World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:17, No:04, 2023

Degradation of the Cu-DOM Complex by Bacteria: A Way to Increase Phytoextraction of Copper in a Vineyard Soil

Authors : Justine Garraud, Hervé Capiaux, Cécile Le Guern, Pierre Gaudin, Clémentine Lapie, Samuel Chaffron, Erwan Delage, Thierry Lebeau

Abstract : The repeated use of Bordeaux mixture (copper sulphate) and other chemical forms of copper (Cu) has led to its accumulation in wine-growing soils for more than a century, to the point of modifying the ecosystem of these soils. Phytoextraction of copper could progressively reduce the Cu load in these soils, and even to recycle copper (e.g. as a micronutrient in animal nutrition) by cultivating the extracting plants in the inter-row of the vineyards. Soil cleaning up usually requires several years because the chemical speciation of Cu in solution is mainly based on forms complexed with dissolved organic matter (DOM) that are not phytoavailable, unlike the "free" forms (Cu2+). Indeed, more than 98% of Cu in the solution is bound to DOM. The selection and inoculation of invineyardsoils in vineyard soils ofbacteria(bioaugmentation) able to degrade Cu-DOM complexes could increase the phytoavailable pool of Cu2+ in the soil solution (in addition to bacteria which first mobilize Cu in solution from the soil bearing phases) in order to increase phytoextraction performance. In this study, sevenCu-accumulating plants potentially usable in inter-row were tested for their Cu phytoextraction capacity in hydroponics (ray-grass, brown mustard, buckwheat, hemp, sunflower, oats, and chicory). Also, a bacterial consortium was tested: Pseudomonas sp. previously studied for its ability to mobilize Cu through the pyoverdine siderophore (complexing agent) and potentially to degrade Cu-DOM complexes, and a second bacterium (to be selected) able to promote the survival of Pseudomonas sp. following its inoculation in soil. Interaction network method was used based on the notions of co-occurrence and, therefore, of bacterial abundance found in the same soils. Bacteria from the EcoVitiSol project (Alsace, France) were targeted. The final step consisted of incoupling the bacterial consortium with the chosen plant in soil pots. The degradation of Cu-DOMcomplexes is measured on the basis of the absorption index at 254nm, which gives insight on the aromaticity of the DOM. The“free” Cu in solution (from the mobilization of Cu and/or the degradation of Cu-MOD complexes) is assessed by measuring pCu. Eventually, Cu accumulation in plants is measured by ICP-AES. The selection of the plant is currently being finalized. The interaction network method targeted the best positive interactions ofFlavobacterium sp. with Pseudomonassp. These bacteria are both PGPR (plant growth promoting rhizobacteria) with the ability to improve the plant growth and to mobilize Cu from the soil bearing phases (siderophores). Also, these bacteria are known to degrade phenolic groups, which are highly present in DOM. They could therefore contribute to the degradation of DOM-Cu. The results of the upcoming bacteria-plant coupling tests in pots will be also presented.

Keywords : complexes Cu-DOM, bioaugmentation, phytoavailability, phytoextraction
Conference Title : ICPPP 2023 : International Conference on Phytoremediation Processes and Phytotechnologies
Conference Location : Paris, France
Conference Dates : April 13-14, 2023