

# Application of Tithonia Compost as Alternative Synthetic Fertilizer Source N, K on Young Oil Palm Plantation

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## ABSTRACT

Currently large oil palm plantations are cultivated on ultisol. Ultisol has various constraint in its utilization for cultivation of plants, because it has high exchangeable Al, low pH, low soil organic nutrient contained and soil nutrient such as N,P,K,Ca,Mg. Needed a large quantities and continuously fertilizer for a long time. To solved these problem required look for alternative fertilizers. This alternative fertilizers are expected to reduce the use of synthetic fertilizers without decreasing production and are available forever. Efforts to produce that location organic matter are the right choice. Tithonia can be grown in the form of alley cropping at young palm plantations. A series of experiments has been conducted at Andalas University experimental farm, Indonesia. This study used Factorial Design with tithonia compost and Lime as a treatment. There are three compost doses in 3 replication each treatment. The Result showed that tithonia compost dosage 25% and 50% + 25% and 50% synthetic fertilizer were changed soil chemical properties such as increased 0.94 units soil pH, availability of nutrient contained; 6.22% C-organic, 0.25% N-total, 0.37me/100g exchangeable K, 2.74 me/100g exchangeable-Ca, 0.29 me/100g exchangeable-Mg, in the soil, as well as the decrease of exchangeable Al. Further more supporting plant growth such as (plant height, plant length, and number of leaf). Liming not significantly different for soil chemical properties and growth of oil palm. The higher the compost dose given the better the growth of oil palms. Cultivation of tithonia as alley cropping at oil palm plantation can be used as composite materials for synthetic fertilizer substitute source N and K

## 1. INTRODUCTION

### 1.1. Research Background

The oil palm (*Elais guineensis* Jack) plantation which is cultivated in Indonesia, generally has low soil fertility, such as ultisol. Ref. [1] reported that soil fertility of ultisol is generally accumulated in thin upper layer or A layer containing low organic material. Essential macro elements such as N, P and K which often in deficiency condition, low soil pH and high Al saturation are the characterization of ultisol that is limiting plant growth.

Soil chemical properties has important role to characterize soil fertility, such as organic matter, nutrient and soil pH. The availability of nutrients are affected by several factors such as soil pH that can influence nutrient availability. Hence, the addition of nutrient should be considered about kind of nutrient can be absorbed by crop [2].

Efforts have been made to overcome various obstacles in Ultisol, among others, by liming, the provision of artificial

fertilizer in large enough quantities, the provision of manure, as well as the provision of green manure directly. But the effort is still experiencing many obstacles.

The use of artificial fertilizers such as N, P and K in large / large quantities has been proven to increase rice and palawija production in Ultisol which are chalked. However, the main constraints are; Expensive fertilizer prices due to subsidized subsidies, difficult to obtain, limited capital owned by farmers, and procurement of some artificial fertilizers still through imports.

Provision of green manure directly, until now only done in the area of rice cultivation of rice, crops and horticultural crops. In large plantation areas for industrial crops such as oil palm plantations this has not been done. Generally in the area of oil palm plantations using green fertilizer form legum family Propagate as a cover of the soil and not as fertilizer. In addition, the growth of legumes green fertilizer is not always successful in Ultisol. This can be caused due to the relation to soil acidity, so to cultivate green manure is necessary liming and fertilizing a lot.

Possible efforts to anticipate these circumstances are to improve the role of organic fertilizer as well as synthetic fertilizer substitution. Furthermore, the source of organic materials that are easy and available in large quantities should be sought. The answer of all that is the provision of organic materials that can be produced locally and can be used in a sustainable manner.

Ref. [3-5] reported that *Thitonia diversifolia* L.) is a kind of grass that qualifies to be a green manure that produces organic matter and nutrients, though not from legume families. They pointed out that fertilizer requirements green *Thitonia* are among others; Deep rooting, multiple, and infected mycorrhiza, many branched soft rods, growing very quickly, easily propagated through stem cuttings or seeds, can be trimmed every 2 months, grow quickly after trimming and de-prune, produce high organic material, and contain nutrients Especially N and K.. High levels of *Thitonia* nutrients from various locations in West Sumatra, ie, about 2.10 - 3.92% (mean 3.02%) N; 0.33 - 0.56% (mean 0.40%) P; 1.64 - 2.82% (mean 2.30%) K; 0.24 - 1.80% (mean 0.60%) Ca; and 0.28 - 0.87% (mean 0.51%) Mg.

Utilization of *Thitonia* as a source of organic material, both in the form of green manure and compost in increasing the availability of plant nutrients, has been widely studied.. However, the results of research is still limited about *Thitonia* cultivation techniques and its utilization as substitution N and K for horticultural crops and food crops. Until now there is no information about the cultivation and utilization of *Thitonia* on plantation land. Whether *Thitonia* can be cultivated and exploited for increased growth and oil palm production on Ultisol soil in order to reduce the use of synthetic fertilizers, without reducing production. The question is a solid basis for doing this research. If it can then what percentage of synthetic fertilizers can be reduced with the utilization of the *Thitonia*.

The high cost of palm oil fertilization ranges (40-60%) from the cost of maintaining the garden, prompting the need for efficient efforts to reduce fertilizer production costs [6]. The need for oil palm fertilizer during the nursery (for 1 year) is; 6 kg Urea, 6 kg TSP, 8 kg MOP and 3 kg of kieserit per ha. Furthermore, for oil palm TBM is; 351 kg Urea, 234 kg TSP, 533 kg MOP, and 266 kg of Kieserit [7].

Oil palm planted with a spacing that is large enough that 9 m x 9 m, at the beginning of the planting to fruiting plants still look big enough gap between the rows of slits. In this study can be used to grow crops *Thitonia* as a producer of organic fertilizer that is used in-situ as an alternative fertilizer for plantations of immature (TBM) .Next in order to achieve a high biomass production *Thitonia*, it is necessary to look for *Thitonia* cultivation techniques in oil palm plantation area TBM is also a strong case in this study.

Green manure fertilizer by Legum do not always gwork well on Ultisols, while *tithonia* weeds survive on the soil. *Thitonia* is easy to find everywhere, especially the nature of life that always congregates on the side of the road, on the edge of rice fields, on the edge of the railroads, on abandoned land and produces a lot of organic matter. Although weeds are often trimmed, but still thrives and lush coupled with the growth of weeds, it did not seem affected by the seasons, because they always looked green though on the dry season [8]. The reason of these arguments is also a strong basis for doing this research.

Ref. [8] reported that in rhizosphere of *Thitonia* there are several rhizobacteria such as N-binding bacteria (*Azotobacter*, *Azospirillum*), bacterial solvent phosphate (BPF), and

phytohormone-producing bacteria. Furthermore, Ref. [9] reported that reinoculation of rhizobacteria found in *tithonia* rhizosphere can improve biomass yield and *tithonia* nutrient content. However, the study is still in the form of *tithonia* cultivation in pots in the wire house. How much is the ability of the titre that has been reinoculated with the rhizobacteria to produce biomass and the nutrient content of the *tithonia* planted as a hedge between the rows of oil palm plantations is unknown. Therefore, the study of the use of rhizobacteria as biological agents in the cultivation of *tithonia* algae as alternative fertilizer for oil palm (TBM) plant in Ultisol needs to be done.

## 1.2. Literature Review

Ultisol is a very potential soil for plant growth and production. Indonesia has wider ultisol soil ( 45.8 million hectare) and its has been cultivated proportionally [10]. However the main problem is its fertility and leve of alumunium saturation, low pH [11]. Compost in an organic matter source with a unique ability to improve the chemical, physical, and biological characteristics of soils. It improves water retention in sandy soils and promotes soil structure in clayey soils by increasing the stability of soil aggregates. Adding compost to soil increases soil fertility and cation exchange capacity and can reduce fertilizer requirements up to 50%. Soil becomes microbially active and more suppressive to soil-borne and foliar pathogens. Enhanced microbial activity also accelerates the breakdown of pesticides and other synthetic organic compounds. Compost amendments reduce the bioavailability of heavy metals-an important quality in the remediation of contaminated soils [12].

Oil palm the main agricultural commodity in Indonesia that has helped transform its growing economic dvelopment. The country, as the second world largest producer of palm oil after Indonesia, has most of its total planted area under matured palms. This shows how significant palm oil industry is to Indonesia, which is a leading exporter of palm oil, producing 26% of the global trade and 11% of oils and fat production to meet world demand. Presently, more than 5 milion ha of land in the country is cultivated to oil palm, producing up to 17.73 milion tonnes of palm oil and 2.13 milion tonnes of palm kernel oil in year. The oil palm industry is rapidly expanding due to the increased demand for oil palm products, which is expected to drive oil palm cultivation to a projected world wide area of about 38 milion hectare by 2050 making palm oil the dominant vegetable oil in the globe [13]. This implies a need for a higher degree of efficiency in the production of the commodity to meet its increasing demand at the marketplace [14].

Oil palm plantations are generally a single plant pattern. A single plant pattern absorbs certain nutrients only in large quantities. In the long run a single cropping pattern can cause nutrient imbalances in the soil. With a combination of good crops, the same excessive nutrient depletion can be suppressed [15].

Ref. [11] reported that *tithonia* great growth in nutrient-poor soil and high content of N. *Tithonia* as non-legume crops was caused by the role of non-symbiotic life rhizobakteria association in rhizosfir *tithonia* asosiation between rhizobakteria with *tithonia* especially on Ultisol had very Importantly, this is because the acid soil is very low availability. Rhizobacteria can be an agent to increase the production of nutrient uptake and production of *tithonia* biomass [9].

Utilization rhizobakteria from the rhizosphere *tithonia* as a biocontrol agent to improve the nutrient quality and *Thitonia*

biomass, can be done by inoculating back in the rhizosphere tithonia. This reinoculation is important because it is expected to have a higher success rate. Reinoculation is also intended to prove that the inoculant obtained is the most suitable rhizobacteria living in the rhizosphere tithonia and has a natural potential in improving the quality of nutrients and titanium biomass that grows on Ultisol [9].

### 1.3. Research Objective

The objectives of the study were: (1) to see the effect of lime and tithonia compost on oil palm seed growth; and (2) to obtain appropriate dosage of tithonia compost as synthetic fertilizer substitute material for young oil palm.

## 2. MATERIALS AND METHODS

The experiment consisted of 40 experimental units. The first factor was the administration of lime (A0 and A1) consisting of; Without lime (A0) and added lime (A1). Factor II is 5 combinations of dosage of composite tithonia and synthetic fertilizer (B). The compost dose used is 2 kg / 10 kg of soil. = 2 x 1.7 = 3.40 kg of compost. Thus the dosage of titanium compost is used as follows:

100% N of tithonia compost = 3.40 Kg / pot  
75% N of tithonia compost = 2.55 Kg / pot  
50% N of tithonia compost = 1.70 Kg / pot  
25% N of tithonia compost = 0.85 Kg / pot

While the dosage of synthetic fertilizer used as follows;  
100% synthetic fertilizer = 50 g Urea + 70 g KCl / pot.  
75% synthetic fertilizer = 37,50 g Urea + 52,50 g KCl / pot.  
50% synthetic fertilizer = 25g Urea + 35g KCl / pot.  
25% synthetic fertilizer = 12,50 g Urea + 17,50 g KCl / pot.

The experimental treatment used consisted of:

Factor I lime;  
A0 = without lime  
A1 = given lime 1.35 g / pot

Factor II, Combination of source of N and K fertilizer from tithonia compost (kt) and synthetic fertilizer (ps);

B0 = 0 NK kt + 100% NK ps  
B1 = 25% NK kt + 75% NK ps  
B2 = 50% NK kt + 50% NK ps  
B3 = 75% NK kt + 25% NK ps  
B4 = 100% NK kt + 0% NK ps

## 3. RESULT AND DISCUSSION

### 3.1. Plant height

The result of the analysis of variance to the height of crop showed that the main effect of lime is not real, whereas the effect of dosage of composite Thitonia as NK source and the interaction both have a significant effect on the height of palm crop. BNT test result (BNT = 8.8021) to palm tree height 7 months since germination as a result of the effects of lime and Thitonia compost as a source of NK are presented in Table 1.

Table 1. Effects of lime and Thitonia compost as a source of NK to plant height.

NK Source			Lime	Mine effect
Code	Compost	Synthetic fertilizer	No lime	Lime add
B0	0%	100%	49.12	49.17
B1	25%	75%	57.92	67.52
B2	50%	50%	77.00	73.45
B3	75%	25%	79.45	76.12
B4	100%	50%	73.80	78.25
Main Effect of lime			68.26	68.90

Note: The numbers followed by different lower case letters in the same column, are significantly different according to 5% BNT (BNT = 8.8021)

Table 1 shown that, the greater the dose of tithonia applied, the greater the increase in the height of the palm seedlings. The highest palm seedlings are not treated with lime obtained at a dose of 75% compost of tithonia + 25% synthetic fertilizer, while on the liming treatment, Obtained from the application of 100% tithonia compost.

The substitution of tithonia compost 50 - 100% was able to significantly increase the height of oil palm seedlings in this experiment. However, if the amount of tithonia is insufficient, the substitution of 25% tithonia compost is able to increase the seedlings of palm oil significantly compared to 100% synthetic fertilizer application.

In order for the relationship between lime administration and the difference in the dosage of titanium compost as a substitution of NK clearer to 7-month-old palm tree height in Wire House can be seen in Figure 1.

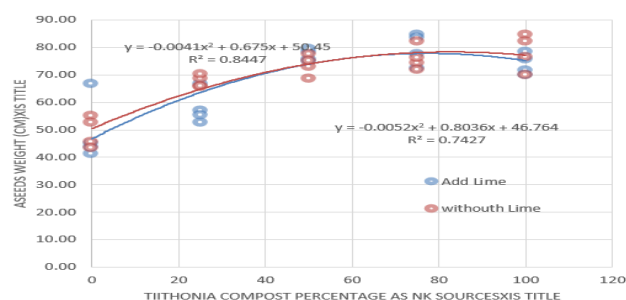


Figure 1. Effect of lime and increased NK source of tithonia compost on 7-month-old palm-tree height

From the regression equation in Fig. 1 it is obtained by the high relationship of palm seedlings by increasing the dosage of composite Thitonia as a non-limiting NK source according to the equation  $Y = -0.005 X^2 + 0.803X +$  with  $R^2 = 0.742$ . Maximum plant height obtained based on the regression equation above is 77,85% in dose of Thitonia to replace NK of synthetic fertilizer equal to 77,30%.

In lime-derived soils, there is a high correlation between the plant and the increase of the composition of Thitonia as the source of NK according to the equation  $Y = -0.004x^2 + 0.675x + 50.45$  with  $R^2 = 0.844$ . Maximum plant height obtained based on the above regression equation is 77.86 cm in dosage of titanium compost to replace NK of synthetic fertilizer 99.91%.

### 3.2. Long leaves

The result of the analysis on the variety of palm seed leaflets showed that the influence of the interaction of dosage compost dosage as the source of NK and lime treatment significantly affected the length of the seedlings. While the main influence of lime has no significant effect on the length of the palm leaf. In general, an increase in the dose of tithonia compost accompanied by calcification applications on growing media can increase the length of the palm seedlings leaf and its effect is significantly different with 100% application of synthetic fertilizer.

The result of BNT test (BNT = 6.9583) to the length of oil palm at 7 months since being added due to the effect of lime and dosage composition of thitonia as NK source is presented in Table 2.

Table 2. Length of oil palm seedlings aged 7 months as lime effect and composition of tithonia as a source of NK.

Code	Source		Treatment	
	NK Thitonia compost	Sinthetic fertilizer	NoLime (A0)	Lime add (A1)
B0	0%	100%	36.50 a	41.08 a
B1	25%	75%	42.20 a	56.50 b
B2	50%	50%	61.27 a	59.17 bc
B3	75%	25%	67.90 b	65.97 c
B4	100%	0%	66.12 b	63.37 bc

Note: The numbers followed by different lowercase letters on the same column, are significantly different according to 5% BNT, whereas the numbers followed by the same uppercase letters on the same row are not significantly different by BNT 5% (BNT = 6. 9583).

Table 2 shows that, the incremental composting of tithonia to replace NK of synthetic fertilizer up to 75% in noncounted soil increases the longest leaves of palm leaves 31.40 cm (46,24%). While on the calcined soil increase significantly length of longest leaves of palm seeds equal to 24.89 cm (37.72%).

Furthermore, in order that the relation of lime administration and the difference in the dosage of titanium compost as NK substitution is more clear to the length of the 7 month old oil palm leaf in RumahKawat can be seen in Figure 2.

From the regression equation shown in Fig. 2, the relationship of palm leaves length with increasing dosage of composite Thitonia as a non-limiting NK source according to the equation  $Y = -0.0036 X^2 + 0.580X + 41.84$  with  $R^2 = 0.716$ . In the lime-derived soil obtained the relationship of leaf length with increasing dosage of composite Thitonia as a source of NK according to the equation  $Y = -0.003x^2 + 0.652x + 33.896$  with  $R^2 = 0.889$ . The maximum leaf length obtained based on the above regression equation is 65.28 cm on the dosage of tithonia compost to replace the synthetic NK of 80.68%.

### 3.3. Leaf widht

The results of the analysis of the variety of palm leaf width showed that the main effect of lime, increased dosage of composite titania as the source of NK and the interaction of both significantly affect the increase of seedlings of palm leaf. BNT test result (BNT = 4.8409) to 7- Lime administration and dosage composite dosage difference as a source of NK are presented on Tab 3.

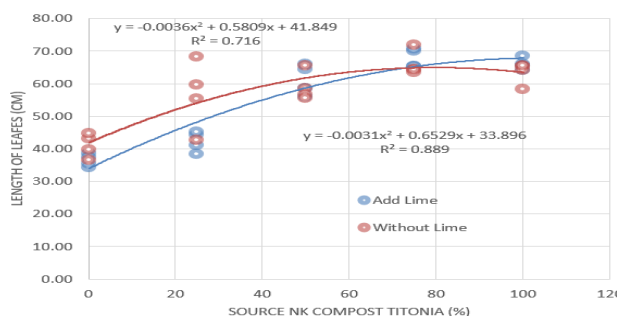


Figure 2. Effect of lime and increased NK source of tithonia compost on 7-month-old palm Long leaves

Table 3 shows that, in the treatment of chalk with increasing dosage of 25% to 75% titania compost there was an increase in leaf width by 10 cm - 26.7 cm. The widest leaf width was obtained at 75% composition of titania + 25% synthetic fertilizer and was not significantly different with 50% composition of titania + 50% synthetic fertilizer and 100% application of titania compost. While on treatment was given lime, width of leaf width was achieved in application of 75% compost of titania + 25% synthetic fertilizer and not significantly different with 75% composition of titania + 25% synthetic fertilizer and 100% compost of titania (no synthetic fertilizer). The application of 25% of titania composite on lime planting medium has not been able to significantly increase the width of palm seedlings.

Table 3. Width of oil palm seedlings aged 7 months due to the influence of lime and compost of tithonia as a source of NK

Code	NK Source				Main Effect NK Source
	Tithonia compost	Synthetic fertilizer	No Lime	Lime Add	
B0	0%	100%	13.33 a	23.13 a	18.23
B1	25%	75%	36.55 b	33.13 a	34.84
B2	50%	50%	47.75 c	49.80 b	48.78
B3	75%	25%	46.66 c	49.83 b	48.25
B4	100%	50%	40.25 b	45.83 b	43.04
Without effect lime			36.91 A	40.34 B	

Note: The numbers followed by different lowercase letters on the same column, are significantly different according to 5% BNT, whereas the numbers followed by the same uppercase letters on the same line are not significantly different by BNT 5% (B = 4. 8409).

Table 3 shows that the dosage of titanium compost to replace NK of synthetic fertilizer up to 50% in non-calcined soil increased by 30%. Whereas in the calculated soil increase significantly the widest width of palm seedlings as big as 26,70 cm (53,58%). The real effect of the application of lime and titania composite has been able to improve the planting medium so that it positively impacts the growth of palm seed leaf width that directly increases photosynthesis.

Furthermore, in order that the relation of lime administration and the difference in the dosage of titanium compost as NK substitution is more clear to the width of oil palm leaves at 7 months in RumahKawat can be seen in Figure 3.

From the regression equation shown in Fig. 3, the relationship of palm leaf width with increasing dosage of composite Thitonia as a non-limiting NK source according to the equation  $Y = -0,000 X^2 + 1,0735 X + 13,897$  with  $R^2 = 0,958$ . The maximum leaf width obtained based on the above regression equation is 49.03 cm in the dose of Thitonia to replace the synthetic NK of 65.46%. In the lime-derived soil obtained the relationship of leaf width by increasing the dosage of composite Thitonia as the source of NK according to the equation  $Y = -0,0051x^2 + 0,7586x + 21,547$  with  $R^2 = 0,8621$ . Maximum leaf width obtained based on regression equation below is 49.67 cm at dosage of composting of titania to replace NK of synthetic fertilizer equal to 74.37%.

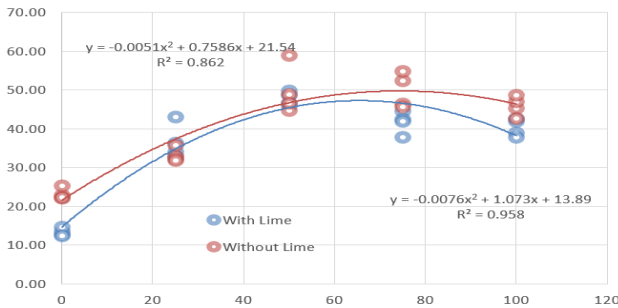


Figure 3. Effect of lime and increased NK source of thitonia compost on 7-month-old palm leaf width.

3.4. Leaf amount

The results of the analysis of the variety of palm leaf figures showed that the effect of interaction between lime and dose of Thitonia and the main effect of lime was not significantly different to the number of palm seedlings. While the main influence of dosage of composite titania as a source of NK significantly affect the number of leaves. The result of BNT test (BNT = 2.0209) to 7 month leaf palm due to effect of lime and dosage composition of titania as NK source is presented in Table 4.

Table 4 shows that the main influence of increased dosage of titanium compost as source of NK up to 50% in lime treatment increased the number of leaf significantly by 2 strands (17.02%), while in lime treatment there was increase of 3 leaves (25%), . Giving 25% of titania compost as a source of NK has not been able to increase the number of palm seedlings. Increased dosage of Thitonia compound as much as  $\geq 50\%$  as substitution of synthetic fertilizer has been able to increase significantly the width of seedlings of palm seedlings. This will certainly help increase the growth of palm seedlings in general because the increase in leaf width will be followed by increasing the rate of photosynthesis and respiration, so that the energy required for oil palm seedlings for growth can also be increased.

Table 4. Number of oil palm seedlings aged 7 months due to the influence of lime and compost of Thitonia as a source of NK.

Code	NK Source		Long Leave (cm)		Main Effect NK Source
	Thitonia compost	Synthetic fertilizer	No Lime	Lime Add	
B0	0%	100%	9.75	9.00	9.37 a
B1	25%	75%	10.75	11.00	10.87 ab
B2	50%	50%	11.75	12.75	12.25 b
B3	75%	25%	11.75	12.00	11.87 b
B4	100%	50%	11.25	12.00	11.62 b
Without effect lime			11.05	11.35	

Note: The numbers followed by different lowercase letters in the same column, are significantly different according to 5% BNT, whereas the numbers followed by the same uppercase letters on the same row are not significantly different by BNT 5% (BNT = 2. 0209)

Furthermore, in order that the relation of lime administration and the difference in the dosage of titanium compost as NK substitution is more clear to the number of oil palm leaves of 7 months in RumahKawat can be seen in Figure 4.

From the regression equation shown in Fig. 4, there is a relationship of palm leaf number with increasing dosage of composite titania as a non-limiting NK source according to the equation  $Y = -0,0005 X^2 + 0,0671X + 9,6786$  with  $R^2 = 0,1997$ . The maximum leaf number obtained based on the regression equation above is 11.58 strands on the dose of Thitonia to replace NK of synthetic fertilizer of 61.70%.

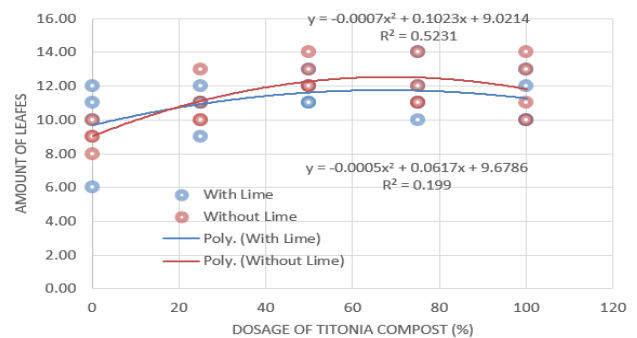


Figure 4. Effect of lime and increased NK source of thitonia compost on 7-month-old palm- Leaf amount

In lime-derived soils, the number of leaves obtained with increasing dosage of composite titania as NK source according to the equation  $Y = -0,0008x^2 + 0,11x + 8,95$  with  $R^2 = 0,5798$ . The maximum leaf number obtained based on the above regression equation is 12.73 pieces at the dosage of titanium compost to replace NK of synthetic fertilizer equal to 68,75%.

4. CONCLUSION

From the results of research that has been done can be concluded as follows:

1. The composition of thitonia can be used as a substitute of synthetic fertilizers and soil enhancers in oil palm nurseries in Ultisol. Of the various doses of titanium compost used as a substitute for synthetic fertilizers, the best dosage is 50% compost of thitonia + 50% synthetic fertilizer. The main result of the decomposition of thitonia compost for improved soil is the



decrease of Al-dd soil content accompanied by the increase of soil pH, there is also an increase of soil nutrient content such as N, P, K, Ca and Mg.

2. Utilization of tithonia in the form of green manure as a substitute of synthetic fertilizer for unproduced palm plantation can be done with a system of cultivation of aisle fence between rows of mustard plants. The right dose of tithonia is 50% titanium + 50% synthetic fertilizer. With this dose can be donated about 200 kg N and 270 kg K per year or equivalent to 450 kg of Urea and 540 kg of KCl.

3. Giving lime on plants that have been fertilized with a mixture of organic fertilizer 50% + 50% synthetic fertilizer is not very necessary anymore, but when the material is organic Under 50% lime is needed to lower Al-dd and increase soil pH.

4. Of the various types of fungi and bacteria that are reinocated in tithonia rhizosphere As a hedge fence in the area of productive palm oil plantations that is most suitable to use is mycorrhizal fungus singly because it can contribute the highest production of N and K which is 15.8 tons / ha / year.

5. A suitable technological package to be undertaken in an effort to find alternative fertilizer and Cost savings for oil palm cultivation in Ultisol is to use 50% compost of tithonia as a substitute of synthetic fertilizer and given lime 1x Al-dd in the nursery, then the tithonia plant is planted between rows Palm plant as a alley cropping with reinoculated with mycorrhiza, yield Titonious pruning can be fertilized in the form of green manure as a substitution of 50% Synthetic fertilizer so the package is: 50% tithonia + 50% synthetic fertilizer + lime 1 x Al-dd.

6. The cultivation of tithonia as a alley cropping is suitable to be done in the area of palm oil plantation as a producer of organic fertilizer. Insitu

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