

## School of Basic Sciences



**Dr. Amit Chatree**  
School Research Coordinator

The School of Basic Sciences of SHIATS, consists of the Department of Biological Sciences, Department of Physics, Department of Chemistry and Department of Mathematics and Statistics. At present the school is offering the following undergraduate programs. B.Sc. (PMCS), B.Sc. (PMS), B.Sc. (PCB), B.Sc. (PCZ), B.Sc. (ZBC), B.Sc. (LSCFS) The post graduate programmes sired are M.Phil. (Physics) and M.Phil. (Chemistry) M.Phil. (Botany) The M.Sc. (Physics) M.Sc. (Botany), M.Sc. (Chemistry) M.Sc. (Polymer Chemistry). M.Sc. and Ph.D. students other school are given guidance depending upon their requirements.

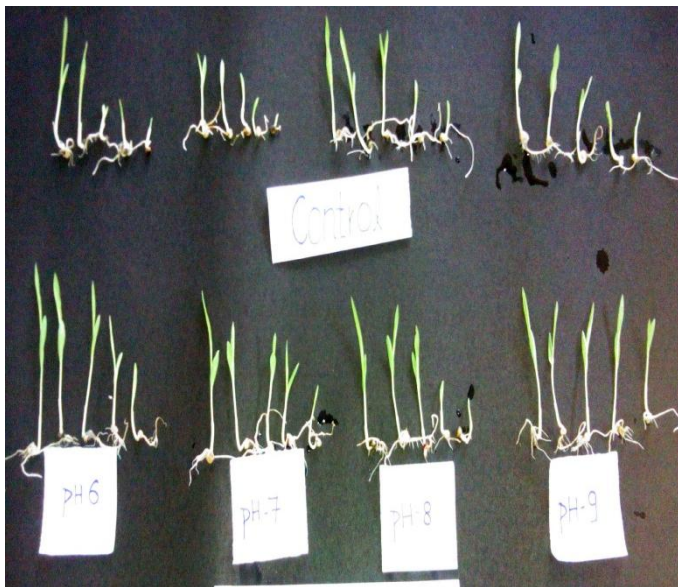
The Department of Biological Sciences is one of the oldest and the most active department of the School of Basic Sciences. Laboratories provide extensive student experience with living organisms and experimental equipments. The Laboratories in the department of Biological Sciences are well equipped with almost all necessary equipments including Spectrophotometers, Flame Photometer, Electrophoresis units, UV Irradiation chambers/units, Culture room, digital pH meters, autoclaves, centrifuges, incubators, shakers, apart from other minor equipments and instruments needed to carry out researches in the thrust areas. Major thrust areas of research of the department are Bioprospecting of Cyanobacteria, Stress Physiology, Population Genetics, Plant-Microbe Interaction, Microbial Enzymes and Bioremediation.

### **Biological Science**

#### **Amelioration of salinity and pH stress by salt and pH-tolerant plant growth-promoting rhizobacteria (PGPR)**

Soil salinity and extreme pH are major limiting factor to productivity of crops grown in arid and semi-arid regions. Plants subjected to stress conditions produce highly reactive oxygen species and can seriously disrupt normal metabolism through oxidative damage to macromolecules. Strategies that have been employed to improve crop production under stress conditions includes development of stress tolerant genotypes and improved irrigation and drainage practices which are very costly. An alternative strategy to ameliorate stress could, therefore, be application of novel plant growth promoting rhizobacteria (PGPR).

Sixty five novel bacterial strains tolerant to 20% salinity, pH range of 5-9 and heavy metals bearing plant growth promoting (PGP) traits such as production of ammonia, HCN, indole acetic acid (IAA), 1-aminocyclopropane-1-carboxylate deaminase (ACCD), siderophore and phosphate solubilizing ability are isolated from Organic Farm. Their inoculation to seeds of rice (variety Sahbhagi), Pearl Millet, Finger Millet, Normal sorghum and maize (varieties Navjyot and SHIATS) induced enhanced seed germination (20-60%) and significant ( $p < 0.01 - 0.001$ ) elongation of root and shoot under both salinity and pH stress. The results suggest their potential in ameliorating salinity and pH stress in sustainable crop production technology.



Millets



Rice



Maize



Wheat - SHIATS DW3

**Phytoremediation of Sewage Water and it's effect on different crops**





**Reclamation of soil through Medicinal plants and Roots Vegetable plants**



**Plantation and Rehabilitation of waste land**



**Karanj (Usar)**

**Karanj (Usar)**

**Krongha (Usar)**

**Krongha (Usar)**



**Karanj (Rocky)**

**Karanj (Rocky)**

**Aonla (Rocky)**

**Aonla (Rocky)**

**Disease Management through PGPR**





**Karanj (Usar)**

**Karanj (Usar)**

**Krongdha (Usar)**

**Krongdha (Usar)**



**Karanj (Rocky)**  
**(Rocky)**

**Karanj (Rocky)**

**Aonla (Rocky)**

**Aonla**



**Soil Testing**  
**of soil**



**Medicinal plant for reclamation**

**Disease management through PGPR**





## Phytoremediation of sewage water and it's irrigation in plants



Enhancing photosynthetic health of cereal crops growing under abiotic stress conditions

Algal biodiesel potential

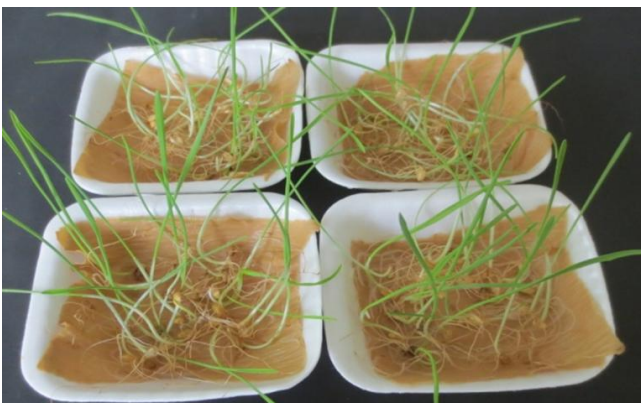
Genetic variation and phylogenetic relationship in families of carrion breeding dipteran populations *Chrysomya megacephala* (Calliphoridae) and *Sarcophaga dux* (Sarcophagidae)

The effects of the invasion of the exotic fishes in river ganga and the morphometrical evaluation of the growth of hybrids and exotics.

Food dynamics and reproduction biology of herbivorous fishes.

Endocrinology of Fishes and other vertebrates

## Amelioration of salinity and pH stress by salt and pH-tolerant plant growth-promoting rhizobacteria (PGPR)



Sixty five novel bacterial strains tolerant to 20% salinity, pH range of 5-9 and heavy metals bearing plant growth promoting (PGP) traits such as production of ammonia, HCN, indole acetic acid (IAA), 1-aminocyclopropane-1-carboxylate deaminase (ACCD), siderophore and phosphate solubilizing ability are isolated from Organic Farm. Their inoculation to seeds of rice (variety Sahbhagi), Pearl Millet, Finger Millet, Normal sorghum and maize (varieties Navjyot and SHIATS) induced enhanced seed germination (20-60%) and significant ( $p < 0.01 - 0.001$ ) elongation of root and shoot under both salinity and pH stress.

### Physics

- **Atmospheric Physics:** Work on calculating nucleation energy of aerosol particles, which are neutral and charged is in progress. This is an effort to predict proper precipitation in areas that are normally dry.
- **Astrophysics:** A modern, efficient and advanced analytical technique called 'Pade' (2,2) approximation "Techniques" to solve Linear (or non linear) form of differential equation occurring in interdisciplinary subject areas of researches (Astrophysics, Engineering, Agricultural Engineering, Flow Problems (Hydro dynamical ) Biomathematics, Biomedical sciences, etc.,) were developed which avoids lengthy and cumbersome process of numerical integrations.
- **Superconductivity:** The Green's functions were found appropriate generalization of the concept of correlation functions and work as a propagation. They are connected with evaluation of observed quantities and have well known advantages when equations are formulated and solved.

### Research Achievements:

- "Theoretical studies of Nucleation Loading to Cloud Formation"
- "Study of Polytropic Problems of Stellar Structures using Pade' Approximation Techniques".
- "Study of Oxypnictide Superconductors using Two Band Model".
- "Interplay between Magnetism and Superconductivity in High  $T_c$  Superconductors".

## **Chemistry:**

### **Projects Completed**

1. Value added products from dehydrated vegetables to combat nutritional deficiencies in rural masses., ICAR (**Dr. A.K. Gupta as Co-PI**)
2. Bioprospecting of pigment producing cyanobacteria isolated from Vindhyan range , CSIR (**Dr. Manju Gerard as Co-PI**)

### **Research Achievements:**

#### **Allele specific sequencing of Human Mu Opiate Receptor: Gene correlation with opiate abuse.**

The study aimed to delineate the frequency of C17T and A118G variants in 275 Indian subjects and to study their association with phenotype of opioid dependence, changes in cytokine and serum immunoglobulin (Ig) levels, the correlation of each with MOR genotype, modified expression of MOR in addicts and non-addicts and cloning and sequencing of MOR gene variants prevalent in India.

Out of a total of 275 enrolled subjects, 137 addicts dependent exclusively on opioid, drugs were recruited at Drug Abuse Treatment and Rehabilitation Center, Institute of Human Behaviour and Allied (IHBAS), Delhi.

A significant association has been observed with the 118G allele of MOR and no association was seen in case of C17T polymorphism with opioid dependence. The occurrence of 118G allele has also been found to correlate with the daily dose of opioids with G allele carrying individual consuming higher amounts. Significant association was observed between the 118G allele of OPRM 1 gene with the clinical diagnosis. The impact of the amounts of the drug consumed suggests that this allele is a direct risk factor of opioid dependence in Indians. The level of MCP-1 was significantly higher in users ( $p = 0.0001$ , to 6.398) and ranged from 8.95 - 80.81 pg/ml (mean 35.97 pg/ml). The mean IL - 8 level in opioid users was 15.08 pg/ml and in non users 12.13 pg/ml which was almost similar ( $p = 0.0061$ ,  $t = 2.773$ ). Significant difference in Ig levels was observed between opiate users and non-users ( $t = 2.218$ ,  $p = 0.0276$ ) bearing different MOR genotype, with the highest difference in AG genotype bearing individual ( $t = 2.95$ ,  $p = 0.0058$ ). The differences between the Ig G and Ig A levels in the addicts and non-addicts was statistically significant ( $p = 0.007$ ,  $p = 0.0051$  respectively) with a decrease observed in the circulating Ig levels in opiate users. A novel splice variant of MOR gene with partial deletion of Exon 2 and Exon 3 has been observed.



Based on the finding of was concluded that presence of 118G allele is positively associated with vulnerability for opiate addiction. Additionally, inheritance of G allele also leads to higher consumption of opiates daily. Addiction to opiates distinctly causes immuno suppression as reflected by decreased Ig G and Ig A levels and elevation of plasma MCP levels. Immunosuppression also positively correlates with the occurrence of 118 G allele. Sequence analysis of OPRM 1, PCR product revealed a novel splice variant with partial detection of Exon 2 & 3. Analysis of sequence of other cloned fragments revealed several non synonymous nucleotide changes leading either to a shift reading frame or amino acid substitution or a novel change in 5' upstream regulatory region of this gene, leading to creation of an additional binding site for EBP, a transcriptions factor known as modulate neutrophil function.

### **Morphophysiological and Molecular Characterization of Improvement of *Kalanamak*, a small medium grained scented rice.**

*Kalanamak* is one of the finest quality scented rice in India, named, due to its black husk, *kalanamak*. Realizing the potential of this cultivars and extinction rate, 40 germplasm were collected from eastern U.P. These germplasms were characterized by morpho-physiological, agronomic aspects, grain quality, diseases and insect pest susceptibility, pH and salt tolerance and molecular characterization with a view to analyze the morphological and genetic diversity, development of database, evaluation of promising germplasm and promotion for large scale cultivation by the farmers.

Thirty eight germplasm of *Kalanamak* varied widely with respect to grain characters like 100 grain weight varied from 1.22 to 1.63 g, dimensions (7 to 8 mm x 1.9 x 2.4 mm) kernel dimensions (4 to 5.6 mm x 1.5 - 2.1 mm), L/B ratio 2.1 to 3.0, cooked kernel length (8.2 to 11.4 mm), elongation ratio (1.5 to 2.7), gel consistency soft to medium, amylose content (20-31 %) and aroma (slight to strong). Some of germplasm showed moderate to high degree of resistance against diseases & pests.

The PCR amplification performed with RAPD markers to assess the level of polymorphism in 38-germplasm of *kalanamak* showed high degree of genomic similarity. There was low genetic diversity among 38 germplasm of *kalanamak*, and one closely related to group *Kola Joha* and 33 out of 38 germplasm exhibited 90% genetic similarity. The strength of this similarity is supported by three different analysis; clustering dendrogram, principal coordinate analysis and cophenetic coefficient. Most of the germplasm showed high salt and pH tolerant.

*Kalanamak* germplasm exhibited diversity with respect to different traits. This diversity was exploited to select high quality, blast resistant and / or, salinity tolerant line, which offer great promise to revive black cultivation of this historical cultivars which had reached at the verge of extinction. For improved selections like 3131 and 3216, there is great enthusiasm among the farmers and officials of native area of cultivation of *Kalanamak* i.e. district Siddhartha nagar, U.P. Two selections of *Kalanamak* 3119 and 3131 also offer great promise for cultivation in *Usar Soil*.

## **Study of the quality of water from different resources in Allahabad, used for domestic and agricultural purposes**

A number of parameters were investigated in this study both for irrigation water and for domestic water. The parameters discussed for irrigation water included pH, electrical conductivity, alkalinity, total hardness and heavy metals, while the parameters discussed for domestic water included dissolved oxygen, bio-chemical oxygen demand, chemical oxygen demand, total coliform count and heavy metals.

On examining all the parameters of surface, sewage and domestic waters, it was found that most of the sources are polluted and if not polluted, then too the levels of different parameters were found to be towards the maximum value of permissible limits. Hence, to take these water sources for domestic and agricultural purposes

It is suggested to exercise all the necessary precautions before the waters are used for public distribution system or irrigation, otherwise it may reflect in many public health problems and soil health problems. Contaminated sources should be carefully surveyed and monitored.

## **Dielectric Elastomer Actuator Based on Acrylic Rubber Modified with Silicone Rubber**

The development of novel light weight polymers which can respond to electrical stimulations so called 'electroactive polymers (EAP) paved the way for their high demand in space applications. Low mass artificial muscles in the actuators can perform specialized tasks such as collecting samples from other planets, gripper action, dust wipers etc. The application of a certain voltage across the compliant electrodes creates an electrostatic force, which compresses and stretches the elastomer film, thus converting electrical energy to mechanical one.

The study focuses on the influence of silicone rubber (SR) networks on the overall performance of acrylate rubber (AR) based dielectric actuators, Silicone rubber chains diffused in to a solvent swollen AR network were thermally crosslinked to form an interpenetrating polymer network. The presence of SR in the AR network was confirmed by various instrumental analyses such as attenuated, total reflectance-Fourier transform infrared spectroscopy, differential scanning calorimetry and thermogravimetric analysis. Maxwell stresses increased in a parabolic fashion with the applied voltage and were found to be dependant on the type of compliant electrode and SR used.

## **Influence of Phosphorus and Biofertilizer (*Rhizobium leguminosarum*) in Chickpea (*Cicer arietinum* L.) and their residual performance in Summer Maize (*Zea Mays* L.)**

The experiment was conducted during 1992-93 and 1993-94 wherein response of organic matter and Rhizobium culture was standardized in combination with four levels of Phosphorus 0,25,50,75, kg/ha

in Chickpea (*Cicer arietinum*) and their residual performance in summer maize (*Zea mays*). The experiments were conducted in factorial randomized block design with three replications. The observation revealed that Rhizobium in association in presence of organic matter have proved to be beneficial in growth and production of chickpea. Nutritive quality of produce was significantly increased. The residual nutrients in succeeding maize crop have shown positive response in enhancing the production of summer maize. However 50kg P<sub>2</sub>O<sub>5</sub> and Rhizobium with organic matter gave higher productions in both the crops.

### **Response of Sulphur and Chelated Zinc on Symbiotic nitrogen fixation on Gram (*Cicer arietinum*)**

The field experiment was conducted in consecutive Rabi seasons of year 1994-95, where four levels of Sulphur (0,20,40,60 kg/ha) and four levels of Chelated zinc (0,2,4,6kg/ha) were applied in factorial R.B.D. with three replications, nodulations and yield parameters significantly. Most suitable treatment combination of 40 kg Sulphur and 4 kg Zinc was found beneficial. The grain yield was enhanced 17.45 and 19.32% biological yield 36.55 and 35.73, protein content 17.42 and 16.26% respectively.

### **Effect of rock phosphate and organic matter on efficiency symbiotic nitrogen fixation by**

#### **Rhizobium culture in Bengal gram.**

The field experiment was conducted during the years 1993-94 and 1994-95 using three levels of organic matter (0,2.5,5 t/ha) and four levels of rock phosphate (0,30,60,90 kg/ha) in factorial RBD with three replications. The growth parameters, yield attributes, quality character and uptake of nutrient elements were studied. The result envisaged that growth of the plants in both the years had significant effect of rock phosphate and organic matter than control. The best contribution was found 2.5 t/ha organic matter and 90kg/ha of Rock phosphate. The combination of 5t/ha organic matter and 90kg rock phosphate/ha was found best in yield attributes and quality characters. Treatments had increased the uptake of Ca, P, K, Mg and Sulphur in crop plants.

### **Sufficiency of plant growth regulators (IAA & NAA) and micronutrient mixture on growth, yield and biochemical constituents of tomato (*lycopersicon esculentum*) fruits and their products**

The research trial was conducted in research field in two subsequent years 1997-98 and 1998-99 in two factorial RBD with 15 treatment combinations and three replications. Two doses of IAA and NAA were applied on 25 and 50 days of transplanting at the rate of 25 and 75 ppm along with two micronutrient mixtures (Multiplex & Humaur) on tomato cultivar Krishna

Application of 75 ppm of NAA along with 2000 ppm of humaur increased the plant growth intake early flowering and fruit setting , shelf life of fruits , ash content of fruit , total soluble solids,



ascorbic acid, sugars, K, Ca, Mg, contents in fruits as well as their products . On the other hand 75 ppm NAA and 2500 ppm multiplex enhanced fruit size, yield, attribute, caretenoid, lycopene, phosphorous, iron content in fruits and their products.

#### **Isolation, purification and characterization of $\beta$ glucosidase from *Rauwolfia* species.**

The crude alkaloids were extracted from different parts of *Rouwolfia serpentine*, *R. tetrafylta*, *R. vomitoria*. Roots and flowers have higher content of alkaloids than leaves. Isolated crude alkaloids contain Ajamaline and serpentine alkaloids 2.16-2.46%. The molecular weight of identified  $\beta$  - glucosidase had 19.5-92.3 KDa in *Rouwolfia serpentina*, 10.7-199.5 KDa in *R. vomitoria*, and 10.7 to 72.4 KDa in *R. tetraphylla*.

The activity of  $\beta$  - glucosidase was found optimum at pH 5.0 in citrate phosphate buffer. The values of  $K_m$  and  $V_{max}$  of enzymes were 1.4mm and 680 unit/ml/min respectively.

#### **Physico-chemical and Microbiological Characteristics of Sewage discharged in Yamuna River and Bioaccumulation of selected heavy metals in cucurbits.**

The characteristics of sewage water discharged in Yamuna river of Allahabad was analyzed during year 2002 - 2005 and effect of Yamuna water on heavy metal accumulation in cucurbits grown irrigated in river beds was studied. pH, electrical conductivity, dissolved solids, total alkalinity, hardness, mineral contents, chloride, nitrate, BOD, COD, total plate count, total coliform, faecal coliform, faecal streptococci, Cu, Fe, Zn, Ni, Cr, Pb were higher inspite of seasonal variations, whereas D.O, was far less than permissible limit. The bioaccumulation of heavy metals in cucurbits grown in river beds irrigated by contaminated water was not inconsiderable.

#### **Response of Streptocycline, Humaar and Multiplex on Growth, Yield and Biochemical Parameters of Tomato (*Licopersicon esculentum* mill).**

The effect of ( $M_2$ ) multiplex spray on growth (plant height, number of branches, number of fruits, fruit size, fresh weight of fruits and yield), quality and biochemical parameters including TSS, acidity, Vitamin C, sugars, Ca-oxalate and Iron was found to be superior among other concentrations of multiplex. It is likely to be most suitable and economical dose to be administered at different concentration of Streptocycline levels.

## Mathematics & Statistics

### Sponsored Research Project

- **“Bayesian Analysis of Unit Root Testing in the presence of Non-Linear Trend”** In this project the Bayesian approach for testing the stationarity of export data was used. While modeling the export data and applying Bayesian unit root tests, explore the possibility of presence of linear/nonlinear trend and structural break in the series.

The presence of outliers in the time series may have serious implications in the estimation of parameters or testing of hypothesis. The analysis of time series in the presence of outlier is not much explored using Bayesian framework. Under this scheme the issue of unit root hypothesis is dealt in Bayesian set-up and posterior odds ratio for the unit root hypothesis has been derived under appropriate prior assumptions. The stimulation study also worked out to justify the theoretical finding. The break in time trend also occurs due to the shift of trend at certain point(s), which cannot be managed by the structural break. This kind of break occurs due to the presence of outlier at changing point(s). Further work is in progress