Thresholds of copper phytotoxicity in field-collected agricultural soils exposed to copper mining activities in Chile

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Abstract

It has been argued that the identification of the phytotoxic metal thresholds in soil should be based on field-collected soil rather than on artificially-contaminated soils. However, the use of field-collected soils presents several difficulties for interpretation because of mixed contamination and unavoidable covariance of metal contamination with other soil properties that affect plant growth. The objective of this study was to estimate thresholds of copper phytotoxicity in topsoils of 27 agricultural areas historically contaminated by mining activities in Chile. We performed emergence and early growth (21 days) tests (OECD 208 and ISO 11269-2) with perennial ryegrass (*Lolium perenne* L.). The total Cu content in soils was the best predictor of plant growth and shoot Cu concentrations, while soluble Cu and pCu^{2+} did not well correlate with these biological responses. The effects of Pb, Zn, and As on plant responses were not significant, suggesting that Cu is a metal of prime concern for plant growth in soils exposed to copper mining activities in Chile. The effects of soil nutrient availability and shoot nutrient concentrations on ryegrass response were not significant. It was possible to determine EC_{10}, EC_{25} and EC_{50} of total Cu in the soil of 327 mg kg^{-1}, 735 mg kg^{-1} and 1144 mg kg^{-1}, respectively, using the shoot length as a response variable. However, the derived 95% confidence intervals for EC_{10}, EC_{25} and EC_{50} values of total soil Cu were wide, and thus not allowing a robust assessment of metal toxicity for agricultural crops, based on total soil Cu concentrations. Thus, plant tests might need to be performed for metal toxicity assessment. This study suggests shoot length of ryegrass as a robust response variable for metal toxicity assessment in contaminated soils with different nutrient availability.