

Impact of glyphosate and aminomethylphosphonic acid on the mobility of trace elements in uncontaminated and contaminated agricultural soils

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Glyphosate is one of the most widely used herbicides in the world and has become controversial due to human health risks. In addition to its herbicidal effect, glyphosate is a chelating agent that can form complexes with trace elements. Yet, agricultural soils can be contaminated with both organic and mineral substances, questioning the possible influence on the trace element mobility due to glyphosate application and its degradation as aminomethylphosphonic acid (AMPA) with similar structure. In this context, we specifically studied the extractability of trace elements in uncontaminated and contaminated (anthropogenic and geogenic) agricultural soils by adding formulated glyphosate, unformulated glyphosate, and AMPA in batch experiments using increasing concentrations (0, 20, and 100 mg L⁻¹). After the extraction, we analysed trace element (e.g., Cu, Pb, Cd, As, Ba, and Zn) and pesticide/metabolite (glyphosate or AMPA) concentrations in the solution by ICP-MS and HPLC, respectively. Results showed contrasting influence according to the active substance considered: while glyphosate enhanced the extractability of some elements (e.g., Cu, As, Zn, Cd), AMPA mainly increased the extractability of As and decreased those of other elements (Ba, Zn, Sn). However, the trends depended on the considered soil and active substance concentration. Interestingly, formulated glyphosate showed higher trace element extractability compared to glyphosate alone in the contaminated soils. This indicates that studying glyphosate alone does not necessary represent the real impact of pesticide application in the field. In parallel, glyphosate concentrations in the residual solutions were always higher after application of formulated glyphosate. Thus, glyphosate can be considered as a probable cause of increase of the mobility of trace elements in the soil, particularly in the surface horizons where the pesticide concentrations are the highest.