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The Impact of Compost Dose and SP36 Fertilizer Application on Soil Chemical Properties and Growth of Corn Plants (*Zea mays* L.) in Ultisol Soils

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ABSTRACT

Ultisol soil has complex problems that result in low nutrient availability, especially P. This research aim was to determine the effect of the application of a mixture of compost and SP 36 fertilizer to increase the growth of corn plants on Ultisol soil. The research was conducted from October 17, 2017, to March 13, 2018. This research was conducted in the village of Aek Goti, Silangkit District, Labuhan Batu Selatan Regency, Sumatera Utara Province. The experimental method used was factorial Randomized Block Design (RBD) with 2 factors and 3 replications. The first factor was a dose of compost in the form of *Tithonia diversifolia* and chicken manure with 4 levels of treatments (B_0 : 0 ton/ha, B_1: 10 tons/ha, B_2: 20 tons/ha, B_3: 30 tons/ha). Factor II was the dose of SP36 fertilizer with 3 treatments levels (P_0: Control, P_1: 100 kg SP36/ha, P_2: 200 kg SP36/ha). The parameters observed were pH H_2O, P Potential, Soil CEC, root dry weight (g), canopy dry weight (g) of corn (Zea mays L.). The results showed that the application of a mixture of compost *Tithonia diversifolia* and chicken manure at the rate of 30 tons/ha significantly increased pH H_2O, P Potential, CEC, canopy dry weight, and root dry weight.

Keywords: organic matter, soil chemical properties, Ultisol

INTRODUCTION

Ultisol is one type of mineral soil in Indonesia which has a fairly wide distribution reaching 45.794.000 ha or about 25% of the total land area in Indonesia. This land can be found in various reliefs, ranging from flat to mountainous. The distribution of Ultisol land in Sumatera Utara province is 1.524.414 ha (Subagyo et al., 2002).

Ultisol soil problems are generally its acidic soil reactions (pH 4.1 - 4.8), hence macronutrients such as nitrogen (N) and phosphorus (P) are relatively unavailable to plants (Sutedjo, 2002). Besides that, Ultisol soil has a base saturation value of <35%, and low organic matter content (Hakim, 2006).

According to Tan (2007), efforts made to improve the properties of Ultisol soil are by liming to increase soil pH, application of organic matter to improve the physical, chemical and biological properties of the soil, and fertilization to provide macronutrients such as phosphorus. The main purpose of this liming is to increase pH from acidic pH to neutral pH. In acidic soil pH, many nutrients (for example: N, P, K, Ca, Mg) are not available to plants. Only the elements of Fe and Al (microelements) are available in acid soils. Hence it is expected, by liming will increase the pH to neutral, in which in many neutral pH nutrients can be available to plants.

Organic matter adds the supply of soil nutrients and serves to improve the physical, biological and chemical properties of the soils. As a growing medium, land required good physical and chemical conditions. A good soil physical condition if it can guarantee the growth of plant roots and capable as a place for aeration and moisture, all of which are related to the role of organic matter (Stevenson, 1982).

Tithonia diversifolia is a weed that is suitable to be used as compost to improve soil chemical properties and plant growth. Based on the analysis results of dried *Tithonia diversifolia* leaves ranging from pH H2O 8.61, C-Organic (Walkley & Black) 39.52%, N-total 2.70%, C/N 14.63, P Total 0.86%, CEC 28,458 me/100g. Another advantage of this plant is that it can grow well on infertile land. *Tithonia diversifolia* has a high potential for restoring soil fertility, a positive impact on soil fertility especially on phosphorus status hence it is very good to compost.

Chicken manure is one of the wastes produced by both laying hens and broilers which have great potential as organic fertilizers. Chicken manure can contribute nutrients that are able to meet the growth of plant seeds because chicken manure contains higher nutrients than other manures (Santoso et al., 2004). Furthermore, Soeminto (1986) stated that the application of chicken manure (10-30 tons/Ha) has a positive effect on some chemical and physical properties of soil such as P available, C organic, Al saturation, bulk density and total pore space. The composition of impurities varies greatly depending on physiological properties of chickens, rations eaten, enclosure environment including temperature and humidity.

Corn (Zea mays L.) is an important food ingredient in Indonesia because corn is the second carbohydrate source after rice. In addition, corn is also an industrial raw material and animal feed. (Santoso et. al., 2004).

MATERIALS AND METHOD

This research was carried out in Aek Goti Village, Silangkit Subdistrict, Labuhan Batu Selatan District, Sumatera Utara Province. Soil analysis was carried out at the Research and Technology Laboratory of the Faculty of Agriculture, University of Sumatera Utara and Research and Development PT. Nusa Pustaka Kencana Analyttical & QC Asian Agri Bahilang Estate Laboratory Tebing Tinggi. This research was conducted from October 17, 2017 to March 13, 2018.

The materials used for this research were Ultisol soil in Aek Goti Village, Silangkit Subdistrict, Labuhan Batu Selatan District, Sumatera Utara Province, Kompos Tithonia, chicken manure, SP36 fertilizer, and corn seeds.

The tools used for this research were hoes, plastic bags, other laboratory equipment for the purposes of soil analysis.

The research used factorial Randomized Block Design (RBD) with 2 treatment factors and 3 replications namely Factor I: Tithonia diversivolia and chicken manure (B), B0: control (0 kg/plot), B1: 10 tons/ha (1,12 kg/plot of T.diversivolia + 1.12 kg/plot of chicken manure), B2: 20 tons/ha (2.24 kg/plot of T.diversivolia + 2.24 kg/plot of chicken manure), B3: 30 tons/ha (3.36 kg/T.diversivolia plot + 3.36 kg/plot of chicken manure). Factor II: SP-36 Fertilizer (P), P0: Control (0 gr/plot), P1: 100 kg SP36/ha (22.4 gr SP36/plot), P2: 200 kg SP36/ha (44.8 gr SP36/plot) with 3 replications hence 36 experimental units were obtained.

RESULTS AND DISCUSSION

Based on the data obtained in Table 1, showed that the average soil pH due to Tithonia diversifolia compost and chicken manure compost in B3 (6.72 kg) treatment was significantly different in increasing soil pH compared to B0 (Control) and B1 (2.24 kg) but not significant different with treatment B2 (4.48 kg).

The lowest pH value of the soil was found in treatment B0 (control), which was 5.44 (sour) while the highest pH was found in the treatment of B3 (6.72 kg) which was equal to 6.51 (slightly acidic). This showed that the increase was 1.07.

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Based on the data obtained in Table 1, it can be seen that the average C organic of soil due to Tithonia diversifolia compost and chicken manure in B3 (6.72 kg) treatment was significantly different in increasing soil C organic compared to B0 (Control), B1 (4.48 kg) and B2 (4.48 kg). The highest value of soil C organic was found in B3 treatment (6.72 kg) which was equal to 0.74%. while the lowest c organic was found in treatment B0 (control) that was equal to 0.52%. This showed that there was an increase of 0.22%.

Based on the data obtained in Table 1, the average value of P potential of soil due to Tithonia diversifolia compost and chicken manure in B3 (6.72 kg) treatment was significantly different from the P-potential compared to B0 (Control), B1 (2.24 kg) and B2 (4.48 kg) treatment. The highest P-potential value of Soil was found in the treatment of B3 (6.72 kg) which was equal to 0.142%, while the lowest P-potential was found in treatment B0 (control) that was equal to 0.057%. This showed that there was an increase of 0.085%.

Based on Table 1, it can be seen that the application of SP-36 fertilizer in treatment P2 (200 kg/ha) was significantly different in increasing the P potential than treatment P0 (Control) and P1 (100 kg/ha). The highest P potential value of the soil was found in treatment P2 (200kg/ha) which was equal to 0.156%, while the lowest P potential was found in treatment P0 (control) which was equal to 0.053%. This showed that there was an increase of 0.103%.

Table 1, The Average Value of soil pH, P potential and soil CEC due to the combination of organic matter and SP-36 fertilizer.

Mix of *T. diversifolia* + Chicken Manure Fertilizer	SP-6 Fertilizer (kg/ha)			Average
	P0 (0)	P1 (100)	P2 (200)	
Soil pH				
B0: Control	5,46	5,43	5,42	5,44c
B1: 2,24 kg	5,66	5,94	5,87	5,82b
B2: 4,48 kg	6,08	6,19	5,91	6,06a
B3: 6,72 kg	6,40	6,59	6,54	6,51a
Average	5,90	6,04	5,94	
P-Potensial		%		
B0: Control	0,017	0,037	0,119	0,057c
B1: 2,24 kg	0,034	0,116	0,129	0,093bc
B2: 4,48 kg	0,068	0,108	0,162	0,112b
B3: 6,72 kg	0,093	0,119	0,213	0,142a
Average	0,053	0,095	0,156	
Cation Exchange Capacity		me/100g		
B0: Control	2,48	2,32	2,53	2,44c
B1: 2,24 kg	2,59	3,04	2,78	2,80bc
B2: 4,48 kg	2,77	2,59	2,58	2,65b
B3: 6,72 kg	2,79	2,98	3,09	2,96a
Average	2,66	2,73	2,74	

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Table 2. The Effect of Organic Matters and SP 36 Combination on Growth of Corn Plants

Mix of *T. diversifolia* + Chicken Manure Fertilizer	SP-6 Fertilizer (kg/ha)			Average
	P0 (0)	P1 (100)	P2 (200)	
Canopy Dry Weight		G		
B0: Control	11,95	28,85	17,32	19,37c
B1: 2,24 kg	38,31	44,61	52,94	45,29bc
B2: 4,48 kg	40,98	42,81	49,71	44,50ab
B3: 6,72 kg	41,07	46,14	51,27	46,16a
Average	33,08	40,60	42,81	
Roots Dry Weight		G		
B0: Control	3,25	4,47	4,24	3,98c
B1: 2,24 kg	7,11	6,08	7,25	6,81ab
B2: 4,48 kg	7,15	4,03	8,35	6,51bc
B3: 6,72 kg	9,15	10,70	11,76	10,54a
Average	6,67	6,32	7,90	

Based on the data obtained in Table 1, the average value of CEC in the soil due to Tithonia diversifolia compost and chicken manure application on B3 (6.72 kg) treatment was significantly different from the treatment of B0 (Control), B1 (2.24 kg), and B2 (4.48 kg). The highest soil CEC value was found in the treatment of B3 (6.72 kg) which was equal to 2.96 me/100g, while the lowest soil CEC was found in treatment B0 (control) that was equal to 2.44 me/100g. This showed that there was an increase of 0.52 me/100g.

Based on the data obtained in Table 2, it can be seen that the canopy dry weight of the soil due to Tithonia diversifolia compost and chicken manure application in the treatment B3 (6.72 kg) was significantly different from the treatment of B0 (Control), B1 (2.24 kg) and B2 (4.48 kg). The highest value of canopy dry weight was found in the treatment of B3 (6.72 kg) which was equal to 46.16 g, while the lowest canopy dry weight value was found in treatment B0 (control) that was equal to 19.37 g, this indicated that there was an increase of 26.79 g.

Based on the data obtained in Table 2, the average roots dry weight due to Tithonia diversifolia compost and chicken manure application in B3 (6.72 kg) treatment was significantly different from the treatment of B0 (Control), B1 (2.24 kg) and B2 (4.48 kg). The highest value of root dry weight was found in the treatment of B3 (6.72 kg) which was equal to 10.54 g, while the lowest value of roots dry weight was found in treatment B0 (control) which was equal to 3.98 g. This showed that there was an increase of 6.56 g.

Soil pH

The application of a mixture of organic matters in the form of Tithonia diversifolia compost and chicken manure and also SP36 fertilizer had a significant effect on increasing soil pH compared to without organic matter. This was because the application of a mixture of organic matters in the form of Tithonia diversifolia and chicken manure was known to produce organic compounds that can bind Al. This was in accordance with Hakim (2006), which stated that weathering organic matter will produce humic acid, vulvat acid and other organic acids. These organic acids can bind metals such as Al and Fe, hence they can reduce the acidity of the soil to increase the soil pH. Whereas according to Stevenson (1982), the application of organic matter in the form of chicken manure was known to increase soil pH, increase microorganism activity, and can release various organic compounds such as malic acid, citrate, and tartate which can bind

Al to an inactive form. According to Wahyudi (2009), green fertilizer application is known to increase soil pH, because it produces organic acids which play a very important role in suppressing aluminum activity in the soil hence the production of H+ ions will decrease (Nasoetion, 1996).

P Potential (P Extract HCl 25%)

Based on the results in Table 1, P Extract HCl 25% in the soil due to the mixture of organic matter increases phosphorus in the soil in which the highest value was found in the application of B3 (6.72 kg) of 0.142% and the lowest was in B0 (Control) of 0.57%.

The increase in soil P-potential was due to Tithonia diversifolia compost and chicken manure which was composed of organic compounds that capable of producing organic acids which can bind metals such as Al and Fe hence P binding can be reduced and P becomes available in the soil. This was in accordance with Hakim (2006) which stated that from weathering organic matter will produce humic acid, vulvat acid, and other organic acids. Acid can bind metals such as Al and Fe, hence P binding was reduced and P will be more available. Organic anions such as citrate, acetate, tartrate and oxalate formed during weathering of organic matter can assist to release P which is bound by Al, Fe, and Ca hicroxides by reacting with it, forming complex compounds.

Soil CEC

From the results based on Table 1, the highest soil CEC value was found in treatment B3: (6.72 kg) which was equal to 2.96. While the lowest soil CEC value was found in treatment B0: (Control) of 2.44. This was in accordance with Prasetyo (2006), which stated that based on the chemical properties of the soil it is known that the research soil is classified as infertile soil. The limiting factors for soil fertility included: soil acidity, soil cation exchange capacity and alkaline cation content of Ca and Mg. Efforts to increase soil fertility can be done by trying to increase soil pH, increase soil CEC and increase the calcium base cation content by organic matter application.

Soils which are dominated by the fractions of Al and Fe oxides usually have a low negative charge on the colloidal surface, hence the value of the CEC is usually low. This condition is often found in mineral soils (dry land) found in wet tropical climates. Conversely, soils that have medium to high organic matter, usually have a relatively higher CEC soil than low soil organic matter.

Canopy Dry Weight

The application of organic matters in the form of Tithonia diversifolia and chicken manure significantly affected the canopy dry weight of corn plants (Zea mays L,) canopy dry weight closely related to plant P uptake. This was in accordance with Prasetyo (2014), which stated that P plays an important role in plant metabolism which includes cell division and development, energy transport, macromolecular biosynthesis, photosynthesis and plant respiration.

The mixture of organic matter in the form of Tithonia diversifolia compost and chicken manure significantly increased the canopy dry weight of 19.37 g in treatment B0 (control) to 46.16 g in treatment B3 (6.72 kg). This is related to N elements which accelerate plant growth (plant height, number of tillers, number of branches).

Roots Dry Weights

The application of a mixture of organic matters in the form of Tithonia diversifolia compost and chicken manure significantly increased root dry weight. This occurred because the application of organic matter can improve the physical, chemical and biological properties of the soil. Good soil conditions make root growth and development more flexible which also affects nutrient absorption in plants.

The application of a mixture of organic matters in the form of Tithonia

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diversifolia compost and chicken manure significantly increased root dry weight. The highest value of root dry weight was found in the treatment of B3 (6.72 kg) which was equal to 10.54 g, while the lowest root dry weight value was found in treatment B0 (control) which was 3.98 g. This showed that there was an increase of 6.56 g. This showed that the P element can stimulate root growth in plants.

CONCLUSION

The mixture of organic matters in the form of Tithonia diversifolia compost and chicken manure application significantly increased soil pH, C organic, CEC, soil P-potential, canopy dry weight and root dry weight of corn plants (Zea mays L,) on Ultisol soil. The application of SP-36 significantly increased the P potential on Ultisol soil and has no significant effect on other parameters. The interaction treatment between a mixture of organic matters (Tithonia diversifolia compost and chicken manure) with SP 36 fertilizer had no significant effect on all observed parameters.

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