

Efficiency of *Echinochloa Colona* in The Removal of Heavy Metals From Contaminated Soils



Biotechnology

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ABSTRACT

Soil contaminated with heavy metals has become a worldwide problem and pose a serious threat to the environment leading to losses in agricultural yield and hazardous health effects as they enter the food chain. Phytoremediation is a generic term for the group of technologies that use plants for remediating soils, sludges, sediments and water contaminated with organic and inorganic contaminants. The selection of suitable plants is the first and the critical step in conducting a successful Phytoremediation. Echinochloa colona commonly known as jungle rice has an Indian origin. In the present study Echinochloa colona species was used for Phytoremediation of lead, nickel, zinc, cadmium and chromium contaminated soils. The results showed that the species was good accumulator of zinc and chromium contaminated soils. The species can be recommended for the Phytoextraction of zinc and chromium contaminated soils.

INTRODUCTION:

Land is being continuously degraded and polluted by human activities such as industrial development, urbanization, mining and intensive agriculture. Soil pollution is a condition of global concern with regard to its implications on ecology and human health due to the presence of organics and heavy metals. The concentrations of heavy metals increase in the environment from year to year (Govindasamy, 2011). Soil contaminated with heavy metals has become a worldwide problem and pose a serious threat to the environment (Anwar et al., 2009), leading to losses in agricultural yield and hazardous health effects as they enter the food chain (Salt et al., 1995). Phytoremediation has a strong potential as a natural, solar energy driven remediation approach for the treatment of polluted sites (Ernst, 2005; Lasat, 2002). Phytoextraction of heavy metals by growing crops and harvesting above-ground material is a promising technology to remediate poly metallic contaminated soils. Phytoremediation is an innovative use of green plants to clean up our environment. Phytoremediation consists of mitigating pollutant concentrations in contaminated soils, water, or air, with plants able to contain, degrade, or eliminate metals, pesticides, solvents, explosives, crude oil and its derivatives, and various other contaminants from the media that contain them (Bouwman, et al., 2007). Phytoextraction seems to be the most promising technique and has received increasing attention from researchers since it was proposed by Chaney (1983) as a technology for reclaiming metal polluted soils (Nascimento and Xing, 2006). Plants have the genetic potential to clean up soil contaminated with toxic metals. The success of Phytoextraction, as an environmental cleanup technology, depends on several factors including the extent of soil contamination, metal availability for uptake into roots, and plant ability to intercept, absorb, and accumulate metals in shoots (Ernst, 2000; Prasad, 2008).

2. METHODOLOGY:

Echinochloa colona commonly known as Jungle rice has an Indian origin. Now it is widely distributed in tropics and subtropics, including South and Southeast Asia and tropical Africa. Roots fibrous. White or brown, stems flat, hairy nodes glabrous. Stipules absent. Leaves alternate spiral, sessile, linear, more than 2 cm long/wide, apex acute, base clasping, parallel veined. Leaf sheath present. Flowers bisexual, grouped together in a terminal spike or panicle, sessile, purple or brown, petals not visible. Fruit is a nut. (Gamble, 2008). The garden soil was obtained from nursery. Seedlings were placed in each pot. The plant species were grown in pots and were irrigated with known heavy metal solutions (Pb, Ni, Zn, Cd and Cr) were added to the pots alternate days for 60 days. In controls normal water was used. The

plants were grown for a period of two months (60days). Uptake of heavy metals by plants in a metal contaminated and normal soil was studied in pot culture experiment. The initial soil heavy metal concentration was analyzed. Every 20 days the plant samples from each pot were collected and washed thoroughly under running tap water and distilled water so that no soil particles remained. The collected samples were washed with distilled water remove dust particles. The samples were air dried and then placed in a dehydrator for 2-3 days and then dried in an oven at 100°C. The dried samples of the plant were powdered and stored in polyethylene bags. The powdered samples were subjected to acid digestion. Samples (1gm) of the plant was weighed in digestion flasks and treated with 5 ml of concentrated HNO₃. 1gm of the powdered plant material was weighed in separate digestion flask and digested with HNO₃ and HCl in the ratio of 3:1. The digestion on hot plate at 110°C for 3-4 hours or continued till a clean solution was obtained. After cooling, the solution was filtered, the filtrate was analyzed for metal content using AAS.

Bioconcentration Factor (BCF) and Translocation Factor (TF):

Metal concentrations in plants vary with plant species. The concentration, transfer and accumulation of metals from soil to roots and shoots was evaluated in terms of Biological Concentration Factor (BCF), Translocation Factor (TF). Biological Concentration Factor (BCF) was calculated as metal concentration ratio of plant roots to soil. The Bioconcentration Factor (BCF) of metals was used to determine the quantity of heavy metal absorbed by the plant from the soil. (Yoon et al., 2006; Ghosh and Singh, 2005). Translocation Factor (TF) was used to evaluate the potential of this species for Phytoextraction, the Translocation Factor (TF) was calculated. This ratio is an indication of the ability of the plant to translocate metals from the roots to the aerial parts of the plant. Metals that are accumulated by plants and largely stored in the roots of plants are indicated by TF values <1, with values greater indicating translocation to the aerial part of the plant (Yoon et al., 2006).

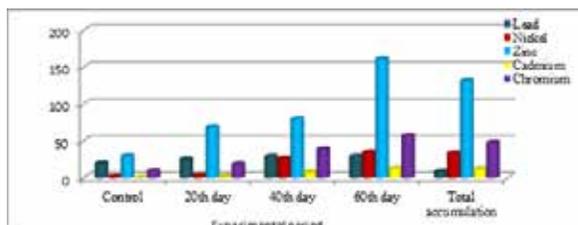
3. RESULTS AND DISCUSSION:

Table 1: Accumulation of heavy metals (Pb, Ni, Zn, Cd and Cr) in the species *Echinochloa colona*:

Heavy metal	Control	20th day	40th day	60th day	Total accumulation
Lead	20.13±0.19	25.31±0.11	28.84±0.18	28.95±0.1	8.82

Nickel	1.63±0.19	3.68±0.13	26.38±0.18	35.34±0.08	33.71
Zinc	29.4±0.19	69.16±0.17	79.79±0.13	161.42±0.12	132.02
Cadmium	0.21±0.18	1.83±0.19	8.05±0.13	13.11±0.16	12.9
Chromium	9.51±0.19	19.03±0.16	39.41±0.19	57.24±0.13	47.73

Fig1: Accumulation of Pb, Ni, Zn, Cd and Cr (mg/kg) in *Echinochloa colona* during the experimental period



Accumulation of Lead (mg/kg) in *Echinochloa colona*:

The total accumulation of lead in *Echinochloa colona* was 8.82 mg/kg in 60 experimental days. The initial concentration of lead was 20.13 mg/kg which increased to 28.95 mg/kg by the end of the experimental period. The accumulation was 5.18 mg/kg in the first 20 days. By 40th day the concentration of lead reached to 28.84 mg/kg in an increase of 3.53mg/kg from 20 to 40 days. Thereafter the accumulation stabilized. By the 60th day the accumulation was 28.95 mg/kg showing an increase of only 0.11 mg/kg from 40th day to 60th day.

Accumulation of Nickel (mg/kg) in *Echinochloa colona*:

The accumulation of nickel in the 60 days of experimental period was 35.34 which showed an increase of 33.71 mg/kg from an initial concentration of 1.63 mg/kg. *Echinochloa colona* absorbed only 2.05 mg/kg of nickel in the first 20 days thereafter the accumulation increased to 26.38 and 35.34 mg/kg by 40th and 60th day, respectively. The nickel accumulation was maximum during 20-40 days of experimental period.

Accumulation of Zinc (mg/kg) in *Echinochloa colona*:

Zinc is normally absorbed in higher quantities by most of the plants. In the present study, *Echinochloa colona* has accumulated 132.02 mg/kg of zinc in 60 experimental days. The initial concentration of zinc was 29.4 mg/kg which has increased to 69.16, 79.79 and 161.42 by 20th, 40th and 60th days respectively. Maximum absorption of zinc was observed between 20 and 40 days.

Accumulation of Cadmium (mg/kg) in *Echinochloa colona*:

The back ground concentration of cadmium was 0.21 mg/kg in the beginning of the experiment which increased to 13.11 mg/kg in 60 days, showing a total accumulation of 12.9 mg/kg. In the first 20 days of experimental period the accumulation of cadmium was slow and later increased to 8.05 mg/kg to 13.11 by 40th and 60th days, respectively. The accumulation was maximum between 20 and 40 days.

Accumulation of Chromium (mg/kg) in *Echinochloa colona*:

The total accumulation of chromium in *Echinochloa colona* in the 60 experimental days was 47.73 mg/kg. The accumulation in the plant continued up to 60th day. By 20th day the accumulation reached to 19.03 which further increased to 39.41 and 57.24 by 40th and 60th days, respectively. The accumulation was highest between 20 and 40 days and lowest in first 20 days.

Echinochloa colona recorded highest total accumulation of among all metals for zinc (132.02 mg/kg), chromium (47.73 mg/kg), nickel (33.71 mg/kg), cadmium (12.9 mg/kg) and lead (8.82 mg/kg) in descending order of total accumulation. From the total accumulations *Echinochloa colona* is a good absorber of zinc,

chromium nickel and cadmium.

4. CONCLUSION:

The concentrations of heavy metals increase in the environment from year to year therefore decontamination of heavy metal contaminated soils is very important for maintenance of environmental health and ecological restoration. Phytoremediation is an innovative use of green plants to clean up our environment. Phytoremediation consists of mitigating pollutant concentrations in contaminated soils, water, or air, with plants able to contain, degrade, or eliminate metals, pesticides, solvents, explosives, crude oil and its derivatives, and various other contaminants from the media that contain them. The selection of suitable plants is the first and the critical step in conducting a successful Phytoremediation. The results showed that the species was good accumulator of zinc and chromium contaminated soils. The species can be recommended for the Phytoremediation of zinc and chromium contaminated soils

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