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Nutrient Retention in an Amazonian Ultisol: Implications for Sustainable Land Use

Bernard Ludwig[1], Dirk Hölscher[2]

[1] *University of Göttingen, Institute of Soil Science and Forest Nutrition, Germany*
[2] *Georg-August University Göttingen, Albrecht von Haller Institute for Plant Sciences, Germany*

Abstract

Knowledge about cation and anion exchange and pH buffering in soils is essential for developing an efficient nutrient management system, especially in tropical soils where nutrient retention capacity may be low. Sorption characteristics and pH buffering of an Amazonian Ultisol were studied in sequential batch experiments. Objectives were to gain additional information on the cation and anion exchange and pH buffer properties of this soil by using a coupled equilibrium model.

The cation exchange capacities in the surface soil and subsoil were below $30\,\mathrm{mmol_c\ kg^{-1}}$, indicating that the soil is highly limited in retaining nutrient cations against leaching. The anion exchange capacity of the soils for both depths was small (1 to $4\,\mathrm{mmol_c\,kg^{-1}}$), indicating insignificant retention of NO_3 and its enhanced losses in seepage water following non-adapted management practices such as high doses of fertilization. More protons could be buffered in the surface soil than in the subsoil. Addition of protons to the surface soil released equivalent amounts of M_b (Ca, Mg, K, Na) cations because of CEC reduction, and an insignificant amount of Al. However, input of protons to the subsoil released large amounts of Al. The model satisfactorily predicted the sorption values for various elements in both depths, indicating that the main processes are understood.

The results indicated a very poor capacity of the soil for nutrient retention and pH buffering and a high risk of Al toxicity. Management options should substitute 'slash and burn' practices (which result in further nutrient losses) with mulch producing technologies and strive for only small additions of fertilizer (to reduce nutrient losses and avoid further soil acidification). A useful nutrient management strategy would include intercropping with legumes, but compensation for the increased acidification may be required.

Keywords: Amazonia, anion exchange capacity, cation exchange capacity, pH buffering, PHREEQC, 'slash and burn', 'slash and chop', soil acidification

Contact Address: Bernard Ludwig, University of Göttingen, Institute of Soil Science and Forest Nutrition, Büsgenweg 2, 37077 Göttingen, Germany, e-mail: bludwig@gwdg.de