The Morphological Growth Response of Immature Oil Palm on Single Fertilizer (N, P and K)

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Keywords: Morphological, growth, response, single fertilizer, immature oil palm.

Abstract: One of the factors thattakes an important role in crop productivity is fertilization, especially in an immature plant (TBM). The goal of this research is to study the morphological response of immature oil palm plants as result ofthe single fertilizer N, P and K. Treatment designuses RandomizedCompletely Block Design (RCBD). The applied treatment consists of 4 treatments, controltreatment (basic fertilizer) and threetreatments of single fertilizer combination. Each treatment is repeated three times so that the total unit tests are 12 plants. The observation of plant morphology includes: plant height, stem circumference, the number of leaf midrib, the ninth midrib leaf length, and the ninth stem leaf width . The results show that the single fertilizer treatment does not have a significant effect on plant height, stem circumference, the number of leaf midrib, the ninth midrib leaf length, the ninth stem leaf width on the palm in 1-3 Months After Treatment (MAT).Nevertheless, the effect of the treatment shows that the higher single dosage package of fertilizer (PT1, PT2 and PT3) is applied,the more increasing the plant height is. The highest growth increase occurs on the stem circumference and the ninth leaf width, that is 31.51% and 26.32%; wider than the control.

1 INTRODUCTION

Oil palm is a very important plantation crop commodity in Indonesia because it has a long economic life about 20-25 years (Kasno and Subardja, 2010). In Indonesia, there are 18.2 million hectares of potential land for the oil palm cultivation. In 2010, it has been planted to reach 9 million hectares (Putra etal. 2012), and in 2016, has been increased to 10 million hectares (Pirker etal. 2016).In Aceh Province, one of the areas with a large oil palm cultivation area is Bireuen Regency with 4,372 hectares, with immature plant (*TBM*) 1,772 hectares (*BKPM*, 2015).

One of the factors that take the important role on the cultivation is fertilizers (Adam et al. 2005; Adam et al. 2011; Wigena et al. 2009; Zuraidah et al. 2012) primarily on the immature plant phase (TBM). Fertilization is one aspect that must be considered, because of its high cost. The fertilization costs about 40-60% of plant maintenance costs or about 30% of total production costs (Goh and Hardter, 2003).

Plant nutrition as a limiting factor of plant growth and production is highly dependent on the area, mostlycausedby soil property factors associated with nutrient availability (Woittiez et al. 2017).

The fertilization with optimum dosage aims to provide sufficient and appropriate nutrients to encourage the healthy vegetative plant growth and to maximize the potential for production of fresh fruit bunches (Tarmizi and Tayeb, 2006; Prasetyo and Suriadikarta, 2006), to improve efficiency (Pulungan et al. 2007) and also to replace the missing nutrients from the soil by leaching, erosion and uptaking by the plantitself (Law et al. 2012). The nutrients given through fertilization should be considered to be the principle of balanced fertilization which is to provide nutrients according to the needs of plants. The provision of fertilizers with lower doses of crop need will not have an optimal effect on the growth and production of both quality and quantity of crops, whereas fertilizer exceeds crop requirements will decrease the environmental quality and decrease the growth and crop production (Safuan et al. 2013).

Soil fertility on permanent farming systems is usually maintained through the applicationof organic materials, inorganic fertilizers, lime and theaddition

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of legumes in plant systems or these combinations. The need of palm nutrient in the time of the immatureplant (*TBM*) varies greatly and depends on the production target, the type of planted seeds, the spacing, the soil type, the land cover conditions, and the climatic factors. In Indonesia, in Aceh especially, the palm is commonly grown on soils of Alfisol, Ultisol and Oxisol soils, where the soil is a land with low nutrient status.

The availability of nutrients for plants to be productive and sustainable can be performed by fertilization, liming and management of organic materials. Unfortunately, until now, there is no fertilizer recommendation that specifies the location, according to the age of development of plants that can be directly used by palm farmers.

The purpose of this research is to study the morphological response of the immature oil palm plant (TBM 0 year) caused by single fertilizer N, P and K.

2 RESEARCH METHOD

The experiment is conducted in Village of Bukit Sudan, Subdistrict of Peusangan Siblah Krueng, Bireuen Aceh which is located on the altitude of 120 m above the sea level. The object of the study is immature plant of oil palm (0 years). This research is part of *Ristekdikti* Grant Research of Excellent AppliedResearch Scheme.The materials used are the oil palm seeds varieties of DP-9 ready for planting, cow manure, urea fertilizer, SP-36, KCl, terusi ($CuSO_4.5H_2O$), phosphate rock, and borat fertilizer. The tools used are analytical scale, meter, chlorophyll meter, microscope, oven, and preparat / glass object.

2.1 Research Design

Treatment design usesthe single factor in RandomizedCompleted Block Design (RCBD), grouping based onthe land slope. The applied treatment consists of 4 treatments, one from controltreatment (basic fertilizer) and threefrom treatments of the single fertilizer combination. Each treatment is repeated three times and eachexperimental unit consists of five palm crops so that the total unit test is 12 plants.The type and fertilization treatments tested are classified on *TBM* palm, (Table 1).

The linear additive model of the plan used is:

$$Yij = \mu + \alpha i + \beta j + \varepsilon ij \qquad (1)$$

Description:

i = 1, 2, 3, 4; j = 1, 2, 3

Y_{ij} = the observational response of the experimental unit that receives the i-fertilization treatment on the j-group

μ = general average

α_i = the effect of the i-fertilization

β_j = influence of the j-group

ε_{ij} = random effects of the i-fertilization and the j-group

The data that obtained are analyzed by variance in the level $\alpha = 0.05$; if there is a significant effect, then it is followed by the test of Honest Real Differences (HSD) for each treatment group.The data analysis is performed with Microsoft Office Excel program.

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

Treatment	Fertilizer Level (times recommended dosage)	Combination and Type of Fertilizer (crop / year)
Single Fertilizer	Control (PT0)	60 kg cow dung + 500 gr rock phosphate + 500gr dolomite
	½ (PT1)	300 gr urea + 375 gr SP-36 + 350 gr KCl + 25 gr borat + 25 gr $CuSO_4.5H_2O$
	1 (PT2)	600 gr urea + 750 gr SP-36 + 700 gr KCl + 25 gr borat + 25 gr $CuSO_4.5H_2O$
	2 (PT3)	900 gr urea + 1125 gr SP-36 + 1050 gr KCl + 25 gr borat + 25 gr $CuSO_4.5H_2O$

2.2 Implementation of Research

2.2.1 Fertilization

All previous palm plants have been fertilized with organic fertilizer cow dung as much as 60 kg / hole, Rock Phospate 500 gr / planting hole and dolomite 500 gr / planting hole (base fertilizer). The application of treatment or giving fertilizer is performed three times in every four month with minimum rainfall 60 mm / month (in April, July and December). The dose of each fertilization is one third from the total treatment dose.

The application of urea fertilizer, SP-36 KCl, NPK compound and organic fertilizer are perfomed in the morning by sprinkling fertilizer on the run and the disk of palm (Soon and Hoong, 2002) except the application of borate fertilizer which is stocked on leaf busted armpits (Goh and Hardter, 2003).

2.2.2 Observation

Observations of plant morphology are performed on each unit plant trial in each month by observing:

1. **Plant height.** Plant height is measured from the boundary of the stem which has been marked until the youngest leaf that opens perfectly established by using a modified fabric meter.
2. **Number of leaf midrib.** The number of leaf sheaths counted is the opening of the leaves.
3. **Ring circumference.** The circumference of the stem is a collection of leaves which is still wrapped in fibers. Measurements are made by using a cloth meter and measured 5 cm from the ground.
4. **The length of the ninth leaf.** Measurements are made with a cloth meter, from the base of the midrib to the top of the midrib.
5. **Leaf** width**.** Leaf width measurements are performed on ninth stem leaf, by measuring several lengths and widths of leaflets and calculated by the formula (Sudrajat et al 2015).

$$\text{Leaf width} = \frac{\sum_{1}^{6} p\,x\,l}{6}\,x\,2n\;x\,k \qquad (2)$$

p = young leaf length (cm)
l = young leaf width
n = number of young leaf left or right
k = constant (0.57 for Immature Plant)

3 RESULT AND DISCUSSION

The results show that the single fertilizer treatment does not have a significant effect on plant height, stem circumference, number of stem, ninth leaf length, and ninth palm leaf width on the palm plants in 1-3 Month After Treatment (MAT) (Table 2 and Figure 1). Nevertheless, the effect of the treatment show that the higher single dosage package of fertilizer (PT1, PT2 and PT3), the more increasing the plant height is.

Table 2: The effect of the single fertilizer dosage on plant height variables, stem circumference, number of ninth leaf midrib,ninth leaf length.

Packageof the single fertilizer dosage	Plant Height (cm)		
	0 MAT	1 MAT	3 MAT
PT0	115,90	125,95	139,41
PT1 (1/2)	114,89	125,94	137,99
PT2 (1)	111,61	126,39	142,90
PT3 (2)	110,92	127,08	140,52
Response map^{c}	tn	tn	tn
	Stem Circumference(cm)		
PT0	20,06	22,76	33,56
PT1 (1/2)	20,01	23,06	32,21
PT2 (1)	20,08	23,58	34,08
PT3 (2)	19,98	23,60	34,46
Response map^{c}	tn	tn	tn
	Number of ninth leaf midrib (sheet)		
PT0	9,40	11,80	17,40
PT1 (1/2)	9,57	11,89	17,62
PT2 (1)	10,60	12,85	18,60
PT3 (2)	10,53	12,70	19,11
Response map^{c}	tn	tn	tn
	Ninth leaf length		
PT0	90,50	94,50	102,50
PT1 (1/2)	90,61	95,31	105,91
PT2 (1)	90,41	95,31	106,01
PT3 (2)	90,44	95,64	107,24
Response map^{c}	tn	tn	tn
	Ninth leaf width		
PT0	0,46	0,57	0,80
PT1 (1/2)	0,54	0,65	0,88
PT2 (1)	0,53	0,65	0,88
PT3 (2)	0,58	0,70	0,95
Response map^{c}	tn	tn	tn

Description: ¢: HSD Test; MAT (Month after treatment). PT0: organic fertilizer 60 kg, Rock Phospate 500 and dolomite 500 hole-1, PT1: 300 g urea + 350 g SP-36 + 350 g KCl + 25 g borate + 25 g $CuSO_4.5H_2O$, PT2: 600 g urea + 750 g SP-36 + 700 g KCl + 25 g borate +25 g $CuSO_4.5H_2O$, PT3: 900 g urea + 1 125 g SP-36 + 1 050 g KCl, PT1 - PT3 plus basic fertilizer (P0).

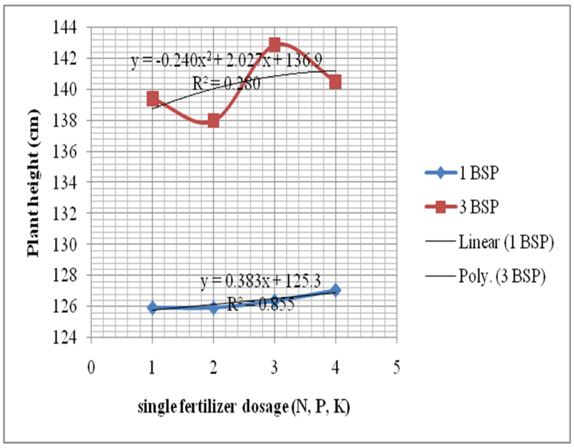

Figure 1: Curve and regression equation of the single fertilizer response to plant height in 1 and 3 MAT.

The highest increase of plant height on 1 BSP is obtained in PT3 12.71% compared to other treatments, while the highest increase in plant height on 3 BSP is obtained in PT2 of 11.55%. Luz et al. (Luz et al.2006) reports that the application of nitrogen fertilizer increasesand accelerates the growth of "lady palm" (Rhapis excels) and phosphorus fertilizer significantly increases the height of the palm seeds (Kasno et al. 2010).

The single fertilizer treatment effects linearly on the variable of plant height in 1BSP, while effectspolynomially in 3 BSP. The linear effect indicates that the higher single dosage package of fertilizer (PT1, PT2 and PT3) increases, the higher the plant dose increases, that is900 g urea + 1125 g SP-36 + 1050 g KCl + 25 g borate + 25 g CuSO4.5H2O g plant^{-1} (PT3). Tarmizi (Tarmizi, 2006) states that young palm plants require a high amount of nutrients for maximum growth. Further Goh and Hardter (Goh and Hardter, 2003) suggest that nitrogen fertilization is the main driving force to rapid vegetative growth of the palm.

The growth chart shows that the single fertilizer treatment has no significant effect on the circumference in 1 and 3 BSP palm stems (Table 2 and Figure 2), but the growth character follows the pattern linearly. The stem rod variable increases with increasing dose of single fertilizer package up to the highest dose (P3). Stem circumference increases to highest dose (P3) 15.3% in 1 BSP and 31.51% in 3 BSP compared to the control and the other treatment. Uwumarongie-Ilori et al. (Uwumarongie-Ilori et al.2012) states that the application of N, P, K fertilizers is capable of producing the largest diameter of the palm seeds compared to the organic fertilizers only and able to increase the circumference of the palm stems in two afdeling of the palm plantations (Poleuleng et al. 2013).

The single fertilizer treatmenthas no significant effect to the number of leaf midlib (Table 2 and Figure 3), but the trend of influence is linear. Linear influence shows that single packet fertilizer increases the number of leaf midlib to highest doses (P3). However, the number of leaf midrib cannot be used as a reference for determining the optimum dosage because it is more influenced by the genetic factors than the environmental factor (Adam et al. 2011), so in this study, the optimum dosage of the single fertilizer package cannot be determined. The results of this study is different from the study obtained by Jannah et al. (Jannah et al.2012), that NPK fertilization has a significant effect and increases the number of the palm leaves in the main breeding.

The results show that the production of midribs ranges from 8 sheets in the first three-months and the average 2.6 sheets per month (Table 2). This amount is slightly more than normal production of midribs, which is about 2 pieces per month (Corley and Tinker, 2008). Then the production of midrib will reach its maximum in the second year (Adam et al., 2011).

The growth trend of leaf width in the single fertilizer treatment shows a linear pattern on ninth leaf width in 1 and 3 *MAT*. The midrib leaf width increases with the increase of the single fertilizer dosage package up to the highest dose of P3 fertilizer. The increase of ninth midrib leaf width to the treatment of P3 fertilizer reaches 17.1% in 1 BSP and 26.32% in 3 BSP, greater than other treatment (Table 2). This result is in line with the finding of Halim (Halim, 2012), that the application of nitrogen fertilizer can increase the leaf width of the fourth seed of the palm. In addition, Corley and Tinker (Corley and Tinker, 2008) also states that the leaf width and length of midrib is influenced by fertilization, but it is not too sensitive to the other factors. The size of the canopy is associated with the leaf width, the length of the midrib, and the number of young leaf with varied growth patterns. Edge size variation is an adaptation mechanism for regulating transpiration rates as responsive on changing in plant water balance (Yahya and Manurung, 2002).

Provision of the single fertilizer treatment in general can increase vegetative growth of the palm plants better than the control. This is because of the fulfillment of nutrient need N, P and K crops by the provision of urea, SP-36 and KCl fertilizers so that the palm plant can grow better. Goh and Hardter (Goh and Hardter, 2003) states that phosphorus takes the role in stimulating the development of rooting of the palm plants, increasing the useage and the transport of plant nutrients that affectsthe plant production. Nitrogen takesthe important role in the formation of protoplasm and as a constituent of cell structure and protein.So, N is a very important component of the plant growth (Rubio et al. 2009). Potassium takesthe role in plant physiology processes such as enzyme activators, turgor cell regulation, photosynthesis, nutrient and water transports, improves plant endurance, and fruit size, taste, color and skin (Rahardjo, 2012). The highest growth increase occurres in the ninth stem circumference and the ninth leaf width, that is 31.51% and 26.32%, wider than the control. The correlation value shows that the ninth leaf width is highly correlated with plant height (0.77), stem circumference (0.82) and number of leaf midrib (0.98), so that when the nineth leaf width increased, the process of photosynthesis is increased and photosynthesis productis also increased for vegetative growth of plants such as plant height, stem circumference and number of leaf midrib. Corley and Mook (Corley and Mook, 1972) states that the application of potassium, nitrogen and phosphorus fertilizers is able to increase the dry weight of the palm plants through increasing leaf width and assimilation rate of plant clean.

Unfactual effect of the single fertilizer treatment on observed variables indicates that the palm crops require a recovery time for 7 months after planting. This appropriates with the research results of Shintarika etal. (Shintarika etal. 2015) that the single fertilizer treatment in the palm TBM has a significant effect on the age 10 MAT. The response of plant growth during the first 7-months after planting is low because the plants undergo transplanting shock and the seeds take time to build an effective root system (Goh and Hardter, 2003).

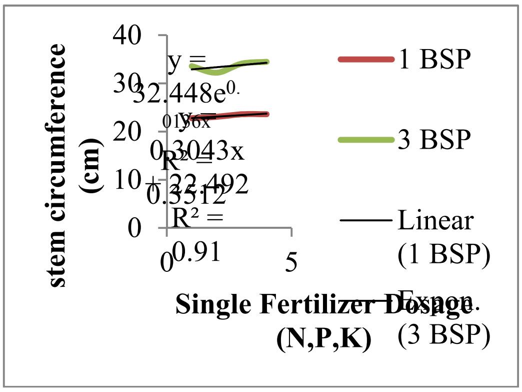

Figure 2: Curve and regression equation of single fertilizer response to stem circumference in 1 and 3 MAT.

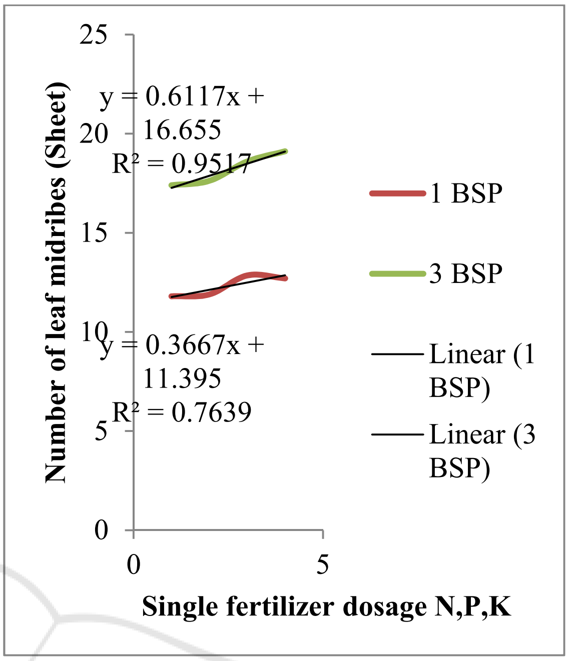

Figure 3: Curve and regression equation of the single fertilizer response to the number of leaf midribes in 1 and 3 MAT.

4 CONCLUSIONS

Based on the results,so it can be concluded that the single fertilizer treatment in general has no significant effect on the plant height, the stem circumference, the number of midrib, ninth the leaf length, and the ninth leaf width in the palm plants in 1-3 Month After Treatment (MAT).The effect of the treatment shows that the higher the single dosage package of fertilizer (PT1, PT2 and PT3)is, the more increasing the plant height is.The highest growth increase occurs in the ninth stem circumference and the ninth leaf width, that is 31.51% and 26.32%, wider than the control.

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