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Influence of compost application on arsenic uptake by beans (Phaseolus vulgaris L.), irrigated with arsenic-contaminated waters at four different concentrations

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The presence of arsenic (As) in soils and/or groundwaters, used for agricultural purposes, causes a strong abiotic stress to the cultivated plants, which results in the reduction of biomasses and yields, and the abundance of non-tradable products. It is therefore desirable to identify and develop production techniques capable of limiting the mobility and phyto-availability of As in soil, through the stabilization of the metalloid on the more recalcitrant soil fractions. Incorporation of compost into soil for As immobilization offers various potential advantages over other methods such as low-cost, simple methodology and low environmental impact.
We studied the influence of compost application on the mobility and phyto-availability of As in soil, the growth of the bean plants irrigated with As-contaminated waters and their own As uptake. Bean was selected as test plant, because this crop is grown in several As-contaminated areas and suffers As toxicity.
Bean plants growth was significantly affected by As and compost treatments. Increasing As concentration in the irrigation water decreased markedly the dry biomass, as a consequence of As phytotoxicity. The influence of compost application on plants growth was also significant, indicating the ability of the compost to alleviate the As phytotoxicity.
Arsenic caused a reduction of the photosynthesis rate. By increasing As concentration in irrigation water, in fact, bean leaves showed a decrease in both chlorophyll A and B concentrations in their own mesophylls. However, by increasing level of compost application there was an increase of both chlorophylls concentrations in bean leaves.
Arsenic concentration in roots was higher than that in shoots and bean yield. Bean plants showed a typical behavior of the plants sensitive to As toxicity, which usually tend to limit the As translocation from roots to shoots and yield. A low As allocation in bean yield is desirable, because a high As content in edible part of the plants could cause contamination of the human food-chain, being beans a low-cost proteins source and a staple food in many Countries. Moreover, the compost application has allowed to reduce the As concentration in all tissues of the amended plants than those non-amended.
The concentration of the As free-fraction in soil decreased significantly by increasing level of compost application, whereas the higher the compost application the higher was the concentration of specifically sorbed As by soil colloidal particles.
The results of this study suggest that the growth of bean plants and their own As uptake were substantially affected by the mobility of As in soils and the plant management. Higher mobility of As in soil resulted in higher As uptake by bean plants. The use of compost, in addition to improve bean plants growth and their nutritional status, has allowed to limit the As uptake by biomasses, through the immobilization of the metalloid, derived by irrigation water, on/in their humified organic macromolecules. Furthermore, the supply of nutrients through the compost falls within the context of the organic farming, eco-friendly production system, which ensures the sustainability of the soil, improving its fertility.