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Utilization of Phytoextraction Technology for Cadmium Removal

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ABSTRACT

Phytoextraction is an environmental cleanup effort depends to a large degree on the identification of suitable plants. Cd Phytoextraction is a promising and environment friendly approach for soil decontamination. Plant potential for Cd extracting generally depends on shoot Cd concentration and shoot biomass yield. Industrial waste materials disposal have been contaminating hectares of productive agricultural land throughout the world. Increase in metal concentrations in the soil is mainly due to this. In the present experiments, this technology has been tested by six plant species in pot experiments. During this study, different Cd concentrations were given to different pots.

Keywords: Contaminated Soils, Cadmium, Phytoremediation, Heavy Metals, Chlorosis

I INTRODUCTION

The apparent complexing and slow release of Cd to root system alleviates its toxicity *(Yanai et al., 2006).* This is probably a result of dilution of the absorbed Cd in a larger biomass of plant tissues (Strickland *et al.*, 1979 and Pathak *et al* 2014). Cadmium being toxic to plant, its increased concentration in soil reduces growth and impairs metabolism (Foy *et al.*, 1978). Heavy metals form the main group of inorganic contaminants. Remediation of metal compounds presents a different set of problems when compared to organics (Pathak *et al* 2013 and 2014). Phytoremediation is often referred to botanical bioremediation or green remediation (Sharma *et al.*, 2012; and Pushpendra *et al.*, 2014). Disposal of Industrial waste materials causes an increase in metal concentrations in the soil (Foy *et al.*, 1978). Unlike organic contaminants, metals cannot be degraded so it requires removal.

Phytoremediation is a new and emerging technology employed for removing toxic metals, contaminants and pollutants from soil (Singh *et al.*, 2012). This study provides a promising start for biomass based phytoextraction as it includes high biomass producing species and growing these species is practically easier than producing hyper accumulators. The main objectives of the present study were to study the seed and dry matter yield of the Raya (*Brassica juncea*), Toria *(B. campastris)*, Oat *(Avena sativa)*, Barley *(Hordeum vulgare)*, Bathua *(Chenopodiun murale*) and Rijhka *(Medicago sativa)* in to two different soils. The successive additions of Cd in soils resulted in a decrease in the yield of different species.

II MATERIALS AND METHODS

The pot experiments were conducted in Cd spiked soils to examine the effect of different Cd concentration on the plant growth. The present investigation was done to fulfill the objectives of the present study. To evaluate the relative efficiencies regarding growth plant species were grown in Cd enriched soil. The experiments were conducted using 5 kg capacity earthen pots.

2.1 Physico-Chemical Properties of Soils

Before starting the experiment, the soil was characterized. Background concentration of Cd and different chemical parameters are shown in Table 1. The yield of different plant parts of all the six species is show in figures respectively.

2.2 Treatments and Cd levels:

The pot experiments were given five treatments (0, 20, 40, 60 and 80 mg Cd Kg^{-1} soil) to examine the effect of different Cd concentration on the plant growth. The experiments were conducted in earthen pots.

2.3 Plant Species

Raya (*Brassica juncea*), Toria *(B. campastris)*, Oat *(Avena sativa)*, Barley *(Hordeum vulgare)*, Bathua *(Chenopodiun murale*) and Rijhka *(Medicago sativa)* were chosen for this work. To observe the seed and dry matter yields these six plant species. All the plants were grown with three replicates.

III RESULTS AND DISCUSSION

The results of the present study are shown by Fig 1 to 2. All the plants species were harvested at the maturity. The root, stem leaf and seeds were separated and weighed for the study of effect of different Cd concentration on the yield of different plant species. After recording other observations, the harvested plants were put in paper bags and kept at 65±2°C for 48 hours till constant weight was obtained and recorded as g $plant^{-1}$ after taking average. It was necessary to observe the amount of cadmium initially in the soil.

3.1 Dry Matter Yield and Toxicity

The chlorotic symptoms became more conspicuous with the increasing levels of Cd, and Chlorosis was most conspicuous in Oat followed by Barley, Toria, Bathua, Rijhka and Raya. Visual toxicity symptoms of Cd were recorded of all six-plant species. In the controlled (Cd_0) treatment, there were no distinct Cd toxicity symptoms throughout the growing period of crops. At 40 mg Cd kg^{-1}, some light chlorotic symptoms, resembling to Fe-chlorosis, appeared after about 2 weeks of germination. At 60 and 80 mg Cd kg^{-1} soil treatments, the leaves were considerably narrow and small as compared to Cd control in all the species tested.

3.2 Yield of grown plants

The decrease in stem dry matter yield was 4, 8, 14 and 28 percent as compared to control in 20, 40, 60 and 80 mg kg^{-1} soil, treatments. The overall dry matter yield of stem was highest in Raya, where as it was lowest in

Rijhka (Fig 1). The data on the leaf dry mater yield of different species as affected by Cd treatments are presented by Fig 2, which shows that the application of different levels of Cd has not much effect up to 40 mg kg^{-1} soil. Further increasing the dose of Cd resulted in the reduction of dry matter yield. Further, increase in Cd amount (after Cd 40 mg kg^{-1}) showed much adverse effect on dry matter yield of leaves. There were 2, 4, 19 and 29 percent decrease in dry matter yield of leaf with the application of 20, 40, 60 and 80 mg Cd kg^{-1} soil, respectively.

IV CONCLUSION

The efficacy of Phytoextraction as a viable remediation technology is still being explored, though the results are positive. This study provides a promising start for biomass-based Phytoextraction as it includes high biomass producing species and growing these species is practically easier than producing hyper accumulators. Phytoextraction as well as agronomic practices for sustaining high shoot biomass production should be further explored. The highest leaf dry matter yield of Raya was also recorded. Similar trend was observed in Toriya, Oat, Bathua, Rijhka and Barley. Cd_0 to Cd_{80} treatment the mean stem dry matter yield decrease the decrease in the stem, leaf yield was from 4 to 28, 2 to 29 percent respectively. The maximum decrease in the mean dry matter yield was at Cd_{80} treatment. The goal was to assess to develop the heavy metal removal technique in natural conditions of the soil. It was observed that Cd affects all the growth parameters. However, it could be used to remediate the Cd contaminated soil without the application of any chemical.

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Table 2: Physico-Chemical Characteristic of the Soil

Characteristics	**Contents**
*pH	7.35
*EC (dSm^{-1})	0.84
Mechanical Composition (%)	
i) Sand	74.4
ii) Silt	12.6
iii) Clay	13.2
Organic carbon (%)	0.82
Olsen's P (mg kg^{-1})	22.7
CEC (m.e/100 g)	8.5
Metal contents (mg kg^{-1})	
i) Lead	2.97
ii) Cadmium	13.4
iii) Nickel	0.32
iv) Zinc	16.1
v) Iron	36.4
vi) Manganese	3.3
vii) Copper	11.8

***1:2 Soil: Water suspension**

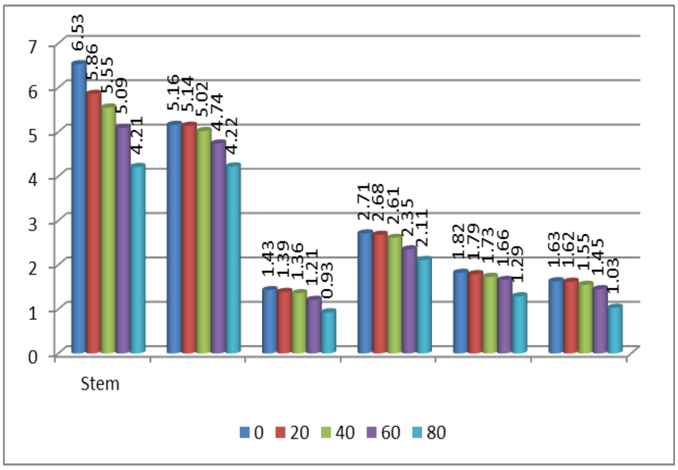

Fig 1: Yield of (g $Plant^{-1}$) Species due to Cd Application in Soil

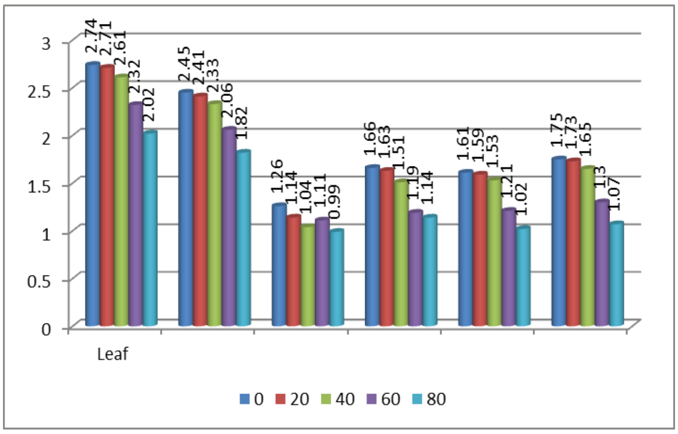

Fig 2: Yield of Species (g Plant^{-1}) due to Cd Application in Soil