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Effects of biochar and clay amendment on nutrient sorption of an Arenosol in semi-arid NE-Brazil

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In the semi-arid Northeast of Brazil nutrient-poor Arenosol with a low capacity to retain water and nutrients is the predominant soil type. Our aim is to provide a long-term melioration of the soils with locally available and inexpensive materials. We hypothesize an increase in nutrient sorption by the addition of biochar and clay.

We conducted adsorption experiments according to OECD 106 batch equilibrium method in order to test this hypothesis. Sandy Arenosol, locally produced pyrolized biochar made of *Prosopis juliflora*, and a clayey Vertisol with a clay content of 69.8 %, all from our project area in Pernambuco, NE-Brazil, were used.

The percentage of biochar and Vertisol added were 0 % (pure Arenosol), 1 %, 2.5 %, 5 %, 10 %, 100 % (pure biochar respectively Vertisol). Samples were shaken for 24 hours in a 1:5 solid-solution ratio in six different concentrations of Ammonium-N, Nitrate-N (0 – 25 mg L^{-1} each), Phosphorus (0 – 19.8 mg L^{-1}) and Potassium (0 – 50 mg L^{-1}). These concentrations were chosen to represent a common range of nutrients in a prevalent quaternary fertilization scheme of N:P:K of 1:0.4:1, with half NH_4-N and NO_3-N each. Then, where possible, sorption isotherms according to Langmuir were derived.

Addition of biochar and Vertisol only showed marginal effects on Ammonium sorption. We detected a high loss of Ammonium with pure biochar, we assume loss of gaseous NH_3. High rates of biochar addition caused Nitrate retention.

Biochar increased P sorption with a maximum adsorption capacity (q_{max}) of 27.35 mg kg^{-1} for the 5 % amendment, although some P was leached out (up to 1.58 mg kg^{-1} for the 10 % addition). Phosphate sorption on Vertisol was even higher with a q_{max} for the 5 % addition of 60.77 mg kg^{-1}. Potassium did not sorb to biochar, but was strongly leached out (84.19 mg kg^{-1} out of the 5 % addition). For Vertisol we observed a strong Potassium sorption that is linear within the concentration range we tested.

A possible enhancement of nutrient retention of an Arenosol by adding biochar was detected for Phosphorus and marginal for Ammonium. For Vertisol we determined a potential to retain Potassium, Phosphorus and, to a minor degree, Ammonium. For Nitrate biochar seems to have a potential to reduce losses. We suggest a mixture of Vertisol and biochar to combine the nutrient retaining effects of both materials.