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RESEARCH ARTICLE

PHYTOREMEDIATION OF TANNERY POLLUTED SOIL USING *ECLIPTA ALBA* (KARISALANKANNI)

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Abstract

Pollution of the biosphere with toxic metals has accelerated dramatically since the beginning of the industries revolution. Toxic metals contamination of soil, aqueous wastes, streams and ground water poses a major environmental and human health problem, which is still in need of an effective and affordable technological solution. Phytoremediation is a new technology in which plants are used to remove pollutants from water and soil. The use of metal accumulating plants to clean environment contaminated with heavy metals is the most rapidly developing component of this environmental friendly and cost – effective technology. Remediation of Cr – contaminated soil is a challenging task that may not only help in sustaining agriculture, but may also minimize adverse environmental impacts. Here, we examined the potential of phytoremediation techniques for treating heavy metals (Cr, Pb, Cd, & Zn) and contaminated soil using vermicompost for pot experiment. The concentrations of Chromium and other heavy metals are studied using Atomic Absorption Spectroscopy.
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Keywords: Heavy metals, Phytoremediation, *Eclipta alba* and Contaminated soil.

Introduction

Industrial wastes are generated from different process and the amount and toxicity of waste released varies with its own specific industrial process (Shen, 1999). Chemicals, both organic and inorganic are released in to the environment and this results in soil, water and air pollution. Ninety per cent of hazardous waste is a product of industrial processing (Pantawat Sampanpanish *et al*., 2010). Heavy metal contamination has increased dramatically since the early 20th century (Nriagu, 1979). The various remediation technologies currently used range from *in situ* vitrification and soil incineration to excavation and land filling, soil washing, soil flushing and solidification and stabilization by electrokinetic systems (Glass,1999).

Among the industries the leather industry are the fifth single foreign exchange earner in India, 2161 tanneries located in India. Tanning industry is recognized as a serious environmental threat all over the world. A variety of chemicals is used in the tanning process along with large quantities of water which are discharged as effluents (Saadia *et al*., 2005).

Chromium (Cr) is abundant in the earth's crust, with both the hexavalent (Cr[VI]) and more predominant trivalent (Cr[III]) forms readily found in nature (Revathi *et al*., 2011). Among the different forms of Chromium, the hexavalent Chromium Cr^{6+} is the most toxic and carcinogenic due to its high solubility in water, rapid permeability through biological membranes and subsequent interaction with intracellular proteins and nucleic acids (Wani *et al*., 2007).

The iron, manganese, copper, zinc and nickel are classified as heavy metals, and depending on the concentration in the plants or organisms, exhibit both deficiency and toxicity. In addition, lead, cadmium, chromium, mercury, selenium and arsenic are the other heavy metals and metalloids which exhibit only toxicity to animals including human beings (Malarkodi, 2007). Heavy metals are conventionally defined as elements with metallic properties (ductility, conductivity, stability as cations, ligand specificity, etc.) and an atomic number >20 (Yan-de et al., 2007). The term heavy metals refers to metals and metalloids having densities greater than 5 gcm^{-3} and is usually associated with pollution and toxicity although some of these elements are required by organisms at low concentrations. Results of these activities end up in outlets and wastes where they are transported to the environment by air, water or deposits, thereby increasing the metal concentrations in the environment (Greger, 2004).

The phytoremediation method was simple, efficient, cost effective and environmental friendly (Mangkoedihardjo *et al*., 2008). The phytoremediation of metal – contaminated soils offers a low cost method for soil remediation, and some extracted metals may be recycled for value. Plants that accumulate metals to high concentrations are sometimes referred to as "hyper accumulators" (Mojiri, 2011) and (Salt, 1995). Proper selection of plant species for phytoremediation plays an important role in the development of remediation methods (Salt *et al*., 1995). The search for indigenous plants, often better in terms of survival, growth and reproduction under metal – stressful field conditions may be an adequate approach to find plant species with metal resistance capabilities and even with the capacity to accumulate heavy metals at very high levels (Yoon *et al*., 2006).

Bioavailability of Cd, Cr, Pb and Zn to plants in metal polluted soil from dumpsites has rarely been investigated. As the concentration of metals increase, the chances of a phytotoxic response also increase. It is therefore important to estimate the concentration of bioavailable metals present in soils and correlating this to total metals in plants (Anawar *et al*., 2008).

Materials and Methods

Collection of materials

The garden soil samples were gathered from nearest places. The effluent was collected from tannery industry located at Sempattu, Tiruchirappalli, Tamilnadu. Karisalankanni (*Eclipta alba*) seeds are collected from this plant (Edavakkudi, Poondi, Thanjavur, Tamilnadu). Vermicompost was prepared with cow dung using earthworm species, *Eurdius euginae*. Seeds were germinated in experimental pots and watered. On fifteenth, thirtieth, forty fifth and sixtieth days the plants were harvested from pots and the concentration of heavy metals Chromium (Cr), Lead (Pb), Cadmium (Cd) and Zinc (Zn) of the samples were noted.

Experimental setup

The seedlings were exposed to different concentrations of heavy metal chromium to find the toxicity. Chromium at high concentrations of 200 and 300 mg/kg showed high toxicity that the plants died (Revathi *et al*., 2011). The various experimental setup used for the present study are listed in Table. 1.

Heavy metal analysis of soil samples

Soil samples of each pot were air dried, crushed and pass through 0.2 mm sieve and stored in Zip lock covers for analysis. Heavy metals present in all the samples were analyzed by AAS (Atomic Absorption Spectroscopy).

Results and discussion

Physico – chemical characteristics of the effluent collected from the tannery industry was tabulated in table.2

Table 1. Experimental setup

S.No.	Pot No.	GS (kg)	KK Seeds (g)	VC (kg)	TE (ml)	Plant harvested (days)
1	A1	1	2	-	50	15
2	A2	1	2	-	50	30
3	A3	1	2	-	50	45
4	A4	1	2	-	50	60
5	B1	1/2	2	½	50	15
6	B2	1/2	2	½	50	30
7	B3	1/2	2	½	50	45
8	B4	1/2	2	½	50	60
9	C1	1	2	-	100	15
10	C2	1	2	-	100	30
11	C3	1	2	-	100	45
12	C4	1	2	-	100	60
13	D1	1/2	2	½	100	15
14	D2	1/2	2	½	100	30
15	D3	1/2	2	½	100	45
16	D4	1/2	2	½	100	60
17	E1	1	2	-	200	15
18	E2	1	2	-	200	30
19	E3	1	2	-	200	45
20	E4	1	2	-	200	60
21	F1	1/2	2	½	200	15
22	F2	1/2	2	½	200	30
23	F3	1/2	2	½	200	45
24	F4	1/2	2	½	200	60

GS – Garden Soil, KK – KarisalanKanni,
VC – VermiCompost, TE – Tannery Effluent

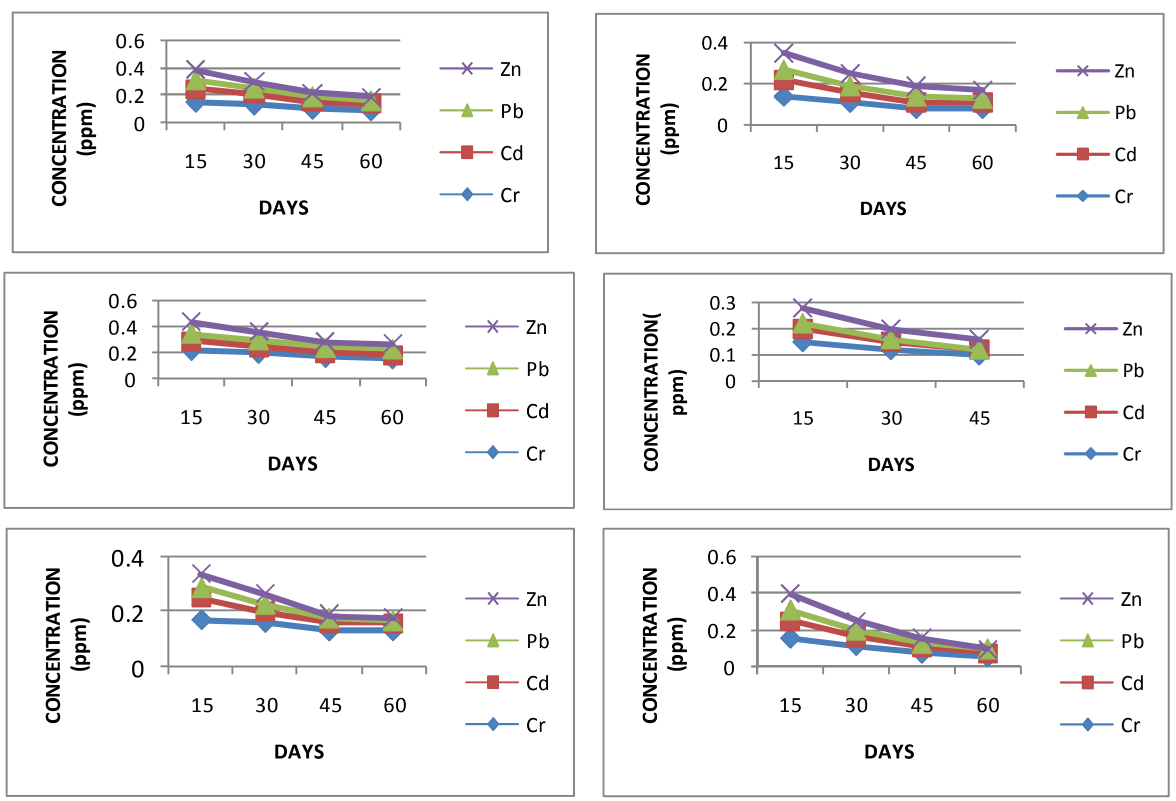
Table 2. Physico – chemical characteristics of the effluent collected from the tannery industry.

S.No	Name of the parameter	Sample details
	Physical parameter	
1	Colour	>1hue
2	Odour	Unpleasant
3	Turbidity	400NTU
4	Total dissolved solids	2746
5	pH	8.19
6	Electrical conductivity (dsm^{-1})	4.29
7	BOD (mg/l)	1450
8	COD (mg/l)	850
	Heavy metals	
9	Zinc (mg/l)	2.56
10	Chromium (mg/l)	5.68
11	Lead (mg/l)	1.26
12	Cadmium (mg/l)	0.89

Table 3. Heavy metal concentrations in various soil samples

S.No.	Pot No.	Cr (ppm)	Cd (ppm)	Pb (ppm)	Zn (ppm)
1	A1	0.15	0.10	0.06	0.08
2	A2	0.13	0.08	0.04	0.05
3	A3	0.10	0.06	0.03	0.03
4	A4	0.09	0.05	0.03	0.03
5	B1	0.14	0.08	0.05	0.08
6	B2	0.11	0.05	0.03	0.06
7	B3	0.08	0.03	0.03	0.05
8	B4	0.08	0.03	0.02	0.04
9	C1	0.22	0.07	0.06	0.09
10	C2	0.20	0.05	0.05	0.06
11	C3	0.17	0.03	0.04	0.05
12	C4	0.16	0.03	0.04	0.04
13	D1	0.19	0.09	0.03	0.10
14	D2	0.15	0.05	0.02	0.06
15	D3	0.12	0.03	0.01	0.04
16	D4	0.11	0.02	0.01	0.04
17	E1	0.17	0.08	0.04	0.05
18	E2	0.16	0.04	0.04	0.04
19	E3	0.13	0.03	0.02	0.01
20	E4	0.13	0.03	0.01	0.01
21	F1	0.16	0.09	0.06	0.08
22	F2	0.12	0.05	0.03	0.04
23	F3	0.08	0.03	0.02	0.00
24	F4	0.08	0.02	0.02	0.00

Figure 1. Heavy metal concentrations in various soil samples



The concentration of heavy metals are varies in tannery effluent (Cr>Zn>Pb>Cd). Heavy metals concentration are decreases largely in B, D and F type (15 – 60 days) pots, because it consists of vermicompost which is used to growing plant and accumulation of heavy metals (Table 3; Figure 1). So, the well growing plants which accumulate heavy metals easily than other pots (A, C and E type). Finally, excess amount of heavy metals in soil are remediated by combination of vermicompost with garden soil.

Conclusion

The results indicated that the concentration of heavy metals were gradually decreases in vermicompost with garden soil combination. So, it is suitable for well growing plant and heavy metals accumulation (15 - 60 days). Other pots (A, C and E type) are not suitable for the removal of heavy metals in contaminated soil, because it decreases heavy metals slowly than above type of combination. This study shows that *Eclipta alba* has a good potential to uptake and accumulate the toxic heavy metals from tannery polluted soil. It also pares away for the development of an economically cheap technology and suitable for a good phytoremediation method.

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