establish a biodegradable and environmental-friendly plant growth regulator.

**Key words:** Growth retardants, Rare sugar ester, Gibberellin, Biological activity, Environmental Friendly.

SVIII/P-6

## **Vermicomposting: Technology towards Green Revolution**

**Bhawna Sharma**

Department of Botany, Shri Shakti Degree College, Sankhahari, Ghatampur, Kanpur Nagar-209206, INDIA, Email: bhawnasharma2468@gmail.com

Domestic solid waste disposal is a matter of every day discussion at local and global level yet the problem evades solution. The technique of vermin-culture, if utilized by every homemaker would certainly reduce the serious environmental and health problem the world over. There is an urgent need to develop proper waste management technique for recycling of organic waste created from kitchen, farms and water bodies. It is estimated that in cities a human being creates about 0.4kg waste per day. Thus by year 2000, when there will create city refuse of about 44 (0.4 kg X 300m X 365 days) million per year. The present practice is just a way to remove dispose-off garbage, no matter where it put off, but actually a standard method of vermin-composting technique is required there. The process of vermin-composting requires the individual to collect the kitchen and garden waste in a container rather than disposing it. So, the vermin-culture is an environmentally beneficial technique and it requires little investment of time and some inexpensive materials.

**Key words:** Kitchen waste, Indoor environment, Eco-friendly, Worms.

SVIII/O-7

## **Legal Perspectives of Control on Air Pollution in Delhi and other Metro Cities**

**Deepika Pandey**

Amity School of Earth and Environmental Sciences, Amity University Haryana, Gurugram-122413, Haryana, INDIA, Email: dpandey@ggn.amity.edu

Almost ten years back Delhi was one of the

greenest metro cities of India owing to its green belt planted along the roadsides, its green zone in the heart of the city and plantation across the city which was a visual treat from above; and very soon it appeared in the list of most polluted cities of the world. The PM<sub>2.5</sub> level in the air of Delhi crossed all the limits and reached a level which is more than 7 times than WHO safe levels. The State and the Central government reacted in the form of series of rules and bans to this grave pollution problem. The old diesel vehicles were banned to enter the city, ban on registration of new SUVs, ban on burning biomass in and around Delhi, odd-even rule and many such regulations were implemented in an attempt to control the situation. The improvement in the Delhi's air quality could not be visualised by scientists. A number of other questions arose such as are the existing rules and regulations not effective? Were the other factors like overpopulation, industrialisation or climate playing a major role? Are these factors easy to control under a short period of time, say 15 days as allocated for odd-even rule? So we go back to the old existing policies, planning and legislation which may have been playing an underlying role and their implementation or non-implementation have worsen the situation over the years. This paper is an attempt to look into the laws and regulations adopted by the government in the time of crisis and what would have been the situation if the existing policies were actually followed.

**Key words:** Air pollution, PM<sub>2.5</sub>, environmental laws, Delhi pollution.

SVIII/O-8

## **To Study the Air Pollution Caused by Informal E-waste Burning and its Effect on Human Health**

**Anju Chauhan<sup>1,2\*</sup>, Charu Gangwar<sup>1,2</sup>, Atul Kumar<sup>1,2</sup>, Juhi Khan<sup>1,2</sup>, Ajay Kumar<sup>1,2</sup>, Garima Varshney<sup>1</sup> and Anamika Tripathi<sup>1</sup>**

<sup>1</sup>Pollution Ecology Research Laboratory, Department of Botany, Hindu College, Moradabad, INDIA; <sup>2</sup>School of Science, IFTM University, Moradabad, INDIA, Email: anjuchauhan696@gmail.com

Informal e-waste burning in Moradabad is one of the major source of increasing toxic heavy metal

concentration in Environment. Present study was aimed to investigate the air pollution and its relation to human health risk. Therefore, three monitoring sites (SI, SII and SIII) were selected on the basis of different activities in the respective areas. Air samples were collected with the help of RDS and then subjected to heavy metal analysis by ICP-OES. One of the objectives of the study to assess the level of heavy metal concentration (ICP-MS) in blood of studied population from different monitoring sites. Results indicated that except SI, all sites had significant level of PM<sub>10</sub> and its heavy metal content. Therefore, local residents had various levels of heavy metal concentrations in their blood. The study concluded that exposure to high level of air pollution, containing toxic metal such as Pb, Cu, Cr, Ni and Zn, released from e-waste burning activities, resulted into significant health risk for the exposed human population. On the basis of above it is concluded that environment of Moradabad City should be closely monitored by government agencies on routine basis, particularly for its metal content in order to safeguard the health of the population exposed in general and e-waste workers in particular.

**Key words:** E-waste Burning Activity, Industrial Activity, PM<sub>10</sub>, Blood, Heavy Metal, Human Health, Air pollution.

#### SVIII/O-9

### Stable Organic Matter Yield Index of Biochar Prepared from Yard-Waste

*Sangeeta Mukhopadhyay\* and R.E. Masto*

Industrial Biotechnology and Waste Utilisation Division, CSIR-Central Institute of Mining and Fuel Research (Digwadih Campus), Dhanbad-828108, INDIA, Email: sangeeta.dccs@rediffmail.com, mastocfri@yahoo.com

Agricultural waste, crop residues, garden and yard wastes are increasing at an alarming rate due to increase in population. It is reported that about 600 MT of wastes have been generated in India from agricultural sources alone. All these organic wastes create environment pollution. There is a vast potential for production of biochar from organic wastes, which is otherwise left unutilized or burnt. Moreover, burning of these wastes causes significant degradation of soil, and emission of greenhouse gases. Biochar is produced by heating organic waste under limited supply of air. Biochar has fertilizer value that improves soil quality,

crop productivity and carbon sequestration in soil. Yard waste biomass samples were carbonised with limited supply of air in a muffle furnace at different temperature (300-500°C) and residence time (30-120 min). The resultant biochar was characterized for labile C and stable organic matter yield index (SOMYI). With increase in temperature, biochar yield decreased, whereas the stability increased. SOMYI was calculated from the biochar yield and stable organic matter content. The carbon liability index of biochar decreased with increasing temperature and duration of pyrolysis. The yield of stable organic matter decreased at temperature >300°C. The optimum condition was found to be heating the yard waste at 300°C for 30-40 min. As the biochar is to be used for soil amendment, stable organic matter (SOM) yield is important, rather than the SOM content. TGA and FTIR studies showed that yard-waste biochar prepared at 300-350°C has aromatic functional groups and the yield of stable carbon is higher. Thus, we recommend a low temperature moderate pyrolysis (300-350°C, 30-40 min) condition for preparation of yard-waste biochar.

**Key words:** Biochar, Yard waste, Labile carbon, Stable organic matter yield index.

#### SVIII/O-10

### Characterization and Adsorptive Removal of Phenol Red from the Water using Green Synthesized Iron Nano Particles

*Shalu Rawat<sup>1</sup>\*, Jiwan Singh<sup>1</sup>, Samiksha Sikarwar<sup>2</sup> and B.C. Yadav<sup>2</sup>*

<sup>1</sup>Department of Environmental Science, Babasaheb Bhimrao Ambedkar University, VidyaVihar, Raebareli Road, Lucknow-226025, INDIA; <sup>2</sup>Department of Physics, Babasaheb Bhimrao Ambedkar University, VidyaVihar, Raebareli Road, Lucknow-226025, INDIA, Email: shalurawat200@gmail.com, jiwansingh95@gmail.com, samiksha9.2009@gmail.com, balchandra\_yadav@rediffmail.com

Synthesis of nanoparticles via green route reduces adverse effects of harmful chemical used in chemical synthesis of nanoparticles. Green synthesis of nanoparticle is an advance and eco-friendly technique. In this study extract of waste tea was used

as reducing agent for the synthesis of iron nanoparticles. The synthesised iron nanoparticles were characterized by UV-Visible spectrophotometer, scanning electron microscope (SEM), energy dispersive x-ray spectroscopy (EDX), Brunauer-Emmett-Teller (BET), particle size analyser, Zeta potential, X-ray diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR). The average particle size of the nanoparticles was found 98.79 nm. Synthesised iron nanoparticles showed maximum weight percentage of iron 69.07% in elemental composition analysis by EDX. Synthesised iron nanoparticles were used as adsorbent for removal of phenol red dye from aqueous solution. Effect of different parameters on the adsorption of phenol red was also investigated. Tea waste iron nanoparticles (TW-FeNPs) effectively adsorbed phenol red from aqueous solution. Maximum adsorption capacity (95.08 mg/g) of TW-FeNPs was found at pH 8 and at room temperature 25°C. The adsorption of phenol red was decreased with increasing temperature of the process that showed that the adsorption of phenol red with TW-FeNPs was an exothermic process.

**Key words:** Green synthesis, Adsorption, Tea waste, SEM, BET.

#### SVIII/O-11

### Effect of Ionizing Radiation on Human Health

*Ashish Chaturvedi*

King George's Medical University, Department of Pathology, Lucknow-226007, INDIA, Email: ashishchaturvedi.jr.sc@gmail.com

The effects of radiation were first recognized in the use of X-rays for medical diagnosis, then later with the discoveries of radiation and radioactivity. The rush in exploiting the medical benefits led fairly to the recognition of the risks and induced harm associated with it. In those early days, only the most obvious harm resulting from high doses of radiation, such as radiation burns were observed and protection efforts were focused on their prevention, mainly for practitioners rather than patients. Although the issue was narrow, this led to the origin of radiation protection as a discipline. Subsequently, it was gradually recognized that there were other, less obvious, harmful radiation

effects such as radiation-induced cancer, for which there is a certain risk even at low doses of radiation. This risk cannot be completely prevented but can only be minimized. Therefore, the balancing of benefits from nuclear and radiation practices against radiation risk and efforts to reduce the residual risk has become a major feature of radiation protection. In this paper, we shall be looking at the precautionary measures for protecting life, properties and environment against ionizing radiation.

**Key words:** Radiation, Alpha particles, Beta particles, Gamma rays, X-rays.

#### SVIII/O-12

### Impact of Healthcare Waste Management on Environmental Health Disaster

*Salil Chaturvedi<sup>1</sup>, Marisha Rai<sup>2</sup> and Rachna Chaturvedi<sup>3</sup>*

<sup>1</sup>Shyama Prasad Mukharjee (Civil) Hospital, Lucknow-226001, INDIA; <sup>2</sup>Balrampur Hospital, Lucknow, INDIA; <sup>3</sup>Amity Institute of Biotechnology, Amity University Uttar Pradesh Lucknow-226028, INDIA, Email: drrachnachaturvedi@gmail.com

Environment hazard disaster due to health care waste management is recognized as the worldwide problem. Globally, it is observed that health care waste management is underfunded and poorly executed. The collective harmful contagious and additional unsafe properties of medical waste characterize a significant environmental and public health threat. Health care waste is created by different health care activities. It includes needles, body fluids, body parts, pharmaceuticals, radioactive materials, and cytotoxic drugs which are generated by health care establishments, health-related laboratories, and health research facilities. There are many potential threats connected with management of health care waste, posing hazards not only to the patients and health care personnel, but also to the community and the environment health. Nevertheless, hospital waste is typically characterised rendering to the hazard it conveys. One of the recognized results of overflowing garbage is the air pollution, which is responsible for various respiratory infections and other adverse health effects as pollutants are absorbed from lungs into other

parts of the body. The poisonous substances in air polluted by waste include different hazardous gases as carbon dioxide, nitrous oxide and methane. Health workers who are managing the waste which is holding harmful chemicals and metals may involve in toxic exposure. Therefore it is advisable that disposal of hazardous health-care wastes must need distinctive care because it can create major health hazards, such as Hepatitis B and C, through wounds caused by discarded syringes. It must be taken in consideration that sharps used needles, syringes, or other contaminated should not be mixed in common waste disposal or recycle bin because by this much of practice the entire waste will become infectious. Some facilities even provided should include special vehicles and protective devices to dispose, handling or transport the health care waste products. Disposing of waste has enormous environmental hazardous impacts and can cause serious problems. In near future this management of health care should be taken seriously to minimize the environment hazard disaster.

**Key words:** Environment health disaster, Health care waste, Public health, Diseases.

#### SVIII/P-1

### **Study of Bioaccumulation in Fishes and Bovines by Feeding Plants Growing Near Mine Void: A Case of Talcher, Odisha**

*S. Chakraborty\**, *S. Dhyani* and *P. Pujari*

Water Technology and Management Division, CSIR-National Environmental Engineering and Research Institute, Nehru Marg, Nagpur, INDIA, Email: s\_dhyani@neeri.res.in, shalini3006@gmail.com, soumya.kol92@gmail.com

Heavy metals are highly stable and persistent environmental toxicants which are a growing problem in nature. The study presented is part of our ongoing monitoring watershed management programme in Talcher, Orissa, which is a rural mining town where the livelihood is mainly based on agriculture and livestock farming. Objective of the study is to analyze how heavy metal leaching from mine void may affect the terrestrial and aquatic, flora and fauna through the food chain. Systematic sampling was planned and plant,

soil, fish, dung and milk samples were collected in and around the mine pit and adjacent villages on an increasing distance of 0.5 to 1 km. These samples were acid digested as per American Public Health Association regulation and diluted in distilled water. The prepared samples were analyzed in ICP-OES and AAS to quantify the concentration of heavy metals. The comparison was made between the bioaccumulations of heavy metals in plant, soil, fish, dung and milk samples through ANOVA statistical analysis and the rate of transfer from each soil to plant and higher trophic level was established by the regression equation. Our result reflect that due to coal mining carried out in the past and maybe mineral mining in Talcher might be responsible for heavy metal accumulation in the soil. Heavy metals accumulated in plants enter the food chain and cause metabolic dysfunction in animals along with blotting and stunted growth in plants. The impact assessment monitoring would help to make changes in the mining process that will help in reducing heavy metal leaching by finding sensitive spots in the mining area and generate awareness for using heavy metal contaminated

**Key word:** Bio-magnification, Spectroscopy, Trophic-level, Watershed, Mineral leaching

#### SVIII/P-2

### ***In silico* Analysis of Peroxidases (Pr9 Protein Family) in *Solanum lycopersicum***

*Amritpreet Kaur*<sup>1\*</sup>, *Pratap Kumar Pati*<sup>2</sup>, *Aparna Maitra Pati*<sup>3</sup> and *Avinash Kaur Nagpal*<sup>1</sup>

<sup>1</sup>Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA; <sup>2</sup>Department of Biotechnology, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA; <sup>3</sup>Planning Project Monitoring and Evaluation Cell, CSIR-Institute of Himalayan Bioresource Technology, Post Box No.:6, Palampur-176061, H.P., INDIA, Email: amritbot.rsh@gndu.ac.in, pkpati@yahoo.com, aparna@ihbt.res.in, avnagpal@rediffmail.com

Plants have a large number of ways to protect themselves against different abiotic and biotic stresses. Production and accumulation of pathogenesis-related proteins (PR proteins) is among one of few important defense related mechanisms. Based on biological



functions, isoelectric point, molecular weight and amino acid sequences, PR proteins are grouped into 17 classes. Few examples of PR proteins are antimicrobial peptides, oxidoreductases, hydrolytic enzymes, proteinases and proteinase inhibitors etc. The present paper focuses on PR9 protein family present in *Solanum lycopersicum* (SIPR9). PR9 (Peroxidases) proteins catalyze cross-linking of macromolecules in the plant cell wall. They also produce free radicals like  $H_2O_2$  against a wide range of pathogens. The present study aims to analyze the cis-elements present in the promoter regions of SIPR9 followed by its gene expression analysis. SIPR9 was found to be down-regulated in all states except in inflorescence visible stage followed by main shoot growth. Protein structure of SIPR9 was modeled using MODELLER followed by docking with various phytohormones.

**Key words:** Peroxidases, *Solanum lycopersicum*, Promoter, Docking

SVIII/P-3

## A Comparative Study on the Effects of Four Wild Variety Medicinal Oil Cakes against Root Knot Nematode Infecting Tomato

*Soumya Sucharita Mohanty<sup>1</sup> and Kumanand Tayung<sup>2\*</sup>*

<sup>1</sup>Department of Botany, North Orissa University, Takatpur, Baripada-757003, Odisha, INDIA; <sup>2</sup>Mycology and plant pathology laboratory, Department of Botany, Gauhati University, Guwahati-781014, Assam, INDIA, Email: namalie44@gmail.com

Tomato (*Solanum esculentum* L.) which is known as “Poor man’s apple” is the world’s largest grown vegetable crop. But many pathogenic microorganisms including nematodes cause various diseases in tomato hampering its adequate productivity. More specifically, it is assumed that for root knot nematodes, tomato behaves as the most favourable host. Root knot nematode causes an annual loss of approximately 27.24% in tomato in India. To manage nematodes diseases farmers often use chemicals like Cartap hydrochloride or Carbofuran. Since most of these chemicals have serious adverse effects on

environment and living organisms, the paper suggests certain biological management practices and eco-friendly approaches which could be a better option for the farmers. So experiments were conducted to evaluate the effectiveness of four wild variety medicinal oilcakes against root knot nematodes infecting tomato in pot cultures. The experiment comprised of six treatments in order of T1 = Neem cake @ 100 gm<sup>-2</sup>, T2 = Mahuacake @ 100 gm<sup>-2</sup>, T3 = Karanja cake @ 100 gm<sup>-2</sup>, T4 = Kusumcake @ 100 gm<sup>-2</sup>, T5 = Carbofuran standard check @ 0.3g a.i.m<sup>-2</sup>, T6 = Untreated check. Each treatment was replicated thrice following complete randomised design. The tomato plantlets variety Pusa ruby was transplanted to the pots. At one week after transplanting, nematodes were inoculated into the pots. Observations were taken at 45 days of inoculation which indicated that all treatments increased the plant growth parameters and reduced root knot nematode population over check. The result revealed that the pot treated with neem cake showed improved plant growth rate and reduction in nematode infection as compared with other treated plants. However the present investigation needs testing of treatments in micro plots / field condition for more concrete results.

**Key words:** *Meloidogyne incognita*, Tomato, Oil cakes, Carbofuran.

SVIII/P-4

## Nutritional Evaluation of Indian Carrot (*Daucus carota* L.)

*Tinu Anand Kain<sup>1\*</sup>, Peer Saffullah<sup>1</sup>, Shahid Umar<sup>1</sup> and Sayeed Ahmad<sup>2</sup>*

<sup>1</sup>Department of Botany, School of Chemical and Life Sciences, Jamia Hamdard, New Delhi-110062, INDIA; <sup>2</sup>Department of Pharmacognosy and Phytochemistry, School of Chemical and Life Sciences, Jamia Hamdard, New Delhi-110062, INDIA Email: tinuanandkain@gmail.com, saif3n9@gmail.com, sumer@jamiyahamdard.ac.in, sahmajh@jamiyahamdard.ac.in

Food security is the major issue in developing countries. In the latest Global Hunger Index (GHI) 2017 report, released by International Food Policy Research Institute (IFPRI), India ranked 100<sup>th</sup> among 119 countries. About one-fourth Indian population is living

under below poverty line resulting in malnutrition. Utilization of indigenous vegetables can help in mitigating food security issues and addressing malnutrition. Carrot (*Daucus carota* L.) is a well-consumed food crop in India. It can be consumed raw, cooked and in processed form. Sixteen Indian carrot accessions were analyzed for variation in root size, dry matter, chlorophyll content, total soluble protein content, total phenolics, total soluble sugar content and mineral compositions. Among carrot accessions, significant differences ( $p < 0.05$ ) were obtained with respect to total phenols and total soluble sugars. Purple coloured accessions were found to be a rich source of calcium and phenols with a very high antioxidant activity. Yellow coloured accessions were rich in sugar content. This study revealed that different coloured carrots have their own distinctive nutritive quality. Roots of carrot contain a considerable quantity of essential nutrients and can be a useful source of minerals for a population suffering from hidden hunger. Indian population is mostly consuming red and oranges carrots. It is required to increase awareness, production and consumption of yellow and purple coloured underutilized carrots, as they are a rich source of nutrients and can help to combat malnutrition.

**Key words:** Carrot, Hidden hunger, Bioavailability, Nutrition, Minerals.

SVIII/P-5

## Micronutrient Availability and Distribution in Soils Amended with Crop Residues and Organic Manures

*Deepika Rajwar\* and Ajay Kumar Bhardwaj*

Central Soil Salinity Research Institute, Kachhwa road, Karnal-132001, Haryana, INDIA, Email: deepika.rajwar@gmail.com; akbhardwaj@gmail.com

Micronutrients are important components of human diet. The intensive cropping systems which are being followed nowadays are depleting micronutrients from soils. Thus, their amount in our diet has decreased significantly. In a 13 year long experiment with fertilization treatments, ion exchange resin membranes were used as plant root simulators to determine availability of micronutrients and their distribution in soil solution (signifying plant availability), grain

(signifying availability in food) and straw (signifying availability to milk animals) over full growing season of rice-wheat for two consecutive years (2013-2014) in an alkaline soil. Treatments included: recommended fertilizer doses (F: N: P: K: Zn 180:26:42:7 kg ha<sup>-1</sup>) compared with reduced fertilizer use (~ 50% cut) but supplemented with organic inputs, namely legume (LE; *Vigna radiata*), green manure (GM; *Sesbania aculeata*), farmyard manure (FYM), wheat straw (WS), and rice straw (RS). The soil stock of Zn was highest in case of F (fertilizers only) where ZnSO<sub>4</sub> fertilizers were applied than organic management. These trends substantiate stray evidences that Zn fertilizer application could be helping in building up Zn content of soils to the level of a pollutant in the western Indo-Gangetic plain (IGP). Overall, Zn availability in rice and wheat through organic fertilizer application was 12.45 and 16.87 µg cm<sup>-2</sup> respectively, which was comparable to the availability provided by fertilizer application. In terms of availability of Iron, manganese and copper, the integrated management with organics and cut down fertilizer application proved better than fertilizers only. The availability was higher in straw than grain and exhibited the following order: Fe > Mn > Zn > Cu. This could be particularly important for areas where straw is fed to milch animals. Organic treatment for nutrient management in soils indicates very effective method of managing plant, human and animal micro-nutrition as well as to control fertilizer pollution.

**Key words:** Crop residues, Organic manures, Micronutrients.

SVIII/P-6

## Development Projects on Silk Production in North East India

*Suman Das<sup>1</sup>\*, Mrinal Ray<sup>2</sup>, Ashmita Ghosh<sup>2</sup> and Gangesh B. Singh<sup>3</sup>*

<sup>1</sup>Department of Handloom, Handicrafts and Sericulture, Sericulture Training Institute, Tripura, INDIA; <sup>2</sup>Department of Sericulture, Raiganj University, Raiganj, Uttar Dinajpur-733134, West Bengal, India; <sup>3</sup>Central Silk Board, R.E.C., Agartala, Tripura, INDIA, Email:suman.agribiotech@gmail.com

India has a long history of silk production and at present ranks second largest producer in the world after China accounting for just five percent of the global silk

market. The North Eastern Region of India is endowed with unique agro-climatic conditions suitable for practicing all the four sectors of sericulture, namely mulberry, eri, muga and tasar contributing about 21% of the total silk production in the country. With the prime objective of promoting the first 3 major sectors in the region, the Government of India introduced Integrated Sericulture Development Project (ISDP) under the North Eastern Region Textile Promotion Scheme (NERTPS) which includes the different objectives like assessment of component-wise impacts, issues etc., assessment of present implementation practices, marketing mechanisms etc. to counter China's growing silk production. Indian government has invested Rs. 690 core in projects in 24 districts under the North East Region Textile Promotion scheme. Under these schemes, six projects are running in Assam, one in Sikkim, two each Meghalaya and Manipur and rest in other states. Eri silk production reached 3,600 tons in 2016-17. The detailed knowledge about the integrated sericulture development projects and intensive bivoltine sericulture development projects of North East has been possible with broad-based support and co-operation from various stakeholders. (Note: NERTPS - North Eastern Region Textile Promotion Scheme, ISDP - India introduced Integrated Sericulture Development Project)

**Key words:** Sericulture, Projects, North-East India, Eri, Muga.

SVIII/P-7

## **Documentation of Herpetofaunal Species and Need for their Conservation: A Study in Tripura, India**

**Sumit Nath and Mithra Dey**

Department of Ecology and Environmental Science, Assam University, Silchar-788011, Assam, INDIA, Email: nathsumit389@gmail.com and, mithradey@gmail.com

The recent increase of threats to amphibian and reptilian population in north-east India, such as deforestation, climate change and various other anthropogenic activities are creating a serious need for the implementation of conservation policies. For better design of conservation practices, study of herpetofaunal population is necessary. Amphibians and reptiles play

key role in the ecosystem, utilizing both terrestrial and aquatic environment. Being both predators and prey, they are essential components of the food web and play a crucial role in maintaining a healthy ecosystem. Worldwide, 32.5% and 22% of amphibian and reptilian species respectively, are endangered, and current trends suggest even more species could become threatened in near future. The present paper gives an overview of the herpetofauna in Tripura. The state of Tripura (named after the Hill Tippera) is located in the north-eastern region of India. Tripura consists of eight districts (North Tripura, Unokuti, Dhalai, Khowai, West Tripura, Sepahijala, Gomati and South Tripura). Several locations of the state were selected for the present study. For identification morphological study along with photography was done. After identification all specimens were released. A total of 53 species of herpetofauna (amphibians and reptiles) belonging to 42 genera and 17 families were recorded; 11 species of amphibians belonging to 9 genera and 6 families; 10 species of lizards belonging to 9 genera and 4 families; 28 species of snakes belonging to 20 genera and 5 families and 4 species of turtles and tortoises belonging to 4 genera and 2 families. Considering the threats it is necessary to design strategies for conservation and also maintain a balance between economic and developmental activities and the environment.

**Key words:** Tripura, Herpetofauna, Amphibians, Reptiles, Threats, Decline, Conservation.

SVIII/P-8

## **Is Nitrogen the Next Carbon?**

**Viney P. Aneja**

Department of Marine, Earth, and Atmospheric Sciences North Carolina State University Raleigh, NC 27695-8208, USA, Email: viney\_aneja@ncsu.edu

Just as carbon fueled the Industrial Revolution, nitrogen has fueled an Agricultural Revolution. The use of synthetic nitrogen fertilizers and the cultivation of nitrogen-fixing crops both expanded exponentially during the last century, with most of the increase occurring after 1960. As a result, the current flux of reactive, or fixed, nitrogen compounds to the biosphere due to human activities is roughly equivalent to the total flux of fixed nitrogen from all natural sources, both on

land masses and in the world's oceans. Natural fluxes of fixed nitrogen are subject to very large uncertainties, but anthropogenic production of reactive nitrogen has increased almost five-fold in the last half-century, and this rapid increase in anthropogenic fixed nitrogen has removed any uncertainty on the relative importance of anthropogenic fluxes to the natural budget. The increased use of nitrogen has been critical for increased crop yields and protein production needed to keep pace with the growing world population. However, similar to carbon, the release of fixed nitrogen into the natural environment is linked to adverse consequences at local, regional, and global scales. Anthropogenic contributions of fixed nitrogen continue to grow relative to the natural budget, with uncertain consequences.

**Key words:** Carbon, Environment, Nitrogen.

SVIII/P-9

## Pollen-Vegetation Relationship in Surface Sediments Renuka Region, Sirmaur, Himachal Pradesh, India

*Anjali Trivedi and Anjum Farooqui*

Birbal Sahni Institute of Palaeosciences, 53, University Road, Lucknow-226007, INDIA, Email: atrivedee@gmail.com, afarooqui@yahoo.com

The Renuka lake and the adjoining reserved forest area is situated at 30°36'23" N Lat. 77°27'30" E Long. The surface sediment samples were collected in a transect from different ecological niches in about 4.0 square kilometers area to study pollen assemblage and its relationship with the vegetation in the region. The qualitative and quantitative study revealed the dominance of arboreals (trees and shrubs) over the non-arboreals (herbs) suggesting forested area. *Shorea robusta* (12-17%) shows its dominance followed by *Terminalia*, *Dalbergia sisso*, *Mangifera indica*, *Syzygium cumini*, etc. *Gardenia* and *Cassia fistula* are in moderate to low values. Acanthaceae, Fabaceae, *Murraya koenigii*, *Lantana camara* and *Saxifraga* sp. are the representatives of under storey shrubby vegetation. The herbaceous flora are less-diversified and largely constituted of Poaceae whereas, Asteraceae, Ranunculaceae, etc.. However, the sporadic presence of ruderal plants as *Artemisia*, Chenopodiaceae and Brassicaceae depicts the human

activities in the area. The wetland/aquatic taxa as Cyperaceae, Apiaceae, *Polygonum* spp. and *Potamogeton* are recorded in good number from lake sediments. The drifted taxa such as long-dispersed *Pinus roxburghii* (Pine), *Cedrus deodara* (Deodar), *Picea* (spruce) and *Abiespindraw* (fir) are recorded in good percentage. The records of oak (broad-leaved temperate taxa) constitutes *Quercus*, *Rhododendron*, *Alnus*, *Betula* etc. indicating its provenance from higher altitudes in the vicinity indicating the frost free conditions conducive for such forests. The overall pollen assemblage is dominated by Semi-evergreen to moist deciduous vegetation with negligible conifers suggesting moderate to low seasonality and good precipitation in the region with dry summer months at an altitude of ~670 m a.m.s.l. with winter temperatures ranging between 0-18°C and summer temperatures between 18-35°C. The study serves as modern analogue for the appropriate assessment of the Climate-vegetation equilibrium in the region in order to define the past climate fluctuations in terms of vegetational evolution. The study also highlights the relative percentage of pollen preservation in the sediment with reference to plant frequency in the studied area providing clue for assessing the quantitative estimation of pollen the sedimentary profile.

**Key words:** Pollen, Tress, Himachal Pradesh.

SVIII/P-10

## Fungalflora Associated with Indian and Foreign Coins and their Potential Health Risks

*Drishiti Navlani\*, Aditi Maheshwari, Vidhatri Thakkar, Rohit Taunk, Naitik Chaudhary and Arun Arya*

Department of Environmental Studies, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara, INDIA, Email: sarojarun10arya@rediffmail.com

Potential role of spread of pathogenic microflora on coins and currency notes has been evaluated in different countries. Notes and currency coins may serve as universal vehicles for transmission of potentially pathogenic microorganisms among persons either directly, through hand to hand contact, or indirectly, through water and food. The Purpose of study was to do qualitative and quantitative analysis of

microflora associated with Indian and foreign coins. Results of the study revealed that bacteria were present in most of the coins more than 40% coins showed presence of fungi like *Aspergillus niger*, *Curvularia lunata*, *Chaetomium globosum*, *Fusarium roseum* and *Trichoderma viride*. Fungi like *Aspergillus niger* and *Fusarium roseum* can cause bronchial diseases and may act as potential allergens and few of these are reported to cause skin problems. The Use of digital transaction will reduce such harmful transaction. Cleaning the coins with water or UV treatment may be reduce the fungal load.

**Key words:** Currency coins, Indian, Foreign, *Aspergillus*, *Fusarium*, *Chaetomium*.

SVIII/P-11

## Bioprospecting Role of *Cetrelia braunsiana* against Pathogenic Microorganisms

*Devashree*<sup>1</sup>, *Anupam Dikshit*<sup>1</sup> and *Sanjeeva Nayaka*<sup>2</sup>

<sup>1</sup>Biological Product Laboratory, Department of Botany, University of Allahabad, Allahabad, INDIA; <sup>2</sup>Lichenology Laboratory, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: devashreerishabh021@gmail.com

Lichens are one of the best examples of symbiotic association where two dissimilar organisms, a fungus and an alga or a cyanobacterium live together physiologically synchronized and well intermixed so as to form a single biological unit. The lichen substances also do have great biological potentials including antibiotic, antimycobacterial, antiviral, antioxidant, anti-inflammatory, analgesic, antipyretic, antiproliferative and cytotoxin. In the present study, crude extracts of *Cetrelia braunsiana* were tested for its antimicrobial activity. *Cetrelia* belongs to the lichenized ascomycete family Parmeliaceae, cetrarioid genera. The name of *Cetrelia* is a fanciful concoction from *Cetraria* and *Parmelia*, in which most of the species had previously been placed. Although there were many reports on the study of *Cetrelia* almost no expert study on *Cetrelia* had been conducted in Korea until the macrolichen flora of South Korea was published there were 8 species of *Cetrelia* recorded in *Korean peninsula*. Thallus

contains atranorin, alectoronic, á-collatolic acid, 4-O-methylphsodic, and physodic acid. These lichens monitor air pollution and play vital role in dye, perfumery and medicinal industries. Samples were collected from inroute *Chansile*, 4 kms on *Pinus* and its organic extract was prepared using solvents methanol, ethanol, acetone and ethyl acetate by the soxhlet setup of extraction. Common negative control used was DMSO i.e. dimethyl sulphoxide and specific positive control streptomycin for antibacterial and ketoconazole for antifungal. This present work was promulgated to explore the lichen *Cetrelia braunsiana* with special reference to its antimicrobial testing against pathogenic bacteria such as *Staphylococcus aureus*, *Streptococcus mutans*, *Agrobacterium*, *E. coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia* and pathogenic fungus *Candida albicans*, *Aspergillus niger* and *Fusarium oxysporium*. Maximum inhibition zones were observed in methanolic extracts against bacteria *Agrobacterium tumefaciens* and *Staphylococcus aureus* whereas ethyl acetate extracts against fungi *Candida albicans* and *Fusarium oxysporum* and it can be used as a herbal formulation in future use. This will definitely provide a base and for the future perspectives and highlight the need for further studies of this promising source to harvest more beneficial in the field of bioprospection.

**Key words:** Symbiotic, Cyanobacterium, Antimycobacterial, Antiproliferative, Bioprospecting.

SVIII/P-12

## Adoption Extent and Horizontal Spread of Tomato (*Lycopersicon esculentum* Mill.) Cultivation through Front Line Demonstration in Eastern Uttar Pradesh of India

*P.K. Misra*<sup>1</sup>, *P.N. Singh*<sup>1</sup>, *S.N. Singh*<sup>2</sup> and *Pardeep Kumar*<sup>3</sup>

<sup>1</sup>Krishi Vigyan Kendra, Varanasi, INDIA; <sup>2</sup>Krishi Vigyan Kendra, Masouda, Faizabad, INDIA; <sup>3</sup>Krishi Vigyan Kendra, Siddharthnagar, INDIA; ND University of Agriculture & Technology, Kumarganj, Faizabad, Email: pkmisra2001@gmail.com

The present study was undertaken to find the yield

gap through FLDS on tomato crop. The Krishi Vigyan Kendra, Varanasi conducted frontline demonstration on 10 farmers for each year since 2010-11, 2011-12 and 2012-13 in different locations of Varanasi district. Frontline demonstrations were conducted on tomato by the active participation of the farmers with the objective of improved technologies of tomato production potential. Use of hybrid variety, balanced use of fertilizer on the basis soil testing report and integrated pest and disease management etc are the main technologies to be tested in this demonstration. Tomato is a major vegetable crop of eastern Uttar Pradesh. But the productivity of tomato are very low in this district due to lack of knowledge and partial adoption of recommended package of practice by tomato cultivators. The data of study revealed the cost of cultivation, production, productivity, gross return and net return were collected as per schedule and analyzed. The result of present study revealed that average highest yield in demonstration was recorded 643.83 q ha<sup>-1</sup> was obtained in demonstrated plot over control (522.66 q ha<sup>-1</sup>) with an additional yield of 121.17 q ha<sup>-1</sup> and the increasing the average tomato productivity by 23.88%. The extension gap and technology gap ranged between 119.50 to 122.50 and 93.50 to 119.50 q ha<sup>-1</sup>, respectively, with the technology index of 16.51% during the demonstration years. Besides this, the demonstrated plots gave higher gross return, net return with higher benefit cost ratio when compared to farmer's practice. In present study efforts were also made to study the impact of FLD on horizontal spread which was increased 269.38 %, if appropriate package and practices are followed.

**Key words:** Frontline demonstration, Tomato, Yield, Extension gap, Technology gap, Technology index, Adoption, B: C ratio.

SVIII/P-13

## Study of Some Morphological and Biochemical traits Based on Triple Test Cross Analysis in Opium Poppy (*Papaver somniferum* L.)

Pawan Kumar Pal<sup>1\*</sup>, Krishna Nand Maurya<sup>1</sup>, Alka Srivastava<sup>2</sup> and Sudhir Shukla<sup>1</sup>

<sup>1</sup>Department of Genetics and Plant Breeding, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA;

<sup>2</sup>Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: pawanpl229@gmail.com, krishnakhushi27@gmail.com, s\_shukla31@rediffmail.com, alkasrivastava@hotmail.com

Opium poppy (*P. somniferum* L.) is an important medicinal plant being a rich source of pharmaceutically active alkaloids viz., morphine, codeine, thebaine, narcotine and papaverine as well as protein and polyunsaturated fatty acids. The global demand of opium alkaloids and seeds are increasing constantly. The opium poppy cultivated in India are moderate in morphine (10-12%) with low percentage of codeine (1-2%), thebaine (2-3%), narcotine (8-10%) and papaverine (0-1.0%). Realizing the demand of morphine and other alkaloids, it becomes necessary to develop varieties or lines for dual purposes having high opium and seed yield. Development of high yielding varieties requires the knowledge of gene actions and interactions so as to devise a suitable breeding strategy. To meet the global demand of alkaloids and seed, an effort was done following triple test cross design involving two genotypes viz. high opium and seed yielding (NBRI-5) and a high papaverine containing mutant line (Papline) and F<sub>1</sub> of NBRI-5 x Papline as testers and 20 distinct lines of opium poppy, which were hybridized and data on various morphological and biochemical parameters were recorded and statistically analysed from the experiment comprising 60 F<sub>1</sub>s along with 23 parents grown in randomized block design (RBD) with three replications in the following year. The analysis of variance revealed highly significant differences for most of the traits except few, among treatments and between first (L<sub>1</sub>) and second (L<sub>2</sub>) parents justifying the presence of substantial amount of genetic variation in parents and hybrids. The j+1 type of epistasis were predominant over i type epistasis thus this can have unique impact

in this crop. Among additive and dominance components additive component of variance was predominant for all the traits. Thus selection of promising lines/plants based on these traits in advance generations can lead to get elite line(s).

**Key words:** Alkaloids, Epistasis, Gene actions, Heterosis.

SVIII/P-14

## Effect of Different Soils on Leaf Growth of *Jatropha*: A Biodiesel Plant

Sapna La'Verne<sup>1,2\*</sup>

<sup>1</sup>Department of Botany, University of Lucknow, Lucknow-226007, INDIA; <sup>2</sup>Residence: 13/1/33, Vikas Nagar, Lucknow, INDIA, Email: sapna.laverne@rediffmail.com.

Soil is a critical part of successful agriculture and is the original source of the nutrients in which we use to grow crops. The nutrients move from the soil into plants through absorption and translocation. Soil plays an important role in filtrating and purifying water. Nutrient cycling, water regulation and other soil functions are normal processes occurring in all ecosystems. Adequate nutrients result into healthy plants, some of them are very good source of economical important constituents. Since carbohydrates synthesis mainly takes place in leaves. It is the size of leaf which matters the nutritive and other quality of plants including that of *Jatropha curcus* plant, which is considered to be an important diesel plant.

**Key words:** *Jatropha curcus*, Plant leaves, Alluvial, Mountain, Desert, Red soil.

SVIII/P-15

## Ethnomedicinal Plants Used by the Tribals for the Treatment of Diabetes in Gajapati District of Odisha

Somani Jethi<sup>1</sup> and Kunja Bihari Satapathy<sup>2</sup>

<sup>1</sup>S.K.C.G (Auto) College, Paralakhemundi, Gajapati, Odisha, INDIA; <sup>2</sup>Centurion University of Technology and Management, Bhubaneswar, Odisha, INDIA, Email: jethi.somani@gmail.com, kbs\_bot@rediffmail.com

Being a tribal rich district of vast forest cover the use of medicinal plants as herbal healers is traditionally

rooted among the local inhabitants. Allopathic drugs having adverse effects, the use of ethnomedicinal plants parts for treating diabetes in form of infusions, decoctions and powders are in demand. An ethnobotanical survey was conducted to identify the medicinal plants being used to treat diabetes in Gajapati district of Odisha. During the survey, all the seven administrative blocks such as Paralakhemundi/Gosani, Gumma, Kashinagar, Mohana, Nuagada, Ramgiri Udaygiri and Rayagada of the district were covered and the traditional practitioners and local tribes (50-70 years age groups) belonging to Savar, Shavarlodha and Kandha were interviewed to collect information regarding the mode of administration, doses and their efficacy in treating diabetes. Over 62 medicinal plant species belonging to 42 angiospermic families were identified used for the treatment of diabetes in the district. The most frequently used plants were observed belonging to families: Fabaceae, Rutaceae and Caesalpiniaceae. According to the traditional practitioners some plants are quite effective in the management of the disease but still clinical intervention studies are required to provide evidence for a safe and effective use of plants or plant parts in the treatment of diabetes.

**Key words:** Diabetes, Ethnomedicinal, Gajapati district, Odisha, Traditional practioners, Tribal groups.

SVIII/P-16

## Defluoridation of Real Groundwater Sample using Two Step Electro-coagulation

Vishakha Gilhotra\* and Manpreet Singh Bhatti

Department of Botanical & Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: mbhatti73@gmail.com, vishgilhotra@gmail.com

In the latest report by Centre Ground Water Board (CGWB), New Delhi, there are many areas in Punjab (Amritsar, Bathinda and Tarn Taran), showing groundwater fluoride content as high as 5 mg/L. Prolonged exposure of fluoride can cause dental fluorosis and osteo-fluorosis. Thus, an effort was made to defluoridize real groundwater sample having fluoride content of 4 mg L<sup>-1</sup> collected from 200 feet tube well in Tarn Taran district (31.39555° N 74.62112° E) Punjab,

India. The health effects of fluoride exposure were also observed in local people such as mottling of teeth, abnormal tooth enamel and crippling disease indicated fluoride toxicity. Electrocoagulation employing aluminium electrodes and response surface methodology (RSM) was used for removal of fluoride from water. The effect of treatment time (3-37 min) and current density (10-40 A/m<sup>2</sup>) on fluoride removal efficiency was studied at fixed pH 7.35. Residual fluoride concentration satisfied BIS standard (< 1.5 mg L<sup>-1</sup>) at 37 min treatment time and 40 A/m<sup>2</sup> of current density with energy consumption of 1.64 KWh/m<sup>3</sup>. To make the treatment process energy efficient, two step defluoridation process was done at low current density (14 A/m<sup>2</sup>) for 37 min with the removal efficiency of 48%. In the second step, final residual fluoride concentration was <1.5 ppm with energy consumption of 0.9 KWh/m<sup>3</sup>. Negative values of zeta potential indicated the OH<sup>-</sup> surface exchange mechanism of fluoride. Furthermore, to elucidate the mechanism of defluoridation, sludge samples were characterized using X-ray diffraction analysis, Fourier transform infrared spectroscopy (FTIR) and Raman spectroscopy suggested the complex formation between aluminium hydroxide/ oxy hydroxide and fluoride. Scanning electron microscope (SEM) indicated the change in surface morphology after addition of fluoride.

**Key words:** Water Pollution, Process optimization, Electrochemical treatment, Response surface methodology (RSM), Aluminium electrodes.

SVIII/P-17

## Prevalence and Antibiotic Susceptibility Pattern of Bacterial Isolates from the Symptomatic Urinary Tract Infection Patients

*Rajanbir Kaur\* and Rajinder Kaur*

Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, INDIA, Email: rajanbir19@yahoo.com, swab2002@yahoo.com

Urinary tract infections (UTIs) are the most prevalent bacterial infections among women of different ages. It usually involves infection of kidneys, ureters, bladder, or urethra. The upper urinary tract infection affects kidneys (pyelonephritis), while the

lower urinary tract infection affects urethra (urethritis) or the bladder (cystitis). The increased susceptibility of the females to UTIs is associated with anatomical, behavioral and physiological factors. Most of the UTIs occur due to bacterial invasion from the bowel or vaginal mucosa. Women are at high risk of infection due to shorter urethra as compared to men which provides an ideal path for invasion of uropathogens. In addition, during sexual intercourse when a diaphragm is used for contraception, and during pregnancy, due to partial stagnation of the urine from pressure on the urinary tract increases the susceptibility rate of UTIs. Strains of *Escherichia coli* are the most commonly identified microorganisms in the UTI cases. Other microbes involved are *Enterobacter*, *Enterococcus*, *Klebsiella*, *Proteus mirabilis*, *Staphylococcus aureus* etc. The UTIs were diagnosed by clean-catch midstream technique which involves the cleansing of skin and mucous membranes around the urethral opening before urination. Urine samples were collected in sterile containers and cultured using calibrated loop. The types of media used for routine culturing includes blood agar, MacConkey's agar and nutrient agar. The antibiotic susceptibility of the uropathogens was also checked using different antibiotics as per standard CLSI guidelines. The most common bacteria identified through morphological and biochemical tests were *E. Coli*, *Klebsiella*, *Enterobacter*, *Staphylococcus* etc. The increasing bacterial resistance to commonly used antibiotics emphasizes us to use them judiciously.

**Key words:** UTI; Bacterial invasion; Uropathogens; Antibiotic susceptibility, Bacterial resistance.

SVIII/P-18

## A Positive and Negative Impacts of Nanotechnology

*Amit Kumar<sup>1,3\*</sup>, Kiran Gupta<sup>1</sup>, Garima Dixit<sup>2</sup>, Sanjay Dwivedi<sup>3</sup> and Sudhakar Srivastava<sup>4</sup>*

<sup>1</sup>University of Lucknow, Lucknow-226007 INDIA; <sup>2</sup>Vivekananda Global University, Jaipur-302012 INDIA; <sup>3</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>4</sup>Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi-221005, INDIA, Email: amit\_gene@yahoo.com

Nanotechnology holds huge potentials in several fields and is envisaged as a technology to lead the way



towards sustainable environment-friendly development in the coming years. The basic theme of nanotechnology is to use particles having size in nanometer range for various applications in medical fields, cosmetics industry, and agriculture and food technologies. The benefits associated with nanotechnology include among others increase in yield and quality of produce in agriculture, improved cosmetic products and directed delivery of medicines. However, immense focus on nanotechnology in past few decades has led to its unrestricted development and consequently enormous use of nanoparticles (NPs). It is considered that NPs may pose risks to the environment and biological systems. It is also becoming evident that the size, structure and type of nanomaterials have different effects on plants and environment. Hence, long term life cycle analyses are needed to assess impacts of nanoparticles. This review presents a brief overview of various applications of nanotechnology and discusses its positive and negative aspects especially in agricultural field. The review emphasizes that future development of nanotechnology must be based on scientific evaluations of benefits and risks associated to it in long term.

**Key words:** Agricultural usage, Growth, Metal oxides, Nanotechnology, Reactive oxygen, Species.

SVIII/P-19

## **Application of Humicil for Enhancing the Soil Quality and Yield of Indian Mustard *Brassica juncea* (L.)**

**Rajan Chaurasia\***, Rama Kant Dubey and P.C. Abhilash

Institute of Environment & Sustainable Development, Banaras Hindu University, Varanasi 221005, UP, India, Email: rajan.chaurasiya92@gmail.com

Agricultural practices may influence soil fertility as they directly influence the soil biochemical processes. The largely practiced conventional farming has led to the global deterioration of arable soil. Today, organic amendments are being promoted for sustainable cropping and better soil quality. Therefore, two-year field experiments were conducted with *Brassica juncea* (L.) to examine the effect of humicil amendment on soil quality, crop growth, yield and its

nutrient contents. Humicil amended and control *B. juncea* (L.) fields were maintained at three selected agro-ecosystems (experimental sites (ES) ES1 (Varanasi), ES2 (Sultanpur) and ES3 (Gorakhpur) of eastern Uttar Pradesh, India. We reported that humicil amendment significantly improved the soil properties by 19.7, 10.4 and 12.3 % increase in moisture content and 7.4, 6.8 and 3.0% increase in cation exchange capacity in comparison to the control at ES1, ES2 and ES3 respectively. A 1.4, 1.4 and 1.5 fold increase in total organic carbon and 2.8, 2.5 and 2.1 fold increase in soil available nitrogen were recorded at ES1, ES2 and ES3 sites respectively. Moreover, humicil also improved the microbial biomass carbon at each site with highest 28.3 % increases at ES1. Under practiced field, soil enzymes showed maximum 3.1, 2.8 and 3.0 fold increase for alkaline phosphatase at ES1, ES3 and ES2 respectively followed by  $\alpha$ -glucosidase and urease activity. Among all three sites, highest 2.9 fold increase in yield were found in 75% NPK+25% humicil amended field at ES1 followed by 2.4 and 2.2 fold increase at ES3 and ES2 respectively. Humicil also enhanced crop nitrogen, phosphorus and potassium contents with maximum 46.4, 47.0 and 17.7% increase at ES1 along with the better soil sustainability indicators at each site. Thus, humicil is a promising amendment for improving the agricultural sustainability through improved soil quality, crop yield and nutritional quality of *B. juncea*.

**Key words:** Agro-ecosystems Sustainability, Crop yield, Crop nutritional quality, Humicil, Soil quality.

SVIII/P-20

## **Endolichenic Fungus: New Horizon for Biopharmaceutical Development**

**Jyotsna Chakarwari\*** and Sanjeeva Nayaka

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, Email: j.chakravorty90@gmail.com

Lichens are the result of symbiotic association between a fungal and a photosynthesising partner (alga or cyanobacteria). In addition to these mycobiont, many non obligatemicrofungi reside in lichen thalli in close relationship with the algae, Thesemicrofungi are called “endolichenic fungus” (ELF). Endolichenic fungus are diverse group of predominantly filamentous fungi that

reside asymptotically in the interior of the lichen thalli. Endolichenic fungi are akin to endophytic fungi of vascular plants in many aspects. Like the endophytic fungi they produce an array of secondary metabolites such as alkaloids, quinones, furanones, pyrones, benzopyranoids, xanthenes, terpenes, steroids, peptide and allycyclic compounds. Natural products remains a consistent source of drug leads with 40% of new chemical entities (NCE). It has become imperative to explore micro organisms for NCEs and lead –drug molecules for the drug discovery. Keeping this in view bioprospecting of micro organisms is carried out from every possible source, including extreme environments like ocean beds, geothermal vents, cold deserts etc., in search of novel strains with promising bioactivities. During past two decades it has been observed that much wealth of microbial biodiversity with novel biochemistry and secondary metabolite production resides in endophytes. So far, numerous bioactive molecules have been isolated from endophytic fungi. An important step towards tapping their potential for human welfare including drug discovery and sustainable agriculture, it is very essential to isolate endophytes from various ecological niches. Among the endophytes lichen associated fungi are unique organisms that have the potential bioactive properties including antibiotic, antioxidant, antiviral, anti-inflammatory, analgesic antipyretic, anti-proliferating and cytotoxic activities. More than 30 endolichenic fungi (ELF) have been characterized for their bioactive compounds, and over 145 novel metabolites have been described so far. Besides metabolites, simple aromatic compounds have also shown high levels of antioxidant activity that might protect against cardiovascular disease and certain cancers. Viridins are unique class of sterols that are promising bioactive compounds due to their potent inhibitory activities. Bioactive sesterterpenes identified in *Ulocladium* species not only exhibited antimicrobial but also displayed potent cytotoxic properties. Ambuic acid, isolated from *Pestalotopsis* sp. showed potential antifungal activity. Xanthoquinodins characterized from *Chaetomium melatum* exhibited strong cytotoxic property against various cancer cell lines. Recently, there has been tremendous interest in use of ELF based metabolites for natural drug

development. An immense amount of effort is still required to discover the potential of these bioactive metabolite producers. As rich sources of unique bioactive metabolites, therapeutic agents from ELF may represent a new horizon for the development of biopharmaceuticals.

**Key words:** Endolichenic fungus, Endophyte, Bioactive metabolite, Antimicrobial activity.

#### SVIII/P-21

### Impact of Radionuclides around Nuclear Facilities: Radio-Ecological and Public Health Approach

*Devi D. Pandey*

Centre for Science Education, (Affi. to VP, DST, Govt. of India-Delhi VP-UP-0050), Mehndawal, Sant Kabir Nagar-272171, U.P., INDIA, Email: vatsdd111@gmail.com

Current study revealed that status of environmental risk and associated risk to public and proper monitoring on the basis of Bioaccumulation and genetic toxicological approach mainly on Non-human biota e.g. Daniorerio, Channapanctatus, Dafniasp and plants mainly spirogyra and lemnamnor and major. Samples are collected from outside of facilities within 30 km. areas and radioecological studies are carried out with the help of counters mainly alpha and beta activities in samples then alpha and beta activities in given target species followed by stable and unstable element profile together by AAS, ICP,LSA etc. Tritium activities also monitored with the help of LSA for assessment of HTO, OBT and Genotoxicity profile. During operation of plant HTO evaluated particularly CANDU Reactors. Activities are under limit and exposure to public as per as norms given by IAEA, AERB etc. bioaccumulation studies show high beta activities because of hyper accumulating species like daphnia. MN assay also carried out over Channa spp., rarely observed because of high tolerant species due to stress.

**Key words:** Bioaccumulation, *Channa* spp., MN Assay, AAS, ICP, Beta activities, Radioecology.

SVIII/P-22

## Crude Herbal Medicines for Treatment of Infectious Disease and Encephalitis

*Akhilesh Kumar Singh<sup>1</sup>, Janmejay Singh<sup>1</sup>, V.K. Patel<sup>1</sup>, V.K. Mishra<sup>1</sup>, V.S. Singh<sup>1</sup> and D.K. Purushottam<sup>2</sup>*

<sup>1</sup>Science Educational Welfare Society, Paidleganj, Gorakhpur, U.P., INDIA; <sup>2</sup>CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: akhilesh.nbri@gmail.com

Herbs have been used as medical treatments since the beginning of civilization and some derivatives (eg, aspirin, reserpine, and digitalis) have become mainstays of human pharmacotherapy. Many hundreds of plants worldwide are used in traditional medicine as treatments for bacterial, viral and fungal infections and Encephalitis. The herbal medicine used against Viral, Bacterial, Fungal and Encephalitis like Tuberculosis, Whooping cough, Influenza, Meangitis, Typhoid, Pneumonia, Diarrhoea, Dehydration, Translities, Malaria, Dengue and Malnutrition disease etc. Some of these have also been subjected to in vitro screening but the efficacy of such herbal medicines has seldom been rigorously tested in controlled clinical trials. Conventional drugs usually provide effective therapy for these infections but there is an increasing problem of resistance and a continuing need for new solutions. Although natural products are not necessarily safer than synthetic antibiotics, some patients prefer to use herbal medicines. The primary goal of the study to evaluate the role of 17 Indian Ayurvedic medicinal plants in the treatment of infection disease (Viral, Bacterial, Fungal and encephalitis) and) by increase the immunity of the children. Crude extract of different parts of plants (17), almost every part of these created with some medicinal properties and employed in traditional Ayurvedic system of natural therapy. Initially, we select the herbal medicinal plant on the basis of anti-bacterial, anti-viral and anti-fungal properties with no side effects, which is previously reported in-vitro analysis. This herbal medicine (17 plants crude extract) was tasted on different people about 2000 persons throughout the state and 6 years follow-up. The dose was decided on the basis of age and height-weight. The dose of the

herbal medicine in children was 250 mg - 1000 mg (age 3-14 years) thrice a day along with honey and in adult 1000 mg - 2000 mg twice/thrice a day for 3-5 days. This herbal medicine (17 plants crude extract) is very effective for the treatments of bacterial, viral and fungal infections and Encephalitis. Moreover, these medicines are able to resist the bacterial, viral and fungal infections by increasing the immunity in pediatrics and adults. There were no toxicity of these herbal medicine. These herbal medicine (17 plants crude extract) were effectively cured the bacterial, viral and fungal infections and Encephalitis and also increase the immunity to minimize and prolong the repletion of these types of infection.

**Keywords:** Herbal medicine, Immunity, Infectious disease, Ayurvedic system.

SVIII/P-23

## Invasive plants as a remedy for Gynecological disorders in Madhya Pradesh

*Vedika Gupta and Vijay V. Wagh*

Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA., Email:rimjhimgupta95@gmail.com

Like the world, India is also struggling with issues of plant invasion as it is known to be the second worst threat and Madhya Pradesh doesn't remain untouched. Madhya Pradesh is blessed with rich flora and ethnic community and these ethnic communities are totally dependent on the forest resources for their livelihood. Invasive Alien plant Species plays a great role in primary health care of the different tribal communities of the Madhya Pradesh. These tribal people consult the traditional healers (vaidhya, ojhas) as they have commendable knowledge of herbs. With the help of various published literature like research papers, flora and various journal gynecological disorders such as dysmenorrhea, amenorrhea, leucorrhea, gonorrhoea etc. occupied the top position which can be treated with the help of herbal formulations. Total 27 plant species are found to be utilized for this purpose. Leaves are the most preferred plant part for the preparation of the formulation. Ethnopharmacological screening of such

potential sources can lead to the discovery of some novel phytomolecules which can be of great use of mankind.

**Keywords:** Invasive Alien Species, Tribal Communities, Madhya Pradesh, Gynecological disorders, Ethnopharmacology.

SVIII/P-24

## **Organic Farming: A Scientific Approach for Sustainable Agriculture in Rainfed Hill Conditions of North-Eastern Hill region**

*A.N. Tripathi<sup>1\*</sup>, Hage Munth<sup>1</sup>, A.K. Tripathi<sup>2</sup> and N.K. Mishra<sup>3</sup>*

<sup>1</sup>Krishi Vigyan Kendra, Yachuli, Lower Subansiri Distt.-791120, Arunachal Pradesh, INDIA; <sup>2</sup>ICAR-ATARI Zone-VI Guwahati, Assam, INDIA; <sup>3</sup>Krishi Vigyan Kendra, Dirang, West Kameng Distt.-790101, Arunachal Pradesh, INDIA

Organic farming is a wholistic production management system which completely excludes the use of chemicals and largely depends upon the living ecological processes, biodiversity and biological cycles adopted to the local conditions and ultimately sustains the health of soil, ecosystem as well as human being. Traditional farming was original type of agriculture and has been practiced for thousands of years. Organic agriculture has a large potential in India because India has large geographical and arable area with a wide variety of agro-climatic zones and two-third of the parable area is rainfed. The demand of organic produce from the global market can provide premium prices because the demand is growing rapidly and supply is still behind and by virtue of this, India can take advantage of this situation. In spite of that, there are some limitations of organic farming and to overcome the issues & limitations of organic farming the ministry of agriculture should introduce favorable government policies and strategies for the promotion of organic agriculture by way of providing assistance to farmers who want to convert their lands to organic farming, increasing the investment or research inorganic agriculture, strengthening of links between the government, private sectors and NGOs, awareness campaigns, support structures for small farmers group certification, establishment of monthly information

bulletin on local and International prices etc. The promotion of organic agricultures is directly concerned with its principles of health, ecology, fairness & care and for promoting organic agriculture in the country niche are and niche crops are to be identified and demand driven crops should be taken. Besides this, for the benefit of farmers there is a need of main streaming the organic agriculture as a sustainable alternative production system approach and long term studies in different agro-ecological regions for strengthening the data support system in terms of productivity, soil health and quality.

**Key words:** Organic Farming, Global market, agriculture, North-Eastern Hill region

SVIII/P-25

## **The Tree Bean *Parkia roxburghii*: An Underutilised Legume with Potential to Provide Food Security**

*Shafquat Fakhrah, Arpit Chauhan, Rayees Ahmad Lone, Sagar Prasad Nayak, Kunwar Sarvendra, Debashish Sahu and Chandra Sekhar Mohanty\**

Genetics and Plant Molecular Biology Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: shafquatfakhrah@gmail.com, arpit12191@gmail.com, isaarhyder18@gmail.com, sagar.nayak51@gmail.com, sarvendrkr88@gmail.com, sekhar\_cm2002@rediffmail.com

*Parkia roxburghii* is ethnobotanically very important among the ethnic natives of north-eastern states Like Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Being a highly nutritive with medicinal properties, it is not in the mainstream cultivation practices. This vegetable is reported to have specific smell due to the presence of thioproline (thiazolidine 4-carboxylic acid) apart from condensed tannin which is not reported yet. This compound is known to be formed non-enzymatically by condensation of formaldehyde with L-cysteine, this compound has plenty of favorable contributions in its significance record. GC-MS analysis of the plant seeds show the presence of some compounds which are biologically active and plays important role in growth and metabolism. Inductively coupled plasma mass spectroscopy (ICP-MS) data also reports the presence

of heavy metals. Copper is present in higher concentration followed by Zinc. Absence of Arsenic and Cadmium shows less threat of this plant to human consumption.

**Key words:** *Parkia roxburghii*, Thioproline, Condensed tannin, GC-MS analysis.

SVIII/P-26

## Assessment of Sensitivities among 11 Wheat Cultivars Towards Ambient Ozone by Application of Ethylenediurea (EDU) in Natural Field Conditions

**Baisakhi Majumder<sup>1,2\*</sup>, Ashutosh K. Pandey<sup>1</sup>, Elina Oksanen<sup>3</sup>, Tapan K. Nailwal<sup>2</sup> and Vivek Pandey<sup>1</sup>**

<sup>1</sup>Plant Ecology and Climate Change Science Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Department of Biotechnology, Kumaun University, Bhimtal Campus, Bhimtal-263136, Uttarakhand, INDIA; <sup>3</sup>University of Eastern Finland, Department of Biology, POB 111, 80101 Joensuu, FINLAND, Email: baisakhi.nbri12@gmail.com

Prevailing ambient ozone in India is sufficiently high to affect the agriculture productivity hence a great threat to food security and agro-economy. Wheat is 2<sup>nd</sup> most important food crop for Indian population and sensitive to ozone. Chemical ethylenediurea (EDU) protect plants specifically against O<sub>3</sub> stress and has been utilized in the natural field conditions as a phytomonitoring agent for assessment of sensitivity and yield losses in various crops and their genotypes. Present study involves screening of 11 cultivars of wheat (*Triticum aestivum*) for ozone tolerance with EDU treatment at an urban site (CSIR-NBRI) experiencing high atmospheric O<sub>3</sub>. During the study ambient O<sub>3</sub> concentration was monitored by automatic ozone monitor (2B Tech). 300 ppm of antiozonant ethylenediurea (EDU) was applied in form of foliar spray at an interval of 15 days. Biochemical parameters such as pigment content, lipid peroxidation, antioxidants and antioxidative enzymes along with yield parameters such as grain wt plant<sup>-1</sup> were measured. During the study period, average O<sub>3</sub> concentration of 8 hr ranged between 44 ppb- 64 ppb. The activities of CAT and antioxidant GSH was significantly higher at flowering stage in comparison to vegetative stage in EDU treated

wheat cultivars. Lipid peroxidation decreased in EDU treated plants at both the stages while increment in total chlorophyll and carotenoids were more prominent at flowering stage. Grain wt plant<sup>-1</sup> increased in EDU treated plants of 9 wheat cultivars. With application of linear regression statistics by taking average grain weight plant<sup>-1</sup> as the main parameter, three cultivars (PBW 502, WH 711 and DBW 17) out of eleven had higher than average grain weight plant<sup>-1</sup> with all treatment combinations and can be recommended for cultivation in areas having high O<sub>3</sub> level. This investigation concluded that EDU had protected the plants from ozone induced toxicity and also helped in monitoring the differential responses of eleven wheat cultivars.

**Key words:** Wheat, EDU, Ozone, Antioxidants, Yield.

SVIII/P-27

## Gentianaceae: Two New Species and One New Addition to Flora of India from Ladakh Trans-Himalaya, India

**Mohd Shabir<sup>1,2\*</sup>, Priyanka Agnihotri<sup>1</sup>, J.K. Tiwari<sup>2</sup> and Tariq Husain<sup>1</sup>**

<sup>1</sup>Plant Diversity, Systematics and Herbarium Division, CSIR-National Botanical Research Institute, Lucknow-226001, Uttar Pradesh, INDIA; <sup>2</sup>Plant Systematics Laboratory, Department of Botany and Microbiology, HNB Garhwal University, Srinagar Garhwal-246174, Uttarakhand, INDIA Email: shabir1610@gmail.com,

Trans-Himalaya region usually described as “High Altitude cold Desert” lies in Ladakh region in Jammu and Kashmir, Lahul, Spiti and Kinnaur in Himachal Pradesh and small portion of Uttarkashi and Chamoli districts in Uttarakhand. The total area of the cold desert in India is ca 98,660 sq.km, of which ca 82,665 sq. km (84%) area is covered by Ladakh, which lies between 32° 50’–37° 20’ N and 72° 30’–80° 15’ E and consists of two districts Leh and Kargil. The area has been surveyed during the recent botanical explorations in our ongoing revisionary studies on genus *Gentiana* L. in Indian Himalaya. As a result two new species *Gentianella tumailica* M. Shabir, P. Agnihotri, J.K. Tiwari and T. Husain, and *Gentiana pringlei* M. Shabir, P. Agnihotri, J.K. Tiwari and T. Husain, have been described as novelty from the region, the former is

named after the type locality Tumail, Kargil district of Ladakh, while the latter is named in honor of Dr. J.S Pringle, Royal Botanical Garden, Ontario, Canada, the authority of new world Gentian. In addition, *Gentiana aperta* Maximowicz, has been reported as a new distributional record to India from Ladakh, Trans-Himalaya, India. Few more discoveries and new reports from the area are in pipeline, thus, Trans-Himalayan region in India serve as a favorable habitat for Gentianaceae and a promising area of research in the family on various aspects. The stout and diminutive nature, deeply rooted, reduced stem, very small leaves are some factors, which help it to flourish in the extreme conditions of cold and harsh environment of Trans-Himalayan region.

**Key words:** Gentianaceae, Two new species, One new record, Trans-Himalaya, India

SVIII/P-28

## **Selection of *Gerbera jamesonii* Cultivars for Subtropical Floriculture through *In vitro* Regeneration of Shoots - A Laboratory to Field Study**

**Dhermendra Kumar Purshottam<sup>\*1</sup>, Ramesh Kumar Srivastava<sup>2</sup> and Pratibha Misra<sup>\*1</sup>**

<sup>1</sup>Council of Scientific and Industrial Research-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>CSIR-Central Institute of Medicinal and Aromatic Plants, Kukrail Picnic Spot Road, Lucknow, INDIA  
Email: pratibhamisra@nbri.res.in

Gerbera (*Gerbera jamesonii*, family Asteraceae) is a temperate ornamental plant. Beautiful cut flowers of this ornamental plant have high potential for floriculture industry in India due to its availability in various colors and long vase life. Natural propagation of this plant is very restricted though viable seeds. *Ex vitro* propagation through suckers /rhizome is also poor to initiate new plants on large scale. A lot of work on tissue culture of gerbera has been done but the selection of suitable cultivars growing in hotter climates, their regeneration potential and the selection of proper explants to obtain maximum shoots in minimum period is the major concern of gerbera growers. Keeping this view in mind we initiated the *in vitro* practices to

propagate gerbera for large scale production of plantlets. Seven most attractive and market valued cultivars were selected for this *in vitro* study. A high frequency shoot organogenesis has been developed from inflorescence and peduncle of *ex vitro* gerbera cultivars grown in CSIR-NBRI polyhouse. Inhibition of ex plant regeneration due to phenolic content was overcome with the addition of ascorbic acid, cysteine and insoluble PVP to the medium. The conversion pattern of floral axis to vegetative axis and the development of shoots from different florets have been discussed. Organogenic cultures were obtained in Murashige and Skoog's medium supplemented with BA and IAA. Regenerated shoots were rooted in medium without plant growth regulator and after hardening grown under net house, where they flowered. It could be inferred from this investigation that gerbera cultivars 'Dana Ellen', 'Salvador' and 'Rosaline' are the best cultivars to grow in this warm subtropical climate, as compared to 'Goliath', 'Zingaro' and 'Silvester', whereas, 'Sunway' is not performing well under field conditions.

**Key words:** Gerbera, cultivars, ex plant, floral axis, inflorescence, tissue culture

SVIII/P-29

## **Technology and Training Needs Assessment of Farm Women in West Kameng District Arunachal Pradesh**

**N.K. Mishra, T.S Mishra, A. N Tripathi and V.K Misra**

KVK West Kameng Dirang Arunachal Pradesh, INDIA; KVK Zero, Lower Subansiari Arunachal Pradesh, INDIA

Email: navneetkumarmishra123@gmail.com

The West Kameng District, comes under remote areas of Arunachal Pradesh having ample scope and opportunity in Agriculture field with very good conducive climate supportive for all type of Agriculture and horticultural crop as the district has a wide range of climate (Temperate and Sub tropical) and elevation about 250 meters at (Bhalukpong) – 4000 meters at Selapass. The most of the population of the district about 99% population is tribal among which most of them are from poor background having no any technical

Know-how for their livelihood support. In this district Women population play a significant and crucial role in agricultural production and development processes. They perform a variety of agricultural operations physically, mostly drudgery filled and manage the livestock production activities. Kitchen gardening and fish farming honey cultivation, spice cultivation, flower cultivation poultry keeping are also the exclusive jobs of women, besides home making. The role of farm women in agricultural development is substantial and their involvement in transfer of technologies is becoming more and more crucial due to the changing socio-economic environment. Therefore, it is imperative to understand the Technology and Training Needs of farm women in the transfer of farm technologies from the laboratories to the land.

**Key words:** Technology, Farm Women, Agriculture, West Kameng district.

#### Late Abstracts

### Application of Four Novel Fungal Strains to Remove Arsenic from Contaminated Water in Batch and Column Modes

*Virendra Jaiswal\* and Pankaj Kumar Srivastava*

Department of Environmental Sciences, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA, Email: virendrajaiswal3@gmail.com

Immobilized biomass of novel indigenous fungal strains FNBR\_3, FNBR\_6, FNBR\_13, and FNBR\_19 were evaluated for arsenic (As) removal from aqueous solution. Alginate beads containing 0.1 g biomass were used in a batch experiment (200 mg l<sup>-1</sup> As; pH 6). Biosorption equilibrium established in first 2 h with As adsorption (mg g<sup>-1</sup>) as 70, 68, 113 and 90 by FNBR\_3, FNBR\_6, FNBR\_13 and FNBR\_19, respectively. The equilibrium was fitted to the Langmuir model ( $r^2 = 0.90-0.97$ ). The absorption kinetic followed the pseudo second order.

Changes in the surface of fungal cells and intracellular As-uptake by fungal biomass were also confirmed by scanning electron microscopy combined with X-ray energy dispersive spectrometer. The presence of different functional groups on fungal cells

capable of As-binding was investigated by FTIR. The As-removal by immobilized fungal beads tested in the packed columns also. The As-adsorption by biomass (qe as mg g<sup>-1</sup>) were recorded as 59.5 (FNBR\_3 and FNBR\_6), 74.8 (FNBR\_13), and 66.3 (FNBR\_19) in the column and validated by Thomas model. This is the first report concerning the arsenic removal by immobilized biomass of these novel fungal strains from aqueous solution both in batch and column studies with a prospect of their further industrial application.

**Keywords:** Biosorption, Arsenic, Immobilized fungal biomass, Sodium alginate, Adsorption isotherm Kinetics.

### Application of Silica Enhanced Growth, Yield and Level of Trace Elements in Rice Grain and Reduced Arsenic Accumulation

*Dipti<sup>1,2</sup>, Sanjay Dwivedi<sup>1</sup>, Amit Kumar<sup>1,3</sup>, Seema Mishra<sup>1</sup>, Neeru Jain<sup>4</sup>, R.P. Singh<sup>2</sup>, Rudra Deo Tripathi<sup>1</sup>*

<sup>1</sup>Plant Ecology and Climate Changes Division, CSIR-National Botanical Research Institute, Lucknow-226001, INDIA; <sup>2</sup>Babasaheb Bhimrao Ambedkar University, Lucknow, INDIA; <sup>3</sup>Department of Botany, Lucknow University, Lucknow-226007, INDIA; <sup>4</sup>Privi Life Science Private Limited, Mumbai, INDIA, Email: diptira916@gmail.com

Arsenic (As), a toxic metalloid, is finding its route to human food chain through intake of As contaminated ground water as well as through the consumption of food grown on such areas having high levels of arsenic. Present study is aimed to assess the impact of commercial formulation of stabilized orthosilicic acid (OSA), the only bioavailable form of silicon (Si), in reducing accumulation of As in rice grains. Application of arsenate (As<sup>V</sup>; 10 and 50 mg L<sup>-1</sup>) and arsenite (As<sup>III</sup>; 10 and 25 mg L<sup>-1</sup>) significantly affected plant growth in dose dependant manner. Results indicated that 25 mg L<sup>-1</sup> As<sup>III</sup> and 50 mg L<sup>-1</sup> As<sup>V</sup> significantly decreased the yield attributes leading to lower yield. A significant accumulation of As in grain was observed in both As<sup>V</sup> and As<sup>III</sup> exposed plants in a dose dependent manner. Arsenic treatment had influenced the accumulation of other trace elements too in the grains. In the grains from As exposed plants a significantly lower accumulation of Zn and Co, while higher accumulation of Cu, Mn and Se was observed in comparison to

control. Application of Si enhanced the growth and yield of plants under As stress by stimulating synthesis of thiols and activities of antioxidant enzymes, and greatly reduced grain As accumulation. The level of trace elements also increased in the grains of Si treated plant in presence or absence of As. Foliar application of Si was found to be more effective in reducing grain As level than soil-Si. Results of the present study showed that application of Si in the form of OSA reduces negative impacts of As, not only in terms of economic yields but also by improved grain quality.

**Keywords:** Antioxidants, Arsenic, Orthosilicic acid, Rice, Trace element.

## Optimistic *Jatropha curcas* in India

*Hoor Fatima*

Department of Botany, University of Lucknow, Lucknow-226007, INDIA, Email: hoorfatima136@gmail.com

The worldwide effort to find a sustainable and environmental friendly alternative to today's fossil fuel dominated energy supply has already resulted in a substantial and rapidly growing demand for bio-fuels. Bio-fuels are fuels produced directly or indirectly from organic material which includes biomass of plant material and animal waste. *Jatropha curcas* is a perennial, oil-seed bearing shrub originating from Central America, and which has now been introduced to other tropical regions in Africa and Asia. It belongs to a spurge family, Euphorbiaceae. There were pronged benefits of this *Jatropha* as it would help in greening the wastelands as it can be grown on solic lands and has drought resistance, yield potential, poverty alleviation and most importantly it will improve the income and livelihood of poor farmers. Also it will reduce India's import bill on oil often referred to as liquid gold. Biodiesel, a promising substitute as an alternative fuel has gained significant attention due to the predicted shortness of conventional fuels and environmental concern. *Jatropha* is ecologically sustainable, eventually reduce the pollution burden. The utilization of liquid fuels such as biodiesel produced from the non-edible vegetable oil from *Jatropha curcas* by transesterification process represents one of the most promising options for the use of conventional fossil fuels. The *Jatropha* oil is converted into *Jatropha* oil methyl ester known as biodiesel prepared in the presence of homogeneous acid catalyst. The analysis

of different oil properties showed: percentage oil yield 32 w/w%, moisture content 0.071%, specific gravity 0.922, acid value 9.718 meg/g, peroxide value 3.56099 meg/kg, saponification value 184.11. Bio-fuel properties showed: percentage oil yield 76v/v%, moisture content 0.04%, specific gravity 0.762, acid value 1.67 meg/g, peroxide value 7.87 meg/kg, saponification value 93.50.

**Key words:** *Jatropha curcas* oil, ransesterification, Future fuel, Bio-diesel.

## Antioxidant Stress Response and Micro Nurient Content Availability in Foliar of Leguminous Varieties under eCO<sub>2</sub> Concentration

*Sonali Mehrotra*<sup>1,3\*</sup>, *Ashish Praveen*<sup>1</sup>, *K.P. Tripathi*<sup>2</sup> and *Pramod Arvind Shirke*<sup>1</sup>

<sup>1</sup>Plant Ecology and Environmental Sciences Division, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001, INDIA; <sup>2</sup>Botany Department, Dolphin (PG) Institute of Biomedical and Natural Sciences, Manduwala, Dehradun-248007, INDIA; <sup>3</sup>Life Science Department, Suddhuwala, Utrkhand Technical University, Dehradun, INDIA, Email: sonali.mehrotra412@gmail.com.

Antioxidant stress response and micro-nutrient content were determined in foliar of *Cyamopsis tetragonoloba* varieties RGC 1002 and RGC 1066 grown under elevated e[CO<sub>2</sub>] and ambient a[CO<sub>2</sub>] concentration (450±50ppm and 300±50ppm respectively) maintained in FACE setup. Antioxidant stress response including Superoxide dismutase (SOD) enzyme assay, Total Ascorbate, Ascorbate peroxidase (APX) enzyme assay, Flavanoid and Total Phenolic content (TPC) were determined in leaves sample in triplicates. Superoxide dismutase activity was found to decline in RGC 1002 [-16.63%] and RGC 1066 [-17.90%] while total ascorbate, ascorbate peroxidase activity, total phenol and flavanoid content increased in RGC 1002 [+9.37%, +6.30%, +11.53%, +10.46%] and RGC 1066 [+66.32%, +12.17%, 76.50%, +19.82%] under elevated carbon dioxide concentration in both the cultivars. Micro nutrient availability and nutritional quality were estimated including Cr, Mn, Fe, Co, Cu, Zn, As, Se, Mo and Pb. Micro nutrient content declines under e[CO<sub>2</sub>] concentration in RGC 1002 including Fe [-56.00%], Cr[-62.14%], Co[-9.11%], Cu[-23.16%], Zn[-30.61%], Se[-13.57%], Mo[-38.42%], Pb[-



49.12%] excluding Mn[+32.29%] content. However, in RGC 1066 Cu[-52.81%], Zn[-20.29%], Se[-19.00%], Mo[-31.54%], Pb[-40.21%] content declined where as Cr[+92.00%], Mn[+14.40%], Fe[+32.99%], Co[+15.30%] content was found to increased under e[CO<sub>2</sub>] concentration. Antioxidant response in both the cultivars was enhanced under elevated carbon dioxide concentration that leads to the scavenging of ROS particles thus leading to declining of ROS and mitigating the plant against abiotic stress condition. This conditions leads to altogether improvement in plant antioxidant

defences system. It was observed that the interaction between e[CO<sub>2</sub>] and both plant varieties increased uptake of micro-nutrients. Apart from these RGC 1066 varieties showed better uptake and translocation of micro-nutrient efficiency (Cr, Mn, Co, Cu, Mo) than RGC 1002 plant variety (Mo) under e[CO<sub>2</sub>] concentration. Thus, it can be concluded that RGC 1066 is better than RGC 1002 plant variety which is adapting and performing in better way under e[CO<sub>2</sub>] concentration.

**Keywords:** e[CO<sub>2</sub>], a[CO<sub>2</sub>], FACE, ROS, SOD, APX.



## **Author Index**



## Author Index

### A

Abdellaoui Med-Salah 180  
Abhilash P.C. 14, 233  
Adhikari B. 160  
Adhikari B.S. 38  
Adhikari Dibeyndu 65, 77, 106, 116, 119, 122  
Aditi 192  
Agnello Ana Carolina 174  
Agnihotri Priyanka 47, 64, 112, 237  
Agrawal Lalit 156, 182, 203, 205, 206  
Ahmad Mustaqeem 42  
Ahmad Rameez 12, 48, 108  
Ahmad Sayeed 225  
Ahmed Mahdi 159  
Ahmed Muhammad 92  
Akeel Arshiya 190  
Akhtar Umme Sarmeen 143  
Alam Md. Mahabub 181  
Albrecht Axel 8  
Alejandro G.J. 217  
Anand Vandana 95, 96, 172  
Aneja Viney P. 227  
Anil Barla 186  
Anjali 106  
Anjum Naser A. 177  
Ansari Mohammad Israil 211  
Ansari Mohd Akram 193  
Anshu 91  
Anthelme Fabien 180  
Anuprabha 53  
Apostol J. 217  
Ara Shoukat 48  
Ariyathna H.A.C.K. 84, 85  
Arkvanshi Salil Kumar 95  
Arora Naveen Kumar 73  
Arora Saroj 165

Arya Arun 228  
Arya Manoj Kumar 53  
Asthana A.K. 52, 57, 198  
Atangana Alain R. 45  
Awasthi A.K. 147  
Awasthi Amrita 108  
Awasthi Garima 205  
Awasthi S. 160  
Awasthi Surabhi 84, 144, 155, 167, 205, 206  
Ayodele A.E. 11  
**B**  
Baali-Cherif Djamel 180  
Babwane Nisa Yusuf 11  
Badgal Priya 54  
Bahadur Lal 25  
Baig Shama Afroze 62  
Baishya Ratul 18, 46  
Bajhaiya Amit K. 197  
Bajpai A. 22  
Bajpai Omesh 31  
Bajpai Rajesh 56  
Bala Anjali 110  
Baleshwar 59  
Balwant P. 163  
Banerjee Maitreyi 87  
Bangcaya P. 217  
Barik Saroj Kanta 18, 39, 77, 116, 119, 122, 123, 124, 126  
Barla Anil 142, 186  
Barua Sushmita 77  
Basnett Pooja 77  
Batish Daizy R. 42, 49, 67, 139, 145, 196  
Bauhus Jürgen 116  
Beaulieu Marie-Ève 45  
Begum Maksuda 15  
Behera M.D. 19

- Behera Mukunda Dev 46  
Behera Prashant Kumar 52  
Behera S.K. 59, 184  
Behera Soumit K. 19, 29, 30, 63  
Besnard Guillaume 180  
Bhagya M.V. 41, 50  
Bhalla Shyna 200  
Bhan Chandra 90  
Bhandari Purnima 87  
Bhardwaj Ajay Kumar 226  
Bharti Amrit 187  
Bhat Mudassir Ahmad 54  
Bhatt Anupam 41  
Bhattacharjee Parmita 111  
Bhattacharya Arpita 204  
Bhatti Manpreet Singh 231  
Bhatti Sandip Singh 164  
Bhushan Shashi 171  
Bhushan Shashi 99  
Bhutia Yangchenla 117  
Bhuyan M.H.M. Borhannuddin 181  
Binh Hoang Thi 119  
Bisht Nikita 95, 100  
Bolte Andreas 10  
Bordoloi R. 14  
Bose Bandana 10  
Bose Sutapa 142, 186, 197  
Bramhanwade K.S. 163  
**C**  
Cao Yue 80  
Castillo A. 217  
Chakarwart Jyotsna 233  
Chakrabarty Debasis 74, 83, 100, 160, 183, 212  
Chakraborty Debika 111  
Chakraborty S. 224  
Chakraborty Tamalika 10, 116, 120  
Chakravarthy P. Ashoka 86  
Chand Jai 138  
Chandel Chandresh 56  
Chander Hem 15, 51, 89  
Chandra Ram 74  
Chandrasekaran A. 109  
Charles Bipin 108  
Charles Bipin 12  
Chattopadhyay Pallavi 55  
Chattopadhyay Pinaki 55  
Chaturvedi Ashish 89, 223  
Chaturvedi Rachna 223  
Chaturvedi Vyomendra 169  
ChaturvedSalil 223  
Chaudhary L.B. 31, 59, 61  
Chaudhary Lal Babu 57  
Chaudhary Naitik 228  
Chaudhary Poonam 88  
Chaudhary Priyanka 165  
Chauhan Puneet Singh 182  
Chauhan Anju 221  
Chauhan Arpit 21, 236  
Chauhan P.S. 112  
Chauhan Priyanka 31, 94, 204  
Chauhan Puneet S. 95, 174, 203  
Chauhan Puneet Singh 94, 100, 155, 159, 173, 203, 212  
Chauhan Reshu 84, 144, 155, 160, 167, 205, 206  
Chauhan Soni 154  
Chaurasia Rajan 233  
Cheema Amandeep 194  
Chen Yanshan 80  
Cherian K.J. 145  
Chettri Arun 125  
Chiampo F. 163  
Choudhury Shamim Sultana 111  
Chowdhary Poonam 54  
Chowdhury Md. Tazul Islam 220  
Chrungoo Nikhil K. 77  
Chudhary L.B. 29, 30  
Czajkowski Tomasz 10

**D**

Dabi H. 14  
Das B. 14  
Das Suchismita 111, 134  
Das Suman 87, 88, 226  
Das Tapati 106  
Dasgupta Chitralekha Nag 92, 158  
Dasgupta Sabyasachi 120, 127  
Deeba Farah 25  
Deka Sangeeta 21  
Dermann Anna 116  
Dermann Florian 116  
Devashree 229  
Devkota Anjana 182  
Dey Daniel C. 115, 127  
Dey Mithra 219  
Dey Sumit Nath and Mithra 227  
Dhankher Om Parkash 131  
Dhanya M.S. 86  
Dhyani S. 163, 224  
Dhyani S.D. 145  
Dhyani Shalini 117  
Dikshit Anupam 229  
Dixit Garima 232  
Dixit Sonal 147  
Dixit Supriya 190  
Dixit Vijay Kant 94, 95, 100, 159, 212  
Dubey Anamika 97  
Dubey Arvind Kumar 24, 168, 172, 193  
Dubey N.K. 35  
Dubey Priya 152  
Dubey R.S. 202  
Dubey Raghvendra 208  
Dubey Rama Kant 233  
Dudhagi Shivanand Suresh 208  
Dutta Venkatesh 31  
Dwivedi Archana 207  
Dwivedi Brajesh K. 141

Dwivedi S. 160

Dwivedi Sanjay 132, 139, 144, 155, 156, 157, 158, 167, 185, 191, 205, 206, 232

**F**

Faizan Rabia 92  
Fakhrhah Shafquat 21, 236  
Falkenberg Gerald 132  
Farooq Fasuil 53  
Farooqui Anjum 16, 228  
Fassnacht Fabian Ewald 121  
Fatima Touseef 26, 93  
Fricke Annika 8  
Fujita Masayuki 181  
Funakawa Shinya 13

**G**

Gangopadhyay Debnirmalya 88, 218  
Gangwar Charu 221  
Gao Yuan 148  
Gardiner Emile S. 127  
Garg Arti 40  
Garg Neera 81, 87, 91, 187, 177, 192, 194, 198, 200, 213  
Gautam Ambedkar 168, 209  
Geetanjali Monika 96  
George V. 35  
Ghate Seemaa 138  
Ghosh Ashmita 88, 218, 226  
Ghoshal Nandita 20, 110  
Gilhotra Vishakha 231  
Giri Ved Prakash 93  
Godio A. 163  
Gogoi Anudip 17  
Gogoi R.R. 123  
Gogoi Rashmi R. 124  
Gondal Amjad Shahzad 27  
Goswami Sunayana 134  
Goyal Vinod 139, 191  
Grantz David A. 195  
Grill Erwin 7

Gulati Ashu 180

Gulzar Basit 90

Gupta Gyan Prakash 184

Gupta Ipsa 91

Gupta Kiran 168, 205, 232

Gupta Manjul 111

Gupta Meetu 177, 178

Gupta Prachi 124

Gupta Pratibha 39

Gupta R.K. 190

Gupta Reesa 57

Gupta Sangeeta 19, 124

Gupta Swati 94, 182, 203

Gupta Vartika 154

Gupta Vedika 235

Gurung Purna B. 116

Gurung Subhankar 125

## H

Hailu Zinabu 98

Halder Tanushree 77

Hamid Maroof 12, 48, 63, 108

Haq Shiekh Marifatul 63

Hasan Zaheen 164

Hasanuzzaman Mirza 181

Hassan Shadi Karbalaee 146

Hazra Alok 87

Hewavitharana N. 82

Hofman Jelle 146

Hossain Joity 38

Hossain Md. Kamal 143

Hurrah Imtiyaz Ahmad 67

Husain Danish 47

Husain Tariq 237

Husain Tariq 47, 64

## I

Ibrahim Mohd. 137

Ijiniu T.P. 35

Indoliya Yuvraj 100

Ingle Komal Kumar 166

Iram Faizia 25

Islam Tariqul 15

## J

Jacobs Douglass F. 127

Jain M.K. 29, 30

Jain Neeru 139, 191

Jaiswal Neha 152, 153, 154

Jaiswal Priya 174, 212

Jaiswal Virendra 153

Jaleel Hassan 190

Jalil Syed Uzma 211

Jamal Rushna 28

Jamir N.S. 51

Jat Hanuman Sahay 13

Jat Mangi Lal 13

Jat Raj Kumar 13

Jauhari Nitanshi 168

Jayasekera L.R. 82

Jena Satya Narayan 122, 126

Jethi Somani 231

Jha Pramod Kumar 182

Jha Suchisree 218

Joshi Babita 122, 126

Joyous T.J. 86

## K

Kadaverugu Rakesh 117

Kain Tinu Anand 188, 225

Kalra Alok 81, 99

Kamili Azra N. 79

Kamlesh 189

Kamthan Mohan 155

Kannagara S.D.P. 82

Kannaujia Rekha 28, 199

Kapoor Kulraj Singh 41

Kardel Fateme 146

Kashyap Shivani 61

Katoch Ankita 195



- Kaur Amritpreet 224  
Kaur Harmanjit 81  
Kaur Harpreet 196  
Kaur Inderpreet 144  
Kaur Ispreet 151  
Kaur Jaskirat 42  
Kaur Jasvinder 172  
Kaur Mandeep 178  
Kaur Rajanbir 232  
Kaur Rajinder 42, 165, 201, 232  
Kaushal Siddhartha 46  
Kawanami Yasuhiro 220  
Kehsay Yemene 98  
Khan Adnan 193  
Khan Athar Ali 193  
Khan B.A. 59  
Khan Bilal A. 63  
Khan Juhi 221  
Khan M. Masroor A. 190  
Khan M.L. 17, 118  
Khan Salman 16  
Khandaker Md. Maniruzzaman 15  
Khanna Vibha 179  
Kharbhi S. 123  
Khare P.K. 66  
Khare R.K. 58  
Khare Ria 183  
Kharwar R.N. 150  
Khasa Damase P. 45  
Khuroo Anzar A. 12, 48, 63, 108  
Khushwaha Meenakshi 97  
Kidwai Mohd. Kashif 189  
Kiran 122, 126  
Kirha Thejasenuo Julia 191  
Kiso Asikho 50  
Kithan N. Abenthung 51  
Kohli Ravinder Kumar 196  
Kopfmüller Jürgen 8  
Kotecha Mitul 26, 28  
Kriti 96, 169, 171  
Kulshoom Mahiya 171  
Kulshrestha U.C. 184, 195  
Kulsoom Mahiya 169  
Kumar Ajay 221  
Kumar Akash 111  
Kumar Akhilesh 60  
Kumar Amit 144, 168, 155, 157, 167, 205, 232  
Kumar Anil 194  
Kumar Ashwani 97  
Kumar Atul 221  
Kumar Chandra Mohan 110  
Kumar Gulshan 15  
Kumar Kundan 40  
Kumar Mukul 48  
Kumar Navin 168, 187  
Kumar Pardeep 229  
Kumar Ravish 78  
Kumar Sanjay 50, 51, 191  
Kumar Sanjeev 26, 93  
Kumar Sanoj 172  
Kumar Smita 183  
Kumar Subodh 207  
Kumar Susheel 203  
Kumar Vijay 66  
Kumar Vinod 107  
Kumar Vipin 29, 30  
Kumar Vishnu 157  
Kumar Vivek 141, 161  
Kumari Babita 184  
Kumari Alka 180  
Kumari Anita 191  
Kumari Arpna 201  
Kumari B. Lalitha 137  
Kumari Babita 169, 171  
Kumari Jyoti 55  
Kumari Kirti 161

- Küpper Hendrik 132  
Kushwaha Meenakshi 83  
Kushwaha S.P.S. 37  
**L**  
La'Verne Sapna 231  
Lade Suchita 65  
Lata Sneh 152, 154  
Latifi Hooman 121  
Lavana Umesh C. 7  
Lehri Alok 138, 212  
Limasenla 50  
Liu Changhong 148  
Liu Xue 148  
Liu Yungen 148  
Lockhart Brian R. 127  
Lone Rayees Ahmad 68, 236  
Lone Shabir Hassan 68  
**M**  
Ma Lena Q. 80, 131, 148  
Mahato Subbasis 120, 127  
Mahesh M.K. 133  
Maheshwari Aditi 228  
Mahishwar Anita 62  
Maji Deepamala 99  
Majumdar Arnab 142, 186, 197  
Majumder Baisakhi 237  
Mallick Shekhar 96, 155, 158, 168, 169, 171, 187, 205, 209  
Mamta 99  
Mandal Palash 218  
Manika N. 63  
Mao Ashiho A. 39  
Mapa M.H.M.M.N. 84, 85  
Marwa Naina 83, 97  
Mase Keiko 119  
Masto R.E. 222  
Mathur Jyoti 136  
Mattusch Jürgen 132  
Matzarakis Andreas 8, 120  
Maurya Krishna Nand 230  
Maurya Mridula 52  
Maurya Vivek K 209  
Mayank 165  
Meduniæ Gordana 105  
Meenakshi 199  
Mehmood Uzma 92  
Mehta Pankaj 110  
Meselhy Ahmed G. 131  
Meshram M.P. 145  
Meyer-Soylu Sarah 8  
Mir Aabid Hussain 126  
Mirsanjari Mir Mehrdad 132  
Mishra Ajay Kumar 13, 106  
Mishra Aradhana 31, 93, 94, 155, 204  
Mishra Gaurav K. 61  
Mishra K.K. 22  
Mishra Krishna 133  
Mishra Kumkum 91, 96, 205  
Mishra N.K. 236, 238  
Mishra Niranjana 184  
Mishra Nishtha 31, 94  
Mishra Richa 153  
Mishra S. 160  
Mishra Seema 132, 139, 144, 155, 156, 157, 185  
Mishra Shashank Kumar 94, 95, 100, 159, 182, 203, 212  
Mishra Shruti 29, 30, 63  
Mishra T.S. 238  
Mishra V.K. 235  
Mishra Virendra Kumar 160  
Misra P.K. 229  
Misra Pratibha 238  
Misra Sankalp 94, 95, 100, 159, 212  
Misra V.K. 238  
Mitsuyuki Chika 119  
Modi Mahendraa Jal Guru 217

Mohanty Chandra Sekhar 21, 236

Mohanty Soumya Sucharita 225

Mohsin Sayed Mohammad 181

Molpa Diksha 56

Mondal Saikat 55

Monika 189

Moniruzzaman Mohammad 143

Mudasiru O.M. 11

Mujib Abdul 90

Mukharjee Shibasis 87

Mukhopadhyay Sangeeta 222

Munth Hage 236

## N

Nagpal Avinash Kaur 42, 88, 144, 164, 178, 196, 214, 224

Nagpoore Nem Kumar 138

Nahar Kamrun 181

Nailwal Tapan K. 237

Namalie M.R. 140

Nand Sampurna 153

Narayan Shiv 27, 202, 204

Naseem Mariya 152

Nath Arindam 111

Naudiyal Niyati 125

Nautiyal Chadra Shekahar 155, 182, 203

Navlani Drishti 228

Nayak Sagar Prasad 21, 236

Nayak Sandeep Kumar 52, 66

Nayaka Sanjeeva 60, 61, 68, 92, 158, 161, 166, 229, 233

Naz Farah 27

Nazrul Islam A.K.M. 7

Ngoc Nguyen Van 119

Nisa Humeera 79

Nonato M.G. 217

Nonghuloo I.M. 123

## O

Ojha Sanjeev Kumar 155

Oksanen Elina 237

Oyama Ken 116

## P

Pal Amit 109, 140

Pal Pawan Kumar 230

Palit Debnath 55

Panda Rajendra Mohan 46

Pande Veena 23, 24, 65, 193, 194, 199, 204, 205

Pandey Abhijeet 49

Pandey Akanksha 150

Pandey Akhilesh K 202

Pandey Alok Kumar 207

Pandey Anvita 122

Pandey Ashutosh 158, 237

Pandey Deepika 221

Pandey Devi D. 234

Pandey Jitendra 31, 179

Pandey Khusboo 173

Pandey Komal 27, 204

Pandey Nalini 63, 186, 209

Pandey Puneeta 146

Pandey S.N. 163, 200

Pandey Shipra 93

Pandey Shivaraman 57

Pandey Shyam Narain 168

Pandey Sudhir Kumar 105

Pandey Swapnil 95, 100, 212

Pandey Usha 179

Pandey Vivek 23, 25, 26, 28, 30, 83, 93, 158, 193, 199, 209, 237

Panthri Medha 178

Panwar V.P. 18

Parodi Oliver 8

Parveen Zeenat 186

Parvin Khursheda 181

Patel V.K. 235

Pathak Bhawana 135

Pathak Isha 198

Pathak Promila 53

- Pathania Jyoti 51  
Pati Aparna Maitra 224  
Pati Pratap Kumar 224  
Patil Sopan 38  
Pattanayak Rojalin 210  
Paul A. 14  
Paul D. 161  
Paulose Bibin 131  
Piarali Sheila Azim 77  
Pittman Jon K. 197  
Pokharia Chitra 208  
Pradhan Srimay 52  
Prajapati Khushaboo 219  
Prajapati Sanjeev Kumar 99, 171  
Prakash Anand 22, 25  
Prakash Jyoti 98  
Prasad Bindeshwari 147  
Prasad Nami 106  
Prasad Rameshwar 57  
Prasad Vishal 26  
Prasad Vivek 199  
Praveen Afsana 136, 177  
Pujari P. 163, 224  
Pulagam Madhu Babu 211  
Purshottam Dhermendra Kumar 235, 238  
Pushpangadan P. 35
- Q**  
Qamar-ul-Islam Tayyaba 92
- R**  
Rahi T.S. 25  
Rahim Motiur 15  
Rahman Laiq-Ur 25  
Rahman Tasmilur 15  
Rai Apurva 20  
Rai Marisha 223  
Raina Riya 139  
Raj Rashmi 203  
Raj S.K. 203  
Rajput Sneha 165  
Rajwar Deepika 226  
Ramachandra T.V. 133  
Ramanan V. Venkat 106  
Ramotra Anu 110  
Rana Dipika 41  
Rana Mohit Singh 99, 171  
Rana Pawan Singh 56  
Rana T.S. 11  
Ranjan Ruma 168  
Rashid Hamide 146  
Rashid Irfan 63  
Rather Zubair A. 48, 108  
Ratti Neelima 69  
Rauf Abdul 27  
Ravisankar R. 109  
Rawat Shalu 222  
Ray Mrinal 88, 218, 226  
Reddy K. Raja 36  
Reddy Vangimalla R. 28  
Rehanuddin 112  
Reif Albert 115, 120  
Ren Wei 148  
Reshi Zafar A. 45  
Rishi Saloni 150  
Rishi Vinod 147  
Rondilla R.R. 217  
Rösch Christine 8  
Rout Jayashree 159  
Roy Aditi 149  
Roy Anirban 38  
Roy Ipsita 77
- S**  
Saddhe Ankush Ashok 40  
Saffeullah Peer 188, 225  
Safronova Irina N. 36  
Saha Somidh 8, 116, 120  
Sahoo Uttam Kumar 17, 44, 58

- Sahu Debashish 236  
Sahu Nayan 16, 63  
Sahu Vinay 52  
Saini Diwakar 108  
Saklani Pooja 56  
Sakshi 144  
Sambyal Vasudha 164  
Sanyal Indraneel 24, 172, 194, 199  
Sardemann Gerhard 8  
Sarkar Sibam 219  
Sarma Hemen 79  
Sarmah Pampi 159  
Saroy Kiran 198  
Sarvendra Kunwar 21, 236  
Satapathy Kunja Bihari 52, 66, 231  
Satyamvadaswayamprabha 76  
Saxena Gauri 57, 59, 97  
Saxena Vishal 58  
Schmerbeck Joachim 125  
Seebacher Andreas 8  
Senanayake S.P. 82  
Shaari Khozirah 218  
Shabir Mohd 237  
Shafeian Elham 121  
Shah Jasmine M. 86  
Shah Kavita 151, 169, 208, 209  
Shah Manzoor A. 45  
Sharma Alpy 49  
Sharma Amrita 213  
Sharma Anita 107  
Sharma Bhawna 221  
Sharma D.C. 149  
Sharma Damodar 43  
Sharma Himangshu 159  
Sharma Manyata 149  
Sharma Monica 96  
Sharma P. 67, 145  
Sharma Pragma 157  
Sharma Rekha 24  
Sharma Ritika 201  
Sharma S.C. 45  
Sharma Vivek Kumar 193  
Shekhar Sujata 60  
Shinjo Hitoshi 13  
Shirke Pramod Arvind 27, 202, 204, 208  
Shrestha Sushila Devi 182  
Shri Manju 83, 160  
Shrivastava J.N. 60  
Shukla Achuta Nand 44  
Shukla Anurakti 97  
Shukla Mridul Kumar 170  
Shukla Navneet 157  
Shukla Shastri Prasad 98  
Shukla Sudhir 230  
Shukla Vinod 157  
Siddiqi Tariq Omar 188  
Sijila J. 86  
Sikarwar Samiksha 222  
Sinam Geetgovind 155, 156, 169  
Singh A.K. 22  
Singh Ajeet 14  
Singh Akhilesh Kumar 235  
Singh Anjali 78  
Singh Arpita 159, 173  
Singh Ashutosh Kumar 20  
Singh Atul Kumar 92, 158  
Singh B.N. 193  
Singh Balwinder 88  
Singh D.P. 143, 147, 213  
Singh Gayatri 169, 171, 226  
Singh Geeta 112  
Singh Gурpal 131  
Singh Gurudatta 160  
Singh H.P. 42, 67, 145  
Singh Harman 196  
Singh Harminder Pal 139, 196

- Singh Harsh 65  
Singh J.S. 3  
Singh Janmejy 235  
Singh Jaswinder 164  
Singh Jay Shankar 75  
Singh Jitendra Kumar 78  
Singh Jiwan 90, 137, 222  
Singh Mukta 219  
Singh N.K. 220  
Singh Nandita 20, 83, 97, 136, 158  
Singh P.K. 24, 160, 185, 212  
Singh P.N. 229  
Singh Poonam C. 26, 91, 93  
Singh Pradyumna Kumar 155  
Singh Prashant 146  
Singh Pratiksha 30  
Singh Prem 122  
Singh Prem Prakash 116, 119  
Singh Priyanka 109  
Singh R. 213  
Singh Rachna 31  
Singh Ranjan 143  
Singh S.N. 168, 229  
Singh Satyendra Pratap 204  
Singh Shardendu K. 28  
Singh Shiv Naresh 63  
Singh Soibam Lanabir 17, 44, 58  
Singh Suman 99  
Singh Suman B. 151  
Singh Tanuja 55, 76, 78  
Singh V.S. 235  
Singh Vandana 138  
Singh Vinayak 21  
Singh Vineet 64  
Singh Vishal 122  
Singha L.B. 17, 21  
Singha R.K. Nilasana 39  
Sinha Alok Krishna 73  
Sinha Kumari Nutan 55  
Sivaranjani S. 18  
Soni Priyanka 110  
Soodan Amarjit Singh 54, 135  
Srikrishna Saripella 187  
Srivastav Anubha 49  
Srivastava Abhai K 64  
Srivastava Alka 168  
Srivastava Alka 166, 202, 230  
Srivastava Anjali 24  
Srivastava Ashish Kumar 197  
Srivastava Nitisha 44  
Srivastava P.K. 160  
Srivastava Pankaj Kumar 91, 108, 111, 149, 150, 151, 152, 153, 154, 171, 172  
Srivastava Ramesh Kumar 238  
Srivastava Ravi Prakash 59  
Srivastava Sonal 95, 172  
Srivastava Suchi 95, 96, 167, 172  
Srivastava Sudhakar 80, 97, 142, 167, 170, 186, 197, 206, 211, 232  
Srivastava Sunil Kumar 220  
Stähler Bernd 8  
Stanturf John A. 127  
Strijk Joeri Sergej 119  
Suchiang B.R. 123  
Sudarshan P. 133  
Sudhakar Ruben 171  
Suman Sonal 76  
Sun Dan 80  
Suprasanna P. 197  
Surabhi 23  
Suyama Yoshihisa 119  
Swain Priyabrata 210  
**T**  
Tagane Shuichiro 119  
Taigor Sita Ram 156  
Tali Jungla 191

- Tamta S. 59  
Tan C. 217  
Tan M. 217  
Tandon Ashmita 91  
Taneja Lisha 165  
Tarun 19  
Taunk Rohit 228  
Tayung Kumanand 225  
Tewari Ashish 30  
Tewari D.D. 164  
Tewari Lalit Mohan 202  
Tewari Rajesh K. 142  
Tewari Sri Krishna 112, 155  
Thadani Rajesh 122  
Thakkar Vidhatri 228  
Thakur Monika 89  
Thapa Namita 123  
Thomas Binoy T. 41, 50  
Thomas V.P. 41, 50  
Tiwari Avinash 67  
Tiwari Gopal Ji 122, 126  
Tiwari J.K. 237  
Tiwari K.K. 162, 173  
Tiwari O.N. 75  
Tiwari Poonam 100  
Tiwary Raghuvar 119  
Todaria N.P. 120, 127  
Tomar Anita 49  
Toppo Kiran 60, 68, 92, 158  
Toyama Hironori 119  
Tripathi A.K. 236  
Tripathi A.N. 236, 238  
Tripathi Anamika 221  
Tripathi Arpita 99  
Tripathi Ashutosh 93  
Tripathi Om Prakash 14, 21, 17  
Tripathi Pratibha 81  
Tripathi Preeti 84  
Tripathi Rudra Deo 81, 83, 84, 132, 139, 144, 150, 155, 156, 157, 160, 167, 183, 185, 191, 205, 206, 212  
Tripathi R.S. 17, 118  
Tripathi Sanjoli 163, 200  
Tripathi Shailja 64  
Tripathi Sunil 108  
Trivedi A.K. 22  
Trivedi Anjali 228  
Trivedi Prabodh Kumar 83, 160, 183  
Tuli R. 19  
Tyagi Nidhi 170
- U**  
Uadav Udit 91  
Uddin Moin 190  
Umar Shahid 188, 225  
Uniyal Sanjay Kumar 42, 49  
Upadhaya K. 123, 124  
Upadhaya Krishna 126  
Upadhyay A.K. 213  
Upadhyay Atul Kumar 143  
Upadhyay Munish Kumar 142, 186, 197  
Uppadhyay Vindhreshwari 166  
Upreti D.K. 56, 61, 166  
Upreti Priyanka 202
- V**  
Vajpayee Poornima 99, 183, 207  
Varshney C.K. 3  
Varshney Garima 221  
Verma Ashok K. 202  
Verma Isha 26, 93  
Verma Lata 137  
Verma Laxmi 186  
Verma P. 160  
Verma Pratibha 31, 94, 204  
Verma Praveen C. 202  
Verma Preeti 24  
Verma R.K. 59  
Verma S.K. 150

Verma Sonam 166

Verma Sushma 60, 68

Vijayan Deepu 39

**W**

Wagh Vijay Vishnu 47, 59, 67, 68, 235

Waitz Colette 8

Wani Gowher A. 45

Weerasinghe P.R. 84, 85

Weerasinghe T.K. 140

**Y**

Yadav Amita 179

Yadav Anju 99

Yadav B.C. 222

Yadav Hemant Kumar 65

Yadav Poonam 211

Yadav Saurabh 85

Yadav Sumit 155

Yadav Udit 26

Yadav Vineeta 108

Yahara Tetsukazu 119

Yan Wang 148

**Z**

Zaidi Jamshed 140

Zargar Mohmad Arief 12





# INTERNATIONAL SOCIETY OF ENVIRONMENTAL BOTANISTS (ISEB)



## EXECUTIVE BODY

President  
Prof. S.K. Barik  
(Director, CSIR-NBRI, Lucknow)

### Vice-Presidents

Dr. S.C. Sharma  
(Lucknow)

Prof. Mohammad Yunus  
(Rampur)

Prof. Muhammad Iqbal  
(New Delhi)

Secretary  
Dr. K.J. Ahmad (Lucknow)

Additional Secretary  
Dr. R.D. Tripathi (Lucknow)

### Joint Secretaries

Dr. Nandita Singh (Lucknow)

Dr. Vivek Pandey (Lucknow)

Treasurer  
Dr. D.K. Upreti (Lucknow)

### Councilors

Prof. Madhoolika Agrawal (Varanasi)  
Prof. Arun Arya (Vadodra)  
Dr. H.M. Behl (Lucknow)  
Dr. Tariq Husain (Lucknow)

Dr. Kamla Kulshreshtha (Lucknow)  
Dr. U.N. Rai (Lucknow)  
Prof. Y.K. Sharma (Lucknow)  
Prof. Rana Pratap Singh (Lucknow)

### Advisors

Prof. J.N.B. Bell (U.K.)  
Prof. C.R. Bhatia (Mumbai)  
Prof. R.K. Kohli (Bathinda)  
Dr. P.V. Sane (Lucknow)  
Prof. P.K. Seth (Lucknow)

Dr. B.P. Singh (Lucknow)  
Prof. R.S. Tripathi (Lucknow)  
Prof. C.K. Varshney (New Delhi)  
Prof. H.N. Verma (Jaipur)

Convener (Environmental Awareness Programme)  
Ms. Kanti Srivastava (Lucknow)

Editor (International Journal of Plant and Environment)  
Dr. R.D. Tripathi (Lucknow)  
Chief Editor

Editors (Environews)

Dr. K.J. Ahmad  
(Lucknow)

Prof. R.S. Tripathi  
(Lucknow)

Dr. Nandita Singh  
(Lucknow)

Contact for Membership of Society:  
Secretary

International Society of Environmental Botanists  
CSIR-National Botanical Research Institute, Lucknow-226001, India  
Phone (Off.): (+91)522-2297821; Mob.: (+91)9935870145  
Email: [isebnbrilko@gmail.com](mailto:isebnbrilko@gmail.com); Website: [www.isebindia.com](http://www.isebindia.com)



# ICPEP-6 Sixth International Conference on Plants & Environmental Pollution 27-30 November 2018



## Sponsors



**Council of Scientific and Industrial Research, New Delhi**



**International Union of Biological Sciences (IUBS), Paris**



**International Union of Forest Research Organizations (IUFRO), Vienna**



**Indian National Science Academy, New Delhi**



**National Biodiversity Authority, India**



**Indian Council of Agricultural Research, New Delhi**



**Department of Biotechnology, Government of India,  
New Delhi**



**Department of Science & Technology,  
Government of India, New Delhi**



**National Bank for Agriculture and Rural Development (NABARD), Mumbai**



**State Bank of India**



**Council of Science & Technology, U.P., Lucknow  
(Department of Science and Technology, Govt. of U.P.)**



**forests**

**Forests-Open Access Journal of Forestry, Switzerland**