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Addition of Tithonia Compost and Lime as Ultisol Soil Fertility Improvement for Oil Palm Seedling Media

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A B S T R A C T

Research to improve soil fertility, especially the chemical characteristics of Ultisol, has been carried out by adding compost and lime. The incubation method of soil plus compost at a dose of 0.5 kg/pot – 2 kg/pot and 1x exchanged Al lime was carried out for 2 weeks. The results of soil nutrient analysis after incubation were an increase in pH of 0.58 points, a decrease in exchanged Al to unmeasured, an increase in the C-organic content of the soil by 3.44%, an increase in the total N-value of the soil by 0.19%, an increase in the amount of soil organic matter. P-available was 5.81 ppm and exchanged K soil increased by 0.02 me/100 g soil. Likewise, the microelements analyzed also increase. Thus there is a change in the chemical properties of the soil for the better. The increase in nutrients N, P, K, Ca, and Mg comes from tithonia, which is the result of the decomposition of tithonia compost which is added containing high nutrients. In addition, tithonia compost produces organic acids that can dissolve previously insoluble nutrients into soluble ones. The improvement of the chemical properties of the soil towards a better direction is expected to be able to increase the growth of oil palm seedlings planted on the seedling medium growing.

1. INTRODUCTION

1.1. *Research Background*

Indonesia is a country with the largest palm oil area in the world, reaching 14.3 million ha as of 2018. Until now, Indonesia is one of the main producers of palm oil (CPO) in the world apart from Malaysia and Nigeria [1]. To cultivate oil palm, the first problem faced by entrepreneurs or farmers is seeds. This becomes very important because nurseries are the beginning of activities that must be started a year before transplanting into the field. The seeds used must come from superior and certified seeds. Oil palm nurseries are usually carried out with a double-stage system. The system is commonly termed as Pre-nursery and Main nursery. Pre-nursery nursery is the initial nursery for 3 to 4 months and Main Nursery is maintained for 9-12 months. The quality of seeds greatly determines production in the field, good and quality seeds and accompanied by cultivation techniques including proper fertilization, namely as needed will be able to produce high fruit production and good quality as well [2]. Fertilization is very important to support seedling growth. Plants in their growth require 16 essential nutrients both macro and micro. Macronutrients consist of C, H, O, N, P, K, Ca, Mg, and S. Micronutrients consist of Fe, Mn, B, Cu, Zn, Cl, and Mo. These nutrients come from the air and some from the soil. The use of titonia and lime compost is expected to provide optimal results in improving soil fertility and increasing the growth of oil palm seedlings in Pre Nursery and Main Nursery nurseries. The provision of titonia compost can provide essential nutrients and can be a food source for soil microorganisms.. Lime can increase soil pH, and reduce high Al solubility which can be toxic to plants [3]. These two components are important in managing acid soils such as Ultisols. The purpose of this study was to determine the effect of giving titonia compost with various doses and lime after incubation for 2 weeks which will be used as planting media for oil palm seedlings.

1.2. *Literature Review*

Ultisols in Indonesia generally develop from old parent material (especially clay rock parent material). Ultisol formation processes in the tropics are generally carried out by Luxivization (washing) and weak podzolization (weak podsolization) processes [4]. According to Ref. [5], intensive washing of bases is a prerequisite for the formation of Ultisols. The washing continues so that the soil reacts with acid and low base saturation to the subsoil (about 1.8 m from the soil surface).

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Ultisols are used for agriculture, so the productivity level is low because the parent material is poor in primary minerals containing nutrients needed by plants. Advanced levels of climatic degradation add to nutrient deprivation, while Al, Fe, and Mn content are often high. High rainfall causes the bases to be washed to the bottom layer, and this soil is sensitive to erosion, low organic matter content and low CEC (< 24 me/100 g soil), and low pH (< 5.5) [4,6]. Now Ultisol is not only used for food crops but has expanded to plantation crops, including oil palm.

Oil palm nurseries are usually carried out with a double-stage system. a system that is commonly termed Pre-nursery and Main nurseries. Pre-nursery Nursery is an early nursery, which starts with planting seeds that have germinated into small polybags or seedbeds. Usually, nurseryPrenursery lasts for 3 to 4 months.

Organic matter is a source of essential nutrients produced through the process of decomposition and mineralization. The higher the rate of decomposition of organic matter, the faster the nutrients become available [7]. The role of organic matter on the availability of nutrients in the soil cannot be separated from the mineralization process which is the final stage of the process of overhauling organic matter. In the mineralization process, plant nutrient minerals will be completely released (N, P, K, Ca, Mg and S, as well as micronutrients) in indeterminate and relatively small amounts. Nutrients N, P, and S are relatively more nutrients to be released and can be used by plants.

Liming, fertilization, and application of organic matter play an important role in improving and increasing the fertility of Ultisol. Lime added to the soil will react with the soil solution to produce OH- ions which play a role in increasing soil pH [8]. The purpose of liming is to neutralize soil acidity and increase or decrease the availability of nutrients for plant growth. In acid soils in the tropics, the purpose of liming should be to negate the toxic effects of Al and provide nutrients Ca for plants [9].

1.3. Research Objective

1. Knowing the effect of lime and titonia compost on changes in propertiesUltisol soil chemistry.
2. Getting the right amount of titonia compost as a substitute synthetic fertilizers in oil palm nurseries.

2. MATERIALS AND METHODS

The research was conducted at the experimental garden of the Faculty of Agriculture, Andalas University, Limau Manis campus, Padang, West Sumatra, at an altitude of 275 meters above sea level, with an average daily temperature of 26.5 0C with Ultisol soil type. Soil analysis was carried out at the Central Laboratory for Research on the Utilization of Nuclear Science and Technology (P3IN) and the Soil Fertility Laboratory, Andalas University

The titonia compost used is self-produced using materials from trimmed tHitonia from various locations in West Sumatra (Padang, Bukit Tinggi, Padang Panjang and Batu Sangkar). This material was chopped using a chopper and put into black plastic and added lime and EM 4. The ripe compost was used for treatment with various doses of compost and added lime (A1) and no lime was added. (A0) Lime is added equivalent to 1x exchanged Al. The dosage of titonia compost used consists of: B0 = no compost, B1 = 0.5 kg compost/pot, B2 = 1.00 kg/pot, B3 = 1.5 kg/pot, B4 = 2.00 kg/pot. There were 10 experimental combinations with each treatment repeated 4 times. A0B0 = no lime and no compost, A0B1 = no lime + 0.5 kg compost, A0B2 = no lime + 1.0 kg compost, A0B3 = no lime + 1.5 kg compost, A0B4 = no lime + 2.0 kg compost, A1B0 = lime and no compost, A1B1 = lime + 0.5 kg compost, A1B2 = lime + 1.0 kg compost, A1B3 = lime + 1.5 kg compost, A1B4 = lime + 2.0 kg compost.

3. RESULT AND DISCUSSION

The effect of lime and tithonia compost on the chemical characteristics of Ultisol, In general, showed significant changes, in the form of an increase in soil fertility which was indicated by a decrease in exchangeable -Al and an increase in pH (Table 1), as well as an increase in nutrients N, P, K and Ca and Mg. The changes to each of these elements will be described in detail.

3.1 Effect of Titonia Compost and Lime on Soil pH and exchangeable -Al

The given titonia compost is produced in-house by adding lime to the composting process. Titonia compost has a different dose for each treatment, while lime in the same amount. The effect of adding titonia compost and lime to pH and Al-dd Ultisol can be seen in Table 1.

Table 1. Effect of lime and titonia compost on soil pH and exchangeable -Al after incubation as long to weeks

Thitonia compost as source NK			A_0 = No Lime		A_1 = add Lime	
code	Kg/pot	% NK	pH H_2O	exchangeable – Al (me/100g)	pH H_2O	exchangeable - Al (me/100g)
B0 =	0	0	4,67 a	2,71	5,25 a	1,59
B1 =	0,50	25	5,36 a	2,11	5,25 a	Im
B2 =	1,00	50	5,46 a	1,75	5,54 a	Im
B3 =	1,50	75	5,49 a	Im	5,56 a	Im
B4 =	2,00	100	5,50 a	Im	5,61 sa	Im

Note: ma = acidic
sa = slightly acidic.
Im = immeasurable

In Table 1, it can be seen that the pH of the initial soil H2O, namely soil that was not given lime and not given titonia compost (A0B0) was 4.67 (classified as acid) based on the table of criteria for soil chemical properties. After incubation, increasing the dose of titonia compost to provide 25% to 100% NK can increase the pH from 4.67 to 5.50 or with an increase of 0.83 units.

Giving lime equivalent to 1 x Al-dd increased the pH from 4.67 to 5.25 or with an increase of 0.58 units. Furthermore, in the application of lime 1 x Al-dd, increasing the compost dose to provide 25% to 100% NK raises the pH from 5.25 to 5.61, or with an increase of 0.36 units. This means that the pH value increases by 0.58 – 0.94 units. It can also be said that the higher the dose of titonia compost given, the higher the pH value of the soil, even the treatment using lime + titonia compost to provide 100% NK (A1B4) can change the pH status of the soil to become slightly acidic.

The increase in the pH value of the soil after incubation was caused by the effect of adding lime, because according to Ref. [10], lime is the most appropriate control of soil acidity and the reaction is fast and shows a significant change in soil acidity. A reaction that produces hydroxyl ions (OH) is a reaction that raises

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the pH, or reduces the acidity of the soil. The chemical reaction when lime is added to the soil is as follows:

Reaction with H_2O

$$CaO + H_2O \longrightarrow Ca(OH)_2$$
$$CaCO_3 + H_2O \longrightarrow Ca^{2+} + HCO_3^- + OH^-$$

Reaction with H_2CO_3

$$CaCO_3 + H_2CO_3 \longrightarrow Ca(HCO_3)_2$$
$$Ca(OH)_2 + 2H_2CO_3 \longrightarrow Ca(HCO_3)_2 + 2H_2O$$

The increase in the pH value is in line with the decrease in Al-dd which makes Al-dd immeasurable (tu). Giving lime equal to 1 x Al-dd reduced Al-dd from 1.59 me/100g to immeasurable. The decrease in Al-dd is caused by the lime reaction which donates OH- ions to precipitate Al. Precipitation of Al in the form of Al(OH)3 will decrease Al-dd, so that the hydrolysis of Al which donates H+ ions will stop, and the pH will increase.

Ref. [11] explained that the addition of lime can neutralize the source of acidity by Al3+ and H+. If the acidity of the soil comes from Al ions the reaction is:

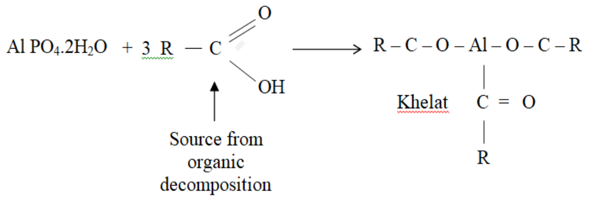
$$3CaCO_3 \rightleftarrows 3Ca^{2+} + 3CO_3^{2-}$$
$$3CO_3^{2-} + 6HOH \rightleftarrows 3H_2CO_3 + 6OH^-$$
$$Al \equiv \boxed{\text{Koloid}} \equiv Al + 6\,OH^- \rightleftarrows \boxed{\text{Koloid}}\; 2Al(OH)_3 \downarrow$$
$$\boxed{\text{Koloid}} + 3Ca^{2+} \rightleftarrows Ca = \boxed{\text{Koloid}} = Ca + 2Al(OH)_3 \downarrow$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\quad \| \\ \qquad\qquad\qquad\qquad\qquad\qquad\quad Ca$$

From this reaction, it appears that the most important part of lime is the CO_3 ion which can attract H ions from water to form hydroxyl ions. Furthermore, hydroxyl ions can attract Al from soil colloids or adsorption complexes, and form Al hydroxide compounds that precipitate, so Al is not reactive. Then, the soil colloid that has been left by Al is occupied by Ca. Thus the colloid which was originally occupied by Al turned into colloid Ca.

The results of this study are relatively the same as the results of research on the use of lime and titonia conducted by previous researchers, namely: Ref. [12] reported that the chemical characteristics of Ultisol soil used for the experiment of propagation material and the period of pruning of titonia after being given lime equivalent to 1 x Al -dd, the pH increased from 4.86 to 5.38 (an increase of 0.52 units) and for treatments that were given lime and fresh titonia at 300, 600, 900, and 1200 g/pot increased the pH to 5.55 – 6, 95 and reduced Al-dd from 0.8 cmol/kg to 0.3 cmol/kg. Furthermore, Gusmini et al., (2003) also reported that giving lime equal to 1 x Al-dd and fresh titonia as a substitute for NK synthetic fertilizers as much as 25, 50, 75, and 100% increased the pH from 4.41 to 4.66 - 5 .09, while Al-dd fell from 1.50 to 0.75 cmol/kg - unmeasured.

Without lime, increasing the dose of titonia compost to provide 25% to 100% NK decreased Al-dd from 2.11 me/100g to immeasurable. The increase in pH value is closely related to the release of organic acids from titonia compost, namely organic matter can bind metals, especially Al contained in Ultisol, so that it does not undergo hydrolysis which can donate H+ ions and result in an increase in soil pH. This is in accordance with the opinion of Tan [13], which states that organic acids produced from the decomposition of organic matter in acid soils will bind Al. Ref. [11] stated that Al which is adsorbed by the clay complex can be hydrolyzed and produce H+ ions so that the concentration of these ions increases in the soil. With the formation of a complex between Al and organic acids, the Al hydrolysis reaction can be prevented.

$$Al^{3+} + H_2PO_4^- \longrightarrow Al(OH)_2\; H_2PO_4$$
$$= \; Al\,PO_4.2H_2O$$



Ref. [14[, stated that the application of organic matter to acidic mineral soils had a significant effect on the decrease of Al3+. The higher the dose of organic matter given, the concentration of Al3+ also decreased. They reported that the addition of 5 - 9 t/ha organic matter decreased the Al concentration from 5.20 to 0.02 M. The decrease in Al3+ concentration due to the addition of organic matter according to Ref. [15] is thought to be caused by basic cations of organic compounds containing functional groups such as phenol (-OH-) and carboxyl (-COOH) resulting from the decomposition of organic matter to form complex compounds or chelates with Al, so that the solubility of Al in the soil is reduced and the possibility for Al hydrolysis is also reduced. These organic acids will form insoluble complexes with Al, Fe, and Mn so that the metal, especially Al, cannot donate H+ ions which are a source of soil acidity. With the decrease in Al, the concentration of H+ ions in the soil solution decreases so that the soil pH will increase. Ref. [6] stated that easily weathered organic matter is very effective in reducing Al reactivity, thereby reducing the need for lime. This has been proven by Ref. [16].with the use of green manure 2.5 dry tons/ha can reduce the use of lime equivalent to 0.5 x Al-dd (2t $CaCO_3$/ha).

3.2 The Effect of Tithonia Compost and Lime for C-organic Soil Content

C-organic is part of the soil which is a complex and dynamic system, sourced from plant and animal residues in the soil that are constantly changing shape, which is influenced by biological, physical, and chemical factors. The value of organic C after incubation with various doses of tithonia compost and lime on Ultisol soil can be seen in Table 2

Table 2. Effect of lime and titonia compost on C-Organic content

Tithonia compost as source NK			A_0 = No lime	A_1 = add Lime
code	kg/pot	% NK	Organic-C (%)	-Organic-C (%)
B0 =	0	0	1,24 l	1,47 l
B1 =	0,50	25	2,47 v h	3,40 v h
B2 =	1,00	50	4,04 v h	6,15 v h
B3 =	1,50	75	5,24 vh	6,78 v h
B4 =	2,00	100	5,91 vh	7,46 vh

Note: l = low, m = medium v h = very high

Table 2 showed that the C-organic soil that was not limed and not treated with tithonia compost (A0B0) was 1.24% with an increase of 0.05%, while the treatment with organic C-lime was

1.47% or with an increase of 0,28%. The increase in C-organic in the treatment that was given lime was greater than the treatment without lime was caused, because lime can help the decomposition process of organic matter by micro-organisms that decompose. Ref [17] stated that the use of lime causes decomposition to increase, due to the increased activity of micro-organisms. The decomposition of organic matter produces organic acids and when added to the soil will increase the content of organic compounds in the soil which is characterized by an increase in the C-organic content of the soil.

In the treatment without lime, increasing the dose of tithonia compost to reduce the use of synthetic fertilizer NK by 25% to 100% has increased C-organic from 2.47% to 5.91% (up 3.44%) and has changed the status of the soil criteria from low becomes very high based on the table of criteria for soil chemical properties. The occurrence of this is clearly due to the addition of organic matter contained in the tithonia compost which produces a carbon element of 45.78% and in the process of making tithonia compost, lime has also been added. The increase in organic C in all treatments along with the increase in the amount of compost added, namely the addition of 25% - 100% tithonia compost has increased 99% - 376% C. More than 90% of plant tissue is composed of carbon elements. through decomposition, the organic matter will produce carbon thereby increasing the C-organic of the soil [18].

The results of this study are relatively the same as the results of previous studies, Ref. [19] reported that an increase in the dose of titonia from 220 g to 1100 g pot-1 (10 kg) increased C-organic content from 2.7% to 3.3% (up 0.6%). Ref. [20] also reported an increase in C-organic after incubation with titonia compost for 2 weeks, an increase of 1.64%). The behavior of titonia compost in improving the chemical properties of the soil seems to be relatively the same as the behavior of organic matter in general. If plant residues are added to the soil, various organic materials will decompose. Sugar, flour, and protein will decompose quickly, while fat, wax, and lignin will decompose slowly even lignin very slowly. All of that will become soil organic matter. To obtain maximum benefits of fertilizer on acid soils, liming must be preceded. Liming is not the only effort to improve and increase the productivity of land occupied by acid-reacting soils. Liming without fertilizing will be as bad as fertilizing without liming [16].

3.3 Effect of Tithonia Compost and Lime on Total N-Content of Soil

The N-Total content of the soil after incubation with tithonia compost and lime can be seen in Table 3.

Table 3. Effect of lime and titonia compost on the total N content of the soil after incubation

Tithonia compost as Source NK			A_0 = No Lime	A_1 = Add Lime
code	Kg/pot	% NK	Total-N (%)	Total -N(%)
B0 =	0	0	0,23 m	0,23 m
B1 =	0,50	25	0,23 m	0,29 m
B2 =	1,00	50	0,27 m	0,32 m
B3 =	1,50	75	0,32 m	0,47 m
B4 =	2,00	100	0,43 m	0,48 m

Note: m = medium

Table 3, it can be seen that in the treatment given lime and 25% tithonia compost, there was an increase in N-total of 0.06%. Furthermore, with an increase in the tithonia compost dose from 25% - 100%, the N-total increased from 0.29 to 0.48% (an increase of 0.19%). In the treatment of giving 100% tithonia compost, the N-total increase was only 0.1% compared to 75% given tithonia compost. This proves that lime can help accelerate the decomposition process of organic matter thereby helping to reduce the need for fertilizers, but the release of N from organic matter is not as fast as synthetic fertilizers. However, with time during seedling maintenance (7 months) N will be donated gradually (slow-release).In the treatment not given lime, the increase in the dose of tithonia compost from 25% - 100%, N-total increased along with the increase in the compost dose given, namely from 0.23 - 0.43% (an increase of 0.20%). N content of 0.43% is equal to 0.43/100 x 10,000 = 43 g. The N content of 0.43% is equivalent to 43 g/pot.

The increase in the total N content of the soil after being incubated with titonia compost was caused by the contribution of N from the decomposition of titonia compost due to the increased activity of soil microorganisms which will contribute a certain amount of N into the soil coupled with the presence of N elements from the added titonia compost which has a high content of N. which is quite high at 3.01%. High levels of N are required for leaf growth and vegetative plants. Ref. [16] stated that the high levels of N in titonia and rapidly decaying made titonia an effective source of N for plants.

The results of this study are not much different from the results of previous research. Ref. [10] also reported that increasing the dose of fresh titonia as a source of NK from 0.25 - 100% could increase the total N-level from 0.21% to 0.32% (an increase of 0.11%).

3.4 Effect of Tithonia Compost and Lime on P-Available Soil Content

The results of the chemical analysis of available-P soil after incubation with tithonia compost and lime can be seen in Table 4.

Table 4. Effect of lime and tithonia compost on Available-P soil after incubation

Tithonia compost as NK Source			A_0 = No Lime	A_1 = Add Lime
code	kg/pot	% NK	Available-P (ppm)	Available -P (ppm)
B0 =	0	0	10,09 L	13,09 L
B1 =	0,85	25	11,89 L	14,09 L
B2 =	1,70	50	12,98 L	15,60 m
B3 =	2,55	75	13,29 L	14,87 m
B4 =	3,40	100	14,82 L	19,90 m

Note: m = midle, L = low

Table 4 seen that the available P content of soil without lime and compost (A0B0) is 10.09 ppm which is classified as low criteria based on the table of criteria for soil chemical properties. In the treatment with lime and without compost (A1B0) the available P-available was 3 ppm higher than A0B0. This happens according to Corey 1971) due to the role of lime which can increase pH and available P, with the following reaction:

Fe PO4 2H2O + OH- Fe (OH)3 + H2PO4- (soluble)
Al PO4 2H2O + OH- Al(OH)3 + H2PO4- (soluble)

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Without lime, increasing the dose of tithonia compost to provide 25% to 100% NK increased the available P from 11.89 ppm to 14.82 ppm or with an increase of 2.93 ppm. In the application of lime 1 x Al-dd, increasing the compost dose to provide NK 25% to 100% increased P – available from 14.09 ppm to 19.90 ppm or with an increase of 5.81 ppm (equivalent to 5.82 mg P/ pot). A fairly large difference can also be seen between the use of lime and no lime at the same doses of tithonia compost,

The increase in available P was in line with the increase in the source of NK from the titonia compost. This can happen because titonia has a fairly high P content, which is around 0.56%, and is supported by a high water content (400%) so the titonia biomass decomposes quickly so that the P it donates to the soil is also larger and faster. Besides the high P content of titonia compost, an increase in available P can also occur through the action of organic acids or other chelating compounds. Ref. [19] reported the types of organic acids contained by titonia are; 1) Carboxylic acids consisting of gallic, malic, citric, tartaric, acetic, benzoic, and salicylic acids. 2) Phenolic acid consists of p-coumaric, protocatechuate, and vanillate. It seems that these organic acids have played a role in the soil so that the available P is increased in addition to the P contained in the titonia itself. The higher the liberated organic acids, the higher the titonia dose.

The lime application which increases soil pH can increase the activity and population of microorganisms, thereby increasing the amount of available P. Previously Ref. [3] stated that increasing the pH to 5.5 to 7 increased available P. So with the addition of lime which can increase the pH of the soil, the P-available soil also increases.

3.5 Effect of Tithonia Compost and Lime on the Exchangeable- K Content of Soil

The results analysis of the Exchangeable- K of the soil after incubation with tithonia compost and lime can be seen in Table 5. In Table 5 it can be seen that the Exchangeable- K soil was very low, namely 0.08 me/100 g, after being treated there was an increase. Giving lime equivalent to 1 x Exchangeable- Al increased Exchangeable- K from 0.08 me/100 g to 0.22 me/100g or with an increase of 0.11 me/100g. Without lime, increasing the dose of tithonia compost to provide 25% to 100% NK increased the Exchangeable- K from 0.11 me/100 g to 0.14 me/100g or in increments of 0.03 me/100g.

Table 5. Compost tithonia and lime effect to Exchangeable- K after incubated

	Tithonia compost as NK sources		A_0 = No Lime	A_1 = Add Lime
Code	kg/pot	% NK	Exchangeable- K me/100 g)	Exchangeable- K (me/100 g)
B0 =	0	0	0,08 sr	0,22 L
B1 =	0,85	25	0,11 r	0,43 m
B2 =	1,70	50	0,12 r	0,53 m
B3 =	2,55	75	0,14 r	0,44 m
B4 =	3,40	100	0,14 r	0,45 m

Note: m = midle, L = low

In the application of lime increasing the compost dose to provide NK 25% to 100% increased Exchangeable- K from 0.43 me/100g to 0.45 me/100g or with an increase of 0.02 me/100g, while the value of The highest Exchangeable- K was in the application of 50% tithonia compost and 50% synthetic fertilizer. This could be because tithonia compost contains a high element of K (3.01%), also due to the function of lime which can help the activity of microorganisms in terms of decomposition of organic matter which produces nutrients such as N, P, and K. Lime can reduce the use of fertilizer so that only 50% of fertilizer is given.

K content of 0.43 me/100 g in the provision of tithonia compost for 100% NK is equivalent to 1.677 g K. This means that not all of the K in the tithonia compost has decomposed, it is expected that overtime for 7 months in nurseries K will be released gradually until can provide higher nutrients needed by oil palm plantations.. Ref. [19] explained that the decomposition of tithonia which produces organic acids can also increase the availability of K contained in soil minerals. Ref. [10] stated that giving tithonia plays a role in increasing soil K-dd, where K is one of the important elements and greatly affects crop production.

The use of lime showed a much higher difference in the rate of increase compared to the treatment without lime, thus changing the status of the soil K criteria from very low to low. In the treatment that was given lime and titonia compost by increasing the dose of tithonia compost to provide 25% to 100% NK, the status of the soil K criteria had changed from low to medium according to the table of criteria for soil chemical properties. An increase in Exchangeable- K in that soil can occur because there is an interaction between lime particles and organic matter particles resulting from decomposition by microorganisms. Particles that were originally affected by H+ were replaced by Ca+ [21]. Organic acids and a number of cations (ammonium, sodium, and others) have a very important role in increasing soil K availability. Oxalic acid and citric acid contained in organic matter can release non-exchangeable-K to exchangeable-K [22].

4. CONCLUSION

The addition of tithonia compost and lime was effective to improve Ultisol soil fertility. An increase in the soil is characterized by an increase in C-organic, Total-N, Available-P, and exchangeable-K soil. Doses 50% compost tithonia and 50% soil added with lime as much as 1t/ha is the best dose mixture media seedling in this research.

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