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ESTIMATION OF SOME HEAVY METALS ACCUMULATION IN PLANTS AND SOILS FROM COPSA MICA AREA

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Abstract

Heavy metals pollution of soil enhances plant uptake causing accumulation in plant tissues and eventual phytotoxicity and change of plant community. The research was carried out within the area affected by emissions released from Copsa Mica industrial platform. The sampling grid of soil and plant was regular - 118 plant samples and 103 soil samples were collected. Main crops identified within investigated area were: maize (Zea mays), wheat (Triticum aestivum), oat (Avena sativa), soybean (Glycine max). The analyses carried out to determine the heavy metals (Cd, Zn and Pb) contents in plants revealed that Equisetum pratense, Cynodon dactylon, Verbascum phlomoides, Calamagrostis pseudophragmites and Asclepias syriaca accumulated high amounts of heavy metals in their tissues. The regression curves were used to assess the stochastic dependences between heavy metal content in soil and heavy metal content in plant.

INTRODUCTION

Copsa Mica is a small town that developed around two industrial SOMETRA and CARBOSIN, both with a high potential pollutant: SOMETRA - producer of zinc, lead, cadmium and ferrous alloys and CARBOSIN - producer of carbon black, a product used in manufacturing tires. The paper presents the regression curves that estimate stochastic dependence between the total metal content of soil and the metal content in plant.

MATERIAL AND METHODS

The sampling of soil was done on a radial network of 103 collection sites. Plant samples were harvested from the same points with soil. The plant samples were collected from agricultural crops, pasture, meadow and spontaneous vegetation.

The total content of heavy metals (Cd, Pb and Zn) was measured with flame atomic absorption spectrometer in hydrochloric solution resulted by digestion of soil samples in $HClO_4$-HNO_3 mixture.

Estimating the stochastic dependencies between total metal content of soil and metal content of plants was achieved by means of the regression curves.

RESULTS AND DISCUSSION

Main crops identified in the investigated area were: maize (*Zea mays*), wheat (*Triticum aestivum*), oats (*Avena sativa*), soybean (*Glycine max*), lucerne (*Medicago sativa*) and red clover (*Trifolium pratense).* Of these the most common is maize, of the 37 plant samples collected from specific agricultural crop area, 25 were samples of maize (leaves).

The main plant species belonging of meadows and pastures vegetation from studied area were: *Festuca pratensis, Lolium perenne, Poa pratensis,* etc. These samples represented approximately 18% of total samples analyzed.

From spontaneous vegetation of Copşa Mică area were collected plants belonging to the following species: *Amaranthus retroflexus, Artemisia vulgaris, Asclepias syriaca, Calamagrostis epigeios, Calamagrostis pseudophragmites, Cynodon dactylon, Daucus carota, Equisetum pratense, Phragmites australis, Picris hieracioides, Setaria glauca, Sinapis arvensis, Verbascum phlomoides* and *Xanthium strumarium.*

Log-log diagram for regression curve that estimates the dependency between the zinc content in soil and the zinc content in plant is presented in figure 1. Values of zinc content in plant ranged between 41 mg/kg and 3162 mg/kg. The highest value was determined for plants of *Verbascum phlomoides* developed on a soil with a total zinc content of 4151 mg/kg.

Plants identified and harvested from areas where the zinc content in soil exceeded 4000 mg/kg belonging to the species: *Cynodon dactylon, Calamagrostis pseudophragmites, Phragmites australis* and *Equisetum pratense*. These plants have adapted to stressful conditions induced by excessive levels of heavy metals in soil managing to grow even in such a hostile environment. *Phragmites australis* is a plant species recognized as able to tolerate high levels of zinc in the culture [2]. With regard to agricultural crops, values of zinc content in plant ranged between 41 mg/kg and 1273 mg/kg. The lowest value of zinc content was determined in maize leaves, when the plants were grown on soil with a relatively low content of zinc (79 mg/kg). Maize plants harvested at 1 km SE from the source were the most polluted (1273 mg/kg). Worrying is the fact that these plants were cultivated near a building housing city Copşa Mică. Long-term consumption of products with high content of heavy metals may damage the health of the population.

Changes of the cadmium content in plants depending on the total content of cadmium in soil is presented in figure 2. Values of cadmium content of plants analyzed varied between 0.3-83 mg/kg. The lowest value (0.3 mg/kg) was determined in plants of *Medicago sativa*.

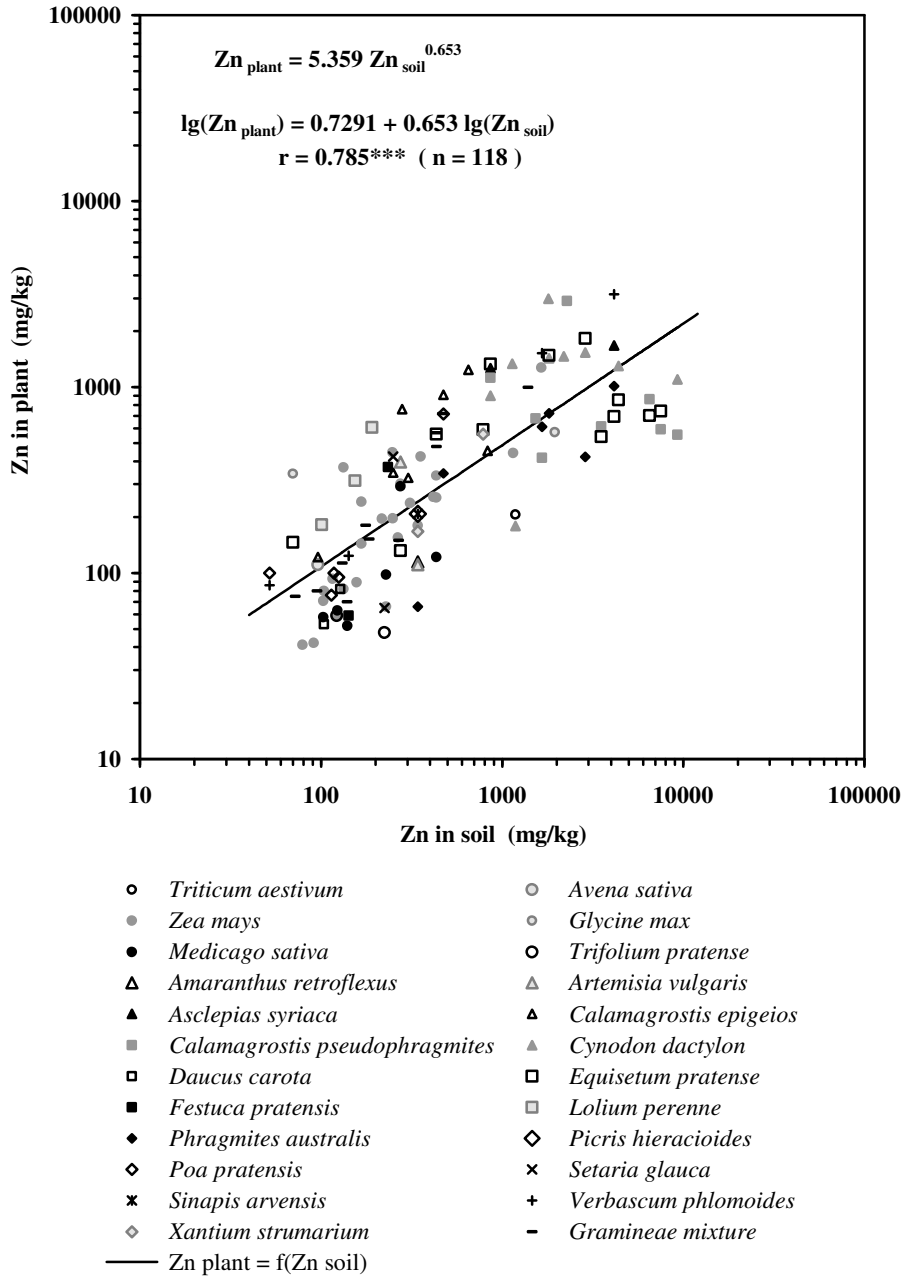

Fig. 1. Log-log diagram for regression curve that estimates the dependency between the zinc content in soil and the zinc content in plant

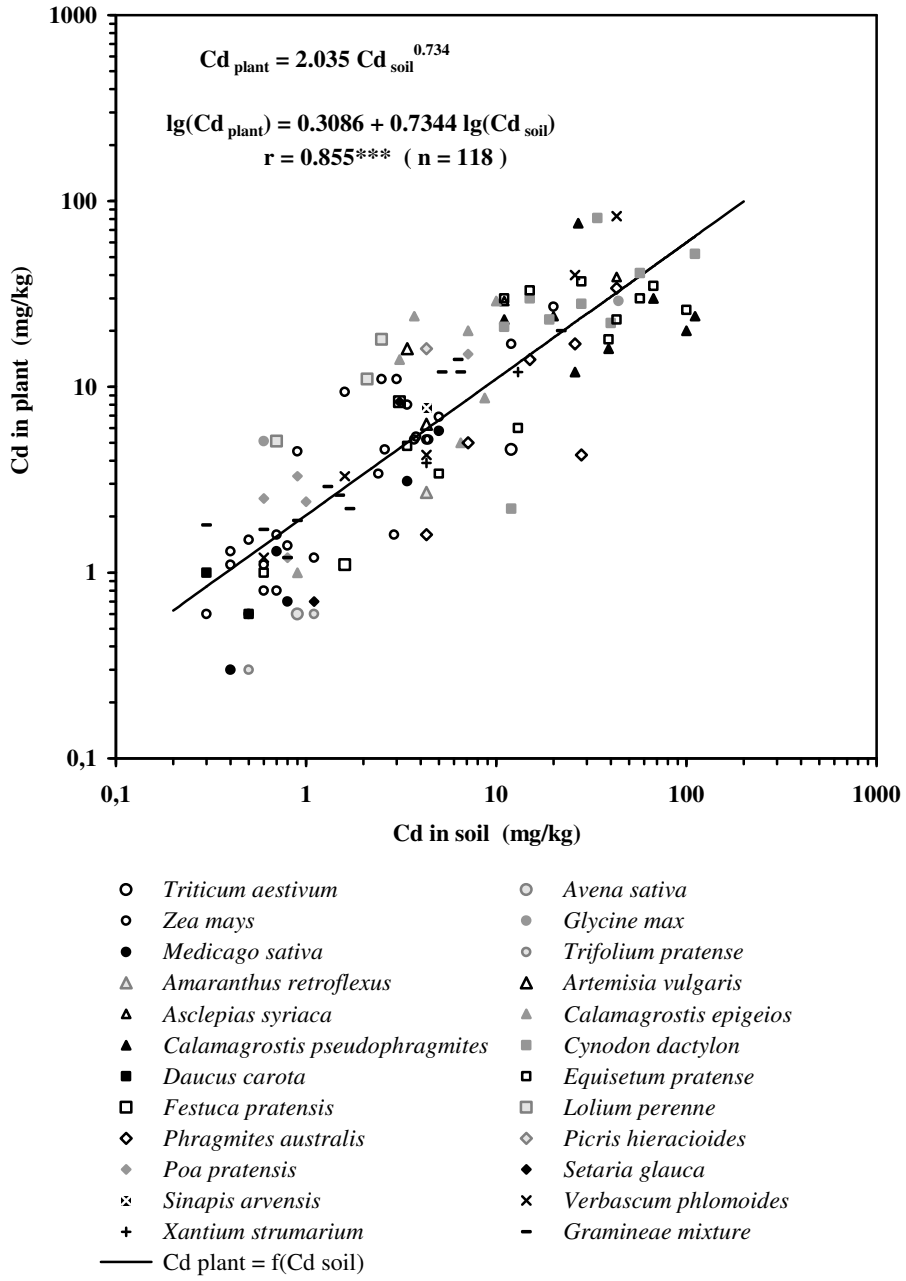

Fig. 2. Log-log diagram for regression curve that estimates the dependency between the cadmium content in soil and the cadmium content in plant

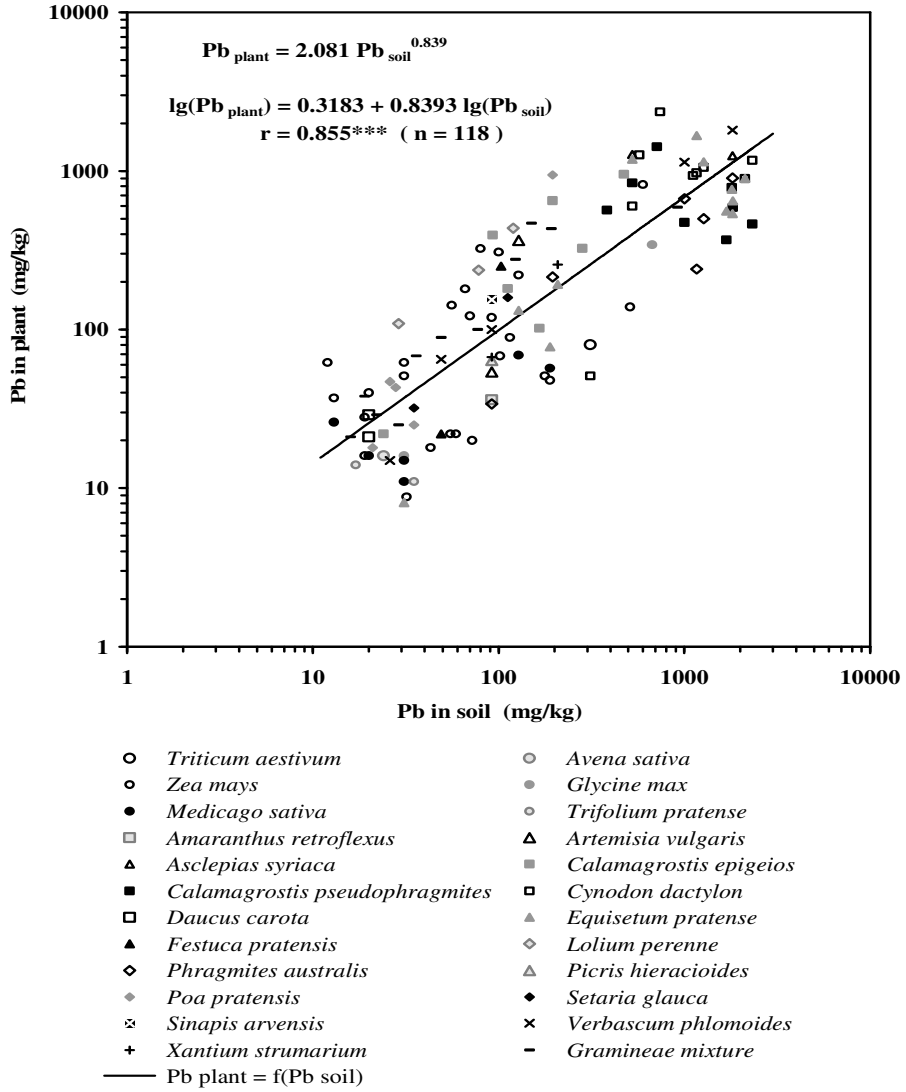

Fig. 3. Log-log diagram for regression curve that estimates the dependency between the lead content in soil and the lead content in plant

Plants of the species *Verbascum phlomoides* and *Cynodon dactylon* had the highest content of cadmium (83 respectively 81 mg/kg). The crop plants growing on soils with the highest levels of cadmium were those of *Glycine max* (29 mg/kg Cd), and *Zea mays* (27 mg/kg).

Figure 3 is shown log-log diagram for regression curve that estimates the dependency between the lead content in soil and the lead content in plant from Copsa Mica area. The total content of lead in the 0-40 cm layer of soil on which were harvested plant samples ranged from 12 mg/kg to 2320 mg/kg.

The lead content determined in plants of spontaneous vegetation ranged from 8.1 mg/kg (*Equisetum pratense*) and 2362 mg/kg (*Cynodon dactylon*). The highest levels of lead content were determined in plants of the spontaneous vegetation of the area. Of the 9 samples of *Cynodon dactylon*, 8 samples had lead content greater than 600 mg/kg. It confirms the ability of these species to accumulate excessive amounts of lead without the visible signs of toxicity.

Crop plants had lead content levels that ranged between 8.8 mg/kg and 820 mg/kg, these extreme values being determined in maize leaves (*Zea mays*). Of the 25 samples collected from maize crops, for one sample the lead content determined was lower than the tolerance limit (10 mg/kg) presented by Kabata Pendias and Pendias (1992) quoted by [1]. The other 24 samples had lead contents higher than 10 mg/kg, presenting risk of toxicity.

Estimation of metal content in plant depending on the total metal content in soil based on the proposed regression equation for each element (Cd, Pb and Zn) can sometimes lead to results with high degree of uncertainty. However this estimation is useful in the preliminary stage of the study of risk assessment in the Copsa Mica area.

CONCLUSIONS

1. The intensity of stochastic dependence, as measured by correlation coefficient corresponding linear form of equation ($\lg y = \lg a + b \lg x$) is very high for each of the metals considered ($r_{Zn}=0.785^{***}$, $r_{Cd}=r_{Pb}= .855^{***}$).
2. In the very polluted area were identified plant species able to accumulate heavy metals in tissues in excessive amounts without adverse effects on the general development of the plant (*Asclepias syriaca, Cynodon dactylon, Calamagrostis pseudophragmites, Equisetum pratense, Verbascum phlomoides*).

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