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Local soil amendments enhance soil organic carbon quantity and quality in Indonesian post-tin mining soil

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Abstract

Using locally available soil amendments is considered as an effective and affordable strategy to reclaim highly degraded soil, such as in post mining areas. This is especially crucial in tropical regions where soil erosion and decomposition rates are particularly high. Increase in soil organic carbon (SOC) serves as a key indicator of soil health and, consequently, soil productivity improvement. Thus, the study aimed to demonstrate the quantitative and qualitative response of SOC accumulated in a post-tin mining soil in Indonesia during the first four years of reclamation, utilising local soil amendments. Soil samples (0–20 cm) were collected from an experimental plot prior to treatment and then annually after applying dolomite, compost, and charcoal, as well as control (without any amendments). SOC stocks were assessed from the collected samples. Its chemical composition was determined by Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopic technique. The results revealed that the soil amendments used significantly influenced SOC stocks and altered its chemical composition. Compost and charcoal increased SOC stocks by ≥ 40 Mg ha^{-1} compared to control during the study period. They accelerated SOC gain within the first two years, whereas it required four years to attain SOC acquisition in control. SOC under compost and control shared similar chemical composition with broad variation throughout the study period. The chemical composition of SOC in dolomite amended soil was distinct from the others, and this was notably enhanced by aliphatic hydrocarbons. In contrast, chemical composition of SOC under charcoal exhibited variation over time, highlighting its richness in C-N of amide III in the third year. This indicated a benefit of charcoal for SOC accumulation through absorption of organic substances released by e.g., plant roots. Stronger correlations between SOC chemical composition and both soil pH and EC than its correlation with the amount of SOC implied an indirect effect of soil amendments on controlling SOC quality. Therefore, using compost and charcoal is a potential strategy to improve SOC stock in the studied soil despite differences in their chemical composition.

Keywords: Carbon stock, chemical composition, degraded soil, soil reclamation, tropical soil

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