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Improving degraded coastal acrisol with biochar and compost enhances soil quality and carbon storage

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Abstract

Tropical soils of the world continue to experience soil fertility decline due to continuous cultivation. This study assessed the effects of Empty Fruit Bunch (EFB) biochar and/or compost amendments on the physicochemical properties and soil carbon pools of a coastal savannah Acrisol under okra cultivation. A field experiment was conducted over two cropping cycles at the University of Cape Coast's AG Carson Technology Centre using a randomised complete block design with six treatments: control, biochar (10 and 20 t/ha), compost (20 t/ha), and combinations of biochar (10 or 20 t/ha) with compost (20 t/ha).

The combined application of 20 t/ha biochar and 20 t/ha compost significantly improved soil water holding capacity and reduced bulk density. Soil pH, total nitrogen, soil organic carbon, and available phosphorus were also markedly enhanced under this treatment. Exchangeable calcium and effective cation exchange capacity increased significantly, while nitrate-N and ammonium-N were reduced, particularly in sole and combined biochar treatments. Compost alone led to the highest dissolved organic carbon, while the combined amendments enhanced the storage of particulate organic carbon (POC) and mineral-associated organic carbon (MAOC) across all soil aggregate sizes. Recalcitrant carbon levels were also highest under the combined treatment.

Overall, the study demonstrates that integrating EFB biochar and compost not only improves soil physical and chemical properties but also enhances the stabilisation and storage of key soil organic carbon fractions within different aggregate sizes. These findings underscore the potential of biochar–compost combinations as an effective soil management strategy for improving soil health and long-term carbon sequestration in highly weathered tropical soils.

Keywords: Acrisol, carbon fractions, empty fruit bunch (EFB), organic amendments, soil aggregation, soil fertility

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