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Plants Biomass generation in Cadmium contaminated Sandy Loam Soil

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ABSTRACT

This study provides a promising start for biomass based Phytoextraction. It includes high biomass producing species. Growing these species is practically easier than producing hyper accumulators. Cd Phytoextraction is a promising and environment friendly approach for soil decontamination. In the present experiments, this technology has been tested by six plant species in pot experiments. The success of Phytoextraction is an environmental cleanup effort depends to a large degree on the identification of suitable plants that not only concentrate metals up to certain levels but growth also remains good. 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. Plant potential for Cd extracting generally depends on shoot Cd concentration and shoot biomass yield. During this study, different Cd concentrations were given to different pots.

Keywords: Phytoremediation, contaminated soils, chlorosis, cadmium, heavy metals

I INTRODUCTION

Organic compounds can be degraded while metals remediation requires physically removal or immobilization. Therefore, Remediation of metal-contaminated soil faces a particular challenge. Disposal of Industrial waste materials have been estimated to contaminate hectares of productive agricultural land throughout the world. It causes an increase in metal concentrations in the soil (Pathak *et al.*, 2013). Unlike organic contaminants, metals cannot be degraded so it requires removal. 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* 2014). Phytoremediation is often referred to botanical bioremediation or green remediation (Chaney *et al.*, 1997; and Pushpendra *et al.*, 2014). Phytoremediation is a new and emerging technology employed for removing toxic metals, contaminants and pollutants from soil (Clijsters, *et al.* 1985). 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). Cadmium being toxic to plant, its increased concentration in soil reduces growth and impairs metabolism (Foy *et al.*, 1978). The beneficial effect of sewage waste water irrigation and adverse effect of Cd on different crops have also been reported by several workers (Ebbs *et al.* 2002). 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. Generally, the background cadmium (Cd) concentration in agricultural soils remains less than 1 mg per kg (Chaney *et al*., 1997). Increased Cd levels were also found in the surface soils near the metal processing industries (Pushpendra *et, al*., 2014).

II MATERIALS AND METHODS

To evaluate the relative efficiencies regarding growth plant species were grown in Cd enriched soil. 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. 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. The soil was characterized for background concentration of Cd and different chemical parameters and they 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 were grown. All the plants were grown with three replicates.

III RESULTS AND DISCUSSION

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..

3.1 Dry Matter Yield and Toxicity:

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. 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. 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 in plant grown in sewage water irrigated soil:

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. The data on the leaf dry mater yield of different species as affected by Cd treatments 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. There was a little seed yield decreases in all the plant species up to 40 mg Cd kg^{-1} soil, whereas the seed yield decreased much at the 60 and 80 mg Cd kg^{-1} soil than control. The reduction in seed yield was about 2, 6, 26 and 38 percent with the application of 20, 40, 60 and 80 mg Cd kg^{-1} soil in the comparison of control respectively.

IV CONCLUSION

The results indicated that there was increase in the biomass yield in the sewage water irrigated soil, over the sandy loam soil. The highest leaf dry matter yield of Raya was also recorded in sewage water irrigated soil. Similar trend was observed in Toriya, Oat, Bathua, Rijhka and Barley. In the sandy loam soil, Cd_0 to Cd_{80} treatment the mean leaf and seed yield was from 4 to 28, 2 to 29 and 2 to 38 percent respectively. The goal was to assess to develop the heavy metal removal technique in natural conditions of the soil with and without chelators. 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. 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.

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Table 1: 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**

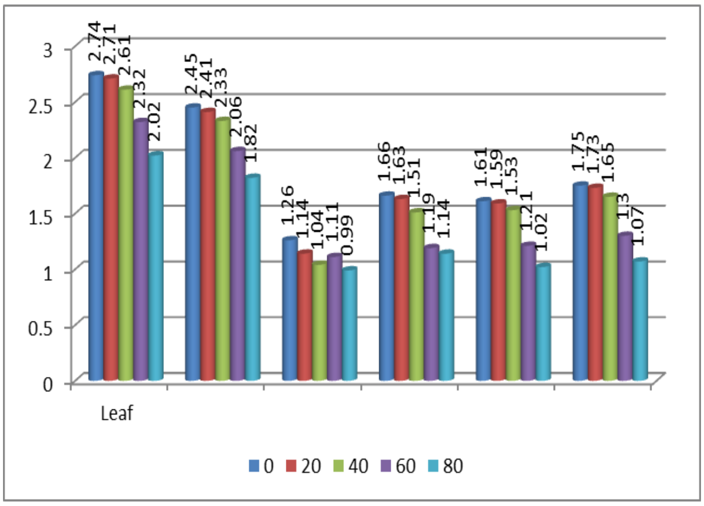

Fig 1: Yield of (g Plant^{-1}) Species due to Cd Application in Soil

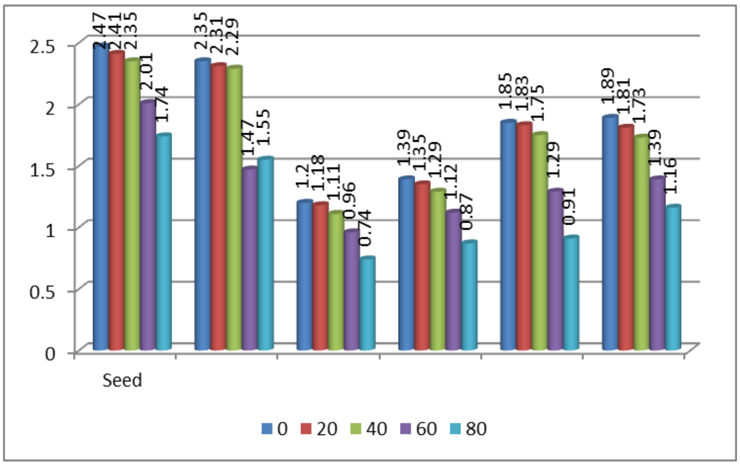

Fig 2: Yield of Species (g Plant^{-1}) due to Cd Application in Soil