Phytoremediation of Soil Mercury and Cadmium by Weed Plants, Trianthema Portulocastrum L., Saccharum Spontaneum L. and Ipomoea Carnea Jacq.

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Abstract- Phytoremediation appears as a very promising technology for the removal of metal pollutants from the environment and at present, the technology becomes commercially applied throught the world becomes commercially throughout the world.

The success of using plants to extract metals from contaminated soils requires a better understanding of the mechanism of metal update, translocation, and accumulation by plants. The present study was conducted to find useful weed species for Cadmium (Cd) and Mercury (Hg) phytoremediation. Three species of locally available common weeds were grown for two months in pot culture with three treatment doses of Cd and Hg (5, 10 and 25 mg / kg dry weight (DW)) using $HgCl_2$ and $CdCl_2$ salts. The Cd and Hg concentrations in the dry plant biomass were determined by Atomic absorption spectrometry. The concentrations of Cd were relatively higher in *Ipomoea cornea* (38.710±0.324 mg/kg) *Trianthema portulocastrum* (6.0720±0.232 mg/kg). Higher concentrations of Hg were recorded in *Ipomea cornea* (58.150±0.247mg/kg). These results suggest that *Ipomoea cornea* and *Trianthema portulocastrum* accumulate Cd in higher concentrations and *Ipomoea cornea* also accumulate Hg significantly.

Index Terms- Mercury, Cadmium, weed and phytoremediation

I. Introduction

A major environmental concern due to dispersal of industrial and urban wastes generated by human activities is the contamination of soil. Controlled and uncontrolled disposal of waste, accidental and process spillage, mining and smelting of metaliferous ores, sewage sludge application to agricultural soils are responsible for the migration of contaminants into non – contaminated sites, as dust or leachate and contribute towards contamination of our ecosystem. As far as the impact of environmental pollution is concerned, heavy metals are known to be the most harmful, because like most organic pollutants, the metals are not biodegradable or Perishable. Heavy metals are elements having atomic weight between 63.54 and 200.59, and a specific gravity greater than 4 (Kennish, 1992).

The processes include all plant-influenced biological, chemical, and physical processes that aid in the uptake, sequestration, degradation and metabolism of contaminants, either by plants or by the free living organisms that constitute a plant's rhizosphere. Phytoremediation takes advantage of the unique and selective uptake capabilities of plant root systems, together with the translocation, bioaccumulation and contaminant storage and degradation capabilities of the entire plant body.

Phytoremediation appears as a very promising technology for the removal of metal pollutants from the environment and at present, approaches towards commercialization

Weed plants selected for phytoremediation study

Common weed plants found in Thanjavur area were taken up for this study. Among weeds growing in and around stagnant and polluted water bodies.

S. No	Species (Vernacular name)	Common Name
1	*Saccharum spontaneum* L.	Naanal
2	*Trianthema portulacastrum* L.	Sikappu Saranathi
3	*Ipomoea carnea* Jacq.	Neyveli kattamanakku

Saccharum spontaneum L.

Trianthema portulacastrum L.

Ipomoea carnea Jacq.

This experiment was conducted to identify Mercury and Cadmium accumulation of these selected plants.

Pot culture experiments

Stem cuttings of *Ipomoea carnea* Jacq. ,and uprooted *Saccharum spontaneum* L., and *Trianthema portulacastrum* L. were planted in polythene bags containing the mixture of sand, red soil and compost in the ratio of 1:1:1 and placed in earthen pots. To assess the heavy metal accumulation capacity of selected plant species were planted in pots filled with 4 kg of above soil mixture containing the heavy metals (Hg and Cd) with different concentrations (5, 10, 25 ppm). Soil mixture with heavy metals was packed in polythene bag and kept in earthen pot to prevent loss of heavy metal leaching. The experimental setup was kept in green house conditions. The mean temperature inside the green house was 34 ± 4^{o}C and humidity 70-80 RH. The plant growth parameters were recorded once in fifteen days by sacrificing three plants from each treatment group.

Plant samples were dried in a hot air oven at 60^{0}C and ground to 20 meshes using a stainless steel Wiley Mill. The ground material was digested using Nitric and Perchloric acids (3:1). The resulting solution was analyzed for metal content by (U.S EPA.1983) AAS (SHIMADZO – 7000 model) by flame method for Cd and Hydride vapor generator method for Hg in The South India Textile Research Association (SITRA), Coimbatore.

Statistical Analysis

All the data were analyzed using the multiple mean comparison test (Agres Statistical Software) and the interrelationship between parameters were assessed using ANOVA (Analysis of Variance) analysis.

Table-1: Accumulation of Hg and Cd by weed plants in pot culture

S. No	Species	Control		5ppm		10ppm		25ppm	
		Hg (mg/kg)	Cd (mg/kg)	Hg (mg/kg)	Cd (mg/kg)	Hg (mg/kg)	Cd (mg/kg)	Hg (mg/kg)	Cd (mg/kg)
1	***Saccharum spontaneum* L.**	**0.012±0.010**	**0.125±0.018**	**0.1254±0.012**	**0.564±0.023**	**0.954±0.025**	**0.8246±0.021**	**1.1500 ±0.320**	**1.348±0. 256**
2	***Ipomoea carnea* Jacq.**	**0.548±0.024**	**0.214±0.025**	**1.246±0.0542**	**2.545±0.145**	**18.654±0.142**	**12.657±0.264**	**58.150±0.24 7**	**38.710±0 .324**

3	***Trianthema portulacastrum* L.**	**0.114±0.014**	**0.102±0.012**	**0.231±0.012**	**0.854±0.241**	**0.245±0.124**	**1.498±0.214**	**0.2211±0.12**	**6.0720±0.232**

The values are Mean ± SEM, n=4, ** P < 0.01 and compared with Treatment

II. RESULTS AND DISCUSSION

Hg and Cd accumulation of *Ipomoea carnea* Jacq. , *Saccharum spontaneum* L., and *Trianthema portulacastrum* L. in Pot culture was studied

It was observed in the present study, the rate of Hg and Cd accumulation differs in selected plant species and in different concentrations in pot culture methods. Hg and Cd accumulation by *I. carnea* was comparatively higher than that in other two selected plant species in all the treated concentrations. Even in *I. carnea*, Hg accumulation was comparatively higher than Cd accumulation (Table-1) in all the concentrations used. And at 25 ppm, Hg accumulation by *I. carnea* was 58 fold more than that by other two species. Adhikari *et al.*, (2010) also revealed that *Typha angustifolia* L. and *Ipomoea carnea* L. plants showed promise for the removal of Pb from contaminated wastewater because they can accumulate high concentrations of Pb in roots. *Trianthema portulacastrum* L. accumulate 6.0720±0.232 mg/kg of Cd in T_3 treated concentration. It is Inferred that *I. carnea* was significant for Hg and Cd phytoremediation.

Similar high metal accumulation pattern was also observed in Mulberry plant for Cd and Cu (Prince et al., 2001), in tomato and *Calamus tenuis* Roxb. for Cd (Cho and Park 1999; Khan and Patra 2007; in *I. carnea* for Cd,Cr and Pb Ghosh and Sing 2005). It has been suggested by Vitoria *et al.*, (2001) and Fargasova, (2001) that amount of Cd absorbed by the plants could be elevated by inducing higher transpiration rates. Higher heavy metal accumulation.

III. CONCLUSION

Based on the present investigation it is suggested that Ipomoea carnea have better accumulation capacity for Hg phytoremediation and *Trianthema portulacastrum* L. and *I. carnea* can be used for Cd phytoremediation.Phytoremediation appers a very promising technology for the clean- up of metal pollutants from the environment.

REFERENCES

[1] Adhikari, T., Ajay kumar, K., Singh, V., and Subba rao, A., 2010. Phytoaccumulation of Lead by Selected Wetland Plant Species. Communications in Soil Science and Plant Analysis. 41:2623–2632.

[2] Cho, U., and Park., J., 1999. Distribution and phytotoxicity of cadmium in tomato seedlings. J. Plant Biol. 42 : 49-56

[3] Fargasova, A., 2001. Phytotoxic effects of Cd, Zn, Pb, Cu and Fe on Sinapsis alba L. seedlings and their accumulation in roots and shoots. Biol. Plant. 44: 471-473

[4] Kennish, M.J., 1992. Ecology of Estuaries: Anthropogenic Effects. – CRC Press, Inc., Boca Raton, FL.: pp.494.

[5] Khan, M. H., and Patra, H. K., 2007. Sodium chloride and cadmium induced oxidative stress and antioxidant response in Calamus tenuis leaves. Indian J. Plant Physiol., 12(1): 34-40

[6] Prince, S.P.M.W., Senthilkumar, P. and Subburam, V., 2001. Mulberry-silk worm food chain – A templet to assess heavy metal mobility in terrestrial ecosystem. Env. Mon. and Assess, 69: 231-238

[7] U.S. EPA., 1983. Technical support manual: Waterbody surveys and assessments for conducting use attainability analyses. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C. Volumes 1-3.

[8] Vitoria, A.P., Lea, P.J., and Azevedo, R.C., 2001. Antioxidant enzymes responses to cadmium in radish tissues. Phytochemistry 57: 701–710.

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