

Impact of iron oxide nanoparticles on Pb leaching and phytoextraction by *Helianthus annuus*

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Soil pollution with metallic trace elements linked to anthropogenic, urban, industrial and agricultural activities is a major problem of the current century, leading in particular to significant toxicity for the environment. Conventional methods of remediating soils polluted with trace metal elements are extremely costly. On the contrary, bioremediation methods such as phytoremediation are more profitable but take a long time to implement. Stimulation of phytoextraction by using iron oxide colloids could be an interesting alternative. This technique could allow an increase of the amount of metallic trace elements available to the plant while promoting the plant growth. Thus, the aim of this study is to assay the phytoextraction potential of lead, one of the toxic contaminants found in the environment, by sunflower (*Helianthus annuus*) in association with iron nanoparticles. This association was studied on a long-term (90 days) soil culture where 150 mg of lead per kg of dry soil were introduced by adding $\text{Pb}(\text{NO}_3)_2$ into pristine soil supplemented or not with iron nanoparticles. Succinct additions of $\text{Pb}(\text{NO}_3)_2$ brought the final lead concentration to 375 mg.kg^{-1} of dry soil. The added iron nanoparticles consisted of a solution of non-stoichiometric magnetite ($\text{Fe}_{3-\delta}\text{O}_4$) and represented 1% of the dry soil mass. Geochemical analyses were carried out on the soil as well as on the leaching solutions on a weekly basis. Weekly biological monitoring of the plants was carried out throughout the study. Physico-chemical and biochemical analyses were carried out on the plants at the end of the experiment. All the analyses thus carried out make it possible to evaluate the impact of the synergistic association of the iron nanoparticles on the phytoextraction of lead by sunflower.