PHYTOEXTRACTION: A TECHNOLOGY FOR EFFECTIVE SOIL RECLAMATION AND POLLUTION MANAGEMENT USING DIFFERENT PLANT SPECIES

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ABSTRACT

Disposal of industrial waste has been contaminating thousands of hectares of productive agricultural land. Disposed materials contain inorganic and organic substances. Organic compounds can be degraded while metals normally need to be physically removed or be immobilized. Remediation of metal-contaminated soil faces a particular challenge. 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. 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. The results indicated that there was an increase in cadmium concentration in various plant parts with respect to increase in background cadmium concentration in soil. In this study, the response of different plant species, in the sandy loam soil has been observed.

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

I INTRODUCTION

Soil pollution especially due to non degradable substances is a very serious important environmental problem. Such pollutants from soil enter into the food chain (Aery *et al*., 1991, Blaylock *et al*., 1997). Organic compounds can be degraded while metals normally need to be physically removed or be immobilized (Clijsters *et al*. 1985; Huang *et al*., 1997; Mahler *et al*., 1978). Remediation of metal-contaminated soil faces particular challenge. Synthetic chelators may facilitate the uptake of heavy metals, and their translocation to the above ground parts but they also pollute the soil. EDTA is the most popular reagent because it is a strong, recoverable and biostable chelating agent (Chaney *et al*., 1997, Foy *et al*., 1978). Disposal of industrial waste has been contaminating thousands of hectares of productive agricultural land throughout the world causing an increase in metal concentration.

The concerns about the risks associated with long-term consumption of crops contaminated with heavy metals require strategy so that food may be free from contaminants (Chaney *et al*., 1997). Cadmium has no essential biological function and is highly toxic to plants and animals (Narwal *et al*., 1983; Turget *et al*., 2004). Blaylock *et al*., 1997 reported that Cd accumulates largely in roots than in shoots. Hyper accumulation of potentially phytotoxic metallic elements is a phenomenon, which has been found in a wide range of plant families for Cd and several other heavy metals. The phenomenon has presented possibilities for exploitation in the remediation of metal polluted soils. Many of the metal accumulating plants are member of the Brassicacae family.

II MATERIALS AND METHODS

Keeping the above things in mind the present study has been planned to achieve the objective of enhancement of cadmium uptake by plants so that soil may be reclaim biologically. The Raya (*Brassica juncea*), Toriya *(B. compastris)*, Oat *(Avena sativa)*, Barley *(Hordeum vulgare)*, Bathua *(Chenopodiun murale*) and Rijhka *(Medicago sativa)* were in the Cd contaminated soil. The plant samples taken at harvest were chemically analyzed to estimate Cd concentration in different plant parts. Each sample was ground in grinder after drying and then in oven at 65±2°C till a constant weight was achieved. A known amount of ground sample was digested by diacid mixture. The Cd concentration was obtained by atomic absorption spectrophotometer (AAS).

2.1 Analysis of Leaf and Seed

In order to determine Cd in leaf and seed, 1 g of ground and well mixed plant material was digested in a diacid mixture of nitric and perchloric acid (4:1). After digestion, the volume was made to 50 ml with double distilled water, filtered and stored in well washed plastic bottles. Cd was estimated using the Atomic Absorption Spectrophometer (GBC 932 Plus) Standard solutions were prepared by diluting 1000ppm standard of heavy metal, purchased from 'Merck'. Analytical grade (AR) chemical were used throughout the study.

III RESULTS AND DISCUSSION

Cadmium Concentration in Different Plant Parts

Cadmium concentration in different plant parts grown in sandy loam soil was studied. A perusal of data presented from table 1 to 2, showed that cadmium concentration varied with all the plant species. The relative concentration of Cd in different plant parts varied markedly with plant species and increased with increasing rate of Cd. The data presented in table showed that Cd concentration in all the species increased up to the highest rate of applied Cd over control. The highest Cd concentration was found in Raya while the lowest was found in roots of Bathua. In this study the data shows that among the Brassica genotypes i.e. in Raya and Toriya Cd concentration was almost similar. The relative concentration of Cd in different plant parts varied markedly with plant species and increased with increasing rates of Cd application. However, the Cd concentration significantly varied between the species. Raya was having highest concentration than other species.

Different levels of Cd application also affected Cd concentration in leaf. Application of 20, 40, 60 and 80 mg Cd kg^{-1} soil resulted in about 9, 21, 33 and 52 fold increase in Cd concentration respectively over control. However, the magnitude of increase varied with in the species. The mean Cd concentration in Raya was greater than the Toriya, Bathua Oat and Barley but less than Rijhka.

The mean Cd concentration in seed increased with increasing levels of Cd. However, the magnitude of increase in Cd concentration varied with the species. The increase in Cd concentration in seed was about 8, 17, 27 and 46 times more at 20, 40, 60 and 80 mg Cd kg^{-1} soil, respectively as compared to control. Among the species the maximum Cd accumulated in Raya seeds.

IV CONCLUSION

The Cd concentration increased in various plant parts in all the six species tested due to increasing levels of Cd application. It is interesting to note that root had higher concentration of Cd than in stem, leaves and seed of different species at different Cd levels which demonstrate that there is limited transport of this element from the root system to the above ground parts. Differences in Cd concentration were observed between the Cd levels. Raya had higher Cd concentration than those of other species. Higher Cd concentration in Raya indicates that it has better absorbing ability than other and has higher potential for removing Cd from moderately contaminated sandy loam soils. These findings corroborate with those of who indicated that heavy metals usually accumulate more in root than aerial parts, most of Cd was retained in roots and little was translocated to shoot. Several research workers reported that several *Brassica* species moderately enhance Cd accumulation and are most effective in removing Cd from the contaminated soil and suggested for phytoremediation of polluted soil. It is interesting to note that root had higher concentration of Cd than in leaves and seed of different species at different Cd levels tried demonstrating that there is limited transport of this element from the root system to the above ground parts. Research worker observed that Cd like Fe, Cu, Al and Co get accumulated more in roots than the other parts. It is also reported by scientists that much of the Cd taken up by plant is retained in the root, but a proportion is translocated to the above ground parts of the plants and into the seed. The amount of Cd accumulated and translocated in plants varies with species.

Table 1: Cd concentration (mg g-1) in leaf of different species as influenced by Cd application in sandy loom soil

Cd levels (mg kg-1)	Different species						Mean
	Raya	Toriya	Rijhka	Bathua	Oat	Barley	
			Leaf				
0	3.27	1.62	0.49	0.28	0.64	0.51	**1.14**
20	12.49	12.64	9.79	6.29	8.77	9.78	**9.96**
40	33.52	23.51	23.62	17.52	22.65	23.61	**24.07**
60	40.88	28.65	42.11	31.42	41.38	42.11	**37.76**
80	51.24	41.61	69.21	57.09	66.22	69.16	**59.09**
Mean	28.28	21.61	29.04	22.52	27.93	29.03	

Table 2: Cd concentration (mg g-1) in seed of different species as influenced by Cd application in sandy loom soil

			Seed				
0	1.83	1.28	1.62	1.08	0.38	0.45	**1.11**
20	20.10	12.77	5.14	4.58	4.42	4.08	**8.52**
40	35.51	27.35	15.58	13.18	11.17	9.97	**18.79**
60	47.93	39.28	29.30	27.14	19.39	15.88	**29.82**
80	67.34	52.64	71.58	58.94	30.09	23.12	**50.62**
Mean	34.54	26.66	24.64	20.98	13.09	10.70	

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