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Cadmium chemical speciation and absorption in plant in a polluted soil

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Cadmium is a very toxic heavy metal presents in nature in small amounts, with an average content of 0.2 mg kg-1 in the geosphere. Nonetheless, anthropogenic activities such as industrial processes, large use of phosphate fertilizers and sewage sludge disposals may determine a massive accumulation of Cd in soil. Cd is considered a particularly interesting heavy metal as it can be accumulated by plants to levels that can be toxic to humans and animals, when consumed even in minor amounts. The aim of the present work was to study in a soil polluted with Cd for a long time i) the distribution of Cd in different chemical fractions by means of a sequential extraction procedure; ii) the adsorption of Cd by plants grown in this polluted soil; iii) the change in the distribution of Cd in the soil fractions possibly due to root exudates after plant growing.
The chemical fractionation procedure used involved the following forms: a) exchangeable, b) bound to carbonates, c) bound to Fe-Mn oxides and hydroxides, d) bound to organic matter, e) residual part. The following reagents and extraction times were applied:
a) 1 M CH3COONa (1:10, w/v; pH 8.2) for 16 h at room temperature; b) 0,1 M CH3COOH for 16 h at room temperature; c) 0,1 M NH_2OH•HCl (1:10, w/v; adjusted to pH 2.0 with HNO_3) for 16 h at room temperature; d) 30% H_2O_2 (adjusted to pH 2.0 with HNO_3) at 85 °C, followed by extraction with 1 M CH3COONH4 (1:10, w/v; adjusted to pH 2.0 with HNO_3) for 16 h at room temperature; e) acid digestion with concentrated HNO_3 and 30% H_2O_2 for residue fraction.
Festuca seeds were germinated in the contaminated soil in plastic flats and non–contaminated soil. After two days the seedling were submitted to day/night conditions.
The seedlings were collected 6 weeks after seeding and divided in roots and shoots and analysed for Cd concentration.
The polluted soil has average Cd content of 200 mg kg-1, instead, the Cd content in the same unpolluted soil was about 0.44 mg kg-1. The speciation results showed that a significant amount of Cd (45%), before plant seeding, was associated with the metal oxide fraction (typically Fe-Mn oxides and hydroxides) followed to Cd bound to soil organic matter (39%), despite the content of organic matter in the soil was very low. Instead the amount of Cd bound to carbonates (13%), exchangeable phase (1%) and residue fraction (2.5%) were negligible.
After six weeks of plant seeding the Cd fractionation was slightly different, with a decrease of metal bound to oxide and hydroxide from 45% to 29% and an increase of fraction bound to carbonate from 13% to 19% and exchangeable fraction from 1% to 8%. The roots system of Festuca had colonized all pot and the fractionation of metal was disturbed by plants growth. Roots may induce changes in the biochemical, chemical and physical properties of the rhizosphere increasing potentially toxic elements diffusion through the production of roots exudates. The soil environment immediately adjacent to the root can be strongly influenced by root exudates, so that chemical process of dissolution, chelation and precipitation outside the root also occur.
Cd was absorbed by plant root in a great concentration, but not translocation to leafs was noticed.