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Original Article

Studies on Hyper accumulation of Copper, Zinc and Nickel using plant Chromolaena odorata from contaminated soil

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Abstract

Anthropogenic activities of human being have led to heavy metal contamination in soil especially on the banks of rivers. However, for this heavy metal removal, many plant species called as metal accumulators show amazing property of accumulating metal from soil and help in soil clean up. Chromolaena odorata is one of such plant which shows hyperaccumulator activity with Bioconcentration factor ranging from 1.42 to 7.8 at different sites for Cu & Zn metal, whereas for Ni metal tolerance is observed. (BCF-0.043 to 0.076). This plant's potential is useful for technologies like phytoremediation and phytoextraction. It is greener method of soil filtration.

Keywords*: Heavy metal removal, hyperaccumulators, tolerance, phytoextraction,*

Introduction

Heavy metal contamination in soil is major issue. Today's increased globalization and industrialization, have led to increased heavy metal pollution. Now a days technologies like phytoremediation, phytoextraction are used for soil clean up. Many plants act as hyper accumulators, tolerant for different heavy metals and are useful in phytoremediation process for contaminated soils at different sites like river banks, industrial sites. Such Plants are observed to adapt with the higher concentrations of heavy metals and become hyperaccumulator or tolerant. So, this research mainly aims to know Chromolaena odorata plant's hyperaccumulation ability of for Cu, Zn and Ni metals. This is greener easy way of soil filtration.

Literature review:

Vardanyan Get al, (2006) reported vegetation's metal uptake as plant specific, element specific. According to Vuduta Subhashini, (2017) metal concentrations in plants are different at different sites. So Bioconcentration Factor (BCF) was **c**alculated as the metal concentration ratio of plant roots to soil (Joonki Yoon, 2006). Atagana,2011 reported that Chromolaena odorata is useful for reduction of contaminated soil's toxicity and compared to results of germination rates and germination energy measurements of Chromolaena odorata.(Agunbuade, 2009).Thus scientists reported this plant as pollution Biomarker.

Material method:

In present investigations, the concentrations of three heavy metals i.e. Cu, Ni, and Zn are determined from soil and plant species Chromolaena odorata (L) with the ICP –MS method, from selected sites S_1. S_2 and S_4 and Bioconcentration factor is calculated for further studies. Figure 1 shows plant Chromolaena odorata *(L)* as follows--



Figure 1 –Plant of Chromolaena odorata

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Classification of plant is:

1. Kingdom-Plantae Phylum- Angiosperms family-Asteraceae
2. Order- Asterales Genus: Chromolaena Species: C. odorata

The total metal concentration of Cu, Ni, and Zn metals in 0.1 gm of dry biomass of Chromolaena odorata observed is given below in table1.

Table 1-Sitewise variation of metal content in plant and in soil

Site details	Cu in p lant	Cu in soil	Zn in plant	Zn in soil	Ni in plant	Ni
	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	in soil
						mg/Kg
S1	1033.75	147.26	127.75	90	3.5	81.74
S2	677.75	110.93	134.25	78.35	4.75	74.62
S4	601	76.33	123	82.67	5.25	68.52

From observations, it is observed that heavy metal concentrations in plants and soil are above desirable limits. Higher concentrations of Zn metal are observed in plant i.e. 127.75 mg/Kg ,134.25 mg/kg and 123 mg/Kg at sites 1, site 2 and site 4. In soil, observed concentrations are 90 mg/kg,78.35mg/Kg and 82.67 mg/Kg. Thus, soil is purer. Similar observations are for metal Cu. This proves that plants accumulate more metals like Cu and Zn, so lesser is remaining in soils. So, these plants act are hyperaccumulator of Cu, Zn metals. But for Ni metal more amounts are observed in soil and lesser in plants, so this plant is tolerant to Ni metal. So, this plant is hyperaccumulator for Cu moderate for Zn and tolerant for Ni metal. Following figure 2,3&4 shows Site-wise & comparative variation of Cu, Ni, and Zn metals concentrations in soils and plant.

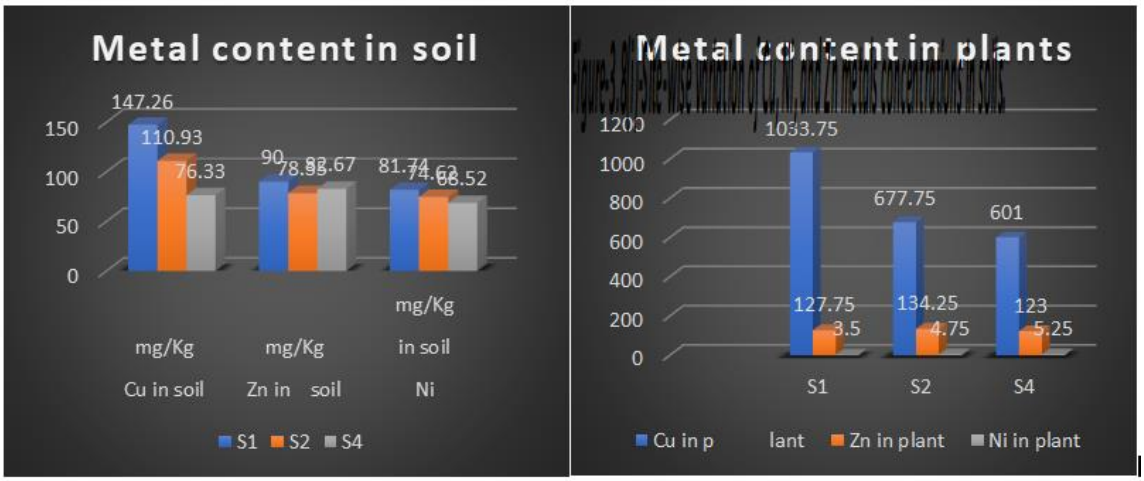

Figure-2-Site-wise variation of Cu, Ni, and Zn metals concentrations in soils. Figure-3.-Site-wise variation of Cu, Ni, and Zn metals concentrations in plants.

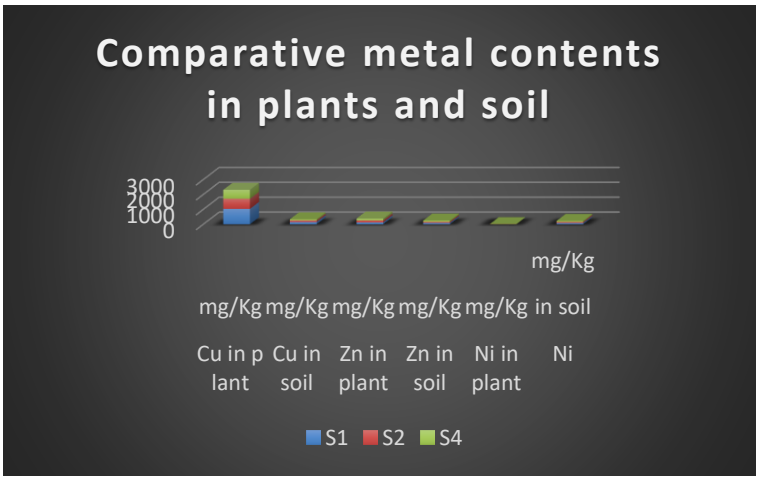

Figure-4 Comparative Site-wise variation of Cu, Ni, and Zn metals concent in soils.

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Phyto remedial potential of plant can be checked with BCF. BCF is the ratio of metal content in plant-to-metal content in soil. Observed BCF are as follows-Plants can be "tolerant (BCF<1)," "indicator" and "hyperaccumulator (BCF>1)" of these metals and can be used for phytoextraction Pb& Cd accumulated by leaves of C. odorata were remarkable with contamination factor 10.51 and 23.50 respectively observed in areas with traffic pollution. (Agunbuade, 2009). Following table 2& figure 5 show site wise and metal wise variation in BCF of the plant as follows-

	Cu BCF	*Zn BCF*	*Ni BCF*
S1	*7.019*	*1.42*	*0.043*
S2	*6.109*	*1.713*	*0.063*
S4	*7.873*	*1.487*	*0.076*

Table 2- Site wise BCF variation

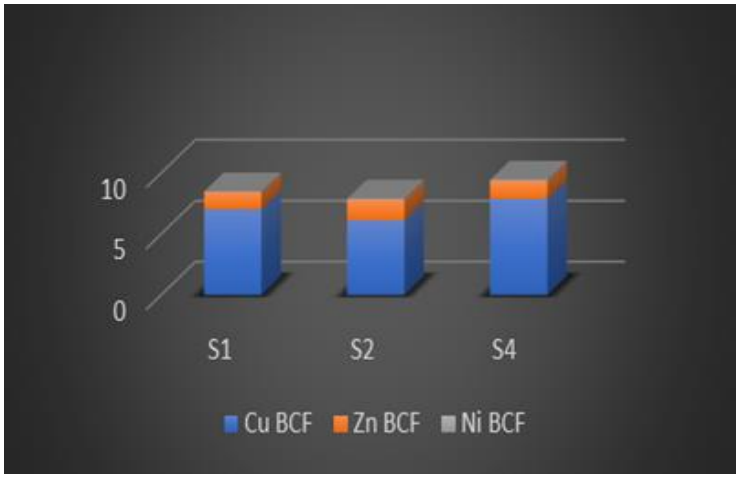

figure 5- Site wise variation in BCF

Following table shows BCFs and their accumulation ability-

Copper	Zinc	Nickel
S1-BCF-7.019 (high accumulation)	S1-BCF-1.42 (moderate accumulation)	S1-BCF-0.043 (low accumulation)
S2-6.109 (moderate accumulation)	S2-1.713 (moderate accumulation)	S2-0.063 (low accumulation)
S4-7.8573 (high accumulation)	S4-1.487 (moderate accumulation)	S4-0.076 (low accumulation)
Effective Cu removal from site S1&S4	Moderate removal of Zn removal from site S1, S2 &S4	Low Ni removal from site S1, S2 &S4

Table 3-Showing BCF values and their interpretation

From above table, it is observed that these plants are very useful in removing Cu and moderately useful in removing Zn from the soil. However, they are less useful in removing Ni from the soil. The BCF values suggest that the plants can be used for phytoremediation of Cu and Zn contaminated soils. Such type of soil -purification is natural greener process, which in creating pollution from ecosystem. But further studies and progressive technologies are required in this research area.

Conclusion

The present study highlights the phytoremediation potential of Chromolaena odorata for heavy metal–contaminated soils. The investigation revealed that the plant exhibits strong hyperaccumulation ability for copper (Cu), with Bioconcentration Factor (BCF) values greater than 6 at all studied sites, indicating its effectiveness in removing Cu from contaminated soils. Zinc (Zn) showed moderate accumulation, with BCF values slightly above unity,

suggesting that Chromolaena odorata can also be effectively used for Zn remediation. In contrast, nickel (Ni) demonstrated very low BCF values (<1), indicating that the plant is tolerant rather than accumulative for Ni.

The results confirm that Chromolaena odorata significantly reduces Cu and Zn concentrations in soil by transferring these metals into its biomass, thereby improving soil quality. This plant-based remediation approach is eco-friendly, cost-effective, and sustainable compared to conventional physicochemical methods. However, the limited accumulation of Ni suggests the need for further research to enhance metal uptake efficiency or to combine phytoremediation with advanced remediation technologies. Overall, Chromolaena odorata proves to be a promising candidate for the phytoremediation of Cu- and Zn-contaminated soils, particularly in polluted riverbanks and industrial areas.

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