

Investigation of Phytoextraction Coefficient Different Combination of Heavy Metals in Barley and Alfalfa

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Abstract—Two separate experiments by barley and alfalfa were conducted to a 2×8 factorial completely randomised design, with four replicates. Factors were inoculation (M) with *Gomus mosseae* or uninoculation (M0) and seven levels of contaminants (Co, Cd, Pb and combinations) plus an uncontaminated control treatment (C). Heavy metals in plant tissues and soil were quantified by Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) (Variant-Liberty 150AX Turbo). Phytoextraction coefficient of contaminants calculated by concentration of heavy metals in the shoot (mg kg^{-1}) / concentration of heavy metals in soil (mg kg^{-1}). In the barley, the highest rate of phytoextraction coefficient of Pb, Cd and Co was in M0Pb, M0PbCoCd and MCo, respectively ($P < 0.05$). In the alfalfa plants, the highest phytoextraction coefficient of Cd, Co and Pb obtained in the treatments M0CoCd, M0Co and M0PbCd, respectively.

Keywords—phytoextraction coefficient, heavy metals, barley, alfalfa

I. INTRODUCTION

HEAVY metal pollution of the biosphere has accelerated rapidly since the onset of the industrial revolution and heavy metal toxicity poses major environmental and health problems. Clean up of hazardous wastes using conventional technologies will expensive [1].

Metal accumulation by plants is affected by many factors. In general, variations in plant species, the growth stage of the plants, and element characteristics control absorption, accumulation, and translocation of metals. Furthermore, physiological adaptations also control toxic metal accumulations by sequestering metals in the roots [2].

Phytoremediation (Green Clean) is a cost-effective and eco-friendly strategy, which can compliment or replace conventional approaches. Plants are endowed with the capacity to degrade the pollutants and/or accumulate them in their vegetative parts, which help to remove materials from their immediate environment. Plants can be used to remove, transfer, and stabilize heavy metals from the contaminated soil [3, 4, 5].

In the present investigation phytoextraction coefficient of Cd, Co and Pb by barley and alfalfa was estimated.

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II. MATERIALS AND METHODS

Two separate experiments were set up in a 2×8 factorial completely randomised design, with four replicates. The first factor was inoculation (M) with *Gomus mosseae* or uninoculation (M0). The second factor had seven levels of contaminants: (Co, Cd, Pb and combinations) plus an uncontaminated control treatment (C). A sample of soil (clay 35%, silt 40% and sand 25%) were used. Total Co content = 51.91 mg kg^{-1} dried soil, total Cd content = 8.5 mg kg^{-1} dried soil and total Pb content = 436 mg kg^{-1} dried soil. The heavy metal salts used included CoSO_4 , CdCl_2 and $\text{Pb(NO}_3)_2$. The soil was contaminated before planting by adding the calculated amounts of heavy metal salts in distilled water and mixed throughout the soil profile. They were allowed to stabilise for 15 days. Then, 50 g *G. mosseae* inoculum was mixed with 5 cm of upper surface of soil and alfalfa and barley seeds planted as before. Plants were cut from soil surface in early flowering stage.

Roots were extracted from pots. Aboveground materials separated into the stems and leaves and were washed by distilled water. Plant material was dried at 70°C for 48 hours. Heavy metals in plant tissue and soil were quantified by Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) (Variant-Liberty 150AX Turbo). Phytoextraction coefficient of contaminants calculated by concentration of heavy metals in shoot (mg kg^{-1}) / concentration of heavy metals in soil (mg kg^{-1}). Statistical analysis of data was performed by SAS software. The data were analyzed through one-way analysis of variance (ANOVA) and Comparisons between means were performed using Duncan's multiple range test at the significance level of $P < 0.05$.

III. RESULT AND DISCUSSION

Figure 1A presents the phytoextraction coefficient of Cd in barley. The M0PbCoCd treatment produced maximum phytoextraction coefficient ($P < 0.05$). There was maximum rate of phytoextraction coefficient of Co in barley in the treatment of MCo (Fig. 1B) ($P < 0.05$). Also, in the treatment of M0Pb phytoextraction coefficient of pb was maximal (Fig. 1C) ($P < 0.05$).

The figures 1D to 1f shows phytoextraction coefficient of metals in alfalfa. Phytoextraction coefficient of Cd of alfalfa was highest in the treatment of M0CoCd (Fig. 1D) ($P < 0.05$). Co and Pb phytoextraction coefficient in the M0Co and M0PbCd was the highest, respectively (Fig. 1E and 1F) ($P < 0.05$).

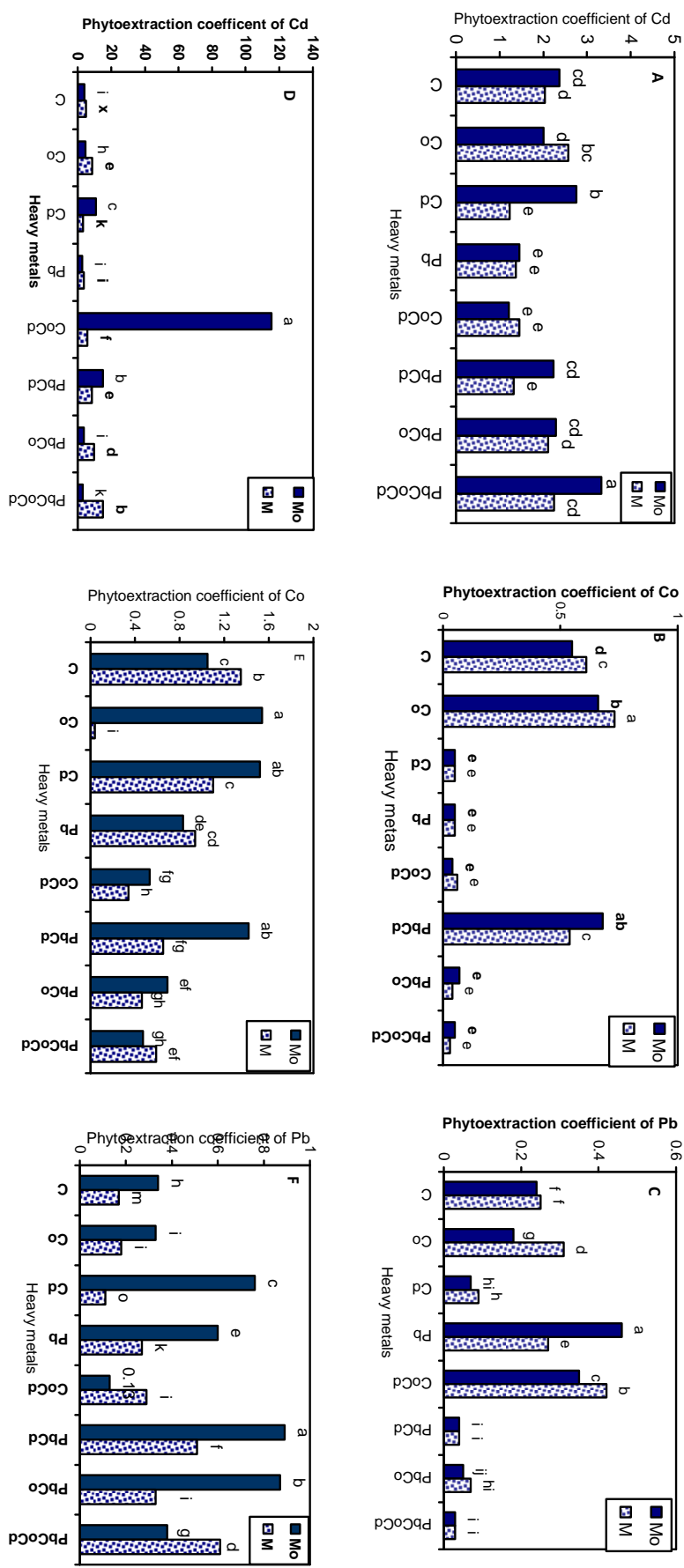


Fig. 1 Phytoextraction coefficient of heavy metals of barley and alfalfa. Different letters above the columns represent statistically significant differences between the data sets ($P < 0.05$, MO: noninoculated, M: inoculated)

IV. CONCLUSION

The present investigation shows that in both plants phytoextraction coefficient was depend on type and combination of metals.

REFERENCES

- [1] Environmental Investments: The Cost of a Clean Environment. US Environmental Protection Agency (EPA). (ed EPA-230-11-90-083) 5 (US Government Printing Office, Washington, D.C. 1990
- [2] P. Guilizzoni, The role of heavy metals and toxic materials in the physiological ecology of submersed macrophytes. *Aquatic Bio.* 1991, 41: 87-109.
- [3] D.E. Salt, M. Blaylock, P.B.A.N. Kumar, V. Dushenkov, B.D. Ensley, I. Chet, and I. Raskin. Phytoremediation: a novel strategy for the removal of toxic metal from the environment using plants. *Biotech.* 1995, 13: 468-474.
- [4] P. B.A.N. Kumar, V. Dushenkov, H. Motto, and I. Raskin. Phytoextraction—the use of plants to remove heavy metals from soils. *Environ. Sci. Technol.* 1995, 29: 1232-1238.
- [5] M.M. Lasat. Phytoextraction of toxic metals: a review of biological mechanisms. *J. Environ. Qual.* 2002, 31: 109-120.