

Efficacy of woody biomass and biochar for alleviating heavy metal bioavailability in serpentine soil

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Abstract Crops grown in metal-rich serpentine soils are vulnerable to phytotoxicity. In this study, *Gliricidia sepium* (Jacq.) biomass and woody biochar were examined as amendments on heavy metal immobilization in a serpentine soil. Woody biochar was produced by slow pyrolysis of *Gliricidia sepium* (Jacq.) biomass at 300 and 500 °C. A pot experiment was conducted for 6 weeks with tomato (*Lycopersicon esculentum* L.) at biochar application rates of 0, 22, 55 and 110 t ha⁻¹. The CaCl₂ and sequential extractions were adopted to assess metal bioavailability and fractionation. Six weeks after germination, plants cultivated on the control could not survive, while all the plants were grown normally on the soils amended with biochars. The most effective treatment for metal immobilization was BC500-110 as indicated by the immobilization efficiencies for Ni, Mn and Cr that

were 68, 92 and 42 %, respectively, compared to the control. Biochar produced at 500 °C and at high application rates immobilized heavy metals significantly. Improvements in plant growth in biochar-amended soil were related to decreasing in metal toxicity as a consequence of metal immobilization through strong sorption due to high surface area and functional groups.

Keywords Soil amendment · Ca/Mg ratio · Chemical stabilization · Black carbon · Charcoal

Introduction

Serpentine soil is characterized by a high natural abundance of heavy metals such as Ni, Mn, Co and Cr (Hsiao et al. 2009; Oze et al. 2004; Rajapaksha et al. 2012, 2013). Weathering and dissolution may transport these toxic metals into surrounding environment. The presence of excessive metal concentration in the serpentine surroundings may reduce the agricultural productivity and generate the phytotoxicity and bioaccumulation in crops (Houben et al. 2013b). The serpentine-associated soils subjected to agriculture have shown high concentrations of metals in soil and plants, in Northwestern Spain (Fernandez et al. 1999), Canada (Baugé et al. 2013), Greece (Antibachi et al. 2012), Philippines (Susaya et al. 2010) and Japan (Kayama et al. 2002).

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