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# Response of different plant species to heavy metals in soils from an abandoned mining area in Murcia Region (Spain)

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Plant species to be used in phytoremediation (either for extraction or for immobilisation of the pollutants) must be adapted to the soil and climatic conditions of the area to be recovered. In addition, those species have to show tolerance to the contaminants to overcome soil toxicity. Seven different species were examined to determine their tolerance and their ability to accumulate metals, in a range of polluted soils from the "Sierra Minera of Cartagena-La Union" mining site (SE Spain). The response of the plants to the addition of soil amendments was also studied for phytoremediation purpouses.

The growth and metal (Fe, Mn, Cu, Zn, Cd and Pb) accumulation of crop (*Beta vulgaris*,L., *Brassica juncea* (L.) Czern., *Lupinus albus*, L. and *Raphanus sativus*, L.) and native species (*Beta maritima* L., *Atriplex halimus* L., and *Moricandia arvensis* (L.) D.C.) were studied in field and pot experiments. Different soil organic (cow manure and solid olive mill waste) and inorganic (EDTA) amendments were used to promote plant growth and/or heavy metal accumulation.

Brassica juncea plants were able to accumulate elevated Zn concentrations and up to 108 $\mu$g g$^{-1}$ Pb in a pot experiment using a calcareous (pH 7.7; OM 0.7 %; $CaCO_3$ 30%) contaminated soil (Zn 2602, Cu 42, Pb 1572 Pb mg kg$^{-1}$) after the addition of EDTA to the soil. This enhancement in metal uptake was also observed in radish leaves from plants grown after *B. juncea* harvest (Zn 1180, Pb 157, Cu 22 $\mu$g g$^{-1}$), showing a long term effect of the EDTA addition that may imply serious environmental concerns due to increased solubility. The use of cow manure or compost as soil amendments favoured plant growth and decreased Zn, Cu and Pb concentrations in the plants.

Several plant species were grown in an agricultural soil neighbouring the mining area (pH 7.9; OM 0.7 %; $CaCO_3$ 15%; Zn 1826, Cu 35, Pb 2345 mg kg$^{-1}$): two crops (*B. vulgaris*, *L. albus*) and three native species (*B. maritima.*, *A. halimus*, *M. arvensis*), to evaluate the metal transfer to the food chain. Both glasshouse (pot) and field (with the addition of organic amendments) experiments were carried out. High Mn concentrations were found in all the plant species tested, exceeding the maximum allowable concentrations for plants (300 $\mu$g g$^{-1}$, Kabata-Pendias, 2001). This fact was of special relevance for *L. albus* leaves that accumulated up to 4960 $\mu$g g$^{-1}$, showing an accumulator behaviour. Overall, the rest of the elements studied did not accumulate in the plant tissues over their 'normal' concentrations despite elevated pseudo-total concentration of the metals in this soil. This can be attributed to the calcareous nature and elevated pH of the soil, which led to low metal availability.

The different plant species studied showed tolerance to soil metal toxicity through exclusion mechanisms, not accumulating the metals in the above ground/aerial parts of the plants. With the exception of *L. albus*, which showed high Mn concentrations in its leaves, all the species seem to be good candidates for their use in phytostabilisation, enhancing immobilisation of the contaminants in the soil. Metal concentrations in *B. maritima* and *R. sativus* reflected the soil metal concentrations, so they could be used as metal indicators in contaminated soils.

Kabata-Pendias, A., 2001. Trace Elements in Soils and Plants, 3ª ed. CRC Press, Boca Raton. Florida. EEUU. 413 pp.