

PHYTOREMEDIATION OF LEAD (Pb) CONTAMINATED SOIL USING AZADIRACHTA INDICA CONOCARPUS ERECTUS AND EUCALYPTUS OBLIQUA

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Abstract: The pollution of heavy metals in soil is one of the world's biggest environmental issues which pose serious threats to human health and ecosystem. Many natural and anthropogenic or manmade activities are caused to soil contamination. Lead (Pb) is considered seriously harmful for human life due to its toxicity persistence bioaccumulation and bio magnification through the food chain and high level of accumulation in the soil more than 800,000tons of Pb have been released into the environment over the 50 years, most of which has accumulated in the soil causing consequential heavy metal pollution. The study was designed to examine the potential of three plant species to reclaim the soil contaminated from Lead (Pb). The experiment was conducted at Institute of Environmental Engineering & Management in Mehran university of Engineering and Technology Jamshoro. In the present study Azadirachta Indica Conocarpus Erectus and Eucalyptus obliqua has been used for phytoremediation of lead contaminated soil. Accumulation of heavy metal has been analyzed after 15 30 and 45 days by Atomic absorption Spectrophotometer (AAS).Lead (Pb) accumulated in all parts of the plant i.e. root leaf and stem however maximum lead removal from soil was recorded in Eucalyptus obliqua was 77.52% followed by Azadirachta Indica 62.63% and Conocarpus Erectus 57.17%.The study has shown that these plant species can be grown in lead contaminated soil to reclaim the soil from the contamination of Lead(Pb).The result suggests that Eucalyptus obliqua remove maximum lead from soil and it can be good accumulator of Lead from soil.

Keywords: Phytoremediation Lead Eucalyptus Obliqua Azadirachta Indica Conocarpus Erectus

1. Introduction

One of the World's biggest environmental issues is the pollution of heavy metals in soil posing serious threats to human health and ecosystems. (Stephen J couple et al.,2013).The soil is an integrated biological system and contains various organic and inorganic substances which are very crucial for good nutrition and plant growth (Gatyari et al., 2019).The contamination of soil is caused by natural and anthropogenic or manmade sources. The Anthropogenic activities are the main cause of contamination of agriculture lands and special attention is needed to address this issue (Mohd.Javeed et al., 2019). The contamination of soil and water is caused by many sources encompass of industrial waste mining waste fertilizer and pesticide residue.(Lina Herlina et al.,,2018). Lead (Pb) is considered seriously harmful for human life due to its toxicity persistence bioaccumulation and bio magnification through the food chain and high level of accumulation in the soil .Over the past 50years more than 800,000tons of Pb have been released into the world's environment, most of which has accumulated in the soil causing consequential heavy metal pollution. Lead is a toxic metal that affects the growth of the plants and the environment. (Hussein M.A et al.,2020).Pakistan has

different topography with a collection of climatic zones with high floral diversity. Pakistan has more than 6000 species of plants presently more than 400 plant species among angiosperms have been examined and identified as hyper accumulator all over the world. However in Pakistan only 50 species have been examined and identified as metal accumulators to remediate the contaminated soil and water.(Aqeel Kamran et al.,,2013).Traditional remediation techniques such as Physical and chemical processes are expensive often harmful to the local ecosystem and require large amounts of hazardous waste.(Ahmadreza Yazdan baksh et al.,2020). Phytoremediation is one of the biological approaches used for the remediation of soils. Phytoremediation is preferred because of its safety and low cost correspondence to physical and chemical (Md. Mahadi Hassan et al 2019). Phytoremediation could be a novel procedure and an integrated multidisciplinary approach that provides an excellent potential in the treatment of such contaminated system with the help of plants (wani et al .,2017). Phytoremediation (Phyto i.e. Plant and remediation i.e rebalancing) is an environmentally friendly cleaning technology that involves the use of plants and rhizosphere related microorganisms to treat environmental pollutants such as heavy metals.(singh H et al 2017).Several chemical amendments have been used to enhance the plant's

extraction process .In recent years, chemical additives including Ethylene diamine tetra acetic acid(EDTA) Ethylene glycol tetra acetic acid (EGTA) and Sodium dodecyl sulfate (SDS) have been widely used for soil remediation applications that may pose a potential risk of metal leaching (Md. Mahadi Hassan etal 2019). The promising adsorbents for wastewater treatment metal oxides (ZnO Fe₂O₃ CeO₂ TiO₂ ZnO₂ etc) have emerged as potential material due to their relatively large surface area low cost and high natural abundance Mn O₂ is preferred over these oxides because of its low cost high activity good stability high surface area environmentally friendly nature structural flexibility and strong oxidizing properties which are essential for an adsorbent for wastewater treatment.(Syed M .Hussain).Recently use of Mnox as soil amendments for Pb remediation has increased interest (Clare M. McCann etal.,2015).The objective of this study was to examine the phytoremediation potential of lead by using local plants Azadirachta Indica Conocarpus Erectus and Eucalyptus obliqua plants these are easily available and can grow everywhere across the country and also investigating the optimization remediation conditions by using Mn O₂ as an amendment adsorbent material.

2. Materials and Method

2.1 Study Area. Soil was taken from site area Hyderabad nearby unique battery at a depth of 0-15cm kept in polythene bags and bring into Hi Tech lab at IEEM and the lead concentration was analyzed by using flame Atomic absorption spectrophotometer (AAS) (Aurora Model – AI 1200 Canada) that was 4mg/kg.

2.2 Experimental Site. The study was a pot experiment conducted at the center of Institute of Environmental Engineering and Management Mehran UET Jamshoro. The experimental pots were filled with 10kg lead contaminated soil of different concentration of Pb contaminants such as 10ppm 20ppm 20Amendment ppm 30 ppm. The plants were irrigated with 200ml per pot of tap water daily and sampling of the plants to monitor metal uptake and soil for residual metal contents for 15 30 and 45 days after planting.

2.3 Soil Sample Preparation and Digestion. Soil samples were separated from pots and dried in oven at 70°C for 24 hours to remove moisture. The digestion of sample was perform by weight 1gram of soil for digestion 1:1 is used it means 5ml distill water and 5 ml nitric acid on hot plate continuously nitric acid is adding till the brown fumes are stopped after that 2ml D.W is added with 3ml H₂O₂ continuously added till the sample condition is changed the Adding of hydrogen per oxide is not more than 10ml after that HCl is added up to the sample volume remains 5ml after cooling each sample is diluted up to 50ml after that the analyze from atomic absorption spectrophotometry.

2.4 Analysis of Lead. After 15 30 and 45 days of planting all the plants were harvested separately according to soil treatment, separated into components namely roots leaves and stem then analyzed through Atomic Absorption spectrophotometer (Aurora Model – AI 1200 Canada).

2.5 Statistical Analysis. Statistical analysis was done by using Statistical Product for the service Solution software (SPSS).

3. Methodology

3.1 Physico chemical Properties of Soil. Physico Chemical Properties of soil are described in Table 1.

Table .1 Physico Chemical properties of Soil

PH	8.09
Alkalinity	13.3 mg/L
Electric Conductivity	0.10 mS/cm

3.2 Removal of Pb from contaminated soil at 10ppm

In the present study initial Pb concentration applied was 10ppm in Azadirachta Indica the highest uptake concentration of Pb from contaminated soil by root observed with a value of 4.67mg/kg within 45 days and lowest concentration uptake by root was observed 3.76 mg/kg in 15 days. The highest concentration uptake by leaves with a value of 22mg/kg within 45 days and lowest value observed in leaves with a value of 0.126mg/kg in 15 days. Highest concentration uptake by stem with a value of 2.28mg/kg and lowest concentration observed in stem with a value of 1.5mg/kg for 30 and 45 days. In Conocarpus Erectus the highest uptake concentration of Pb from contaminated soil by root observed with a value of 3.88mg/kg within 45 days and lowest concentration uptake by root was observed 3.58mg/kg in 15 Days. In leaves the highest accumulation was observed within 45 days with a value of 0.20mg/kg. In stem the highest accumulation was 1.62mg/L within 15 days and lowest value 1.51mg/kg within 30days was observed. In Eucalyptus Obliqua the highest uptake concentration of Pb from contaminated soil by root observed with a value of 3.35 mg/kg within 45 days and lowest concentration uptake by root was observed 3.12 mg/kg in 15 days.Leaves uptake Pb from contaminated soil with a highest concentration 0.70 mg/kg within 15 days and the lowest uptake of Pb by leaves with a value of 0.40 mg/kg. Stem uptake Pb at highest value of 1.95mg/L within 45days while the lowest was 1.34mg/kg within 15 days.

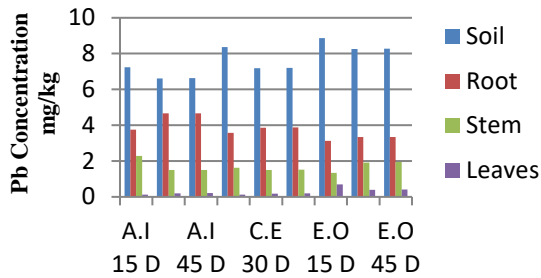


Fig.1 Shows Accumulation of Pb at 10ppm in Plant Species. Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O= Eucalyptus Obligua D=Day. Maximum Pb was removed from soil at 10ppm by using Azadirachta Indica 52.78% with Conocarpus Erectus Pb was removed from soil was 48.64% and by using Eucalyptus Obligua 41% Pb was removed from soil.

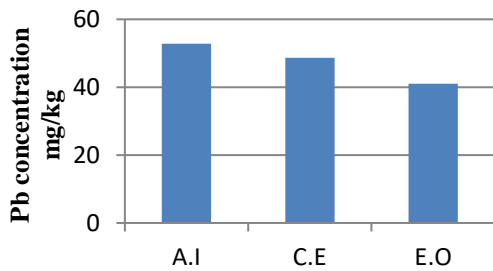


Fig.2Shows Removal of Pb from Soil at 10ppm Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O=Eucalyptus Obligua.

3.3 Removal of Pb from contaminated soil at 20ppm

In the present study the initial Pb concentration applied was 20 mg/kg for 15 30 and 45 days the Azadirachta Indica uptake highest concentration of Pb from contaminated soil by root observed with a value of 8.10 mg/kg within 45 days and lowest concentration uptake by root was observed 6.63 mg/kg within 15 days. Leaves uptake Pb within 45 days with highest value of 2.19 mg/kg and lowest value 2.542 mg/kg. Stem uptake Pb with highest concentration 4.79 mg/kg within 45days and lowest value 4.26 mg/kg within 15 days. In Conocarpus Erectus the highest uptake concentration of Pb from contaminated soil by root observed with a value of 5.34mg/kg within 45 days and lowest concentration uptake by root was observed 5.26mg/kg in 15 days. Leaves uptake Pb with highest value 0.32mg/kg within 45 days and lowest 0.20mg/kg within 15 days. Stem uptake Pb with highest value 3.74mg/kg in 15 days while the lowest value was 3.68mg/kg within 30days. In Eucalyptus Obligua the highest uptake concentration of Pb from contaminated soil by root observed with a value of 6.2 mg/kg within 45 days and lowest concentration uptake by root was observed 5.64 mg/kg in 15 days. Highest uptake of Pb by leaves with a value of 1.95 mg/kg within 45days and lowest value was 1.68 mg/kg within 15days. Highest concentration of Pb was uptake by stem was 3.85 mg/kg within 45days and lowest uptake by stem 2.28 mg/kg within 15days.

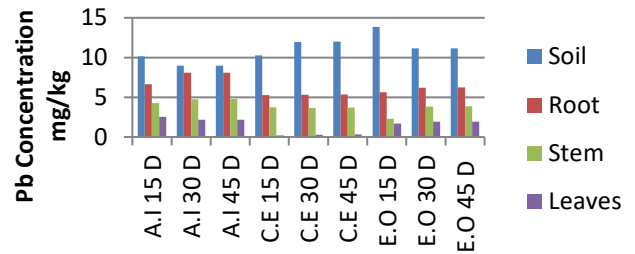


Fig.3 Shows Accumulation of Pb at 20ppm in Plant Species. Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O= Eucalyptus Obligua D=Day. Maximum Pb was removed from soil at 20ppm by using Azadirachta Indica 62.63% with Conocarpus Erectus Pb was removed from soil was 57.17% and by using Eucalyptus Obligua 53.60% Pb was removed from soil.

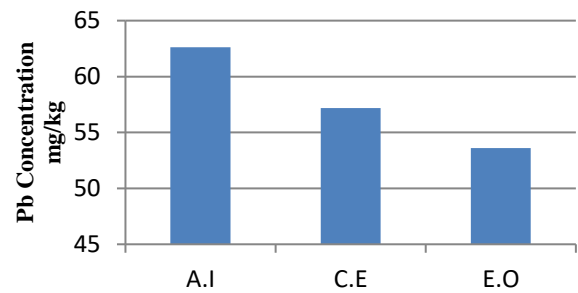


Fig.4 Shows Removal of Pb from Soil at 20ppm Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O= Eucalyptus Obligua.

3.4 Removal of Pb from contaminated soil at 20ppm Amendment

In the present study the initial Pb concentration applied 20 mg/kg and 10mg manganese di oxide as an amendment material for 15 30 and 45 days the Azadirachta uptake highest concentration of Pb from contaminated soil by root observed with a value of 2.2 mg/kg within 15 days and lowest concentration uptake by root was observed 1.96 mg/kg in 30 days. Leaves uptake Pb highest with a value of 1 mg/kg within 30 and 45 days. Stem uptake Pb with a highest value of 0.36 mg/kg within 30 and 45 days and lowest value was 0.30mg/kg within 15days. In Conocarpus Erectus highest uptake concentration of Pb from contaminated soil by root observed with a value of 2.26 mg/kg within 15 days and lowest concentration uptake by root was observed 1mg/kg in 45 days. Leaves uptake Lead with a value of 0.5 mg/kg which is highest value and lowest 0.2 mg/kg concentration was in leaves within 15 days. Stem uptake Pb with highest concentration 0.88 mg/kg within 45 days while the lowest concentration was observed within 15 days with a value of 0.8 mg/kg. In Eucalyptus Obligua the highest uptake concentration of Pb from contaminated soil by root observed with a value of 3.82 mg/kg within 45 days and lowest concentration uptake by root was observed 2.93 mg/kg in 30 days. In leaves highest uptake within 15 days at a value of 1.70 mg/kg and lowest uptake within 30days at a value of 1.12 mg/kg. Stem uptake lead from contaminated

soil highest at a value of 2.64 mg/kg and lowest value 2.24 mg/kg within 30days.

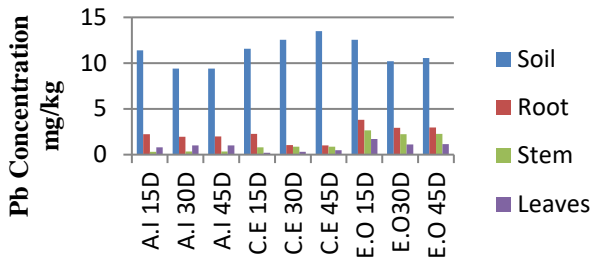


Fig.5 Shows Removal of Pb from Soil at 20ppm MnO₂ Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O=Eucalyptus Obliqua

Maximum Pb was removed from soil at 20ppm MnO₂ used as an amendment material by using Azadirachta Indica 60.85% with Conocarpus Erectus Pb was removed from soil was 51.75% and by using Eucalyptus Obliqua 57.45% Pb was removed from soil.

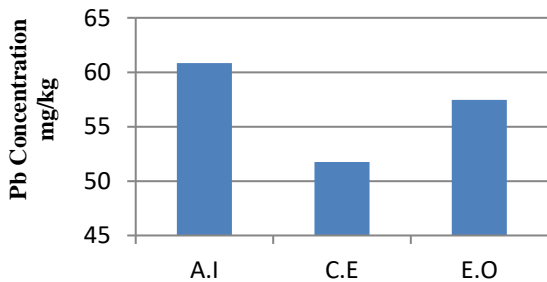


Fig.6 Shows Removal of Pb from Soil at 20ppm MnO₂ Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O= Eucalyptus Obliqua

3.5 Removal of Pb from contaminated soil at 30ppm

In this study the initial Pb concentration applied was 30mg/kg for 15 30 and 45 days In Azadirachta Indica the highest uptake concentration of Pb from contaminated soil by root observed with a value of 11.65mg/kg within 45 days and lowest concentration uptake by root was observed 10.34mg/kg in 15 days. Highest uptake of Pb by leaves was 2.5mg/kg within 45 days and lowest was 1.8 mg/kg within 15days. Stem uptake Pb with highest concentration of 2.69mg/kg within 45 days and the lowest value was 2.36mg/kg within 15 days. In Conocarpus Erectus the highest uptake concentration of Pb from contaminated soil by root observed with a value of 3.985 mg/kg within 45 days and lowest concentration uptake by root was observed 2.208 mg/kg in 15 days. In Leaves the highest concentration of Lead was uptake at a value of 0.98 mg/kg within 45days while the lowest concentration was 0.8 mg/kg within 15 days. Stem uptake highest Pb concentration within 45days at a value of 2.8 mg/kg and lowest uptake was 1.9 mg/kg within 15days In Eucalyptus Obliqua the highest uptake concentration of Pb from contaminated soil by root observed with a value of 7.27 mg/kg and lowest concentration uptake

by root was observed 6.12 mg/kg. Leaves uptake highest within 45days

at a value of 2.25 mg/kg and lowest within 15days at a value of 2.15 mg/kg. Stem accumulate Lead highest within 45days with a value of 5.94 mg/kg and lowest was within 15days 5.64 mg/kg.

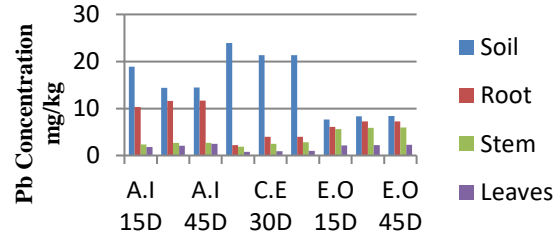


Fig.7 Shows Removal of Pb from Soil at 30ppm Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O=Eucalyptus Obliqua. Maximum Pb was removed from soil at 30ppm by using Azadirachta Indica 57.61% with Conocarpus Erectus Pb was removed from soil was 37.29% and by using Eucalyptus Obliqua 77.52% Pb was removed from soil.

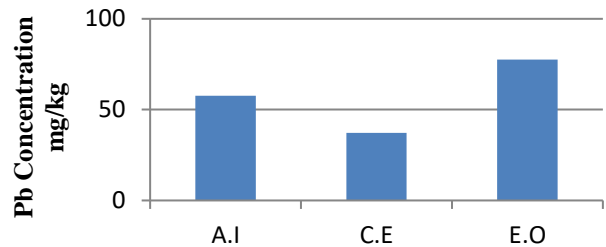


Fig.8 Shows Removal of Pb from Soil at 30ppm Note. A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O=Eucalyptus Obliqua.

3.6 Bio concentration factor (BCF) and Translocation factor (TF)

The bio concentration factor (BCF) and Translocation Factor (TF) values assist to recognize eligibility of plants for phytoremediation (i.e. Phytoextraction or phytostabilization) by explicating the accumulation characteristics and translocation practices of metals in plants.

Plants with BCF and TF values greater than one are treated likely phytoextractor, acceptable for phytoextraction although those with BCF and TF less than one are not considered for phytoextraction/phytostabilization. In spite of plants with BCF greater than one and TF less than one are designed potential phytostabilizers suitable for phytostabilization (immobilization). (Hira Amin etal 2018,). The bio concentration factor (BCF) was represented as the ratio of the Pb concentration in plant roots to the soil and calculated as follows:

$$BCF = \frac{\text{Metal content in plant tissue}}{\text{Metal content in soil}}$$

The translocation factor (TF) was determined as a ratio of heavy metals in plant shoot to that in plant root calculated as follows:

$$TF = \frac{\text{Shoot}}{\text{Root}}$$

The highest BCF was recorded in Eucalyptus obliqua 1.85 at 30ppm for 30days while Azadirachta indica the highest BCF was recorded 1.68 at 20ppm for 45 days and lowest BCF value was recorded 0.17 in conocarpus erectus at 20

amendment for 30 days. The highest TF in Eucalyptus 1.27 at 30ppm in 45 days In neem tree TF was recorded 1.02 at 20ppm for 15 days and in conocarpus 1.38 at 20 Amendment in 45 days. The BCF and TF values are summarized in table 2

Table.2 for BCF and TF

A.I= Azadirachta Indica C.E= Conocarpus Erectus E.O= Eucalyptus Obliqua.

Treatment	Plant	BCF15D	BCF30D	BCF45D	TF15D	TF30D	TF45D
10ppm	A.I	0.85	0.96	0.96	0.63	0.366	0.37
20ppm	A.I	1.32	1.67	1.68	1.02	0.85	0.86
20 A	A.I	0.29	0.35	0.35	0.49	0.69	0.68
30ppm	A.I	0.76	1.13	1.16	0.40	0.41	0.44
10ppm	C.E	0.63	0.77	0.77	0.48	0.43	0.44
20ppm	C.E	0.89	0.77	0.17	0.74	1.03	0.75
20 A	C.E	0.28	0.17	0.17	0.44	1.12	1.38
30ppm	C.E	0.205	0.34	0.36	1.22	0.86	0.94
10ppm	E.O	0.58	0.68	0.68	0.65	0.69	0.70
20ppm	E.O	0.692	1.07	1.08	0.70	0.92	0.92
20 A	E.O	0.65	0.61	0.60	1.13	1.14	1.14
30ppm	E.O	1.82	1.85	1.84	1.27	1.12	1.12

Table.3 for Statistical Correlation

		Correlations		
		Azadirachta (Neem Tree)	Cornocarpus Erectus	Eucalyptus Obliqua
Azadirachta (Neem Tree)	Pearson Correlation	1	.994	.898
	Sig. (2-tailed)		.069	.290
	N	3	3	3
Cornocarpus Erectus	Pearson Correlation	.994	1	.845
	Sig. (2-tailed)	.069		.359
	N	3	3	3
Eucalyptus Obliqua	Pearson Correlation	.898	.845	1
	Sig. (2-tailed)	.290	.359	
	N	3	3	3

3.7 Statistical Analysis by SPSS

By using Pearson correlation adding all uptake values of Pb ions of Eucalyptus Obliqua Azadirachta Indica and

Conocarpus Erectus at 10ppm 20ppm and 30ppm and correlate them with each other. It was observed that strongest correlation was Conocarpus Erectus with Neem tree was 99%. Correlation of Neem tree with Eucalyptus Obliqua was 89%. Correlation of Eucalyptus Obliqua with Conocarpus Erectus was 84%. Correlation calculation was done at a 95% confidence level.

4. Acknowledgment

I would like to thanks that supported me during My research work and especially thanks for the lab faculty member of institute, who cooperate support and provided me equipment during my lab work.

5. Conclusion

Aim of this study was to remove lead from contaminated soil by using local plants Azadirachta Indica (neem tree) Conocarpus Erectus and Eucalyptus Obliqua for 15 30 and 45 days. The Eucalyptus Obliqua (Bedmushk) accumulated higher Lead concentration with removal of 77% at 30ppm Pb concentration in 30 days, while the results were almost same after 45 days. Whereas after Eucalyptus obliqua, the Azadirachta Indica plant indicated Pb uptake of 62.63% from soil at 20 mg/kg concentration. The least uptake of Pb was measured for Conocarpus with 57.17% uptake at 20 mg/kg of Pb. Pearson correlation between the plants suggested that the Eucalyptus indicated slight higher

correlation with Azadirachta Indica than Conocarpus Erectus with value of 0.898 at 95% confidence level.

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