CHEMICAL STABILIZATION OF SELECTED HEAVY METALS BY TSP, ROCK PHOSPHATE AND DOLOMITIC LIMESTONE

R.M.S. RATNAYAKE, H.U.K.CHATURANI AND S.P. INDRARATNE*

Department of Soil Science, Faculty of Agriculture, University of Peradeniya

Introduction

Heavy metals present in soils pose an environmental concern since these heavy metals are transferable through food chains. Research over the past few decades has focused on the use of chemical immobilization products to chemically alter soil heavy metals to less bioavailable forms. In situ stabilization makes metals less bioavailable which can be accomplished by adding different forms of phosphorus containing materials and limestone. Therefore, this investigation was conducted to study the suitability of TSP, dolomitic limestone (DL) and High-grade Eppawala Rock Phosphate (RP) as an ameliorant for Zn, Cu and Cd contaminated Alfisols.

Materials and methods

Reddish Brown Earth (Alfisols) soil collected form Mailluppallama at 0-20 cm depth was contaminated with metals by spiking Zn, Cu and Cd ($ZnCl_2$, $CuCl_2.2H_2O$ and $CdCl_2.2.5$ H_2O) at the rate of 150, 300 and 10 mg kg^{-1} of soils respectively for the remediation study. An incubation study was conducted for 90 days at room temperature maintaining gravimetric moisture content at 35% through out the period. Following treatments in duplication were tested; i.e., Control (with out any P source), 5 g kg^{-1} P_2O_5 as TSP, 5 g kg^{-1} P_2O_5 as RP, 5 g kg^{-1} of DL and 2.5 g kg^{-1} DL+ 2.5 g kg^{-1} RP. Available P, pH, electrical conductivity were measured using standard methods. Available metal and total metal were analyzed and metals were sequentially extracted for water soluble, exchangeable, carbonate bound, Fe-Mn bound and organic matter bound using different extractions as described by Tessier et al (1979). A monometal adsorption study was conducted for DL and RP separately by equilibrating varying concentration of Zn, Cu and Cd. Maximum adsorption capacity was calculated using the linear form of Langumuir Isotherm.

Results and discussion

The available Zn, Cu and Cd content were significantly reduced by addition of TSP (Fig. 1), indicating the formation of separate stable mineral phases of metal-phosphates. Available Zn was significantly lower in DL and DL+RP treatments than the control treatment after 70 days of incubation. Rock phosphate treatment alone did not reduce the Zn availability in soils with in the incubation period. Cadmium availability was significantly reduced by the addition of RP and DL+RP. For Cd, DL treatment alone did not reduce the available Cd in soils. Copper shows the similar trend as Zn, reducing availability of Cu by DL and DL+RP. Sequential extraction showed Cu was associated with carbonate fractions and residual fraction in DL and RP treatments (data not shown). Zn was associated with water soluble fraction, exchangeable fraction, carbonate bound, and residual fraction in control treatment. Addition of DL and DL+RP reduced water soluble and exchangeable fractions but increased carbonate and residual fraction bound heavy metals. Therefore, DL and DL+RP can be used as an ameliorant for Zn. Copper is available in carbonate bound, Fe-Mn bound and comparatively higher amount in organic matter bound fractions. On the other hand, Cd is available in all five fraction including water soluble, exchangeable, carbonate bound, Fe-Mn bound and organic matter bound in considerable amounts except in TSP treated soil.

Conclusions

This study reveals that RP and DL addition reduces bioavailability of Cu, Cd and Zn and has potential for in-situ remediation of heavy metal contaminated soil. Significant reduction in all available metals in TSP treated soil indicated its superiority among the treatments in the amelioration process of the metals.

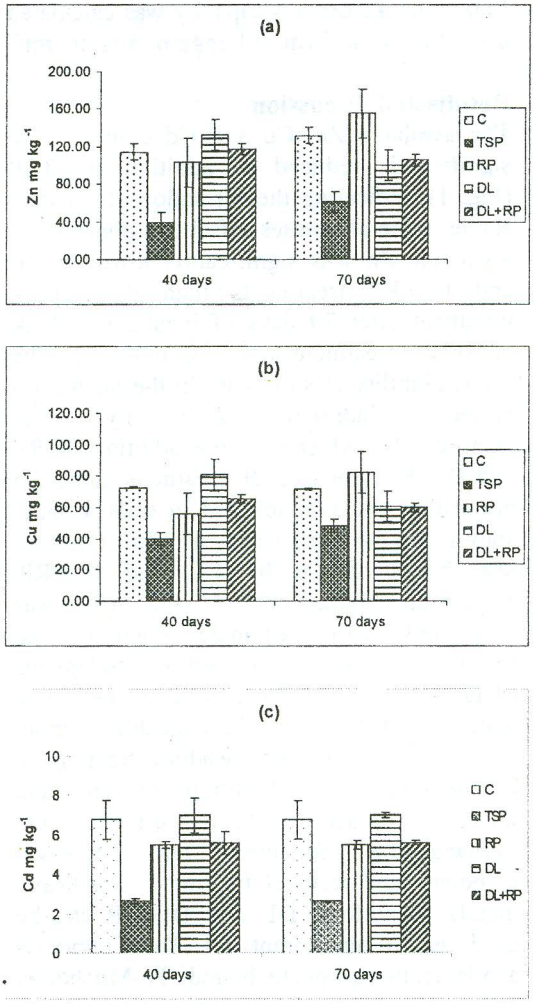

Figure 1. Availability of Zn (a) Cu (b) and Cd (c) in soils treated with selected soil amendments of control (C), Tripple super phosphate (TSP), rock phosphate (RP), dolomotic limestone (DL) and DL+RP) at the end of 40 and 70 days after incubation

The effectiveness of the materials for remediation of Zn can be arranged as TSP >> DL = DL+RP > RP = control, for Cu as TSP >> DL = DL+RP > RP = control, and for Cd as TSP >> RP=DL+RP > DL=control.

References

Tessier A, Campbell PGC and Bission M (1979) .Sequential extraction procedure for the speciation of particular trace metals. Anal.Chem.51:844-851