

Effects of Combination of Inorganic and Organic Fertilizers Application on Morphology and Physiology of Immature Oil Palm

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Zahrul Fuady*, Halus Satriawan, Agusni

Department of Agrotechnology, Faculty of Agriculture, Universitas Almuslim,
Jl. Almuslim, Matanglumpangdua, Bireuen, Aceh 24261, Indonesia

*Corresponding author, email: zahrulfuady17@yahoo.com

ABSTRACT

Oil palm requires nutrients both macro and micro nutrients for its growth and development processes. This study aimed to study the morphological and physiological responses of immature oil palm plantations at 1 year of planting to the provision of organic fertilizer and micro fertilizers as a complement to inorganic fertilizers. The research was arranged in a Randomized Completely Block Design (RCBD). The treatment applied consisted of 7 treatments, namely one control treatment (basic fertilizer) and six treatments from a combination of type and dose of fertilizer, consisting of single fertilizer, compound fertilizer, organic fertilizer and micro fertilizer. Based on the results, single and compound fertilizers accompanied by micro fertilizers (M1a, M1b) had a significant effect on plant height showing 13.78%, 27.55%, 25.11%, and 54.18% higher than others and on length and width of the 9th midrib reaching 7.47%, 22.40% and 51.04% better than others. The best response of growth of stem circumference at 6 MAT was observed in PO1 reaching 112.43%, better than M1a (111.96%) and M1b (109.20), while the lowest was observed in PO0 (97.84%). Meanwhile, chlorophyll and stomata were implied by a package of compound fertilizer and single fertilizer. The highest leaf chlorophyll content was in the MOa fertilizer treatment, while the highest stomata level was in the M1a treatment.

Keywords: Fertilization packages, Oil palm, Immature plants, Vegetative growth, Physiological growth

ABSTRAK

Kelapa sawit membutuhkan nutrisi untuk proses pertumbuhan dan perkembangannya, baik nutrisi makro maupun mikro. Penelitian ini bertujuan untuk mempelajari respon morfologis dan fisiologis dari perkebunan kelapa sawit belum menghasilkan pada 1 tahun tanam karena pemberian pupuk organik dan pupuk mikro sebagai pelengkap pupuk anorganik. Percobaan menggunakan Rancangan Acak Kelompok Lengkap (RAK). Perlakuan yang diterapkan terdiri dari 7 perlakuan, yaitu satu perlakuan kontrol (pupuk dasar) dan enam perlakuan dari kombinasi jenis dan dosis pupuk, terdiri atas pupuk tunggal, pupuk majemuk, pupuk organik, dan pupuk mikro. Berdasarkan hasil yang diperoleh, pupuk tunggal dan pupuk majemuk yang disertai dengan pupuk mikro (M1a, M1b) memiliki pengaruh signifikan terhadap tinggi tanaman, dengan persentase 13,78%, 27,55%, 25,11%, dan 54,18% lebih tinggi dibandingkan perlakuan lainnya; Parameter panjang dan lebar daun pelepah ke-9 lebih baik 7,47%, 22,40% dan 51,04% dibandingkan perlakuan lainnya. Pertumbuhan lingkaran batang pada 6 bulan setelah perlakuan terbaik pada PO1 setara dengan 112,43%, lebih baik dibandingkan M1a (111,96%), dan M1b (109,20), terendah pada PO0 (97,84). Sementara klorofil dan stomata diimplikasikan oleh paket pupuk majemuk dan pupuk tunggal. Kandungan klorofil daun tertinggi ada pada perlakuan pupuk MOa, sedangkan kadar stomata tertinggi ada pada perlakuan M1a.

Kata Kunci: Paket pemupukan, Kelapa sawit, Tanaman belum menghasilkan (TBM), Pertumbuhan vegetatif, Pertumbuhan fisiologi

INTRODUCTION

One factor that plays an important role in crop productivity is fertilization (Adam et al. 2005, 2011; Sun et al., 2011; Wigena et al. 2009; Zuraidah et al. 2012) especially in the phase of immature plants (TBM). Therefore, given the high cost, fertilization is an aspect that must be considered in oil palm cultivation. Fertilization costs range from 40-60% of plant maintenance costs or about 30% of the total production costs (Goh and Hardter, 2003). As a provider of plant nutrition, nutrient availability

which is a limiting factor of plant growth and production is highly dependent on location, mostly due to soil characteristics (Woittiez et al., 2017).

Like other plants, oil palm also requires nutrients both macro and micro nutrients for its growth and development processes. Macro nutrients play a major role in the constituent of cell protoplasm so that it is needed in large quantities. Macro nutrients include C, H, O, N, P, K Ca, Mg and S. Meanwhile, micro nutrients are needed in very

small quantities. If there is an excessive amount it can be toxic to plants. Micro nutrients include Fe, Mn, B, Mo, Cu, Zn, Cl and Co (Hardjowigeno, 2010). Moreover, oil palm plants are known as plants that require high amounts of fertilizer, considering that 1 ton of FFB produced is equivalent to 6.3 kg of urea, 2.1 kg of TSP, 7.3 kg of MOP, and 4.9 kg of Kiserit (Poeloengan et al., 2001). According to Tarmizi (2000), oil palm cultivated in tropical regions such as in Malaysia requires 0.5-1.1 kg N, 1.1 kg P₂O₅, and 0.5-2.2 kg K₂O per year.

Fertilization with optimum doses aims to provide sufficient and effective nutrients to encourage healthy vegetative growth of plants and maximize the potential for fresh fruit bunches production (Tarmizi and Tayeb, 2006; Prasetyo and Suriadikarta, 2006), to increase efficiency (Poeloengan et al, 2007) and to replace nutrients that are lost from the soil through washing, erosion and extraction by the plants themselves (Law et al., 2012). Nutrients given through fertilization must be based on the principle of balanced fertilization, which is to provide nutrients according to the needs of plants. Giving fertilizer with a lower dosage than the plant needs will not give optimal influence for the growth and production of plants both in quality and quantity, while fertilizer application exceeding the needs of plants will reduce the quality of the environment and decrease the growth and production of plants (Safuan et al., 2013).

In addition to inorganic fertilizers, fertilizer can also be in the form of organic fertilizers, such as manure, green manure, and compost. Providing organic fertilizer can increase nutrient content in the soil, although the nutrient content in organic fertilizer is relatively low (Uwumarongie et al., 2012). The results of the study by Kanny et al. (2015) showed that oil palm given with certain level of P nutrient had not yielded at the age of 2 years, while the provision of organic fertilizer with a dose

of 90 kg / plant / year could give the best effect. In addition, Siallagan et al. (2014) showed that a combination of inorganic and organic fertilizers resulted in a good plant height and stem circumference in oil palm plants that had not yielded at the age of 1 year of planting. The provision of inorganic fertilizers and organic fertilizers can also improve physiological growth in oil palm plants.

Besides being beneficial to plant growth, organic fertilizers are also known for soil nutrient flux compared to inorganic fertilizers, enriching soil fertility in a longer period of time (Khatun et al., 2017). In addition, providing organic fertilizer can increase the water holding capacity and the cation exchange capacity of the soil so that if inorganic fertilizer is added, washing by rainwater and erosion can be inhibited (Sukmawan, et al., 2015).

This study aimed to study the morphological and physiological responses of immature oil palm plantations at 1 year of planting to the provision of organic fertilizer and micro fertilizers as a complement to inorganic fertilizers.

MATERIALS AND METHODS

The experiment was carried out in Bukit Sudan Village, sub-District of Peusangan Siblih Krueng, Bireuen District, Aceh, located at an altitude of 120 m above sea level. This research was carried out for 9 months starting from March - November 2018. The data presented in this article are research data for 6 months after application (April-September). The field experiment was conducted in community oil palm plantation in Peusangan Siblih Krueng Subdistrict, Bireuen Regency of Aceh Province (5°4'30"N and 96°45'18"E with 116 m elevation), which previously had been determined slightly sloping or bumpy (8-15%), with mild - moderate soil depth (85-125 cm). The soil of the experimental area is classified as Typic Paleudults (USDA, 2010). The parent material is dominated by andesite rocks.

The texture of the soil in the study area is classified as sandy clay in the topsoil (0-0.15 m depth), having a deep argillic horizon with clay content between 19 and 37%. Rainfall events generated with total rainfall recorded amount is 1,895 mm.

The ingredients used were oil palm varieties DP-9, cow manure, urea, phosphate, NPK, terusi ($\text{CuSO}_{4.5}\text{H}_2\text{O}$), rock phosphate, and Borat fertilizer. The tools used were analytic scales, meters, chlorophyll meters, microscopes, ovens, and pre-plate / glass objects.

The research was arranged in a Randomized Completely Block Design (RCBD) design in which grouping was done based on land slope. The treatment applied consisted of 7 treatments, namely one control treatment (basic fertilizer) and six treatments from a combination of type and dose of fertilizer, consisting of single fertilizer, compound fertilizer, organic fertilizer and micro fertilizer (Table 1). Each treatment was replicated three times and each experimental unit consisted of five oil palm plants so that the total experimental unit was 63 plants.

Fertilization

All oil palm plants have been previously fertilized with 60 kg / hole organic manure, 500 gr / planting hole cow manure and dolomite as much as 500 grams / planting hole (basic fertilizer). Fertilizer application according to treatment was carried out three times, i.e. every four months with

a minimum rainfall of 60 mm / month (in March and July).

Application of urea, SP-36, KCl, compound NPK, organic fertilizer and micro fertilizer was carried out in the morning by sprinkling fertilizer on the palm oil larikan and disks (Soon and Hoong, 2002) except the application of borate fertilizer which was stocked on the leaf midribs. (Goh and Hardter, 2003).

Morphological Observations on Plants

Morphological observations on plants were carried out on each experimental unit every 3 months. The height of the plant was measured from the base of the stem marked up to the youngest leaf opening perfectly enforced using a modified fabric meter (Siallagan, et al., 2014)

Number of leaf midribs. The number of leaf midribs counted were leaf midribs that had opened (Legros et al., 2009). The stem circumference is a collection of leaf midribs that are still wrapped in fibers. Measurements were made using a fabric meter at 5 cm from the ground level (Legros et al., 2009). The length of the 9th from leaf midrib were made with a fabric meter, starting from the base of the midrib to the tip of the midrib. The measurement of leaf size was carried out on the 9th leaf midrib, by measuring several strands of the length and width of the leaflets and they were calculated by the formula by Sudrajat et al. (2015):

Table 1. Treatment of various levels of immature oil palm fertilization

Fertilizer Level	Combination and Type of Fertilizer (plant / year)
PO0	600 g urea + 750 g SP-36 + 700 g KCl + 25 g borate + 25 g $\text{CuSO}_{4.5}\text{H}_2\text{O}$
PO1	1300 g NPK + 25 g borate + 25 g $\text{CuSO}_{4.5}\text{H}_2\text{O}$ + 30 kg cow manure fertilizer
PO2	600 g urea + 750 g SP-36 + 700 g KCl + 25 g borate + 25 g $\text{CuSO}_{4.5}\text{H}_2\text{O}$ + 30 kg cow manure fertilizer
Single fertilizer with micro fertilizer (M1a)	600 g urea + 750 g SP-36 + 700 g KCl + 25 gr borate + 25 g $\text{CuSO}_{4.5}\text{H}_2\text{O}$
Compound fertilizer with micro fertilizer (M1b)	1300 g NPK + 25 g borate + 25 g $\text{CuSO}_{4.5}\text{H}_2\text{O}$
Single fertilizer without micro fertilizer (M0a)	600 g urea + 750 g SP-36 + 700 g KCl
Compound fertilizer without micro fertilizer (M0b)	1300 g NPK

$$Leafsize = \frac{\sum_1^6 p \times l}{6} \times 2n \times k$$

Description:

- p = the length of the leaflets (cm)
- l = width of leaflets
- n = number of left or right leaflets
- k = constant (0.57 for TBM)

Stomata density.

Observation of leaf stomata density was carried out at 8 months after treatment. Observation of stomatal samples was carried out by applying transparent nail polish on the bottom surface of the 9th leaf midrib, about 2 cm x 2 cm in the morning and it was allowed to dry. Transparent tape was then taped on the surface of the leaf that has been smeared with nail polish, so that the nail polish stuck perfectly. After that the tape was released and affixed to the object glass. Stomata were observed under an electron microscope at a magnification level of 40. The stomata density was calculated by the following formula (Rahhutami, 2015):

$$Stomata\ density = \frac{Number\ of\ Stomata}{broad\ field\ \text{view}}$$

The area of view was calculated by the formula:

$$\begin{aligned} A &= \pi r^2 \\ &= 3.14 \times (0.25)^2 \\ &= 0.19625\ mm^2 \end{aligned}$$

Chlorophyll content of leaves.

Chlorophyll content was measured by observing the greenness level of leaves with chlorophyll meters every 4 months for 12 months on the 9th midrib leaf. This tool digitally measures the greenness and the relative amount of chlorophyll molecules contained in the leaves in one value which is based on the amount of light transmitted by the leaves. Leaf

samples were placed at the point of the reader, then the reader button was pressed. Measurements were made at three points (base, middle and end) which were ± 5 cm from the edge of the leaflet. The real value of chlorophyll content was calculated using the formula by Farhana et al. (2007): $Y = 0.0007x - 0.0059$, where: Y = chlorophyll content and X = measurement result value.

RESULTS AND DISCUSSION

Plant height

The results showed that the treatment of organic fertilizers and micro fertilizers significantly affected the height of oil palm plants at 1, 3 and 6 months after treatment (MAT) (Table 2).

The treatment of compound fertilizers with micro fertilizers (M1b) resulted in the highest growth of plant height at 1 MAT, 3 MAT and 6 MAT compared to other treatments. However, in terms of increasing the growth rate at 1, 3 and 6 MAT, the best effect was obtained in the M1a treatment, namely: 13.78%, 27.55%, 25.11%, and 54.18%.

In Table 2, it can be seen that single fertilizer supplementation with addition of Cu and borate micro fertilizers can increase the best plant height. Compared to other treatments, during the initial growth stage, plants fertilized with a single fertilizer with the addition of micro fertilizer were more

Table 2. Effect of doses of organic fertilizer and micro fertilizer on plant height

Fertilizing Level	Plant Height (cm)			
	Initial	1 MAT	3 MAT	6 MAT
PO0	117.99	131.47c	144.95b	179.15b
PO1	116.49	128.06ab	147.63d	178.63b
PO2	118.73	132.13c	146.53cd	177.93b
M1a	114.04	129.75b	145.46bc	179.46b
M1b	118.94	134.90d	149.86e	182.86c
M0a	118.00	131.48c	144.96b	179.16c
M0b	112.95	126.76a	140.57a	174.14a
LSD		1.22	1.22	1.22

Note: Values followed by different letters in the same column are significantly different according to LSD test at 5% level.

responsive than those fertilized with other types of fertilizers (compound fertilizer and addition of manure). This can be seen in observations at 1 and 3 MAT, while at 6 MAT, 6 of 7 treatments produced plant growth > 50%. The results of this study is not in accordance with the findings of Syahputra and Wardati (2015) and Siallagan and Wardati (2015) reporting that fertilization of compound fertilizers and Cu did not have a significant effect on plant growth in peatland.

In this case, nitrogen plays a role in the photosynthesis process which produces assimilates needed by plants during the morphological growth phase (Suharno et al., 2007). This result is also in line with the phenomenon of the results of Luz et al. (2006) who reported that nitrogen fertilizer increased and accelerated the growth of “lady palm” plant seeds (*Rhapis excels*). Goh and Hardter (2003) showed that nitrogen fertilization was the main driving force for rapid vegetative growth of oil palm. Likewise, Kasno et al. (2010) showed that giving phosphorus fertilizer significantly increased the height of oil palm seedlings. The Cu element contributes to chlorophyll formation and also plays a role in symbiotic N fixation and lignin preparation.

Stem circumference

The results of fertilization treatment analysis showed that there was a significant effect on the circumference of the oil palm stems in each observation period (Table 3). In each observation period, the largest stem circumference growth was found in different treatments. The best response in stem circumference growth at 1 MAT was found in M0a and PO0 treatment, at 3 MAT was in M0a treatment and at 6 MAT was in PO1. The growth of stem circumference for the treatment of PO1 at 6 MAT was equivalent to 112.43% since the beginning of planting, the highest compared to other

Table 3. Effect of doses of organic fertilizer and micro fertilizer on stem circumference

Fertilizing Level	Stem Circumference (cm)			
	Initial	1 MAT	3 MAT	6 MAT
PO0	19.8	23.4c	33.5b	39.1b
PO1	19.0	22.6a	34.3e	40.4d
PO2	19.8	23.0b	34.0d	40.2c
M1a	18.9	22.6a	33.8c	40.1c
M1b	18.8	22.6a	34.0d	39.3b
M0a	19.7	23.4c	34.5f	40.1c
M0b	19.4	22.7a	32.6a	38.6a
LSD		0.19	0.19	0.19

Note: Values followed by different letters in the same column are significantly different according to LSD test at 5% level.

treatments, i.e. 111.96% (M1a), 109.20 (M1b), and the lowest in PO0 (97.84%).

In the stem circumference growth parameter, PO1 treatment (1300 g NPK + 25 g borate + 25 g $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ + 30 kg cow manure) most significantly stimulated the growth of stem circumference. The use of compound fertilizers combined with manure and micro elements that are slow in nature was able to influence the growth at 3 and 6 MAT. It is suspected that compound fertilizer and Cu after 3 months of application can be utilized by oil palm plants. This result is consistent with the research of Uwumarongie-Ilori et al. (2012) and Siallagan et al. (2014) showing that application of organic fertilizer can increase stem circumference as a result of improvement of soil physical and chemical properties. Organic fertilizer applications are beneficial for plants for the long term because the nutrients contained in them are released slowly (Ermadani and Muzar, 2011). In addition, organic fertilizer can also improve rhizosphere so that it can maintain the nutrient cycle and improve exudation by plant roots which can increase the degradation of soil organic matter and N mineralization (Suprayitno et al., 2017). Tiemann et al. (2018) also state that the stem is an area of nutrient accumulation during plant growth, which is around 35-40%. The avail-

ability of nutrients in sufficient quantities causes the metabolic activity of the plant to increase so that the enlargement of the stem occurs.

Number of Leaf midribs

Fertilization treatment resulted in significant effect on the amount of oil palm leaf midrib at each observation period (Table 4). PO1 treatment is known to produce the highest number of leaf midribs at three observation periods (1, 3 and 6 MAT). However, the highest number of leaf midribs obtained in M0a treatment was 17%, 51% and 85% at three observation periods.

Table 4. Effect of doses of organic fertilizer and micro fertilizer on the number of leaf midribs

Fertilizing Level	Number of Leaf Midribs (sheet)			
	Initial	1 MAT	3 MAT	6 MAT
PO0	14.30	16.55d	19.95a	23.35a
PO1	14.33	16.48cd	20.78e	25.08e
PO2	14.13	16.31c	20.66de	25.01e
M1a	13.80	15.98b	20.28bc	24.58c
M1b	13.73	15.96b	20.46cd	24.96de
M0a	13.23	15.48a	19.98a	24.48c
M0b	13.43	15.61a	19.91a	24.21b
LSD		0.21	0.21	0.21

Note: Values followed by different letters in the same column are significantly different according to LSD test at 5% level.

The results showed that midrib production ranged from 15-24 strands at 6 months after treatment with an average of 2-4 strands per month (Table 4). This amount is higher than the midrib production under normal land conditions, which is about 2 strands per month (Corley and Tinker, 2008). Midrib production in the first year is low and will then reach a maximum in the second year (Adam et al., 2011). Midrib production seems also related to climate factors, such as rainfall. Midrib production in a month is affected by the amount of rainfall one or two months before. In this study, rainfall in July and August was higher than in the previous month.

The Length and Area of the 9th Leaf Midrib

Fertilization treatment has a significant effect on the length of the 9th leaf midrib of oil palm at each observation period (Table 5). M1a treatment is known to produce the best leaf midrib growth at three observation periods (1, 3 and 6 MAT). Likewise, if the leaf midrib growth is converted as a percentage of growth rate, it is best obtained in treatment M1a of 7.47%, 22.40% and 51.04% at three observation periods. Meanwhile, the lowest growth rate was in the treatment of PO2 (3.09%, 9.28% and 18.07%).

Fertilization treatment has a significant effect on the length of the 9th leaf midrib of oil palm at each observation period (Table 5). The treatment of M1b is known to produce the best leaf midrib area at two observation periods (1 and 3 MAT), while in 6 MAT the widest leaf midrib area was observed in PO2. Likewise, if the growth of leaf midrib area is converted as a percentage of growth rate, the best was obtained in M1b treatment of 39%, 78% and 103% at three observation periods.

This result is consistent with that stated by Corley and Tinker (2008) that leaf area and length of midrib were affected by fertilization, but not too sensitive to other factors. The canopy size which is related to leaf area, midrib length, and number of leaflets has a changing growth pattern. Change in

Table 5. Effect of doses of organic fertilizer and micro fertilizer on the length of the 9th leaf midrib

Fertilizing Level	The Length of the 9 th Leaf Midrib (cm)			
	Initial	1 MAT	3 MAT	6 MAT
PO0	91.26	96.06b	105.66c	134.20e
PO1	93.27	96.90c	104.15b	128.67b
PO2	92.43	95.29a	101.01a	109.14a
M1a	90.65	97.41d	110.95e	139.25g
M1b	90.82	97.03c	109.45d	137.17f
M0a	91.53	96.34b	105.96c	129.80c
M0b	91.07	95.97b	105.77c	131.78d
LSD		0.49	0.49	0.49

Note: Values followed by different letters in the same column are significantly different according to LSD test at 5% level.

Table 6. Effect of doses of organic fertilizer and micro fertilizer on the area of the 9th leaf midrib

Fertilizing Level	9 th Leaf Midrib Area (cm ²)			
	Initial	1 MAT	3 MAT	6 MAT
PO0	0.57	0.67b	0.87b	0.95b
PO1	0.56	0.65b	0.83b	0.95b
PO2	0.57	0.67b	0.87b	1.13d
M1a	0.54	0.65b	0.85b	1.00bc
M1b	0.50	0.70bc	0.89c	1.02c
M0a	0.57	0.68b	0.88bc	1.04c
M0b	0.43	0.54a	0.75a	0.88a
LSD		0.05	0.05	0.05

Note: Values followed by different letters in the same column are significantly different according to LSD test at 5% level.

Table 7. Effect of doses of organic fertilizer and micro fertilizer on leaf chlorophyll content and stomatal density

Fertilizing Level	Leaf Chlorophyll		Stomata density
	4 MAT	8 MAT	8 MAT
PO0	0.0450d	0.0433b	206.33b
PO1	0.0427a	0.0417a	205.22a
PO2	0.0443c	0.0440c	208.07c
M1a	0.0477c	0.0430b	208.30c
M1b	0.0437ab	0.0427ab	208.20c
M0a	0.0447c	0.0447c	206.63b
M0b	0.0460d	0.0410a	206.60b
LSD	0.001	0.001	0.48

Note: Values followed by different letters in the same column are significantly different according to LSD test at 5% level.

canopy size is an adaptation mechanism for regulating transpiration rate as responsive to changes in plant water balance (Yahya and Manurung, 2002).

The function of element N is for overall plant growth, namely for protein formation, chlorophyll synthesis, and metabolic processes (Rachman et al., 2008). P element acts as an ATP molecule forming element which is an energy-rich molecule that is needed in metabolic processes such as protein synthesis, so that P nutrient deficiency can cause stunted growth (Goh and Hardter, 2003). K element acts as an enzyme activator and maintains osmotic potential and water uptake, as well as

translocation of photosynthetic results out of the leaves to the sink (Pettigrew, 2008).

Stomata Density and Leaf Chlorophyll Content

In general, fertilization treatment has significant effect on leaf chlorophyll content at 4 and 8 MAT, and stomata density at 8 MAT (Table 7). The highest leaf chlorophyll content was in the M0a fertilizer treatment, while the highest stomata density was in the M1a treatment.

Stomata density is influenced by temperature, light intensity and plant adaptation to the environment. Taiz and Zeiger (2006) stated that high density and number of stomata are strongly influenced by plant adaptation to their environment. The stomata density in this study was between 205-208 mm⁻². Stomatadensity of oil palm leaves depends on the characteristics of an area. The stomata density of oil palm leaves in Nigeria and Malaysia is 146 mm⁻² and 175 mm⁻², respectively. The oil palm leaf stomata are classified as semi-xeromorphic which has a structure to adapt to long dry periods (Corley and Tinker, 2008).

Even so, leaf chlorophyll content tended to decrease during the 8th month compared to the 4th month after planting. The provision of organic fertilizer and compound NPK up to the highest dose has not been able to increase the chlorophyll content of immature oil palm until the end of the (Table 7). This is predicted because the doses of fertilizer are still not sufficient or the plant takes longer time to be able to respond to fertilizer. Associated with the function of nutrients to the formation of leaf chlorophyll, Simbolon and Zuhri (2017) explained that nitrogen is beneficial for the formation of chlorophyll which is very important for photosynthesis so that it can increase plant growth. Photosynthesis will work well with the availability of K in sufficient quantities. Potassium

can function to form and transport carbohydrates, increasing the growth of meristem tissue.

CONCLUSION

Single and compound fertilizers accompanied by micro fertilizers (M1a, M1b) have significant effect on plant height, length and width of the 9th midrib leaf. Variables of stem circumference and number of midribs were adhered to by a package of compound fertilizer + micro + manure, while chlorophyll and stomata were implied by a package of compound fertilizer and single fertilizer. However, in terms of increasing the growth rate in plant height at 1, 3 and 6 MAT, the best effect was observed in M1a treatment, namely: 13.78%, 27.55%, 25.11%, and 54.18%. The best stem circumference growth at 1 MAT was found in M0a and PO0 treatment, at 3 MAT was in M0a treatment and at 6 MAT was in PO1. The growth of stem circumference for the treatment of PO1 at 6 MAT was equivalent to 112.43% since the beginning of planting, the highest compared to other treatments, M1a (111.96%), M1b (109.20), and PO0 (97.84%). The highest number of leaf midribs obtained in M0a treatment was 17%, 51% and 85% at three observation periods. The best effect on percentage of growth rate was obtained in treatment M1a of 7.47%, 22.40% and 51.04% at three observation periods. The highest leaf chlorophyll content was found in M0a fertilizer treatment, while the highest stomata density was in M1a treatment.

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