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ABSTRACT

Sugarcane is an important commercial crop of Northeast Thailand grown as monoculture on an area of 0.4 million hectares. Most soils in Northeast are sandy soil which are easily eroded. Sugarcane management for yield improvement through chemical fertilizer application, pesticide and heavy machinery cultivation has led to physical, chemical and biological soil degradation. Depletion of Organic matter, cation exchange capacity and soil structure has caused soil degradation and paved way for sugarcane productivity decline. These can be reduced by soil management techniques especially organic material amendment. If we need to increase organic matter in tropical soils, fast decomposition of organic materials should be supplied regularly. However, addition of high-activity clay (2:1 clay) can maintain organic matter and improve cation exchange capacity of soil for sustainable sugarcane production.

Two field experiments were established to investigate method and type of organic and clay amendments for sugarcane productivity improvement. These trials were located at Kalasin province in the middle of Northeast Thailand with different methods of organic and clay material amendments. First method was broadcast application followed by incorporation and basal application at 50-50-25 kgN-P_2O_5-K_2O. Second method was banding application and basal application at 25-25-12.5 kgN-P_2O_5-K_2O. Treatments consisted of organic materials including filter cake @ 50 t ha^{-1}, cattle manure @ 25 t ha^{-1} and bagasse @ 12.5 t ha^{-1} and clay soil (smectite @ 0,

25, 50 and 75 t ha^{-1}). Effect of these treatments on physical and chemical properties were investigated in degraded Korat sandy soil (fine-loamy siliceous, isohyperthermic, Oxic Paleustults) at 0-30 and 30-60 centimeter depths and measured sugarcane (K 88-92 variety) growth and yield. The experiment on broadcast method was laid in Completely Randomized Design (CRD) with 4 replications and banding method laid in Randomized Completely Block Design (RCBD) with 4 replications.

The degraded sandy soil in this study site before amendment was deficient in exchangeable potassium, organic matter, CEC and improper texture with high sand fraction for sugarcane production. The potential yield in general sandy soil of Northeast Thailand was about 80 t ha^{-1} (plant cane) but capability in this site was about 60 t ha^{-1} while addition of conventional chemical fertilizer could increase cane yield to 90 t ha^{-1}. However, the organic and clay material amendments could enhance sugarcane production especially in cattle manure @ 25 t ha^{-1}, filter cake @ 50 t ha^{-1} and clay soil @ 75 t ha^{-1} that increased yield upto 100 t ha^{-1}. Therefore, appropriate materials for soil fertility improvement for sugarcane production were cattle manure @ 25 t ha^{-1} which decreased soil bulk density 13%, increased soil pH 28%, organic matter 8%, exchangeable potassium 7%, exchangeable magnesium 7% and CEC 15 %. The increase of organic matter, which can reduce soil bulk density with organic matter, supplied directly and indirectly through microbial action, the major cementing agent for soil aggregate-forming and increases soil porosity. In addition, cattle manure contained high potassium and magnesium which increased pH and CEC in soil. Filter cake @ 50 t ha^{-1} increased aggregate stability 50%, organic matter 17% and available phosphorus 566%. Filter cake had great chemical properties (N, P, K, Ca and Mg) that enhanced microbial activity and root growth influenced to granulation with more stability. Clay soil @ 75 t ha^{-1} decreased soil bulk density by 9%, increased clay fraction (5%), soil pH (24%), exchangeable calcium (15%) and CEC by 16 %. Clay soil (CS) contained with high clay particles, N, P, K, Ca and CEC which increased soil pH and CEC. In addition, clay particle is cementing agent which enhanced organic matter adsorption and higher cation exchange capacity. The superiority of clay soil amendment could reserve soil organic matter, calcium and CEC at sufficient level for plant utilization. The soil properties after amendment was determined in limiting factors for sugarcane production and found no materials can improve

exchangeable potassium, organic matter and cation exchange capacity over than sugarcane requirement. However, clay soil amendment could retain exchangeable calcium at sufficient level. The increase of calcium in soil increased soil pH and reduced bulk density which enhances sugarcane growth and yield. However, from cost benefit ratio analysis we found highest gain from filter cake application at 32,000 baht ha^{-1} followed by conventional chemical fertilizer at 30,000 baht ha^{-1} and cattle manure at 27,000 baht ha^{-1} respectively. The appropriate organic and clay material amendment method was broadcast which higher specific surface with soil particle than banding method and without effect on germination.

Korat degraded sandy soil can be improved in soil pH, organic matter, exchangeable potassium, exchangeable calcium, exchangeable magnesium and cation exchange capacity by organic and clay material amendments that can enhance sugarcane growth and yield. The rehabilitation process of organic materials amendment was increased organic matter which is reserve of plant nutrient (nitrogen, phosphorus and potassium) and anion. The anion arises largely from ionization of COOH groups, although some contribution from phenolic OH in organic matter (variable charge). Organic matter could enhance cation exchange capacity and attract with basic cation nutrients (potassium, calcium and magnesium) by ionic bonding which can enhance soil pH. The rehabilitation process of clay soil amendment could increase cation exchange capacity with their permanent and variable charge which can attract with basic cation nutrients (potassium, calcium and magnesium) by ionic bonding which can enhance soil pH. In addition, organic matter can adsorb with clay material and retain soil organic matter in longer period.

The effect of organic and clay material amendments should be studied more in utilization of recommendation rate of cattle manure @ 25 t ha^{-1}, filter cake @ 50 t ha^{-1} and clay soil @ 75 t ha^{-1} for sugarcane production should reconsider for other crops production. Otherwise, organic and clay material combination should be tested for application method and appropriate rate for degraded soil improvement in sugarcane cropping system. The combination material could increase and maintain organic matter for organic sugar production in future. In addition, the effect of organic and clay material amendment on subsequent ratoons according to trash management in long-term period for sugarcane production should be studied. That can understand in

nutrients cycling in continuous sugarcane monoculture and use for nutrient management in sugarcane cropping system with sufficient level according to growth stage. The improvement of soil pH in acid sandy soil using lime can support organic and clay material amendments efficiency. Local high activity clay inventory and recommendation for sustainable crop production should be studied for further works.