The bioavailability of cadmium and lead in soil and bioaccumulation in barley from a contaminated soil

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- ❖ Cadmium and lead are among the most environmentally toxic heavy metals.
- ❖ In agricultural soil, sources of contamination by Cd are the phosphate fertilizers and the use of sewage sludge as amendment.
- ❖ The main sources of Pb are: industrial products, fuels, fungicides and insecticides containing arsenates and sewage sludge.
- ❖ The bioavailable heavy metal fraction is of great interest in soil contamination studies because it is the most environmentally mobile.
- ❖ The plant species show a different ability to absorb heavy metals from the soil depending both on the type of metal and the plant.
- ❖ In presence of high concentrations of heavy metals in the soil, most plants put radical barrier mechanisms in place thus limiting their toxicity on the plant organism.

OBJECTIVE

➢ to evaluate the capability of barley (Hordeum vulgare L.) to bioaccumulate Cd and Pb from an artificially contaminated soil and translocate them from roots to shoots (straw and grain) at maturation and its suitability for use in phytoremediation techniques.

METHODOLOGY

Plants were cultivated in pots on soil contaminated with Cd 100 mg kg^{-1} (Cd_{100}) or Pb 300 mg kg^{-1} (Pb_{300}). Soil and plant samples were collected at maturation. The concentrations of cadmium and lead in soil (total and bioavailable) and plant extracts were determined by ICP. The bioaccumulation factor (BCF) and the translocation factor (TF) were elaborated.

BIOACCUMULATION FACTOR

(heavy metal plant /tot. soil heavy metal)

CADMIUM	BCF
Control soil	0.04
Cd_{100}	0.35
LEAD	**BCF**
Control soil	0.43
Pb_{300}	0.35

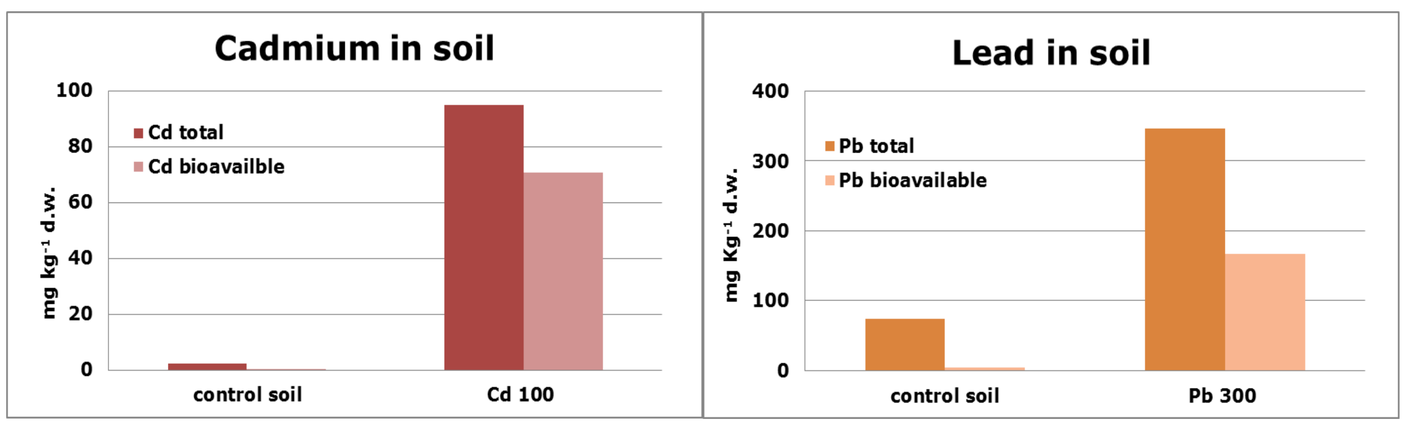
The barley bioaccumulates Cd from contaminated soil. In fact BCF in Cd_{100} was 9 times greater than control. Instead Pb_{300} has a BCF value lower than control.

TRASLOCATION FACTOR

	Control soil	Cd_{100}	Control soil	Pb_{300}
TF_1 (shoots/ roots)	2.0	0.10	0.62	0.12
TF_2 (straw/ roots)	2.0	0.09	0.60	0.12
TF_3 (grain/ roots)	0.0	0.01	0.01	0.00

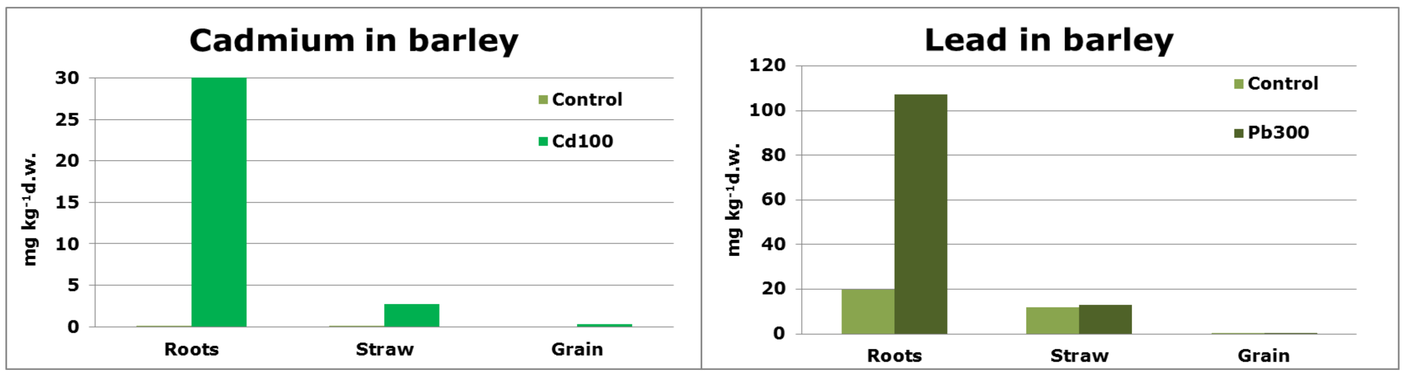
The translocation of Cd and Pb from roots to shoots is limited in polluted soil.

CADMIUM AND LEAD BIOAVAILABILITY IN SOIL



Pb in soil is less bioavailable than Cd because of its ability to form more stable bonds with the organic substance of the soil.

CADMIUM AND LEAD BIOACCUMULATION IN BARLEY



A different distribution of cadmium and lead in barley plants was observed. In Cd_{100}, plants showed concentrations significantly higher than C in the roots, straw and grain. In Pb_{300}, lead concentrations were significantly higher than C in roots and grain. Instead, in straw no significant differences were found between the two theses.
The roots are the main organs involved in the accumulation of cadmium and lead.

CONCLUSIONS

In soils contaminated by cadmium and lead, the barley plant activates physiological and biochemical mechanisms at the soil/root interface (in the case of lead) and at the root level (for both heavy metals) limiting the bioaccumulation of the two heavy metals from the soil to the roots and their translocation into the shoots (straw and grain). In polluted soil, the translocation of two heavy metals from the roots to the grains was low compared to the straw. Nevertheless, the barley plants grown on contaminated soil should be considered as possible means of entry for the cadmium and lead into the trophic chain. In this case study, the barley does not seem to be a species that can be used in phytoremediation techniques.

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