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Role of Manure on Aggregate Stability Improvement of Several Clayey- Textured Soil under Wet Tropical Environment

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Abstract

A pot trial on aggregate stability improvement was conducted through application of manure as an organic matter (OM) source on clayey-textured soils. Organic matter was used due to the fact that it does not only function as a qualified soil binding agent, but it is also relatively cheap and easy to find around farmland. The objective of the research was to find out the amount of manure needed to improve soil aggregate stability several clayey-textured soils found under wet tropical environment. The treatment consisted of 2 factors, different textured soil (6 types) and dosage of manure applied (5 levels). The experimental units were allocated in completely randomized design (CRD). The first factor was clayey textured soils derived from mixing Ultisol and Entisol(A1=50% clay, A2=46% clay, A3=42% clay, A4=38% clay, A5=34% clay, and A6=28% clay) and the second factor was manure dosages (Bo=0 %, B1= 1%, B2=3%, B3=5%, and B4=7%). The treatments were incubated under field capacity for 3 months in glasshouse. Parameters analysed were texture (pipette and sieve method), Organic Carbon (OC) (wet oxidation method), bulk density and total pore (gravimetric method), aggregate formation and aggregate stability index (dry and wet sieving method). The result showed that there was no significant interaction between soil texture and percentage of manure application, but the main factors significantly affected the OC content and aggregate percentage of the soil. Increase in manure application from 0% to 7%, increased soil organic matter (SOM) content by 19% (from 3.93% to 4.67%) and improved aggregation percentage by 35% (from 33.2% to 45.0%). Decrease inclaycontent of the soil from 50% to30% increased SOM by 48% (from 3.48% to 5.16%), aggregate stability index by 18% (from 35.2 to 41.7), but decreased aggregation percentage by 52% (from 55.2% to 26.3%). Aggregate stability index, however, was not yet affectedafter 3 months of manure application.

Key words: clayey textured soils, manure, aggregate stability index, aggregation percentage

I. INTRODUCTION

In wet tropical area, farming activities under sloping land and marginal soil cannot be avoided since the fertile soils are mostly changed into non-agriculture activities such as in West Sumatra. An example of marginal soil dominantly found in West Sumatra is Ultisols. The soil has, besides low chemical fertility, problematic soil physical properties. Reference {1], [2] reported that the soil high clay content reaching >80% on the top 20 cm depth, low SOM content, slow permeability, and less aggregate stability.

Aggregate stability is a quality control of a soil as a medium for plant growth. Clayey-textured soils such as Ultisols mostly found in wet tropical environment have low aggregate stability due to low soil organic matter (SOM) content [1].One way to improve soil aggregate stability is by applying OM to the soil [3], [4]. The condition induces land degradation and environment unsustainability, since the area receiving high annual rainfall and located in sloping areas.

Reference [5], reported that incorporation of fresh OM to Utisol incresed aggregate stability index of Ultisols under wet tropical area. Reference [6], considered SOM as the best soil binding agent. Organic matter was found to be beneficial as aggregate binding agent in wet tropical areas, because the OM can create soil aggregates stable within water or sudden wetting. Moreover, OM is a kind of binding agent easily got either in forms of fresh, composted, or manure materials around the farming lands.

Besidesable to bind and stabilize soil aggregates, OM can also retain more water, loose clayey soils, aswell as provide nutrients for plant growth.Organic matter is classifiedd as very important materials in farming activities, especially in wet tropical area such as in West Sumatra Indonesia. Manure is a kind of OM source mostly found in traditional farmers in West Sumatra. How effective of manure application on aggregate stability of clayey textured soils in wet tropical area is interested to know.

II. MATERIAL AND METHOD

A pot trial is conducted in glasshouse. Soil textured with different clay content was got from mixing between Ultisols (heavy clay textured soil from Limau Manis West Sumatra Indonesia) and Entisols (sandy textured soil from Ketaping, West Sumatra Indonesia). The physical characteristcis of both soil were provided in Tabel 1. The OM source was cow manure.

The treatments were 2 factors (Clayey textured soil and OM dossage). Clayey textured soils (A) consisted of 6 types (A1=50% clay, A2=46% clay, A3=42% clay, A4=38% clay, A5=34% clay, and A6=28% clay) and OM (B) consisted of 5 levels (Bo=0 %, B1= 1%, B2=3%, B3=5%, and B4=7%). The mixture between soil and OM was incubated for 3 months under field capacity in

glasshouse. The experimental units were allocated based on Completely Randomized Design(CRD). Parameters analyzed were texture (pipette and sieve method), Organic Carbon (OC) (wet oxidation method), bulk density and total pore (gravimetric method), aggregate formation and aggregate stability index (dry and wet sieving method). The data resulted were statistically analysed the variance using F-test at 5% level of significance, and then continued with DNMRT if F-calculated >F-table.

III. RESULTS AND DISCUSSIONS

A. Initial Soil Physical Characteristics of Ultisols and Entisols

Based on data at Table 1 it can be concluded that both soils had low aggregate stability (the index < 0.5). This could be due to either the texture or the organic matter content of both soils. High clay content and low SOM at Ultisols caused the aggregate bonding agent of the soil dominated by the clay itself. Therefore, the aggregates were susceptible to degrade as it is wetted. Since the research area has high (>5000 mm) annual rainfall [5], the aggregates are very susceptible to degradation. Low clay as well as SOM content of Entisolfrom *Ketaping* caused the soil to have low soil aggregate stability index.

Soil textures as a first factor in this reseach were described in Figure 1. The clay content decreased from 50% to 30% with 4.1% interval from A1 to A6. On the other hand, the sand content increased from 18% to 47%, respectively. While the silt content, a slightly decrease as the increase in soil sand content.

Based on texture triangle, the soil texture class belongs to clay for A1, A2 and A3, clay loam for A4 and A5, and sandy clay loam for A6. This was due to the mixture between clayey soil (Ultisols having 50% clay) and sandy soil (Entisols having 77% sand).

Tabel 1.Initial physical characteristics of Ultisols Limau Manis and Entisols Ketaping, from West Sumatra Indonesia

Soil Physical Characteristics		Ultisol Limau Manis	Entisol Ketaping
Prarticle size distribution			
-	Sand (%)	18.37	76.64
-	Silt (%)	31.33	14.02
-	Clay (%)	50.23	9.35
Texture Class		Clay	Sandy loam
Bulk Density (g cm^{-3})		1.13	1.43
Total Pore (%)		59.67	51.45
Organic matter (%)		2.73	2.68
Permeabilitas (cm jam^{-1})		0.89	19.18
Aggregate Stability Index		0.38	0.37

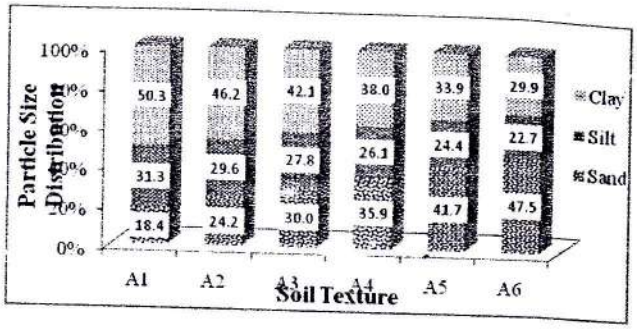

Figure 1. Soil texture after being mixed between Ultisol and Entisol from West Sumatra

B. Physical Characteristics of Clayey Textured Soils after OM Application

There was no interaction found between soil texture and manure application on SOM content, aggregate formation, and aggregate stability index of the clayey textured soil. However, there were some effects for the main factors.

Organic matter content of the soil tended to increase by decreasing clay content of the soil (Table 2). Soil OM content increased by 19% (from 3.93 to 4.67%) as CM applied up to 7% based on soil dry weight. As reported by Ref. [1] fresh OM application increased SOM content of ULtisol.

Soil organic matter content increased by decreasing clay content in the soil.Decreasing clay content by 41% (from 50.3% to 29.9%) in the soil increased SOM content by 48% (from 3.48% to 5.16%).This could be due to the effect of better soil aeration under coarser textured soil. Good aerated soil provides enough oxygen for the microbes to degrade fresh organic matter derived from manure applied to the soil. Therefore, the amount of SOM content increased after 3 month manure application.

As SOM content increased, the aggregate formation also increased significantly after 7% manure application. The formation of soil aggregates increased by 35% (from 33.21% to 44.98%) as addition of 7% manure to the soil. This was due to the fact that manure is a source of OM. Application of manure from 1 to 5 % did not able to bind soil into aggregates after 3 months incubation. It means that for a 3-month incubation period, application of 5% manure based on soil dry weight was enough to create soil aggregates.

Unlike SOM content, aggregate formation decreased by decreasing clay content of the soil. Decreasing clay content by 41% (from 50.3% to 29.9%) decreased soil aggregate formation by 55% (from58.20% to 26.26%).

Tabel 2. Soil organic matter content, Aggregate Formation, and Aggregate Stability Index of Clayey Textured Soil after OM Application

Soil Texture	Organic Matter (%)					Means
	0	1	3	5	7	
SOM	(%)					
A1	3.15	3.66	3.53	3.45	3.73	**3.48 E**
A2	3.13	3.64	3.65	3.87	3.93	**3.61 D**
A3	4.33	4.79	4.53	4.53	4.93	**4.63 B**
A4	3.53	3.54	4.55	4.75	5.55	**4.27 C**
A5	4.76	4.67	4.76	4.75	5.32	**4.80 B**
A6	4.87	5.32	5.12	5.53	5.15	**5.16 A**
Means	**3.93 c**	**4.24 b**	**4.33 b**	**4.44 a**	**4.67 a**	
CV (%)	6.84					
Aggregation	(%)					
A1	53.29	58.61	55.58	50.32	58.20	**58.20 A**
A2	37.69	46.60	42.67	49.06	53.99	**46.60 B**
A3	32.74	36.31	33.90	39.56	50.52	**38.60 C**
A4	29.13	25.32	29.43	39.15	36.29	**31.86 C**
A5	23.91	24.43	28.45	22.14	37.02	**27.19 D**
A6	22.44	28.40	24.66	21.92	33.87	**26.26 D**
Means	**33.21 b**	**36.61 b**	**35.78 b**	**37.02 b**	**44.98 a**	
CV (%)	17.50					
Aggregate Stability Index						
A1	0.34	0.35	0.33	0.36	0.38	**0.35 B**
A2	0.50	0.43	0.40	0.37	0.36	**0.41 A**
A3	0.41	0.40	0.40	0.40	0.39	**0.40 A**
A4	0.39	0.41	0.40	0.38	0.41	**0.40 A**
A5	0.40	0.42	0.41	0.48	0.41	**0.42 A**
A6	0.43	0.39	0.42	0.42	0.42	**0.42 A**
Means	**0.41**	**0.40**	**0.40**	**0.40**	**0.39**	
CV (%)	12.50					

It means that, besides SOM, clay played an important role in formatting soil aggregates.

Aggregate stability index, however, was not affected by manure application up to 7% based on the soil dry matter weight.This could be the effect of clay content in the soil. Reference [7] found that SOM did notaffect much soil aggregate stability at soils containing high amount of clay. It indicated that 3 months after OM application to clayey textured soil did not enough time yet to improve the soil aggregate stability index as clay did, even though the SOM and aggregate formation increased. As reported by Ref. [8], that soil organic carbon did not directly influence aggregate stability, but it did through the effects of microbial biomass, as found under black soil in Northeast China.

IV. CONCLUSION

Based on the data resulted, it showed that both soils, Ultisols and Entisols from West Sumatra, had low (<3%) SOM content and low aggregate stability index (<0.50). Application of manure as an OM source on the mixed soils (producing some clayey textured soils) did not show any interaction, but the main factor significantly affected SOM content, soil aggregate formation, and aggregate stability index of the soil, except the effect of manure on aggregate stability index.

Increase in manure application from 0% to 7%, increased soil organic matter (SOM) content by 19% (from 3.93% to 4.67%) and improved aggregation formation by 35% (from 33.2% to 45.0%). Decrease in clay content of the soil from 50% to 30% increased SOM by 48% (from 3.48% to 5.16%), aggregate stability index by 18% (from 35.2 to 41.7), but decreased aggregation percentage by 55% (from 58.2% to 26.3%). Aggregate stability index, however, was not yet affected after 3 months of manure application.

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PROSIDING

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29-30 September 2015

Q-Grand Dafam Syariah Hotel

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