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The Effect of Arsenic on Phosphorus, Iron, Zinc and Manganese Concentrations in Soil and Corn Plant

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Introduction: Arsenic (As) is the twentieth element in earth's crust and the contamination of soils and ground waters by it is common and disturbing. In addition to geological factors and soil parent material, human activities such as mining and smelting, coal combustion and the use of arsenic-containing compounds such as insecticides, pesticides, wood preservations and etc lead to the accumulation of high levels of this metal in the soils. Long-term exposure to As can lead to skin, bladder, lung, and prostate cancers.The presence of As in soil and water causes its transfer to different parts of the plant. Because of the crucial role of corn in human nutrition, investigation of the uptake, transport and accumulation of As in different parts of this plant is very important, thus this study was carried out with the aims of evaluating the response of corn to the presence of As in the environment and its impact on concentrations of phosphorus (P), iron (Fe), zinc (Zn) and manganese (Mn) in this plant.

Materials and Methods: Soil samples were collected and after air drying, passed through a 2 mm sieve and analyzed for some physico-chemical properties. The samples were then artificially contaminated by different levels of arsenic (0, 6, 12, 24, 48 and 96 mg/kg) using $Na_2HAsO_4.7H_2O$ salt and incubated for 6 months, and then planted to corn. Before planting, the concentration of available As was determined. At the end of growth period, mean height of plants was measured and then the above and below ground parts of plants were harvested, washed, dried and digested using a mixture of HNO_3 and H_2O_2. The concentrations of As, P, Fe, Zn and Mn in plant extracts were measured. Statistical analyses of data were performed using SAS software and comparison of means carried out using Duncan's multiple range test.

Results and Discussion: The results indicated that As concentration increased both in root and in shoot with increasing As concentration. The highest As concentrations in corn root and shoot were 383.41 and 59.56 mg/kg, respectively. Arsenic accumulation in root was higher than the shoot, so that the concentrations of arsenic in the roots of plants grown at 6, 12, 24, 48 and 96 mg As/ kg of soil, were 1.88, 1.99, 3.13, 4.96 and 6.44 times higher than their concentrations in shoot, respectively. Corn was sensitive to As stress and growth of it reduced by increasing the level of soil As. Mean heights of plants grown in soils polluted with 6, 12, 24, 48 and 96 mg As/kg decreased compared to control by 10.74, 25.30, 38.99, 59.71 and 76.66%, respectively. The rate of reduction of dry weights of roots of plants grown in soils polluted with 6, 12, 24, 48 and 96 mg As/kg were 10.66, 30.20, 54.64, 81.65, 95.94 % and ones of shoot were 11.30, 27.25, 47.14, 77.66 and 95.22%, respectively, which showed corn root was more sensitive to As than shoot. Arsenic uptake by root and shoot increased with increasing the As levels to 48 and 24 mg/kg, respectively, but at higher levels of As it decreased, this showed that up to these levels, increasing arsenic concentrations in plant parts surpassed from the decreasing dry weights of them and the amount of uptake obtained by multiplying these two factors, increased. Phosphorus concentrations in root and shoot increased and decreased, respectively, with increasing soil As concentration, and this matter showed As reduced P translocation from the root to the shoot of plants. Iron and Zinc concentrations in root and shoot decreased but Manganese concentration increased with increasing soil As concentration.

Conclusions: The results of this study showed that the corn plant is very sensitive to arsenic and its growth decreased even in the presence of low concentrations of arsenic. Arsenic accumulation in root was higher than the shoot. Arsenic changed the concentration of nutrients in the soil and the corn, So that increased the available P concentration and reduced the available concentrations Fe, Zn and Mn. It also reduced the translocation of P, the concentration of Fe and Zn in the root and shoot. The statement that toxicity limits plant As uptake to safe levels was not confirmed in our study. If corn plants are exposed to a large concentration of As, they may accumulate residues which are unacceptable for animal and human consumption.

Keywords: Arsenic, Corn, Nutrient concentration, Pollution

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