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Research Article

PHYTOREMEDIATION STUDIES ON COPPER AND LEAD CONTAMINATED SOIL BY USING *BRASSICA JUNECEA*

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ABSTRACT

Phytoremediation is an emerging technology that uses various plants to degrade contamination from soil and water. *Brassica* species close relatives of the well-known metal-accumulating wild mustards have received much attention. In the present studies investigated that the *Brassica junecea* was take up of concentrate toxic heavy metal like copper and lead from contaminated soil. The result revealed that the highest height of the *B. juncea* was observed in 8th weeks of pot IV (38 ± 0.4 cm) and followed by copper (37±0.5 cm) and lead (35±0.3 cm) contaminated soil respectively. The fresh weight of these plants was increased as compared to control (without metal mix). Increase in fresh weight shows that Pb and Cu (102.3±2.1 mg) at pot IV in favour of growth in *B. juncea* to compare with other experimental conditions. In this result to indicate the combination of Pb and Cu contaminated soil having height removal percentage at 8th week (48 %) and other group experiment also.

Keywords: Phytoremediation, *Brassica junecea*, Contaminated soil, Heavy metal.

INTRODUCTION

Phytoremediation has emerged as an alternative to the engineering-based methods. In this new approach, plants are used to absorb contaminants from the soil and translocate them to the shoots. The metal rich plant material may be safely harvested and removed from the site without extensive excavation, disposal cost and loss of top soil associated with traditional remediation practices (Blaylock *et al*., 1997).

Phytoremediation is an alternative or complimentary technology that can be used along with or, in some cases in place of mechanical conventional clean-up technologies that often require high capital inputs and are labor and energy intensive. Phytoremediation is an in situ remediation technology that utilizes the inherent abilities of living plants. It is also an ecologically friendly, solar-energy driven clean-up technology, based on the concept of using nature to cleanse nature. Contamination of soil by oil spills is a wide spread environmental problem that often requires cleaning up of the contaminated sites (Akcin *et al.,* 1994).

Heavy metals are naturally occurring elements, and are present in varying concentrations in all ecosystems. There are a huge number of heavy metals. They are found in elemental form and in a variety of other chemical compounds. Those that are volatile and those that become attached to fine particles can be widely transported on very large scales. Each form or compound has different properties which also affect what happens to it in food web, and how toxic it is. Human activities have drastically changed the biochemical cycles and balance of some heavy metals (Nriagu, 1995). The main anthropogenic sources of heavy metals are various industrial processes, mining, foundries, and smelters, combustion of fossil fuel and gasoline, and waste incinerators. The major heavy metals of concern to EMEP are Hg, Cd and Pb, because they are the most toxic and have known serious effects on e.g. human health. Environmental exposure to high concentrations of heavy metals has been linked with e.g. various cancers and kidney damage. Heavy metals (Ni and Cd) uptake, distribution and accumulation in plants as well as their effects on physiological and morphological traits have been summarized in several recent reviews (Lux *et al*., 2011).

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Brassica juncea belongs to family brassicaceae and is a very important oil crop. Mustard oil is one of the major edible oils in India. In the recent past decades, *Brassica juncea* has drawn the attention of researchers because of its high biomass production with added economical value and its high capacity to translocate and cumulate many metals and metalloids as As, Cd, Cu, Pb, Se, and Zn from polluted soils and therefore, can be considered as a good candidate in phytoremediation processes (Salt *et al*., 1995).

Several studies have shown that metals such as Lead (Pb), Cd, Nickel (Ni) amongst others are responsible for certain diseases that have lethal effects on man and animals (Giddings, 1973; Gustav, 1974). The present study aimed that the different concentration of heavy metals were removed from soil by using *Brassica juncea.*

MATERIALS AND METHODS

Collection of seeds

The healthy *Brassica juncea* seeds were collected from local market in Thanjavur, and brought to the laboratory under sterile condition.

Preparation soil sample

Top soils (0-15 cm) were collected from Garden of Marudupandiyar College, Thanjavur, Tamil Nadu, India. The soils were thoroughly mixed by a mechanical mixer and passed through 4 mm sieve to remove fibre and non soil particulate in the sample. To take four plastic pots were filled with 2 kg of soil samples in each that passed through a 4mm sieve. The first pot labelled as control because of doesn't add metal concentration. 5mg/kg of lead to added second pot of sample, 5mg/kg of copper was added to third sample pot and 5mg/kg of each copper and lead were added to fourth sample pot. The soils in the pots were thoroughly mixed for even distribution of the contaminant and watered to field capacity. Three seeds of Mustard were planted in each pot. Deionised water (300ml) was added twice a week during the first month and then every two days. All the pots to place on 500 µmols of photo synthetically active radiation at the plant top with a 12:12 hr photoperiod at 22± 2° C for 60 days.

Enumeration of height and weight of *Brassica juncea*

After 60 days, these plants were removed from pots and washed with distilled water. Then they are weighted for fresh and dry weight and also to measure the height of the plant from four different pots.

Estimation of heavy metal concentration

The plants samples were digested in $HClO_4$ / HNO_3 (1:2 ratio) mixture and were analyzed for heavy metals like cu and pb were measuring by atomic absorption spectrophotometer (AAS). Metal content of plants was noted in µg/g of dry weight and kg/ha of soil.

RESULTS AND DISCUSSION

The dry weight content of *Brassica juncea* was analysed after treatment in artificially contaminated soil. The fresh weight of these plants was increased as compared to control (without metal mix). Increase in fresh weight shows that Pb and Cu (102.3±2.1 mg) at pot IV in favour of growth in *Brassica juncea* to compare with other experimental conditions (Table 1). The earlier study suggested that the fresh weight of these plants was increased as compared to control (without Ni). Increase in fresh weight shows that Ni favours growth of water hyacinth (Qian *et al.*, 1999). Table 1 shows the change in fresh weight. The increase in fresh weight was reported by Lu *et al*. (2004).

In Table 2 show the increase in height of the *Brassica juncea* at 8th weeks of the different experimental condition. The highest height of the *Brassica juncea* was observed in 8th weeks of pot IV (38 ± 0.4 cm) and followed by copper (37±0.5 cm) and lead (35±0.3 cm) contaminated soil respectively. The little height was observed in 2nd week of Pot I (control) and followed by copper contaminated soil at Pot III (23±0.2). The pervious study revealed that the metal rich plant material may be safely harvested and removed from the site without extensive excavation, disposal cost and loss of top soil associated with traditional remediation practices (Blaylock *et al*., 1997).

Heavy metal removal by Phytoremediation

Removal of heavy metal from artificially contaminated soil by using *Brassica juncea.* The highest removal of lead and copper at pot IV in 8th week of treatment (5.2±0.4 mg/kg) and followed by pot III (Cu) and Pot II (Pb) respectively (Table 3). In this result to indicate the combination of Pb and Cu contaminated soil having height removal percentage at 8th week (48 %) and other group experiment also. To extent the incubation period and also increase the heavy metal removal percentages. For better land restoration or remediation, plant species used for the phytoremediation process must produce sufficient biomass while accumulating high concentration of the metal (Chaney *et al.*, 1997). The accumulation of metals in plant organs attained the highest values in roots, rhizomes and old leaves (Akporhonor and Egwaikhide, 2007). Garbisu and Alkorta (2001) evaluated phytoextraction and remediation efficiency of *Mirabilis jalapa* (L.) in multi-metal contaminated soil. It was found that this plant was most efficient in Zn accumulation in above ground tissues.

Table 1. Weight of the *Brassica juncea* in different experimental condition.

S. No.	Group	Experimental conditions	Weight of the *Brassica juencea* (mg)
1	Pot I	Control	85.2±2.0
2	Pot II	Lead	98.5±1.5
3	Pot III	Copper	87.4±1.2
4	Pot IV	Lead and Copper	102.3±2.1

Table 2. Height of the *Brassica juncea* in different experimental condition at different incubation periods.

S. No.	Group	Experimental conditions	Height of the *Brassica juncea* (cm)			
			2 weeks	4weeks	6 weeks	8weeks
1	Pot I	Control	20±0.1	23±0.3	25±0.2	30±0.1
2	Pot II	Lead	24±0.2	26±0.3	29±0.3	35±0.3
3	Pot III	Copper	23±0.2	27±0.4	30±0.3	37±0.5
4	Pot IV	Lead and Copper	24±0.2	27±0.3	34±0.4	38±0.4

Table 3. Removal of heavy metal by *Brassica juncea* in different experimental condition at different incubation periods.

S. No.	Group	Experimental conditions	Initial (mg/kg)	Heavy metal removal after treatment			
				2 weeks	4 weeks	6 weeks	8 weeks
1	Pot I	Control		10±0.1	10±0.1	10±0.2	10±0.1
2	Pot II	Lead	10	9.4±0.2	8.7±0.3	8.4±0.3	7.2±0.3
3	Pot III	Copper	10	9.5±0.2	8.5±0.4	7.3±0.3	6.2±0.5
4	Pot IV	Lead and Copper	10	9.5±0.2	7.8±0.3	6.2±0.4	5.2±0.4

CONCLUSION

The present investigation indicates that *Brassica juncea* showed excellent removal of Cu and Pb from artificially contaminated soil. The developed technologies used can be applied for phytoremediation of heavy metal contaminated soil. This technology requires no additional nutrient requirement, has the cheapest regeneration of bio sorbent and high possibility of metal recovery.

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