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Mercury and cadmium accumulation in selected weed plants: Implications for phytoremediation

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ABSTRACT

With increasing use of heavy metal by human activities, ecosystems have and are being contaminated with heavy metals. Contaminated soil can be remediated by chemical, physical or biological methods. Phytoremediation is an on-site remediation strategy that employs plants to remove non-volatile and immiscible soil contents. To enhance phytoremediation as a viable strategy, fast growing plants with high metal uptake ability and rapid biomass gain are needed. The present study was conducted to find useful weed species for Cadmium (Cd) and Mercury (Hg) phytoremediation. Seven 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 Trianthema portulocastrum (6.0720 mg/kg), Jatropha curcas (4.8990mg/kg) and Ipomoea cornea (3.0108 mg/kg). Higher concentrations of Hg were recorded in Ipomea cornea (3.1500 mg/kg) and Jatropha curcas (2.3175 mg/kg). These results suggest that Ipomoea cornea and Jatropha curcas accumulate Cd in higher concentrations and they also accumulate Hg significantly. Trianthema portulocastrum and Jatropha curcas accumulate high concentrations of Cd then Ipomoea cornea. Based on the present investigation it is suggested that Ipomoea cornea and Jatropha curcas have better accumulation capacity for Hg remediation and Trianthema portulocastrum, Jatropha curcas and Ipomoea cornea can be used Cd phytoremediation.

Key words: Mercury, Cadmium, weed and phytoremediation

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 dispersal of waste, accidental and process spillage, mining and smelting of metalliferous ores, sewage sludge application to agricultural soils are responsible for the migration of contaminants into non - contaminated sites as dust or leachate of inorganic contaminants. Some heavy metals like Cadmium, Mercury, and Chromium are lethal to human beings even at minimum concentration. Mercury and mercurial compounds are non-nutritive metals, which are hazardous to all biological organisms (Ragh et al., 1996). So heavy metal contaminated soil must be cleaned in an Ecofrindly method.

Phytoremediation

In recent years, phytoremediation, i.e., the use of plants to cleanup soils contaminated with non-volatile hydrocarbons and immobile inorganics is showing promises as a new method for in situ cleanup of large volumes of low to moderately contaminated soils. Plants can be used to remove, transfer,and stabilize heavy metal soil

contaminants (Anderson and Coats, 1994; Baker et al. 1994; Markert, 1994; Raskin et al. 1997; Saraswat and Rai, 2009; Sun et al. 2011). Current efforts now focus on expanding the phytoremediation strategy to address contaminated soils and air pollutants in an attempt to preserve the biodiversity of soil and its biota (Markert, 1994; Ono and Abe, 2007). From this remediation method, the biological properties and physical structure of the soil are maintained, and the techniques are environmentally friendly, potentially cheap, and visually unobtrusive and offer the possibility of bio-recovery of the heavy metals.

MATERIALS AND METHODS

Plant materials and Heavy metal application

For the present study seven species of locally common weeds was screened from in and around Thanjavur district. Stem cuttings of *Ipomoea cornea, Jatropha curcas* and *Jatropha tanjorensis* and uprooted *Saccharum spontaneum, Cypruss spp., Trianthema portulocastrum* and *Acalypha indica* were planted in earthen pots containing the mixture of soil, clay and compost in the ratio of 1:1:1 in earthen pots. Each pot was filled with 4kg of above soil mixture and the metal concentration of Cd and Hg 5,10 and 25 mg / kg dry weight (DW) using $HgCl_2$ and $CdCl_2$ salts. This study was carried out for a period of 30 days in green house in the Herbal Garden of Tamil University Campus, Thanjavur.

Heavy metal analysis:

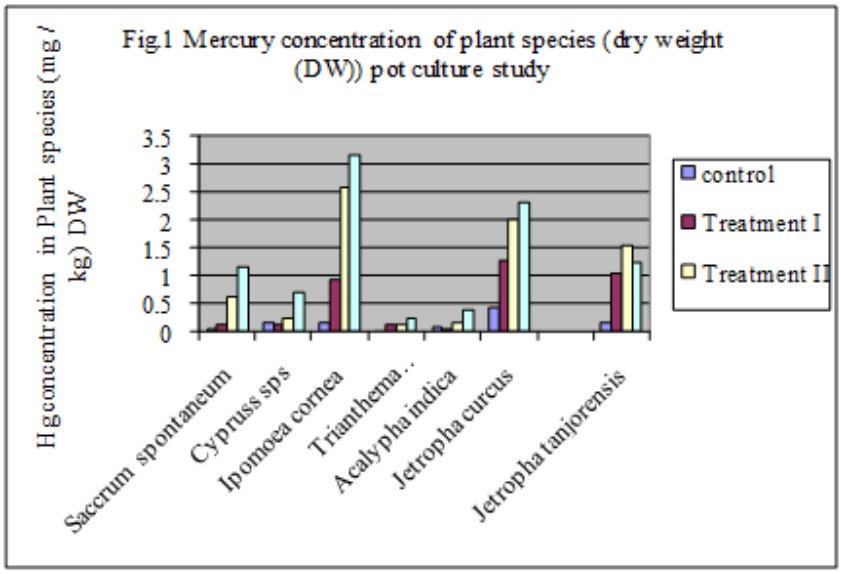
Plant tissue samples were dried in a forced air oven at 60^0C and ground to 20 meshes using a stainless steel Wiley Mill. The ground material was digested using Nitric and Perchloric acids (3:1). The resulting solution was analyzed for metal content by, The sample was diluted to 25ml and annualized for total metals by flame method for Cd and Hydride vapor generator method for Hg AAS (SHIMADZO - 7000 model) in The South India Textile Research Association (SITRA), Coimbatore.

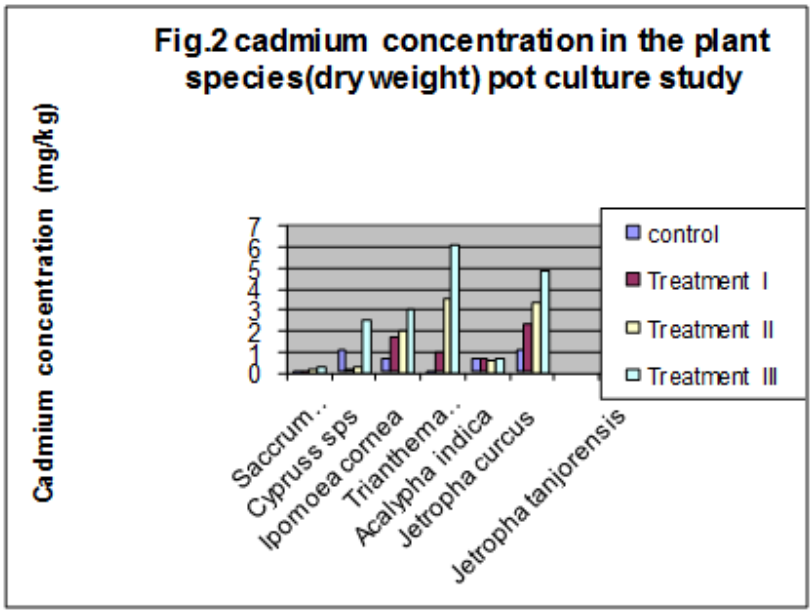
Statistical Analysis

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.

RESULTS AND DISCUSSION

The accumulations of Mercury and Cadmium in plants were noted when compared with control plant (Fig.-1 and 2). The accumulation of mercury in *Ipomoea cornea* and *J.curcas* was found to be significantly high with increasing concentrations and ranged from (T1(1mg/Kg) to T3 (25mg/Kg)) 0.9230±0.206 - 3.1500±0.426 and 1.2782±0.127 - 2.3175±0.26 mg/kg dry weight (D.W) 30 days of growth.





The concentrations of Cd were relatively higher in *Trianthema portulocastrum* (6.0720 mg/kg), *Jatropha curcas* (4.8990mg/kg) and *Ipomoea cornea* (3.0108 mg/kg). Some strains of *Oryza sativa* L. are also known to be accumulator of Cd (Arao and Ae, 2003 ; Murakami *et al*., 2007). *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 (Adhikari *et al*., 2010). Mellem *et al*., (2012) studied that *A. dubius* has limited potential for the bioaccumulation of Cr, Hg, Pb, Cu and Ni, but is capable of hyperaccumulating of As.

These results suggest that *Ipomoea cornea* and *Jatropha curcas* accumulate Cd in higher concentrations and they also accumulate Hg significantly. *Trianthema portulocastrum and Jatropha curcas* accumulate high concentrations of Cd then *Ipomoea cornea*. 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.

These results suggest that *Ipomoea cornea* and *Jatropha curcas* accumulate Cd in higher concentrations and they also accumulate Hg significantly. *Trianthema portulocastrum and Jatropha curcas* accumulate high concentrations of Cd then *Ipomoea cornea*. Ghosh and Singh (2005) reported among the five species, *B.juncea* accumulated maximum Cd but *I.carnea* followed by *D.innoxia* and *P.karka* were the most suitable species for phytoextraction of cadmium, if the whole plant or above ground biomass is harvested.

CONCLUSION

Based on the present investigation it is suggested that Ipomoea *cornea* and *Jatropha curcas* have better accumulation capacity for Hg remediation and *Trianthema portulocastrum*, *Jatropha curcas* and *Ipomoea cornea* can be used Cd phytoremediation. Phytoremediation appears a very promising technology for the removal of metal pollutants from the environment and may be, at present, approaching commercialization.

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