Cultivation on Polluted Areas with Heavy Metals and Naturally Enriched Areas

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Introduction

With increasing heavy metal contamination due to various human and natural activities, ecosystems are being contaminated with heavy metals.

Contaminated soil can be remediated by chemical, physical or biological techniques. Techniques grouped into two categories: (a) *ex situ* techniques: require removal of the contaminated soil for treatment. (b) *in situ* methods: remediate without excavation of contaminated soil. *In situ* techniques are favored over the *ex situ* techniques due to their lower cost and reduced impact on the ecosystem. Phytoremediation is an innovative technology that utilizes the natural properties of plants to remediate hazardous waste sites. In the extreme forms of tolerance, plants exhibit hyper-tolerance and often accumulate exceptionally high concentrations of heavy metals in their tissues, these plants are called hyper-accumulators. To enhance phytoremediation as a viable strategy, fast growing plants with high metal uptake ability and rapid biomass gain are needed. In general, hyperaccumulation can be defined as uptake and sequestration of exceptional concentrations of an element in the aboveground parts of a plant under field conditions .

This sustainable and inexpensive process is emerging as a viable alternative to traditional contaminated land remediation methods. To enhance phytoremediation as a viable strategy, fast growing plants with high metal uptake ability and rapid biomass gain are needed.

phytoremediation strategies focus on their accumulation in above-ground plant parts and removal from the contaminated site. Phytoremediation is most effective on sites containing a low level and widely dispersed contaminant over a large area in the upper surface of the soil. Phytoremediation Can work with site restoration with minimum site disruption. Additionally, plant biomass can be harvested to remove contaminants from the site and trees without disturbing the site.

Material and methods

Five *Eucalyptus* species which planted and well growing in north are *Eucalyptus camaldulensis, E. microtheca, E. occidentalis, E.sargentii ,E. Largiflorens and in south Eucalyptus camaldulensis, E. microtheca.* Sampling from trunk with Increment borer, leaves, root and soil in depth of 0-20, 20-40, and 40-60cm belonged to each tree from polluted area in Khozestan (South) and clean areas of Golestan (North) provinces of Iran had been carried out.

This experiment had been carried out based on Completely Randomized Design with 3 replications and control as well as 3 levels of heavy metals with 5 different heavy metal elements with 5 species of: *Eucalyptus camaldulensis, E. microtheca, E. occidentalis, E.sargentii ,E. Largiflorens.*

Also these *Eucalyptus* species are planted as seedlings in glasshouse under controlled condition to investigate heavy metals uptake by plant in different parts of root, stem and leaves. Plants will be harvested after 10 months for analysis. Also biomass of *Eucalyptus* species under control and treated with heavy metals will be measured in different parts of root, stem and leaves.

Results and Discussion

Chemical analysis of heavy metals in Golestan Province showed that in spite of former imagination on clean and free contamination regards to heavy metals, contamination of this province is lower than European standards but contamination is higher than Environmental Protection Agency of USA (EPA-US). There is not meaningful significance between Eucalyptus species regards to Copper (Cu) in Golestan Province. Order of Heavy metals concentration(mg/kg) inside soil, root,trunk and leaf of *Eucalyptus microtheca* are as follows: Zn: soil > leaf > trunk > root ,

Cu: soil> leaf , root , trunk, Ni: soil > leaf > root > trunk, Pb: soil> leaf > root , trunk

Order of Heavy metals concentration(mg/kg) inside soil, root,trunk and leaf of *Eucalyptus camaldulensis* are as follows: Zn: soil > leaf > trunk > root, Cu: soil > leaf > trunk > root

Ni: soil > leaf > root > trunk, Cd: soil> leaf , root , trunk, Pb: soil> leaf , root , trunk

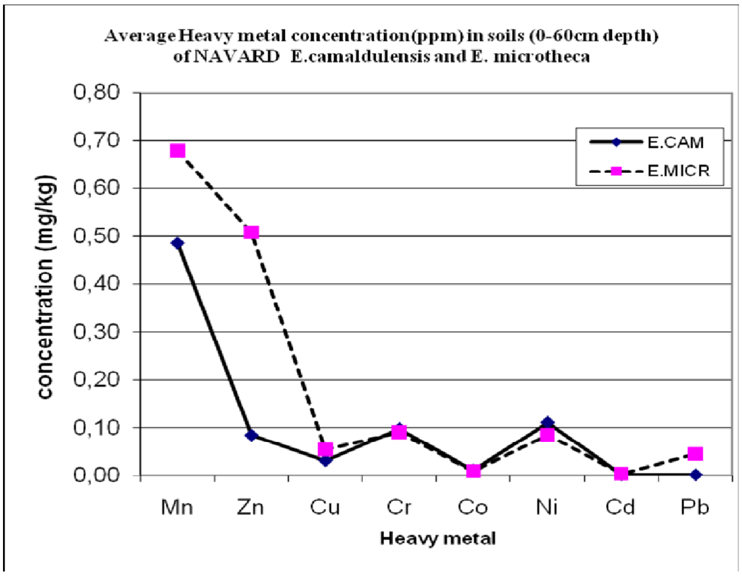
Conclusions and outlook

Statistical analysis of data provided by chemical analysis through Khuzestan sites for soil sampling in different depth of 0-20cm, 20-40 cm and 40-60 cm are as follows:

Different soil depth of 0-20cm, 20-40 cm and 40-60 cm had not significant difference for elements of P, K, Ca, Mg, Mn, Fe, Cr , Zn , Ni, Cd, Pb and Cu in level of 1% and 5% . Depth of 0-20cm and 40-60 cm had significant difference for element of Carbon (C) in level of 5% .
Different soil depth of 0-20cm, 20-40 cm and 40-60 cm had significant difference for element of Nitrogen (N) in level of 5% . Different soil depth of 0-20cm, 20-40 cm and 40-60 cm had significant difference for element of Sulfur (S) in level of 5% . Different soil depth of 0-20cm, 20-40 cm and 40-60 cm had significant difference for element of Sodium (Na) in level of 5% . Different soil depth of 0-20cm and 40-60 cm showed significant difference with together for element of Aluminium (Al) in level of 5% .

Correlation of root elements uptake regards to different Eucalyptus species in Khuzestan Province

	Zn	**Cu**	**Co**	**Ni**	**Cd**
Zn	1	.745**	.649**	.716**	.714**
Cu	.745**	1	.722**	.817**	.564*
Co	.649**	.722**	1	.761**	.417
Ni	.716**	.817**	.761**	1	.331
Cd	.714**	.564*	.417	.331	1



- Chemical analysis of heavy metals in Golestan Province showed that in spite of former imagination on clean and free contamination regards to heavy metals, contamination of this province is lower than European standards but contamination is higher than Environmental Protection Agency of USA (EPA-US).

- *E. camaldulensis* is most efficient accumulmator under field conditions of Golestan Province
- concentration of elements inside leaf, trunk and soil relevant to *Eucalyptus* species are higher than EPA limits, and lower than critical load (C.L) in loam and background soil.

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