SRCC

Scientific Reviews
&
Chemical Communications

Sci. Revs. Chem. Commun.: 2(4), 2012, 606-609
ISSN 2277-2669

ALBIZIA JULIBRISSIN : POTENTIAL PHYTOMINING PLANT FOR HAZARDOUS WASTE SITES

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(*Received : 13.10.2012; Revised : 22.10.2012; Accepted : 25.10.2012*)

ABSTRACT

Phytoremediation is an emerging technology that uses various plants to degrade, extract, contain, or immobilize contaminants from soil and water. This technology has been receiving attention lately as an innovative, cost-effective alternative to the more established treatment methods used at hazardous waste sites. Excessive heavy metal accumulation can be toxic to most plants leading to reduction in seed germination, root elongation and biomass production; inhibition of chlorophyll biosynthesis as well as disturbance in cellular metabolism and chromosome distortion. For studying the heavy metals load of sewage sludge and their effect on crop quality in relation to non applied sites, solid sludge and woody plant *Albizia julibrissin* was collected from seven STPs viz. Howrah, Garulia, Bhatpara, Nabadwip, Srirampur, Kona, Chandannager, and from the Periurban areas viz. Nadia/Chakdaha/Ektapur (N/C/E), Nadia/Chakdaha/Pumlia, Nadia/ Chakdaha/Sikarpur (N/C/S), Nadia/Chakdaha/Tatla (N/C/T). The results suggest that woody plant like *Albizia julibrissin* has more scavenging capacity for Pb and Cr and if this plant is cultivated in sites abundant with above heavy metals, this would scavenge the heavy metal toxicity from the soil.

Key words: *Albizia*, Bhatpara, Cellular, Heavy metal, Metabolism, Phytoremediation

INTRODUCTION

Degradation of natural resources is perhaps one of the gravest lapses mankind has ever made in its journey of progress and civilization. Land and water resources are worst affected and under continuous stress, both biotic and abiotic, due to anthropogenic interventions. Heavy metal contamination is of special concern due to widespread reports emanating from all over the world about various diseases and disorders in human and livestock due to metal toxicity. Due to rapid industrial development and urbanization during the last two decades in India, disposal of industrial effluents has become a serious problem. About 30 billion liters of wastewater is generated in India producing 1200 tons of sludge a day. Sewage is the main point-source pollutant on a global scale[1]. About 90-95% of the sewage produced in the world is released into the environment without any treatment[2,3].

In India, about 40% sewage and domestic wastewater is disposed off on land that contaminate the soil and aqueous stream with large quantities of toxic metals[4] and the remaining is drawn into different water bodies with or without little treatment. Concern over the possible build up of heavy metals in ground water

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resulting due to heavy land application of sewage sludge, industrial and city effluents have prompted research on the fate of these chemicals in soils. On one hand the flow of metals to ground water as their ultimate sink is continuously taking place through geogenic or anthropogenic causes, which are difficult to control and on the other hand, the obvious question which comes to our mind is how to get rid of this metal load from ground water. The issue of decontaminating ground water from metal is even more difficult to address due to strong sorption properties of metals with soil colloids and consequent long residence time of these metals in soil.

The use of specially selected and engineered metal accumulating plants for environmental clean up is an emerging frontline technology called 'phytoremediation' which describes a system wherein plants in association of soil organism can remove or transform contaminants into harmless and often valuable and adsorb pollutant, mainly metals, from water bodies and aqueous waste streams. The purpose of the present study was to investigate the phytomining efficiency of Siris (*Albizia julibrissin),* a woody plant to different heavy metals from hazardous waste sites.

EXPERIMENTAL

Methods

For studying the heavy metals load of sewage sludge and their effect on crop quality in relation to non applied sites, solid sludge and plants were collected from seven STPs in West Bengal viz. Howrah, Garulia, Bhatpara, Nabadwip, Srirampur, Kona, Chandannager and from the Periurban areas viz. Nadia/Chakdaha/Ektapur (N/C/E), Pumlia (N/C/P), Sikarpur (N/C/S), Tatla (N/C/T).

Sludge samples were taken from heaps, covering various places, in the pile of each plant, using an auger. The samples were generally not taken from the outer layer of the heap, as the material tended to be very dry in those places. About 6-10 individual samples were mixed together and one average sample was compiled for analysis.

Sludge samples were air dried grounded and sieved through 80 mesh sieve. Then the samples were stored in refrigerator after packing in polyethylene packets. Plant samples were cleaned thoroughly with 0.01 N HCl followed by distilled water. Finally the plant samples were dried at 60°C and grinded.

Total heavy metal content of sludge: 0.5 g of the processed samples were digested with di-acid mixture (HNO_3 : $HClO_4$, 9 : 4) on a hot plate[5]. The clear solutions were filtered through Whatman No. 42 filter paper and diluted to 50 ml for analysis by Atomic Absorption Spectrophotometer (GBS-902, Australia) (Table 1).

Heavy metal content in plant samples: 0.5 gram of dried sample was digested with di-acid mixture (HNO_3 : $HClO_4$, 9 : 4) on a hot plate[5], until the discoloration of solution (Table 2) (Fig. 1).

RESULTS AND DISCUSSION

The concentration of Cd, Pb, Cr and Ni in the roots of Siris plants at various STPs was 1.27, 11.75, 9.53 and < 0.05 mg Kg^{-1}, respectively (Table 2, Fig. 1). Similarly a significant accumulation of heavy metals in the sewaged woody ornamental plants like *Ficus benjamina variegate* and *Quisqualis indica* near STPs of West Bengal was reported by several workers[6-8]. The concentration of Cd, Pb, Cr and Ni in the shoots of Siris plants at STPs was estimated as 1.56, 13.77, 6.53 and < 0.05 mg Kg^{-1}, respectively. When investigation was done with shoots of woody ornamental plants other than Siris, a similar finding was noticed by other workers; the concentration of Cd, Pb, Cr and Ni in the shoots of *Bougainvillea glabra*, *Toonia ciliate*, *Croton spp.* and *Quisqualis indica* at STPs ranged from 1.02 to 1.56, 9.25 to 15.25, 1.75 to 7.95 and < 0.05 mg Kg^{-1}, respectively[9-12]. The concentration of Cd, Pb, Cr and Ni in the leaves of Siris was found to be 1.25, 10.76, 1.57 and < 0.05 mg Kg^{-1}, respectively, similar to other reports[13-15]. Overall, accumulation Pb and Cr in various parts of the plants was higher than the other heavy metals tested. Nickel had negligible concentration in plant parts. So, it can be concluded that *Siris* plant has best scavenging capacity for Pb and Cr from soils and sludges. This plant could prove best source of phytoremediation in wasteland to combat heavy metal toxicity.

Table 1: Heavy metal concentration (mg/Kg) in sludges and soils sample (Soil- Total)

Site	Cd	Pb	Cr	Ni
A	8.28	269	415	216
B	6.99	195	243	112
C	10.1	316	374	155
D	5.51	296	313	184
E	5.84	826	345	220
F	6.27	218	118	218
LSD (P = 0.05)				

Where, A = Howrah STP, B = Bhatpara STP, C = Srirampur STP, D = Nabadep STP, E = Chandannager STP, F = Garulia STP

Table 2: Heavy metals content (mg/Kg) in Albizia julibrissin

	Heavy metals contents in plant parts			
Plant parts	**Cd**	**Pb**	**Cr**	**Ni**
Root	1.27	11.75	9.53	<0.05
Shoot	1.56	13.77	6.53	<0.05
Leaf	1.25	10.76	1.57	<0.05
LSD (P = 0.05)				

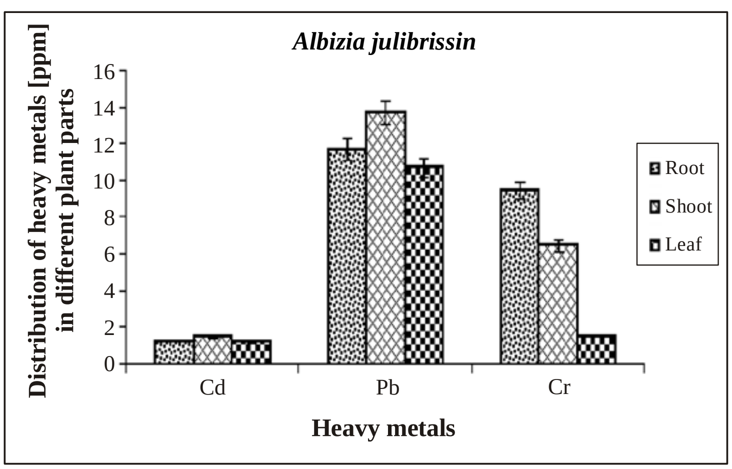

Fig. 1: Distribution of heavy metals in plant parts LSD (P = 0.05)

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