ABSTRACT

Structural Stability, Hydraulic Properties and Erodibility of Humid Tropical Soils under Intense Rainfall

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This research examines major cohesive and disruptive factors and their mechanisms of operation on key soil quality processes for the effective management of soils under wetting and raindrop impact of the humid tropics. Completely randomized factorial experiments involving 23 representative Trinidad soils, varying wetting conditions and varying levels of amendments were examined in a series of laboratory investigations. Wet sieving, percolation stability and single drop techniques were employed to assess structural stability. Infiltration rate and splash detachment were measured under intense simulated rainfall.

A clay content threshold was found to exist above which the support of organic matter (OM) is required to weaken disruptive forces but below which OM and slow pre-wetting are not effective in diminishing them. The contribution to high cation exchange capacity (CEC) by smectites encouraged disaggregation while high CEC jointly contributed by smectites and OM increased cohesive resistance to disaggregating forces. Aggregate stability under fast wetting in the absence of rainfall was not a reliable stability predictor for most of the soils under rainfall. Therefore, its use as a soil quality index and its application to all soils for structural management purposes may not be effective.

Slow as opposed to fast pre-wetting alleviated slaking pressures and susceptibility to the erosive effect of intense rainfall. It masked the effects of clay and OM but not that of exchangeable sodium percentage. However, even if slow wetting is done prior to intense rainfall but not to an antecedent moisture content (AMC) sufficient to eliminate intra-aggregate air, further slaking and erosion occur. To induce suitable conditions for aggregation in these degraded soils, a minimum rate of 60 g farmyard manure/kg is recommended. A minimum residence time of 28 days is also necessary for particle bonding substances to be released and for aggregate improvement through the cationic bridging effect of Ca^{2+}.

Since slaking mechanisms dominated disaggregation in these soils, a simple predictive slaking sensitivity ranking model was developed. It uses readily available soil data to classify the soils into slaking sensitivity classes for appropriate management practices. Its predicted values were in close agreement with measured values. More than 96 % of the soils were found to be in the moderate to high slaking sensitivity classes. Therefore, soil management practices that reduce aggregate slaking pressures are desirable.

For the effective cultivation of these and other similar soils exposed to intense rainfall, certain measures are necessary: appropriate stability assessment must be done, OM content must be maintained at high levels, adequate residence time following OM addition must be allowed, the build-up of sodicity must be avoided and slow wetting to an appropriate AMC must be employed.

Keywords: Mark Nakka Wuddivira; Structural stability; Erodibility; Slaking; Intense rainfall.