Which soil Cu pool governs phytotoxicity in field-collected soils contaminated by copper smelting activities in central Chile?

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Abstract

Several studies have attempted to predict the so-called "phytoavailable" fraction by correlating plant responses with different soil metal pools. Most of the data derived from these studies tend to be inconsistent, making interpretations difficult. Thus, the main objective of this study was to determine which soil Cu pool (free Cu^{2+}, salt-exchangeable Cu or total Cu) controls Cu phytotoxicity in soils near a Cu smelter in central Chile. We studied the following traits of the local plant community grown spontaneously on the study site: species richness, shoot biomass, and plant cover. The site was dominated by four early plant colonizers: *Eschscholzia californica* Cham., *Hirschfeldia incana* (L.) Lagr.-Fossat, *Lolium perenne* L., and *Vulpia bromoides* (L.) Gray. We determined exchangeable soil Cu and activity of free Cu^{2+} in 0.1 M KNO_3 extracts using soil/solution ratio of 1/2.5. The effect of total soil Cu on plant responses was not significant ($p > 0.05$). In our field-collected soil series, exchangeable Cu was a better indicator of soil phytotoxicity than either total soil Cu or free Cu^{2+} in the soil solution. We determined upper critical threshold values for Cu exposure using the three plant traits cited above. The mean values of EC_{10}, EC_{25}, and EC_{50} (effective concentration at 10%, 25%, and 50%, respectively) of exchangeable soil Cu (in $\mu g\ L^{-1}$) were 255, 391, and 533, respectively. The mean EC_{10}, EC_{25} and EC_{50} values of pCu^{2+} were 7.5, 6.8, and 5.9, respectively. We highlight the importance of further studies on Cu phytotoxicity using actual field-contaminated soils.