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Composite of biochar and cooking ash as ameliorant for enhanced nutrient availability and microbial functions of tropical soils

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Abstract

Soils in most tropical savannah ecosystems are acidic due to their non-calcareous parent materials. This limits nutrient release and efficiency of microbial functions, leading to low crop productivity. In an incubation experiment, we assessed the ameliorating potentials of a single addition of corn cobs biochar and its combination with kitchen waste ash or calcium carbonate (CaCO3) on chemical and biological fertility indicators of acidic soil. Petroplinthic Cambisol soil obtained from the Guinea savannah zone of northern Ghana was used for the experiment. Based on a predetermined lime requirement (0.6 CaCO3 t ha^{-1}) of the soil and calcium carbonate equivalent of the ash (63 %), we applied biochar at 10 t ha^{-1} (B10) and 20 t ha^{-1} (B20); ash and calcium carbonate (CaC) at 0.7 and 0.5 t ha^{-1} respectively. In addition, combined application of B10+Ash, B20+Ash, B10+CaC and B20+CaC were studied, each incubated for 8 weeks at 50 % soil water holding capacity. The treatment effects on soil physicochemical parameters including pH, mineral nitrogen (Nmin), available phosphorus and soil organic carbon (SOC) were examined. Further, we measured basal respiration, microbial biomass carbon (Cmic), and extracellular enzymes involved in carbon (β-glucosidase, β-cellobiosidase, and β-xylosidase), nitrogen (Arginine- and Tyrosine-aminopeptidase), and phosphorus (Acid phosphatase) cycling. The results revealed that lime (CaC and Ash) and their combination with biochar improved soil pH by up to 22 % and increased mineral nitrogen and available phosphorus content than in the unamended control soils. The B20+Ash amended soil showed the highest microbial respiration (+56 %) and Cmic (+45 %) compared to the control. Higher SOC in the biochar treated soil stimulated the activities of extracellular enzymes, especially C- and N-cycling enzymes in the biochar-ash amended soil. Co-application of 10 t ha^{-1} biochar and 0.7 t ha^{-1} ash showed greater increases in all the examined soil fertility indicators than when biochar was applied alone, even at 20 t ha^{-1}. The study, therefore demonstrated that co-application of ash with biochar boosted biochar´s liming abilities even at a low rate, resulting in soil mineral N and available P release and effective microbial functions in tropical acidic soils.

Keywords: Biological functions, chemical indicators, liming, savannah soil, soil acidity

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