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

Report on the experimental work on arsenic removal from soil

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Public Summary

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The European project AgriAs focusses on minimizing the risk of As uptake from agricultural water and soil. Widespread contamination on agricultural land poses a challenge for soil treatment, as conventional technologies such as soil washing are not applicable to large areas for economic reasons. Moreover, these technologies are often not environmentally friendly and hinder further agricultural land use. However, amelioration of the effects of As in soils is possible and therefore, an alternative treatment option based on the immobilization of As was tested within the AgriAs project. For this purpose, a novel biologically synthesized Schwertmannite-based adsorbent (named *sorpP*) was used in pot experiments with spring barley. The pure material and two modifications containing stabilizing agents (chalk and ash) were tested in three different dosages: 0.125 % w/w, 0.25 % w/w and 0.50 % w/w. As iron-based adsorbents retain not only As but also P, which can influence the nutrient supply of plants as well as the efficiency of As retention through competition for adsorption sites, an additional test series was done with a double P fertilization at medium adsorbent dosage (0.25 % w/w). Experiments were carried out with soil from Freiberg, contaminated not only by As but also by Cd and Pb, which both were taken into account for the assessment of the application of tested adsorbents on agricultural soils. Aside from analysing the concentration of contaminants in soil and crops, further investigations were done on bio-indicators which should be used to assess the successful application of adsorbents on agricultural soils. Therefore, the most probable number of As (III)-oxidizing and As(V)-reducing microbes in treated soil was studied as a potential bio-indicator for As bio-availability in soils. Also the Omega-3 Index of plants was determined during the experiment as an indicator for the oxidative stress of the plants caused by soil contaminants.

Results of the experimental work revealed a successful reduction of the mobility of the contaminants As, Cd and Pb in soil. As expected, the concentration of P was also decreasing with the application of adsorbents, but a double dosage of P fertilizer could compensate this. However, the higher P fertilization was accompanied by a reduction of the efficiency to immobilize As on agricultural sites due to the competing adsorption on the Schwertmannite-based adsorbent. Looking at the concentrations measured in harvested crops, the reduction of As was also successful for each adsorbent type and each concentration tested. In contrast, the use of the adsorbent without stabilizers led to a higher concentration of Cd and Pb in crops compared to the control condition, which could lead to the assumption that the application of this adsorbent type cannot be recommended for this study site. However, the use of the modified adsorbent *sorpP + chalk* achieved a decreasing concentration of Cd and Pb in crops. Statistical investigations revealed neither a significance of results for *sorpP + stabilizers* nor high coefficients of determination and thus, the results for Cd and Pb do not allow clear conclusions to be drawn. Further studies are required for a reliable evaluation of the impact of adsorbents on those contaminants. Investigations on bio-indicators revealed, that the most probable number of As-transforming microbes in treated soil was not applicable as an indicator of As mobility and the efficiency of the soil treatment. However, the high ratio of As (III)-oxidizing/As (V)-reducing microbes was a good indicator of As speciation, thus indirectly of its geochemical behaviour. The results of the Omega-3 Index determined on leaves of cultivated spring barley corresponded to the results obtained by analyses of contaminants in soil and crops and are valuable for the assessment of

the impact of adsorbents on plants health. Based on the Omega-3 Index the adsorbents with additional chalk and ash could be identified as the best approaches for soil amelioration having the lowest impact on the plants health.

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