Effectiveness of Some Remediation Methods in Cadmium and Nickel Contaminated Soils of Fayoum

By

Hamdi Ahmed Abdurrahman Mohamed

B.Sc. Agric. Sci. (Soils), Fac. of Agric., Fayoum, Cairo University, 2002

M.Sc. Agric. Sci. (Soils), Fac. of Agric., Fayoum, University, 2007

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of Ph.D.

In

Agricultural Sciences

(Soils)

To

Soils and Water Department

Faculty of Agriculture

Fayoum University

(2012)

ABSTRACT

The present investigation included two main parts. The first part was designed to find out the most suitable extraction method for soil available cadmium and nickel that better correlated to the absorbed amounts by plants. The critical limits for soil contamination with both metals were estimated in terms of their total and extractable concentrations that associated with the toxic critical limit in barley plants. Two pot experiments were conducted to achieve this part using five soil types, six successive levels of soil contamination up to 120 mg Cd/kg soil or 400 mg Ni/kg soil in addition to the control (uncontaminated soil), four extractants and barley "*Hordium vulgare*" local variety Giza 132 as the test plant. The second part was a study on the effectiveness of phytoremediation of cadmium and nickel contaminated soils using sorghum *"Sorghum bicolor"* local variety Giza 15 in combination with the application of humic acid, citric acid, EDTA or Arbuscular mycorrhizae (AM) inoculum in six contaminated soils differing in their texture and $CaCO_3$ content. Two other pot experiments were conducted to achieve the second part using Cd or Ni contaminated soils at 50 mg Cd or 500 mg Ni/kg soil.

Data obtained indicated that concentrations obtained with the studied extractants had highly significant correlation coefficients with Co or Ni plant uptake by barley plants with very slight superiority of 0.1 *M* HCl or 1.0 *M* HCl extractants.

Estimated mean critical limits of soil contamination with Cd or Ni as mg/kg soil that corresponded to 10% reduction in plant dry weight with respect to used extractants for soil Cd were: total soil Cd (3.13), 1.0 *M* HCl (0.49), EDTA (0.12), DTPA (0.11) and 0.1 *M* HCl (0.08 mg Cd/kg soil), and for Ni were total soil Ni (181.46), 1.0 *M* HCl (24.34), DTPA (7.70), EDTA (6.91) and 0.1 *M* HCl

(4.74 mg Ni/kg soil). The mean limits of soil pollution (heavy pollution limits) in mg/kg soil that associated with 50% reduction in barley dry matter yield for Cd were: total soil Cd (8.08), 1.0 *M* HCl (1.38), DTPA (0.32), EDTA (0.28) and 0.1 *M* HCl (0.23 mg Cd/kg soil), and for Ni were: total soil Ni (303.80), 1.0 *M* HCl (42.60), DTPA (13.64), EDTA (11.83) and 0.1 *M* HCl (8.29 mg Ni/kg soil).

On basis of simplicity, rapidity, reliability and significance of extracted values, the author recommended the use of estimated 1.0 *M* HCl contamination limits for the evaluation of soil contamination with Cd or Ni, however any of the aforementioned limits could be used.

With respect to phytoremediation of Cd or Ni contaminated soils using sorghum bicolor in combination with the application of humic acid, citric acid), EDTA or mycorrhizae inoculum. It was found that the application of all these materials in contaminated soils resulted in significant increases in the extracted amounts of Cd or Ni by sorghum plants in comparison with those of plants grown on contaminated soils with no added amendment materials, however humic acid surpassed all other used materials.

Sorghum bicolor plants proved to be a good extractor of soil Ni or Cd and could be used in combination with humic acid for the remediation of Ni or Cd contaminated soils.

Key words: critical limits-cadmium-nickel-*Hordium vulgare*-Phytoremediation- *Sorghum bicolor*.