## Group name: Plant Ecology and Environmental Science

## Group Works On:

**1. Objectives**

- Microbial degradation of oily sludge and oil spill over.
- Microbe-assisted phytoremediation of metals from fly ash.
- Biology of green house gas emission.
- Toxicity and tolerance responses of plants to metal and metalloid pollution.
- Phytoremediation of Geogenic, Urban and Industrial pollution in soil and water.
- Development of low grain arsenic rice cultivars (safe for human consumption)
- using molecular and chemical approaches.
- Identification and characterization of contrasting Arsenic accumulating rice lines

**2. Goals:**

- Development of a microbial technology for rapid degradation of oily sludge and oil contaminated soils.
- Development of bacterial consortia for enhancing phytoextraction of metals from fly ash.
- Mitigation of GHG emission from agricultural fields.
- Screening of sensitive and tolerant cultivars of selected crops suitable to be grown on metal and metalloid contaminated soil.
- Strategies for development of low grain arsenic accumulating rice cultivars.
- Phytostabilization and minimization studies of chromium containing tannery wastewater contaminated sites for safe agriculture
- Management of Ganga water pollution through development of constructed wetlands
- Biomonitoring and bioremediation of polluted soil and water resources.

**3. Competencies :**

- Biodegradation of oily sludge and oil contaminated sites.
- Microbe assisted phytoextraction of toxic metals.
- Attenuation of GHG emission from agricultural fields.
- To monitor, develop and recommend strategies for phytoremediation of metal/metalloid contaminated sites through tolerant plants/crops.

**4. Facilities:**

- HPLC-ICP-MS (coupled)
- HPLC

- Fluorescence spectrophotometer
- Gas Chromatograph
- Bioreactor
- LICOR photosynthesis system5. Highlights of Current Research:

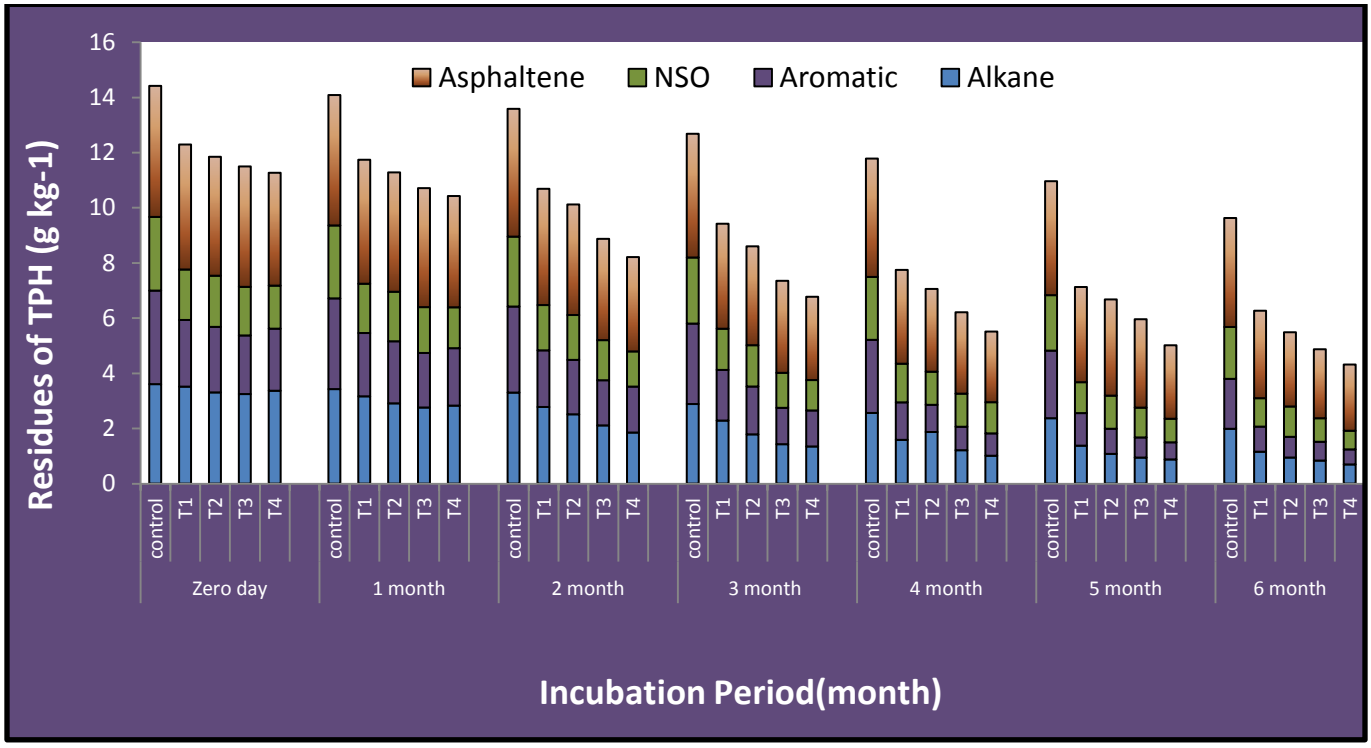


Fig 1: Degradation of different fractions of petroleum sludge by microbial consortium in soil amended with vermicompost and inorganic fertilizer during 6 months of incubation.

**6. List of Ongoing projects**:

**NBRI in house Projects**

I. INDEPTH (CSIR Network project BSC0111) till March, 2017 (email: drsn_s@rediffmail.com)

II. Studies on speciation of arsenic in contrasting lines low and high As accumulation

of rice: minimization of the translocation of As in the upper parts using phosphate,

selenium and iron. DST (Govt. of India) till Sept., 2013, Dr. SaritaSinha (E mail :

sinha_sarita52@yahoo.com)

III. Plant-based management of Ganga water pollution: Plantation along the Bank anddevelopment of constructed wetland for sewage and waste treatment : phase-I Uttaranchal funded by Ministry of Environment & Forests., Govt. of India, New Delhi Till Dec. 2013, Dr.U.N.Rai (Email: rai_un@rediffmail.com).

IV. Role of thiol and nitric oxide metabolism mediated pathways in arsenic stress in higher plants. (Indo-Spanish Joint research project). DST, Govt of India; till September, 2012; Dr. R D. Tripathi (tripathi_rd@rediffmail.com).

V. Plant based screening technologies for biomonitoring and assessment of heavy metal/metalloid pollution (CSIR Network project) till March, 2012, Dr. R D. Tripathi (tripathi_rd@rediffmail.com).

VI. Development of transgenic rice and hyperaccumulator species for arsenic contaminated (CSIR Network project). March,2012 (tripathi_rd@rediffmail.com).

**Outside Agencies like DBT/DST/MOEF Projects:**

**Areas Open for Collaboration:**

**7. Significant achievements:**

**Upto 11th five year Plan:**

- Development of microbial consortia for enhanced degradation of oily sludgeand oil contaminated sites.
- A consortium of three bacteria and two fungi was found very effective for degradation of oil sludge in a microcosmic study.
- A bacterial consortium was developed to enhance the phytoextraction of metals from fly ash.
- Several options were worked out to mitigate GHG emission from agricultural fields.
- Identification of oil yielding crop having lowest accumulation of chromium in its seeds and lesser effect on th oil yield (Fig. 1).
- Demonstration of aquatic macrophyte treatment system for tannery wastewater.

- Identified crop/vegetables safe for growing in chromium contaminated sites.
- Phytostabilization of tannery sludge dumps in order to reduce leaching by woody plants and microbial inoculation (Fig 2).
- Stabilization and transformation of chromium during composting ofphytoremediated biomass.
- Demonstration of amelioration of of toxic metal uptake by essential nutrient.
- PCA analysis of the results of Se & As in grains revealed a site specific affinity of various cultivars to categories of safety. On Chinsurah (a), the safest category A, while at Birnagar (b) except for 8 cultivars all were found grouped as category D; the most unsafe category (Fig. 3 A-C).
- Ceretophyllumdemersu, a high accumulator of As synthesized significant amount of metal binding peptides (poly □-EC) G, the phytochelatins (PCs),catalyzed by phytochelatin synthase. PC synthase gene has been cloned and characterized from C. demersum. (Fig 4).
- Rice plants (IR-64) were transformed using C. demersum PCS for developments of transgenic plant with low grain As accumulation. The lowest grain As level was found in PCS-3 rice line. Over expression of PC Synthase gene reduced the grain As concentration upto 59 % than control (41% in the grain) in PCS-3 rice line, in which most of arsenic (327%) was sequestered inroot when grown on arsenic laded soils (12 mg/kg) (Fig. 5).

**In 12$^{th}$ Five year plan :**

**8. Recent Publications:**


1. Tiwari S.,Kumari B and Singh S. N.(2008) Evaluation of metal mobility/immobilityin fly ash induced by bacteria strains isolated from the rhizospheric zone of Typhalatifolia growing on fly ash dumps. Bioresource Technology 99(5)1305-1310
2. Tiwari S., Kumari B and Singh S. N. (2008) Microbe-induced changes in metal extractability from fly ash. Chemosphere 71(7):1284-1294
3. Tyagi, L., Kumari, B. and Singh, S. N. (2010) Water management –A tool for methane mitigation from irrigated paddy fields. STOTEN 408: 1085-1090
4. Kumari, B. and Singh, S.N. (2011) Phytoremediation of metals from fly ash throughbacterial augmentation Ecotoxicology 20:166-176.

5. Kumar S, Upadhayay SK, Kumari B, Tiwari S, Singh SN, Singh PK (2011) – In vitro degradation of fluoranthene by bacteria isolated from petroleum sludge. Bioresource Technol. 102: 3709-3715.
6. Mishra, S. and Singh, S.N. Microbial degradation of n-hexadecane in mineral salt medium by degradative enzymes. Bioresource Technology 111(2012)148-154
7. Tiwari, S., Singh, S.N. and Garg, S.K. Stimulated phytoextraction of metals from fly ash by microbial interventions. Environmental Technology. iFirst (2012) 1-9.
8. Kumari, B., Singh, S.N. and Singh, D.P. 2012. Characterization of two biosurfactant producing strains in crude oil degradation. Process Biochemistry, 47(12) 2463-2471.
9. S.N. Singh, BabitaKumari, Santosh Kumar Upadhyay, Shweta Mishra, Dileep Kumar Bacterial degradation of pyrene in minimal salt medium mediated by catechol dioxygenases: Enzyme purification and molecular size determination. Bioresource Technology 133 (2013) 293–300.
10. Mishra, S., Singh, S.N., 2013. Biodegradation of benzo(a)pyrene mediated by catabolic enymes of bacteria. Int. J. Env. Sci. Tech. Doi 10.1007/s13762-013-013-03006.
11. Sinha, S., Gupta, A. K., Bhatt, K., Pandey, K. Rai, U. N. and Singh, K. P. (2006)Distribution of metals in the edible plants grown at Jajmau, Kanpur (India) receiving treated tannery wastewater : relation with physico-chemical properties of the soil. Environ. Monit. Assess. 115 (1-3) : 1-22.
12. Sinha S. and Saxena R. (2006) Effect of iron on lipid peroxidation, and enzymatic and non-enzymatic antioxidants and bacoside-A content in medicinal plant Bacopamonnieri L. Chemosphere 62: 1340-1350.8. Gupta, A. K. and Sinha, S. (2007). Phytoextraction capacity of the plants growing on tannery sludge dumping sites. Biores. Tech. 98 : 1788-1794
13. Gupta, A. and Sinha, S. (2009) Antioxidant response in sesame plants grown on industrially contaminated soil : effect on oil yield and tolerance to lipid peroxidation. Biores. Technol. 100, 179-185.

14. Mallick, S., Sinam, G., Mishra, R. K. and Sinha, S. (2010) Interactive effects of Cr and Fe treatments on plants growth, nutrition and oxidative status in Zea mays L. Ecotoxicology and Environmental Safety 73 (2010) 987–995
15. Sinha, S., Sinam, G., Mishra, R. K., Mallick, S. (2010). Metal accumulation,growth, antioxidants and oil yield of Brassica juncea L. exposed to different metals. Ecotoxicol. Environ Safety 73 : 1352-1361
16. Rai, U.N., Pandey, K., Sinha, S., Singh, A., Saxena, R. and Gupta, D.K. (2004).Revegetating fly-ash landfills with Prosopisjuliflora L.: Impact of different amendments and Rhizobium inoculation. Environmental International. 30: 293-300.
17. Rai, U. N., Dwivedi, S., Tripathi, R. D., Shukla, O.P. and Singh, N. K. (2005). Algal biomass: an economical method for removal of chromium from tannery effluent. Bull. Environ. Contam. Toxicol.75: 297-303.
18. Tewari A., Singh, R., Singh, N. K., Rai. U. N. (2008).Amelioration of municipal sludge by Pistiastratiotes L.: Role of antioxidant enzymes in detoxification of metals. Bioresource Technology 99: 87158721
19. Rai, U. N., Dubey, S., Shukla, O. P., Dwivedi, S. and Tripathi, R. D. (2008). Screening and identification of early warning algal species for metal contamination in fresh water bodies polluted from point and non-point sources. Environ. Monit. Assess. 144: 469-481.
20. Shukla, O. P., Rai, U. N. and Dubey, S. (2009). Involvement and interaction of microbial communities in the transformation and stabilization of chromium during the composting of tannery effluent treated biomass of Vallisneriaspiralis L. Bioresource Technology 100 : 2198-2203.
21. S. Dwivedi, R. D. Tripathi, P. Tripathi, A. Kumar, R. Dave, S. Mishra, R. Singh, D. Sharma, U.N. Rai, D. Chakrabartya, P.K. Trivedi, B. Adhikari, M.K. Bag, O. P. Dhankher and R. Tuli (2010). Arsenate Exposure Affects Amino Acids, Mineral Nutrient Status and Antioxidants in Rice (Oryza sativa L.) Genotypes. Environ. Scien. Technol. 44, 9542–9549.
22. Rai A., Tripathi P., Dwivedi S., Dubey S., Shri M., Kumar S., Tripathi P. K., Dave R., Kumar A., Singh R., Adhikari B., Bag M., Tripathi R. D., Trivedi P. K., Chakrabarty D., Tuli R. (2010). Arsenic tolerances in rice (Oryza sativa) have apredominant role in transcriptional

regulation of a set of genes including sulphur assimilation pathway and antioxidant system, Chemosphere, 82, 986–995.

23. Mishra, M., Tripathi, R.D., Srivastava, S., Dwivedi, S., Trivedi, P. K., Dhankher, O. P., Khare, A. (2009): Thiol metabolism play significant role during cadmium detoxification by Ceratophyllumdemersum L. Bioresou. Technol., 100, 2155-2161.
24. Tripathi, RD, Srivastava, S, Mishra, S, Singh, N, Tuli, R, Gupta, DK, Maathuis, FJM (2007). Arsenic hazards: strategies for tolerance and remediation by plants. Trend. Biotech., 25, 158-165.
25. Srivastava, S, Mishra, S, Tripathi, RD, Dwivedi, S, Trivedi, PK, Tandon, (2007).Phytochelatins and antioxidant systems respond differentially during arsenite and arsenate stress in Hydrillaverticillata (L.f.) Royle. Environ. Scien. Tech., 41, 2930-2936.

**Scientists:**

Dr. S. N. Singh (Chief Scientist)

Dr. R.D. Tripathi (Chief Scientist)

Dr. U.N. Rai (Senior Principal Scientist)

Dr. ShekharMallick (Scientist)

**Technical Staff**:

Dr. Mridul Kumar Shukla (TO)

Mrs. BabitaKumari (TA)

**Research Fellows/ Project Assistants**:

Dr. Sanjay Dwivedi Pool Scientist (CSIR)

Mr. Amit Kumar CSIR-SRF

Ms. PreetiTripathi CSIR-SRF

Mrs. SadhnaTiwari CSIR-SRF

Ms. Shweta Mishra CSIR-SRF

Ms. Garima Dixit CSIR-JRF

Mr. DheerajGautam UGC-CSIR-JRF

Mr. Jitendra Kumar Pandey UGC-CSIR-JRF

Mr. Amit Pal Singh CSIR-UGG-JRF

Ms. Sarah Binte Ali UGC-JRF

Ms. ReshuChauhan Inspire Fellow

Ms. RumaRanjanUGC-RGNF-JRF

Mr. Pradyumna Kumar Singh Project –JRF

Mr. Praveen Kumar Jaiswal Project-JRF

Mr. Arvind KumarDubey Project-JRF

Mr. NavinKumari PAII

Ms. NitanshiJauhari PAII

Ms. SurbhiAwasthi PA II

**Name of Group Leader**:

**Phone:**

**Mobile:**

**Email:**