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Cultivation of milk thistle in Pb-contaminated urban soils

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Abstract: In order to remediate heavy metal-contaminated soils of urban areas, we conducted an experiment using a pharmaceutical phytic species such as milk thistle (*Silybum marianum* (L.) Gearn.). The experiment was carried out using two different soil samples (one acid and one alkaline) from urban areas varying in their physicochemical attributes along with Pb levels. In every soil sample we applied three levels of contamination, 150, 300 and 450ppm Pb. Then, estimates of the available-DTPA extractable and pseudo-total concentrations of lead (Pb) were accomplished. Also, assessments of metal transport to different parts of milk thistle from the Pb-contaminated soils were conducted. The results of this experiment revealed that the highest concentration of Pb was found in underground part of the plant, also the Pb movement was higher in acid soil sample than in alkaline.

Keywords: Phytoremediation, Potentially Toxic Elements (PTEs), lead, *Silybum marianum*

1. Introduction

It is well known that soil pollution and degradation have become serious environmental problems for many societies around the world (Cao et al. 2020). One of the reasons of these problems is the accumulation of Heavy Metals (HMs) or Potential Toxic Elements (PTEs) in urban soils, mainly due to anthropogenic activities (Du et al. 2021).

There are several methods for cleaning up polluted soils, including phytoremediation, which is economical, ecologically responsible, and simple to employ on deteriorated soils. (Zhi et al. 2020; Golia et al. 2023).

Milk thistle (*Silybum marianum* (L.) Gearn.) is an annual or biennial plant species of Asteraceae family. This plant in particular satisfies all the conditions for phytoremediation. Also, milk thistle is a medicinal plant due to existence of silymarin substance contained in its seeds (Hammami et al. 2018). Furthermore, it can be used as a bioenergy plant in contaminated soils by HMs and petroleum products (Domínguez et al. 2017).

The aims of this study were: 1. to investigate the capacity of milk thistle to accumulate lead from Pb-contaminated soils, 2. to examine the variation of the uptake and accumulation capacity in soils with different physical and chemical properties and 3. to study the relationships between different levels of lead soil pollution and the degree of metal movement in the underground and above-ground parts of the plant.

2. Materials and Methods

2.1. Sampling Area – Pot experiment

Two different soils were used for this study, which were selected from green parts (parks and playgrounds) of urban areas. One of the soil was acid (pH: 6.1, clay: 16.7%, sand: 40.8%) and other slightly alkaline (pH: 8.2, clay: 17.7%, sand: 42.0%). For each examined sample, 6 sub-samples were collected within an area of approximately two meters' radius. The soil samples were sieved and put in pots. After that we contaminated the soils samples with 3 levels of Pb concentration (150, 300 and 450ppm Pb). After lead contamination, the samples were left for two weeks for incubation and then seeding was carried out. There were 10 replicates for each treatment.

2.2. Chemical and Physical Analysis

Soil samples used in the pot experiments were air-dried and sieved from 2 mm and submitted to various physicochemical analyses. They were analyzed using methods described in Golia et al. (2021) for the estimation of soil pH values, Electrical Conductivity (EC), particle size distribution (Boyoucos' method), organic carbon content (wet oxidation according to Walkley and Black) and $CaCO_3$ (Bernard calorimeter).

Available and pseudo-total concentrations of Pb were measured by DTPA extraction and Aqua Regia method, respectively. After the end of experiment the above-ground and underground parts of plants were examined for the relationships between different levels of lead soil pollution and the degree of metal movement.

3. Results and Discussion

Plant growth was not affected at any level of contamination. Differences were observed both between the 2 different soil types and in the different levels of contamination. All these references present in Figure 1.

Specifically, in acid soil, increased mobility of lead was observed. Also, the available concentration of lead in this soil was higher than in the alkaline soil. It was also noticed that the highest concentration of Pb (450ppm) resulted to the highest accumulation in the above-ground parts of the plant, compared to the other two contamination levels (150 and 300ppm).

4. Conclusions

From the present study that have been concluded, the milk thistle can accumulate Pb from moderately polluted urban soils. Furthermore, infer that lead is retained more in the underground part of plant. Acid soil has a higher available concentration than alkaline soil. More and deeper research is needed to establish this knowledge, using different levels of Pb contamination and a variety of soil types.

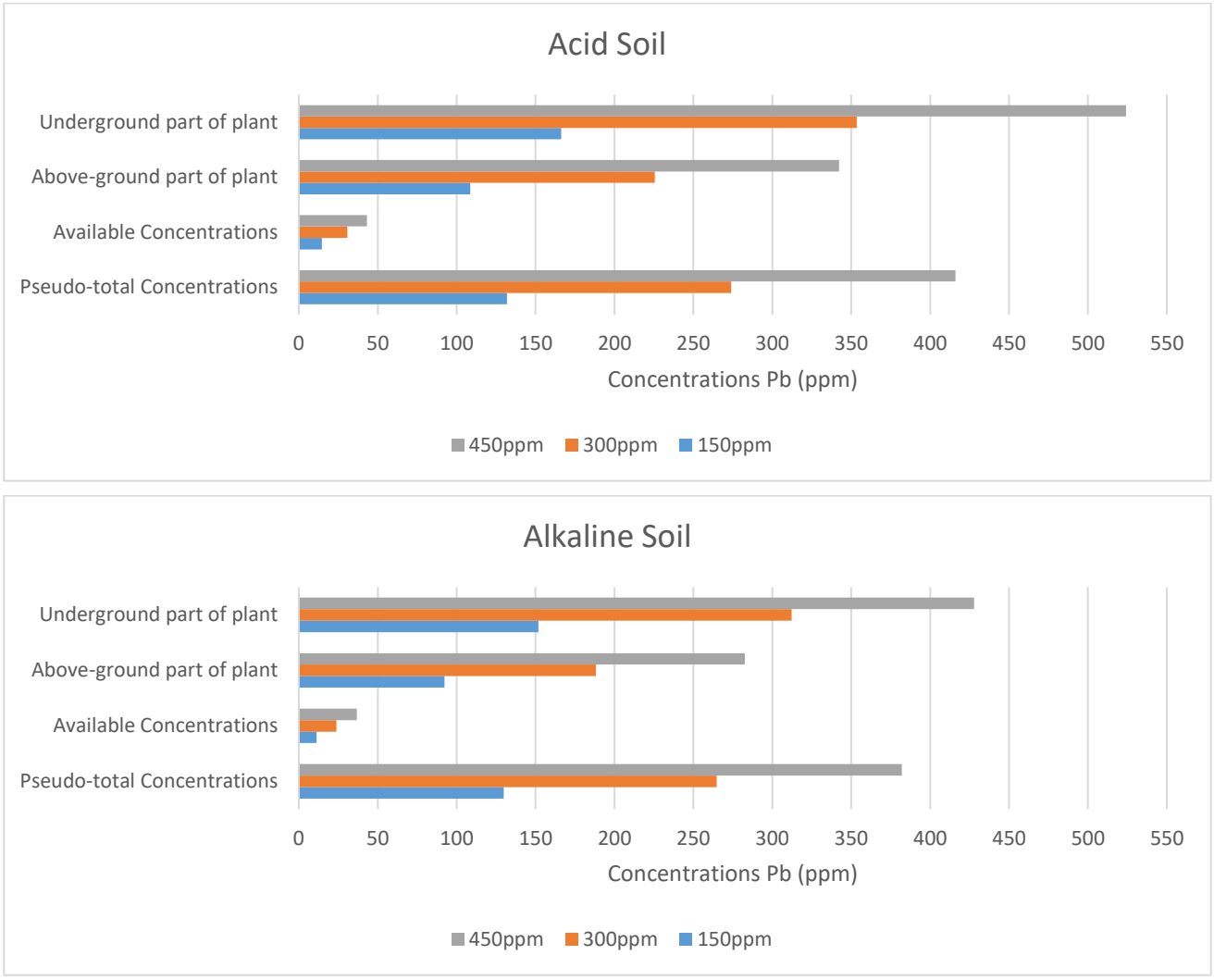

Figure 1. The two different soil types (acid and alkaline), the three levels of contamination (150, 300 and 450ppm) and their effect on plant parts and soil.

References

Cao X, Wang X, Tong W, Gurajala HK, He Z, Yang X (2020) Accumulation and distribution of cadmium and lead in 28 oilseed rape cultivars grown in a contaminated field. Environ Sci Pollut Res Int. 27(2):2400-2411. doi: 10.1007/s11356-019-06826-z.

Domínguez MT, Montiel-Rozas MM, Madejón P, Diaz MJ, Madejón E (2017) The potential of native species as bioenergy crops on trace-element contaminated Mediterranean lands. Science of The Total Environment, 590–591, 29-39, doi.org/10.1016/j.scitotenv.2017.03.018.

Du M, Zhang Q Y, Ren P, Gao S, Bu D (2021) Evaluation of heavy metal distribution and ecological risk in agricultural land in Nianchu River Basin, Tibet. J. Environ. Eng. Technol., 1–13

Golia EE, Angelaki A, Giannoulis KD, Skoufogianni E, Bartzialis D, Cavalaris C, Vleioras S (2021) Evaluation of soil properties, irrigation and solid waste application levels on Cu and Zn uptake by industrial hemp. Agron Res 19, 9299. https://doi.org/10.15159/ar.21.016

Golia EE, Bethanis J, Ntinopoulos N, Kaffe GG, Komnou AA, Vasilou Ch (2023) Investigating the potential of heavy metal accumulation from hemp. The use of industrial hemp (Cannabis Sativa L.) for phytoremediation of heavily and moderated polluted soils, Sustain Chem Pharm 31,100961, doi.org/10.1016/j.scp.2022.100961

Hammami H, Alaie E, Dastgheib SMM (2018) The ability of Silybum marianum to phytoremediate cadmium and/or diesel oil from the soil. Int J Phytoremediation. 2018 Jul 3;20(8):756-763. doi: 10.1080/15226514.2018.1425664. PMID: 29775104.

Zhi Y, Zhou Q, Leng X, Zhao Ch (2020) Mechanism of Remediation of Cadmium-Contaminated Soil With Low-Energy Plant Snapdragon. Front. Chem., Sec. Inorganic Chemistry, 8, doi.org/10.3389/fchem.2020.00222