Can the addition of bacterial siderophores help in the phytoremediation of vinyard soils?

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The use of copper-based fungicides to control downy mildew in the vine has led to Cu contamination of the surface horizons of vinyard soils. Extracting copper from vinyard soils using metallo-accumulative plants is an option but effectiveness is often limited by the low phytodisponibility of Cu in the soil. Bacterial siderophores are molecules that strongly chelate Fe(III) but also divalent metals such as Cu. Their addition could contribute to increase the phytodisponibility of Cu. However, it is necessary to better understand how these molecules interact with soil constituents and modulate Cu dynamics in contrasting soil contexts.

The objective of this work is to evaluate the extent to which an addition of pyoverdine siderophore (Pvd) modulates the mobility and phytoavailability of Cu in vinyard soils. This work is based on a collection of 11 vinyards soils with the same total Cu content (120 ppm), on which $CaCl_2$ extractions have been carried out.

Initial results show that Cu availability can vary by a factor of 5000 between soils with the same total Cu content. Rather than Cu mobility from the solid phase, the speciation of Cu in solution seems to determine its phytoavailability, as shown by the close relationship observed between pCu (activity of the ion Cu^{2+}) and pH in the studied extracts. The addition of pyoverdine systematically increases total Cu mobility in these soils, along with that of Fe and Al. The Cu mobilization factor varies from 1.4 to 16.5 depending on the soil, with no obvious relationship to its physico-chemical characteristics. However, the addition of Pvd systematically reduces the amount of Cu^{2+} (phytodisponible Cu) in these soils due to a significantly increased complexation of this ion – potentially by the Pvd - in the extracts. All these data underline that the participation of the Pvd-Cu complex in root uptake is essential for the addition of Pvd to promote the phyto-extraction of Cu in vinyard soils.