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Effect of chemical forms of lead, cadmium and zinc in polluted soils on their uptake by peanuts

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It is found that heavy metals in soil are associated with various chemical forms with a different degree of availability to plants. Sequential extraction procedure has been used to partition heavy metals among various soil chemical fractions by different selective extractants. A considerable number of schemes have been used with soils for defining the metal content in one or all of the following fraction: soluble, extractable/not selectively sorbed/, adsorbed, organically connected, included in the Mn oxides, included in amorphous Fe oxides, included in the crystalline Fe oxides, carbonates and residue. However, relation between heavy metals in various chemical forms and their bioavailability has not been adequately studied. The objective of this experiment is to investigate the chemical distribution of Pb, Cd and Zn in different fractions of the soils, industrially polluted by a metallurgical factory, as well as to determine the quantities and the centers of accumulation of Pb, Cd and Zn in the vegetative and reproductive organs of peanuts and the effects of concentration and different chemical forms of the elements in soil on their uptake by peanuts.

Five polluted soils used in this experiment were sampled from the vicinity of the area contaminated by the Non-Ferrous-Metal Works (NFMW) near Plovdiv, Bulgaria. Soils were collected from the surface (0-20 cm depth) of fields located at different distance (0; 0.5, 3.0, 5.0 and 15.0 km) from the NFMW. The sequential extraction scheme developed by Tessier et al. (1979) was chosen. The metals were partitioned into five fractions: exchangeable, bound to carbonates, bound to Fe-Mn oxides, bound to organic matter and residual. The peanuts were grown in the same region. Peanuts were harvested at maturity and heavy metal content of roots, stems, leaves, fruits, shell and seeds were determined. The samples were treated by the method of dry mineralization. To determine the heavy metal content in the samples, atomic absorption spectropho-

tometry (Perkin-Elmer 3030 B - Uberlingen, Germany) was used.

The obtained result shows, that in distribution of Pb, Cd and Zn in industrially polluted soil, both similar tendencies and significant differences are observed. The highest amount of Pb and Zn were bound with hardly available forms for plants - Fe- Mn oxides and residual fraction. In terms of Cd, in contrast to the other heavy metals, a significant part of it is found in available forms, which make it potentially dangerous and calls for a precise control of crops grown in this region. Assuming that mobility and biological availability is related to solubility of the chemical form of the metals and decreases in the order of extraction, the apparent mobility and potential metal bioavailability for this polluted soil were Cd> Pb>Zn.

The main part of Pb, Cd and Zn were accumulated in the underground parts, mainly in the roots and fruit shell. Results showed that metals in the roots of peanuts and fruit shell depend mainly on metal content of the soil. Metals in the stems of peanuts were considerably lower compared to the root system, good evidence for restricted mobility. In peanuts the quantities of Zn in the fruit shell and in the seeds were similar, while in the case of Pb and Cd they differed considerably. There was more Pb in the fruit shell compared to seeds, while the opposite was true for Cd. Results indicate that the fruit shell acts as a selective filter to heavy metal accumulation in seeds, depending on the element in question.

The data obtained by regression analysis shows that a significant correlation exists between Pb, Cd and Zn concentration in soil and that in peanuts. The results obtained on the effects of chemical forms revealed that exchangeable and carbonate forms exhibited stronger influence on uptake than the total concentration in soil. The linear correlation between available forms (exchangeable and carbonate forms) of elements in soil and their content in peanuts demonstrates root uptake from the former.

REFERENCES

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