Evaluation and management of Arsenic contamination in agricultural soil and water - AgriAs

Effect of agricultural amendments on transfer and toxicity of As toward plants and groundwater

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Public Summary

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One of the main objectives of the AgriAs project is to develop recommendations and guidelines for the sustainable management of As risk associated to agriculture. The effects of agricultural amendments on the transfer and toxicity of As toward plants and groundwater must be determined in order to develop knowledge about the risks associated to the presence of arsenic in cultivated soils. Two study sites were chosen for the implementation of AgriAs: one in France, a former chemical ammunition destruction facility from the interwar period converted into agricultural land near Verdun, and one in Germany, impacted by historical mining activities, near Freiberg in Saxony. The range of arsenic concentrations was 20 and 1000 mg/kg for the reference and polluted soils of Verdun, respectively, and 130 mg/kg for the soil from Freiberg.

In order to evaluate the influence of agricultural amendments on the transfer and toxicity of As toward plants and groundwater in the two sites, pot experiments with spring barley were designed to simulate, at small scale, conditions resembling those of the real site environment, maintaining globally aerobic (not saturated) conditions. The types of amendments and their amounts were chosen taking into account the real agricultural practices on each site and the results of previous microcosm experiments without plants. For the Verdun site, the amendment was ammonium sulphate, and for the Freiberg site, lime ammonium nitrate.

Results show that these ammonium-based amendments either do not affect or decrease the mobility of arsenic from soil to water. The fertilizers did not influence the speciation of arsenic in the soils which remained mainly as AsV. Conversely, arsenic in the grains of barley was composed of both AsIII and AsV, AsIII being the major arsenic species in all conditions. In the soils, the concentrations of AsIII-oxidizing micro-organisms was clearly linked to the total arsenic concentration, being significantly higher in the polluted than in the non-polluted soil for Verdun site. However, fertilization did not strongly modify their concentration, whereas soil drying seemed to induce a drastic decrease of the concentration of As-transforming microbes.

In the case of the other parameters studied, results differed between the soils of the two sites. With the polluted soil from the Verdun site, the toxicity for plants was decreased by the ammonium sulphate amendment, whereas lime ammonium nitrate did not attenuate the toxicity of the soil from Freiberg. With the polluted soil from Verdun, the fertilization induced an increase of arsenic concentration in the barley grains, whereas the opposite tendency was observed with the soil from Freiberg. These contrasting results must be interpreted with caution because seeding was performed later with the Freiberg soil than with the soil from Verdun. However, they suggest that parameters such as climatic conditions and soil quality influence the arsenic transfer from the soil to the crop more significantly than the total arsenic concentration in the soil.

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