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"Reconcile land system changes
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Carbon mineralisation kinetics and greenhouse gas emission as influenced by biochar and poultry manure

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Abstract

This study investigates the effect of sole and co-application of biochar (B), poultry manure (PM), and mineral fertiliser (MF) on carbon mineralisation kinetics, emissions of CO_2, N_2O, and CH_4, maize growth and yield in the savannah soils of Nigeria. Greenhouse gases evolution was measured over 56 days incubation period. Biochar application as sole and or combined with poultry manure resulted in lower applied carbon mineralised (ACM), indicating C sequestration in the soil. Negative Attributable Effect of co–application of biochar and poultry manure on carbon mineralisation was observed relative to the sole treatments and were negatively correlated with C: N ratio and mineral N content of the soil mixtures, indicating microbial N limitation. The double first- order exponential model described CO_2-C efflux very well and indicated that $> 94\,\%$ of C applied was apportioned to stable C pools with slower mineralisation rate constant and longer half-life. Cumulative C mineralised and modeled C pools were positively correlated with each other but easily oxidisable C of soil amendment mixtures showed negative correlation. The treatments significantly ($p < 0.001$) influenced greenhouse gas emissions, soil chemical properties and Nitrogen Use Efficiency components, including agronomic efficiency (AE) and physiological efficiency (PE). The co-application of B+PM+MF resulted in the highest AE (8.0 kg grain/kg N applied), PE (39.5 kg/kg), and NUE (34.3 %), followed by B+PM, which recorded AE of 7.3 kg grain/kg N applied, PE of 23.0 kg/kg, and NUE of 21.3 %. In contrast, sole applications of MF and B recorded lower NUE values of 14.0 % and 10.0 %, respectively. The results also suggest that co-application of B and PM can promote initial rapid mineralisation to release plant nutrients but sequester larger amounts of applied Carbon in a stable C pool, resulting in larger Carbon sequestration in the soil.

Keywords: Biochar, carbon sequestration, greenhouse gases

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