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Interaction of root exudates with the mineral soil constituents and their effect on mineral weathering

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Plants release significant amounts of high and low molecular weight organic compounds into the rhizosphere. Among these exudates organic acids (e.g. citric acid, malic acid, oxalic acid), phenolic compounds (e.g. flavonoids), amino acids and siderophores of microbial and/or plant origin strongly influence and modify the biogeochemical cycles of several elements, thus causing changes in their availability for plant nutrition. One class of these elements is composed by the trace elements; some of them are essential for plants even if in small concentrations and are considered micronutrients, such as Fe, Zn, Mn. Their solubility and bioavailability can be influenced, among other factors, by the presence in soil solution of low molecular weight root exudates acting as organic complexing agents that can contribute to the mineral weathering and therefore, to their mobilization in the soil solution. The mobilized elements, in function of the element and of its concentration, can be either important nutrients or toxic elements for plants. The objective of this study was to assess the influence of several root exudates (citric acid, malic acid, oxalic acid, genistein, quercetin and siderophores) on the mineralogy of two different soils (an agricultural calcareous soil and an acidic polluted soil) and to evaluate possible synergic or competitive behaviors. X-ray diffraction (XRD) coupled with Electron Probe Micro Analysis (EPMA) was used to identify the crystalline and amorphous phases which were subjected to mineral alteration when exposed to the action of root exudates. Solubilization of trace metals such as Cu, Zn, Ni, Cr, Pb, Cd as well as of major elements such as Si, Al, Fe and Mn was assessed by means of Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). Soil microorganisms have proven to decrease mineral weathering by reducing the concentration of active root exudates in solution. Results obtained are an important cornerstone to better understand the biogeochemical processes acting in the rhizosphere which can play an important role in the availability of trace elements (either nutrient or toxic) for plant uptake.

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