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An Effectiveness Of Mycorrhia And Lime Application On The Growth Of Oil Palm Seedlings (Elaeis Guineensis Jacq) In Peat Soil

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ABSTRACT

High interest in developing oil palm plantations increases land value and relaxes land suitability criteria. Flat topography, specifically peatlands, has been targeted as potential new areas for development since the 1990s. Peatlands are acidic, so improving soil pH with lime, specifically CaCO3, is crucial for oil palm seedling growth. Mycorrhiza presents an effective alternative for nutrient absorption. The study found that mycorrhiza and CaCO3 did not significantly affect plant height and stem girth in oil palms. Lime application especially increased soil pH, with the best treatment being 400 gr of CaCO3 per polybag. Meanwhile, mycorrhiza significantly infected oil palm roots, with the best treatment being 40 gr per polybag. The combination of mycorrhiza and lime did not significantly affect plant growth parameters, but the best treatment was 40 gr of mycorrhiza and 400 gr of lime per polybag.

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INTRODUCTION

Oil palm (Elaeis Guineensis Jacq) originates from West Africa, is the main plant producing vegetable oil which has higher productivity compared to other oil producing plants. Oil palm was first introduced in Indonesia by the Dutch government in 1948. Initially, oil palm plants were cultivated as ornamental plants, while cultivation of plants for commercial purposes only began in 1911. (Triwanto, 2000)

One of the efforts that can be managed to improve the quality and quantity of oil palm production is by paying attention to aspects of oil palm cultivation itself, including soil processing, fertilization, pruning, pest and disease control and the provision of growth promoters. What is also no less important and must be considered in oil palm cultivation is the provision of planting materials in nurseries, because from these seeds will be obtained planting materials that are suitable for planting in the field later. (Triwanto, 2000)

The high interest in developing oil palm plantations has increased land values and further relaxed the criteria for land suitability for oil palm. In this case, the topographic aspect is not the main consideration. New areas with flat topography that were eyed as development areas in the 1990s were peatlands. The area of peatlands in Indonesia is estimated at 21 million hectares or around 10.8% of the land area of Indonesia. Of this area, around 7.2 million hectares or 35% are located on the island of Sumatra. (Wetlands International – Indonesia Programme, 2009)

Peat land is land that has several advantages, namely that there is still a large area available, it is able to provide water throughout the year, its topography is relatively flat so that on one side it makes soil processing easier and it contains high organic material (PPKS News, 2001). Peatlands are acidic in nature, and improving soil pH is done by liming. One of the limes used is CaCO3. The addition of soil conditioners is expected to increase soil pH so that it can be used as an alternative medium for oil palm seedlings in peat areas.

One of the alternatives used and effective in meeting the needs of plant nutrients is mycorrhiza. Mycorrhiza is a mutualistic symbiotic relationship that can be symbiotic with the roots (rhiza) of higher plants (Herly, 2001). Herley. 2001 stated that MVA (Vesicular Arbicular Mycorrhiza) has an important role in increasing plant growth by increasing nutrient absorption by expanding the surface area of absorption. In addition, MVA can protect plant roots from the absorption of pathogens that cause soil-borne diseases, can also increase plant resistance to drought and is able to increase nutrient absorption, N, P, K.

One of the main factors for the success of oil palm cultivation is greatly influenced by the planting media used during the nursery. In line with the development of oil palm plantations to peatlands, the planting media used during the nursery is peat soil as an alternative to soil media needs. The acid content in the soil can be overcome by using lime.

The fertility concept for managing peat soil planting media in oil palm nurseries by applying lime and mycorrhiza is expected to provide positive benefits for the development of oil palm plantation cultivation. The results of this study are expected to be a source of information and be useful for farmers and oil palm plantations in terms of the effect of mycorrhiza and lime applications on the growth of oil palm seedlings in peat soil.

Literature Review

Botany and Morphology of Oil Palm Plants Root.

Oil palm is a monocotyledonous plant, has fibrous roots. The first roots that emerge from the sprouted seeds are called radicles (root buds) and plumules (stem buds). Then these roots will die and then followed by the growth of a number of roots originating from the base of the stem. These roots are called fibrous roots.

Table 1. Grouping of roots based on diameter

Root Name	Diameter
Primary	5 – 7
Secondary	2 – 4
Tertiary	1 – 2
Quarter	0.10 – 0.3

Primary roots grow downwards to a depth of 1.5 m, the lateral growth of these roots is up to ± 6 m from the base of the tree. The largest number is found at a distance of 2-2.5 m from the tree and at a depth of 20-25 cm. The most active roots absorbing water and nutrients are tertiary roots which are at a depth of 0-60 cm at a distance of 2-2.5 m from the base of the tree (Mardiana, 2007).

Item of Research

a. Stem

The stem is called plumula, oil palm plants have straight stems and do not branch. In mature plants, the diameter is 45-60 cm. The lower part of the stem is usually fatter, called a stump with a diameter of 60-100 cm. Until the plant is 3 years old, the stem is not yet visible because it is still covered by unbudded fronds. Then the stem begins to grow taller with a growth rate of 35-70 cm/year (Mardiana, 2007)

b. Leaf

Oil palm leaves form an even-pinnate and parallel-veined frond. The length of the frond can reach 9 m, the number of leaflets per frond can reach 380 strands. The length of the leaflets reaches 120 cm. The frond from formation to maturity reaches ± 7 years, the number of fronds in 1 tree can reach 60 fronds.

1. Stages of development of oil palm seedling leaves:
2. Lanceolate, the initial leaves that emerge during the seedling period are intact leaves
3. Bifurcute, a leaf shape with leaf blades that have split at the ends that have not yet opened.
4. Pinnate, leaf shape with blades that have opened perfectly with leaflets at the top and bottom (Mardiana, 2007).

c. Flower

Oil palm is a monoecious plant. This means that male and female flowers are found on one tree, but not on the same bunch. However, sometimes male and female flowers can be found in one bunch. Flowers appear from the leaf axils, each leaf axil can only produce one compound flower (inflorescence). Usually some of the bases of the inflorescences fall off in the early stages of their development so that on individual plants some leaf axils do not produce compound flowers (spekelets) (Mardiana, 2007).

d. Fruit

Oil palm fruit is arranged in one bunch, it takes 5.5 - 6.0 months from the time of opening to harvest. In one bunch there are ± 1800 fruits, consisting of outer fruit, middle fruit and inner fruit which are small in size because the position is squeezed so that it does not develop properly. The weight of one fruit varies from 25 - 30 grams. Length 3 - 5 cm, fruit that is separated from the bunch is called brondol.

Oil palm fruit is wrapped in three layers, namely skin (Exocarp), fiber or fruit flesh (Mesocarp) and shell (Endocarp) which wraps the core / kernel. The division of fruit types based on skin color can be grouped into 3 types, namely Nigrescens, Virescens, and Albescens (Mardina, 2007). .

e. Peatlands

Peatland is land that has a layer of soil rich in organic matter (C-Organic >18%) with a thickness of 50 cm or more. The organic material that makes up peat soil is formed from plant remains that have not completely decomposed due to environmental conditions that are saturated with water and poor in nutrients, therefore peatland is often found in back swamp areas or depressions with poor drainage, (Hasn, et al., 2001).

f. Peat Formation

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Peat is formed from piles of dead plant remains, both those that have rotted and those that have not. Piles continue to increase because the decomposition process is hampered by anaerobic conditions and other environmental conditions that cause low levels of decomposing biota development. The formation of peat soil is a geogenic process, namely soil formation caused by deposition and transportation processes, in contrast to the process of mineral soil formation which is generally a pedogenic process. (Fahmuddin. and Made, 2008).

Characteristics of Peat Land

Generally, peat soil is acidic with a pH ranging from 3 to 5, this condition gives a bad impression on the growth of the tree directly or indirectly. Oil palm roots are damaged due to the presence of high hydrogen ions (H) in the soil.

Scientifically, peatlands have low fertility because their nutrient content is low and they contain various organic acids, some of which are toxic to plants. However, these acids are active parts of the soil that determine the peat's ability to retain nutrients. Peatlands also contain very low levels of micronutrients (Zn, Cu, B, Fe, Mn) and are bound quite strongly by organic matter so that they are not available to plants. In addition, the presence of strong reduction conditions causes micronutrients to be reduced to forms that are not absorbed by plants. The content of micronutrients in peatlands can be increased by adding mineral soil or adding microfertilizers. (Fahmuddin. and Made, 2008).

The water cadre of peat soil ranges from 100 – 1,300% of its dry weight. This means that peat absorbs water up to 13 times its weight. Thus, to a certain extent the dome is able to drain water to the surrounding area. Another physical property of peat soil is the irreversible drying property. Peat that has dried out, with a water cadre <100% (based on weight). Cannot absorb water again if wetted. (Fahmuddin. and Made, 2008).

Peat is distinguished by the decomposition of its original plants. To find out whether peat soil is ripe or not, a test can be carried out by taking a handful of peat soil and squeezing it. Based on the results of the squeezing, there are 3 levels of peat maturity, namely:

a. Fibric (Raw Peat)
   If after squeezing is done, > ¾ of the fiber remains in the palm of the hand, in addition the ash content is 3.09% and the organic content is 45.9%.
b. Hemic
   If after squeezing, ¼ to ¾ of the fiber is left in the palm of the hand, while the ash content is 8.04% and the organic content is 51.7%.
c. Sapric
   If after squeezing, > ¾ of the fiber is left in the palm of the hand, the sapric peat has an ash content of 12.04% with an organic matter content of 78.3%.

Lime has high alkaline properties and is widely used by farmers to reduce soil acidity. Lime in the soil is associated with the presence of calcium (Ca) and magnesium (Mg). The presence of both elements is often found associated with carbonate. In general, the provision of lime to the soil can affect the physical and chemical properties of the soil as well as the activities of soil microorganisms (Sapta, 2008)

Chalky soil with high alkaline properties is very opposite to soil rich in organic matter. Organic matter has high acidic properties so it is not good for plant growth. If these two things are combined, the results will complement each other's shortcomings of both types of soil. The soil will be rich in minerals and have a neutral pH which is good for plants (Septa, 2008).

Effects of Lime on Soil

The effects of lime on soil are divided into 3 parts, namely: Physical, Chemical and Biological. Physical effects, in heavy soils there is always a tendency for the fines to aggregate too closely. This condition retards the movement of water and air. Granulation is therefore essential. A satisfactory crumb structure is somewhat improved in acid soils by the addition of every form of lime, although its effect is largely indirect. For example, the effect of lime on biotic forces is very great, especially those connected with the decomposition of organic matter and the synthesis of humus.

Chemical effects, usually if the soil with acidic pH is given lime so that the pH value becomes more appropriate then there will be a real chemical change. Among the typical chemical effects of lime, the most commonly known is the decrease in acidity. But perhaps more important is the indirect effect on the availability of nutrients. Liming of peat soil increases the availability of elements such as phosphorus, calcium and magnesium for absorption by plants. Along with this, the concentration of iron, aluminum, and manganese is greatly reduced, these elements in very acidic conditions are easily present in small amounts.

Biological effects, lime stimulates heterotrophic soils thereby increasing the activity of organic matter and nitrogen in acid soils. The rate of change of these elements is more important than the actual amount. This stimulation of enzymatic processes not only benefits humus formation but also increases the supply of certain organic intermediates that can be toxic to higher plants. The biological effects of lime will now be extended to cover higher plants by detailing the levels of lime at which plants grow satisfactorily, thus indicating whether or not a particular plant benefits from liming.

Mycorrhiza

Mycorrhiza is a mutualistic association between fungi and higher-level roots. Mycorrhiza has received much attention because of its ability to associate to form mutualistic symbiosis with almost 80% of plant species. The growth and activation of mycorrhiza differ according to the species and the mycorrhizal environment. (Mikola, 2004)

Each mycorrhizal species has innate effectiveness or specific ability of each mycorrhizal species to increase plant growth in unfavorable soil conditions. The specific ability factor is the ability to form extensive hyphae in the soil. Forming extensive hyphae infections in the entire root system that develops from a plant, absorbing phosphorus from the soil solution by hyphae and the duration of the transport mechanism along the hyphae into the plant roots. (Bhagyaraj, 1999)

The working principle of mycorrhiza is to infect the root system of the host plant, producing intensive hyphae so that plants containing mycorrhiza will be able to increase

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their capacity in absorbing nutrients. In general, the benefits provided by using mycorrhizal biofertilizer are:

1. Increasing the Absorption of Nutrient P
   Plants with mycorrhizae (endo-mycorrhizae) can absorb higher P fertilizer (10 – 27%) compared to plants without mycorrhizae (0.4 – 13%). The latest research on several agricultural plants can save the use of nitrogen fertilizer by 50%, phosphate fertilizer by 27% and potassium fertilizer by 20%.
2. Restraining Root Pathogen Uptake
   Mycorrhizal roots are more resistant to root pathogens because the mental layer (hypa tissue) covering the roots can protect the roots. In addition, some mycorrhizae produce antibiotics that can attack pathogenic bacteria, viruses and fungi.
3. Improves Soil Structure and Does Not Pollute the Environment
   Mycorrhiza can bind the soil structure by covering the soil particles. Aggregate stability increases with the presence of polysaccharide gel produced by mycorrhizal fungi. Because it is not a chemical, this fertilizer does not pollute the environment (Bhagyaraj, 1999).

METHODOLOGY

This research was conducted in the experimental garden of STIPAP – LPP Medan Campus, and in the Soil Biology Laboratory of the Faculty of Agriculture, USU. The research period began in January 2011 – June 2011.

Materials and tools

Materials used:

1. Peat Land
2. Mycorrhizal inoculum with the types Geus Glomus sp+, Aceulospora sp+, and Scutellospora sp+
3. Chalk $CaCO_3$

Tools used :

1. Black polybag size 60 x 40
2. Hoe
3. Plastic Basin
4. Meter
5. pH Meter
6. As well as other equipment needed for research.

The method used in this study is a Factorial Randomized Block Design (RAK), the first factor is Mycorrhiza and the second factor is Lime with treatments consisting of:

Factor I Mycorrhiza (M) with 3 treatment levels, namely:

$M_{0:=}$ Without Mycorrhiza
$M_{1:}$ = 20 gr Mycorrhiza
$M_{2:=}$ 40 gr Mycorrhiza

Factor II Lime (K) with 3 treatment levels, namely:

$K_{0:=}$ Without Chalk $CaCO_3$

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$K_{1:=}$ 200 gr Chalk CaCO3
$K_{2:=}$ 400 gr CaCO3 Chalk
So that 9 assumed treatment combinations are obtained, namely:

Table 2. Assumed treatment combinations

M0K0	M1K0	M2K0
M0K1	M1K1	M2K1
M0K2	M1K2	M2K2

Seeds needed: 3 x 3 x 4 = 36
Number of Repeats: 4 x Repeats
Number of Reserve Plants: 1
Plant/treatmentTotal Number of Seeds: 72
Seeds

The linear model assumed for this Factorial Randomized Block Design (RAK) is:

$$Yijk = \mu + \rho i + \alpha j + \beta k + (\alpha\beta)\, jk + \varepsilon ijk$$

Where :
Yijk: Results of observations of the i-th, mycorrhiza, j-th repetitions and lime treatment at the k-th level.
μ: Common mean value
ρi: Effect of iteration/i-th block
αj: Influence of mycorrhizae at level j
βk: Effect of the kth level of lime
(αβ) jk: Effect of interaction between j-th mycorrhizal and k-th level of lime treatment
εijk: Experimental error in the first replication that received mycorrhiza treatment at the jth level and lime treatment at the kth level.

To see the testing of the parameters observed at the end of the study, a Variance Index List (DSR) was compiled based on the data obtained. For treatments that were significantly affected, a Duncan's Significant Difference Test was carried out with levels of 5% and 1%.

1. Putting peat soil into 10 kg polybags
2. Apply lime according to the dosage for each treatment.
3. After the lime is applied to the soil, it is incubated for 1 month.
4. Oil Palm Planting
5. Mycorrhiza application is carried out simultaneously with oil palm planting.
6. Maintenance (Watering and cleaning the research area from weeds)
7. Fertilization 2 months after planting

There are several parameters observed during the research period, namely:

1. Increase in Plant Height (CM)
   The increase in seedling height is measured once a month, which is measured from the lower stem by making a wooden stake to determine the root neck, and so it is not difficult to carry out measurements and then measured to the tip of the longest leaf.
2. Stem Wrap (CM)

Measurement of stem diameter is carried out once a month, on the stem stump, measuring the circumference of the stem using a cloth meter.

3. Soil pH
   Soil pH is measured once a month using a pH meter, soil sampling is done by taking soil in a polybag, then taking 10 grams and mixing it with 25 ml of distilled water, then shaking it for 30 minutes and then observing it with a pH meter.
4. Degree of Infection in Oil Palm Roots
   Analysis of the degree of infection in oil palm roots was carried out at the end of the study. Analysis of the degree of infection was carried out at the Soil Biology Laboratory, Faculty of Agriculture, USU.

RESULTS AND DISCUSSION

Plant Height Increase

From the results of observations and analysis of variance in appendices 1 to 4, it can be seen that the mycorrhizal and lime treatments did not have a significant effect on increasing plant height in observations 1 to 4. The interaction between the two also had no significant effect in observations 1 to 4. The results of the real difference test between mycorrhizal and lime treatments and the interaction between the two on increasing plant height can be seen more clearly in Table 3.

Table 3. Recapitulation of the average increase in plant height in observations 1 to 4.

Treatment	Observation of Increase in Plant Height To:			
	1	2	3	4
Mycorrhiza				
M0	2.69	6.48	10.15	12.08
M1	2.91	6.60	9.80	12.89
M2	2.63	7.27	10.23	12.98
Lime				
K0	2.36	6.39	10.08	11.75
K1	3.21	6.76	10.08	12.50
K2	2.66	7.19	10.03	13.71
Interaction				
M0K0	2.20	6.15	10.43	11.35
M0K1	3.00	6.15	9.88	12.30
M0K2	2.88	7.13	10.15	12.60
M1K0	2.10	5.55	8.93	10.65
M1K1	3.73	7.25	11.10	13.93
M1K2	2.90	7.00	9.38	14.10
M2K0	2.78	7.48	10.88	13.23
M2K1	2.90	6.88	9.25	11.26
M2K2	2.20	7.45	10.58	14.43

Description: Unannotated figures indicate an insignificant effect according to the Dukan Real Distance Difference Test F0.01 and F0.05. In table 3 it can be seen that the influence of mycorrhiza did not have a significant effect on observations 1 to 4. Although it did not have a significant effect in general, the highest seedlings were those with mycorrhiza application treatment in observation 4. M2 (12.98 cm) was higher than M0. (12.08 cm).

Lime treatment did not have a significant effect on increasing plant height in observations 1 to 4. Although it did not have a significant effect, in general the tallest seedlings were those treated with lime application in observation 4. K2 (13.71 cm) was higher than K0 (11.75 cm).

The interaction between mycorrhizal and lime treatments did not have a significant effect on observations 1 to 4. The highest interaction was in observation 4 M2K2 (14.43 cm), which was higher than MIK0 (10.65 cm). Bambang, 2006 stated that oil palm plants are one of the annual plants so that growth development is relatively slow, so that the effects of each treatment given to annual plants are very difficult to see in a short time, unlike horticultural plants.

Observation of Plant Stem Twist

From the results of observations and analysis of variance in appendices 5 to 8, it shows that mycorrhizal and lime treatments did not have a significant effect on stem circumference in observations 1 to 4. The interaction between the two also had no significant effect in observations 1 to 4. The results of Duncan's real-time distance test of mycorrhizal and lime treatments and the interaction between the two on plant stem circumference can be seen in more detail in Table 4 below.

Table 4. Recapitulation of the average stem circumference in observations 1 to 4

Treatment	Observation of Increase in Stem Circumference to:			
	1	2	3	4
Mycorrhiza				
M0	1.18	2.88	3.84	4.86
M1	1.28	2.79	3.81	5.06
M2	1.05	2.68	3.73	4.89
Lime				
K0	1.22	2.82	3.91	5.10
K1	1.11	2.73	3.63	4.69
K2	1.18	2.83	3.83	5.02
Interaction				
M0K0	1.25	2.90	3.95	4.98
M0K1	1.13	2.88	3.65	4.70
M0K2	1.18	2.88	3.93	4.90
M1K0	1.30	2.80	3.93	5.38
M1K1	1.18	2.65	3.55	4.60
M1K2	1.35	2.93	3.95	5.20
M2K0	1.10	2.75	3.85	4.95

Treatment	Observation of Increase in Stem Circumference to:			
	1	2	3	4
M2K1	1.03	2.65	3.70	4.78
M2K2	1.03	2.65	3.63	4.95

Description: Unannotated figures indicate an insignificant effect according to the Dukan Real Distance Difference Test F0.01 and F0.05. In table 4, it can be seen that the influence of mycorrhiza did not have a significant effect on observations 1 to 4. Although it did not have a significant effect in general, the seedlings with the largest stem circumference were those treated with mycorrhiza application in observation 4 M1 (5.06), which was higher than M0 (4.86 cm).

Lime treatment did not have a significant effect on stem circumference in observations 1 to 4. Although it did not have a significant effect, in general the seedlings with the largest stem circumference were those treated with lime application in observation 4 K0 (5.10 cm) which was greater than K1 (4.69 cm). The interaction between mycorrhizal and lime treatments did not have a significant effect on observations 1 to 4. The highest interaction was in observation 4, MIK0 (5.38 cm), which was greater than MIKI (4.60 cm).

Peat Soil pH Observation

From the results of observations and analysis of variance in appendices 9 to 12, it shows that mycorrhizal treatment did not have a significant effect on peat soil pH in observations 1 to 4. Meanwhile, lime treatment had a very significant effect in observations 1 to 4. And the interaction between the two did not have a significant effect in observations 1 to 4. The results of the real difference test using mycorrhizal and lime treatments and the interaction between the two on peat soil pH can be seen in more detail in Table 5 below.

Table 5. Recapitulation of the average pH of peat soil in observations 1 to 4.

Treatment	Peat Soil pH Observation To:			
	1	2	3	4
Mycorrhiza				
M0	5.93	5.80	6.08	4.83
M1	6.06	5.94	6.03	5.02
M2	6.19	5.95	6.08	4.98
Lime				
K0	4.63 C	5.24 B	5.33 B	4.21 C
K1	6.63 B	6.22 A	6.38 A	5.05 B
K2	6.93 A	6.23 A	6.48 A	5.57 A
Interaction				
M0K0	4.45	5.08	5.40	4.10
M0K1	6.50	6.28	6.35	4.78
M0K2	6.85	6.05	6.48	5.60
M1K0	4.53	5.35	5.33	4.35
M1K1	6.65	6.13	6.40	5.18
M1K2	7.00	6.33	6.38	5.53
M2K0	4.90	5.28	5.28	4.18

Treatment	Peat Soil pH Observation To:			
	1	2	3	4
M2K1	6.73	6.25	6.40	5.20
M2K2	6.95	6.33	6.58	5.58

Description: The numbers marked show a very significant effect according to the Dukan Real Distance Difference Test F0.01. In table 5, it can be seen that the influence of mycorrhiza did not have a significant effect on observations 1 to 4. Although it did not have a significant effect, the treatment with the highest pH value was the mycorrhiza application treatment in observation 1. M2 (6.19) was higher than M0 (5.93).

Lime treatment had a very significant effect on soil pH in observations 1 to 4. The highest pH value was in observation 1 K2 (6.93) which was higher than K0 (4.63). The interaction between mycorrhizal and lime treatments did not have a significant effect on observations 1 to 4. The highest interaction was in observation 1, MIK2 (7.00), which was higher than M0K0 (4.45). According to Sapta, 2008. Lime has high alkaline properties so it can improve the pH of acidic soil. Liming is stated as the most appropriate technology in utilizing acidic soil, because lime has a fast reaction in increasing soil pH.

Degree of Root Infection of Oil Palm Plants

From the results of observations and analysis of variance in appendix 13, it shows that the effect of mycorrhizal treatment has a significant effect on root infection. The results of the real distance difference test using mycorrhizal treatment on the degree of root infection can be seen more clearly in table 6 below:

Table. 6 Average Degree of Infection

Treatment	Chalk (Gr/Plot)			Average
	0 (K0)	200 (K1)	400 (K2)	
M0	1.34	0.71	0.71	0.92 B
M1	6.15	6.65	7.27	6.65 A
M2	7.09	7.26	7.44	7.26 A
Average	4.86	4.83	5.14	

Description: The numbers marked show a very significant effect according to the Dukan Real Distance Difference Test F0.01. In table 6 it can be seen that the effect of mycorrhizal infection has a very significant effect at the level of 0.01. The highest value is in the M2 treatment (7.26) which is higher when compared to M0 (0.92). In this study, M0 was also infected with mycorrhizae but in small amounts because mycorrhizae are also available in the soil but in small populations and in this study, soil sterilization was not carried out first so that the mycorrhizae in the soil also infected the roots. Molina, 1999. States that this is caused by fungi entering the roots or causing infection. The infection process begins with the germination of spores in the soil. The growing hyphae penetrate into the roots and develop in the cortex. Infected roots will form Intravascular Viscal Arbuscules.

CONCLUSION

The Conclusion of this paper are: Mycorrhizal application did not significantly affect the increase in plant height, stem circumference and soil pH in oil palm plants. But it had a very significant effect on the degree of infection in the roots of oil palm plants. The best treatment was on M2 with a dose of 40 gr/polybag. Lime application has no significant effect on increasing plant height, stem circumference and degree of infection in oil palm plants. But it has a very significant effect on soil pH. The best treatment is K2 with a dose of 400 gr / polybag. The interaction of mycorrhiza and lime did not significantly affect the increase in plant height, stem circumference, pH and degree of infection in oil palm plants. However, if seen the best treatment is in M2K2 with a dose of 40 gr of mycorrhiza and 400 gr of lime.

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