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Frequency of Inorganic Fertilizer at The Intensity of Soil Treatment On Nutrient Levels And Growth of Oil Palm (*Elaeis guineensis* Jacq) at The Replanting Stage

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Oil palm is a plantation crop that produces vegetable oil, and people highly need it, so it requires efforts to increase its production. One way is by utilizing existing land without having to open new oil palm plantation areas with replanting. This study aimed to analyze the effect of fertilization frequency on different tillage and to get the best fertilization frequency on different tillage on leaf nutrient levels and growth of oil palm plants. This research experimented with a split-plot design (SPD) with a randomized block basic design. The factors tested in this study consisted of the main plot, e.g., tillage (No tillage, 1 time of tillage, 2 times of tillage) and subplots, e.g., the fertilization frequency (D1: 5 times frequency of NPK fertilization D2: 4 times frequency of NPK fertilization D3 : 3 times frequency of NPK fertilization). The two factors were combined, and 12 treatment combinations were obtained. Each treatment combination consisted of 3 groups, totaling 36 experimental units. Each experimental unit consisted of 2 plants, so 72 plants were obtained. The data obtained were analyzed using variance and further tested with the honest significant difference test (BNJ) at the 5% level and advanced test analysis using the Satker application (SAS). This study showed that NPK fertilization with a frequency of 2 times in 2 times tillage increased vegetative plant growth (increased stem circumference). The main plot of tillage two times increased leaf nutrient content (leaf N content) and plant vegetative (plant height gain and stem circumference increase). NPK fertilization with a frequency of 2 times increased plant growth (increased stem circumference).

Keywords: *Oil palm, tillage, fertilization frequency, replanting, nutrient content.*

1. INTRODUCTION

Oil palm plants, especially in Indonesia, have good development prospects because oil palm can produce vegetable oil that the community needs (Susila, 2006). The high demand for vegetable oil requires some efforts to increase production by utilizing existing land without opening new oil palm plantation areas. One form of increasing the yield of oil palm commodities is by replanting oil palm plants. The People's Oil Palm Rejuvenation Program (PSR) in 2022 will reach 540 thousand hectares spread across various regions in Indonesia, including Sumatra as much as 397,200 ha, Java 6,000 ha, Kalimantan 86,300 ha, Sulawesi 44,500 ha, and Papua 600 ha (Badan pusat statistik Indonesia, 2023).

The implementation of smallholder plantation replanting is faced with several problems, resulting in constrained replanting efforts. One of the obstacles hindering the replanting efforts is soil compaction because the land has been used for planting oil palm for a long time. Soil compaction will interfere with plant growth. Compacted soil will interfere with the penetration of plant roots so plant growth will be slow. The method used to overcome soil compaction problems and limited nutrients in the replanted land is cultivating the soil with NPK fertilization.

Efforts in cultivating soil and overcoming nutrient availability are mechanical plowing (*Luku*) using a tractor with different frequency NPK fertilization. According to Gunawan (2014), piracy (*Luku*) in tillage is to cut, split and turn over the soil. Prihmantoro (2000) states that one should consider in fertilization, the frequency and dosage given must follow the rules or recommendations given on the label or calculation, which are adjusted to soil conditions and plant growth phases.

This study aimed to analyze the effect of fertilizing frequency on different tillage and to get the best fertilization frequency on different tillage on leaf nutrient levels and growth of oil palm plants.

2. MATERIAL AND METHODS

This research was carried out on an oil palm plantation belonging to the Tunas Baru Village Cooperative Unit (KUD) in Paket A Village, Kepenghuluan Suka Maju, Bagan Sinembah District, Rokan Hilir Regency, Riau Province with an area of 2 ha that has been replanted. And data collection was carried out for eight months, from February 2022 until September 2022.

The materials used in this study were 12-month-old oil palm seeds of the SP540 variety produced by the Palm Oil Research Center (PPKS), dolomite, Rock Phosphate (RP) fertilizer, NPK fertilizer (12,12,17), and pesticides. The tools used are an Excavator type PC 200, Tractor, meter, cutter, hoes, machetes, and stationery.

This research experimented with a split-plot design (RPT) with a randomized block basic design. The factors tested in this study are as follows. Main plot: Soil preparation, (without tillage, time of application, 2 times of treatment). Subplot: fertilization frequency, NPK fertilization frequency 5 times, NPK fertilization frequency 4 times, NPK fertilization frequency 3 times, NPK fertilization frequency 2 times

The two factors were combined, and 12 treatment combinations were obtained. Each treatment combination consisted of 3 groups, with 36 experimental units. Each experimental unit consisted of 2 plants, so 72 plants were obtained. Sample plants are taken by determining the sample point, which is located in the middle of the experimental unit. The data obtained were analyzed using variance and further tested with the honest significant difference test (BNJ) at the 5% level. The study used the Satker application system (SAS) to apply advanced test analysis.

Observations consisted of measuring leaf nutrient levels, such as leaf N content (%), leaf P content (%), and leaf K content (%), as well as plant growth observations, including plant height increase (cm) by measuring the difference in initial and final plant heights, the increase in stem circumference (cm) by measuring the difference in the increase in the initial and final stem circumference, and the increase in the number of fronds (fronds) by calculating the difference in the number of fronds at the beginning and end.

3. RESULT AND DISCUSSION

3.1. RESULT

Leaf N Content

Table 1. The average leaf N content (%) in tillage with different frequency NPK fertilization

Soil Processing	NPK Fertilization Frequency (times)	Leaf N content (%)	Average
without processing	5	3.41 a	3.46 a
	4	3.65 a	
	3	3.32 a	
	2	3.44 a	
plow 1 time	5	2.93 a	3.07 b
	4	3.53 a	
	3	3.10 a	
	2	2.72 a	
plow 2 times	5	3.28 a	3.37 a
	4	3.55 a	
	3	3.38 a	
	2	3.28 a	
Average	4	3.58 a	
	5	3.21 b	
	3	3.27 b	
	2	3.15 b	

Numbers followed by the same letter in the same column show no significant difference according to the Tukey Advanced Test (BNJ) at the 5% significance level.

Table 1 shows the fertilization frequency in different tillage results in no different leaf N levels. The main plot of tillage without tillage and 2 times tillage resulted in higher leaf N content and differed from 1-time tillage. Subplots of 4 times fertilization produced higher leaf N levels and differed from 5, 3, and 2 times fertilization. The single factor of soil tillage and the fertilization frequency resulted in lower leaf N levels of around 2-11% compared to those without mulches. The 4-time fertilization frequency had a higher value of around 8-12% compared to other fertilization frequencies. Compared to other fertilization frequencies.

The N nutrient levels in Table 1 are included in the excessive criteria for TBM 1 oil palm plants, except for the 2 and 5 times fertilization treatment. The 1 time *Luku* tillage has N levels at the optimum criteria. NPK fertilization with different frequencies needs to be applied to avoid a decrease in N nutrient levels. N nutrient levels have decreased due to the loss of N nutrients in soil treated with greater lubrication than without it. Nitrogen is absorbed by plants in the form of NO3- and NH4+. Goh et al. (2000) stated that NO3- produced from the mineralization of N fertilizers is very susceptible to leaching. Furthermore, Schwendener et al. (2005) added that timing is mainly related to using N fertilizer which is easily lost due to evaporation. Increasing application

frequency always increases uptake efficiency; the common practice is to apply N fertilizer 2-3 times per year to reduce the risk of nutrient loss (Goh and Chew, 1995).

Leaf P Content

Table 2. The average leaf P content (%) in tillage with different frequency NPK fertilization

Soil Processing	NPK Fertilization Frequency (times)	Lead P Content (%)	Average
without processing	5	0.68 a	0.59 a
	4	0.52 a	
	3	0.47 a	
	2	0.71 a	
plow 1 time	5	0.63 a	0.59 a
	4	0.59 a	
	3	0.55 a	
	2	0.58 a	
plow 2 times	5	0.53 a	0.52 a
	4	0.51 a	
	3	0.49 a	
	2	0.56 a	
Average	5	0.61 a	
	4	0.54 a	
	3	0.51 a	
	2	0.62 a	

Numbers followed by the same letter in the same column show no significant difference according to the Tukey Advanced Test (BNJ) at the 5% significance level.

Table 2 shows the fertilization frequency in different tillage results in no different leaf P levels. The main tillage plot for all treatments produced no different leaf P levels. Subplots of all fertilization frequencies produced no different leaf P levels. The NPK fertilizer frequency in tillage results in leaf P levels, included in the excessive criteria for TBM 1 oil palm plants. The single tillage factor and the fertilization frequency result in leaf P levels included in the excessive criteria except for 1-time lubrication. The fertilization frequency during tillage resulted in P levels which tend to decrease by 13% in the 2nd plow treatment compared to the 1st plow and without the plow.

On sandy soils in Malaysia, yield response to P applied as rock phosphate was greater when applied annually than once every four years. Still, application frequency did not affect leaf P content (Foong and Sofi, 1993). The frequency of application is usually increased in very young palms where for practical reasons, compound and mixed (mixed) fertilizers plus direct fertilizer are common (Goh et al., 2000).

Leaf K Value

Table 3 The average leaf K content (%) in tillage with different frequency NPK fertilization

Soil Processing	NPK Fertilization Frequency (times)	Leaf K Content (%)	Average
without processing	5	1.64 a	1.50 a
	4	1.56 a	
	3	1.53 a	
	2	1.26 a	
plow 1 time	5	1.20 a	1.33 a
	4	1.45 a	
	3	1.28 a	
	2	1.39 a	
plow 2 times	5	1.33 a	1.33 a
	4	1.31 a	
	3	1.24 a	
	2	1.45 a	
Average	5	1.39 a	
	4	1.44 a	
	3	1.35 a	
	2	1.37 a	

Numbers followed by the same letter in the same column show no significant difference according to the Tukey Advanced Test (BNJ) at the 5% significance level.

Table 3 shows the fertilization frequency at different tillage results in no different leaf K levels. The main tillage plot for all treatments produced no different leaf K values. Subplots of all fertilization frequencies produced no different leaf K levels. The NPK fertilization frequency in tillage with a hoe tends to decrease K levels by around 11% compared to that without a hoe. The frequency of 4 times fertilization tends to show a higher yield of around 3-6% compared to other fertilization frequencies.

The frequency of NPK fertilization during tillage resulted in K levels in the leaves included in the optimum criteria for TBM 1 oil palm plants. Still, the K value of the leaves was not different between fertilization frequencies. In line with Sanhueza (1994), adding potassium fertilizer to plowed land had no significant effect.

Plant Height Gain

Table 4. The mean value of plant height gain (cm) in tillage with NPK fertilization at different frequencies

Soil Processing	NPK Fertilization Frequency (times)	Plant Height Gain (cm)	Average
without processing	5	15.03 a	16.08 c
	4	15.93 a	
	3	15.67 a	
	2	17.67 a	
plow 1 time	5	23.70 a	24.68 b
	4	24.43 a	
	3	26.33 a	
	2	24.23 a	
plow 2 times	5	30.60 a	28.57 a
	4	27.70 a	
	3	29.67 a	
	2	26.33 a	
Average	5	23.11 a	
	4	22.69 a	
	3	23.89 a	
	2	22.74 a	

Numbers followed by the same letter in the same column show no significant difference according to the Tukey Advanced Test (BNJ) at the 5% significance level.

Table 4 shows the fertilization frequency in different tillage results in no further increase in plant height. The main plot of tillage with the higher the intensity of tillage, the higher the height of the oil palm plants. Subplot fertilization at all frequencies resulted in no difference in plant height gain.

The fertilization frequency in tillage does not affect the increase in plant height due to the influence of environmental factors. Sukmawan et al. (2015) stated that rainfall is an environmental factor that can affect the growth and development of plants; in the dry season, water absorption is limited or stopped, thus causing the absorption of N and P elements to be limited or stopped. Lack of water results in decreased cell turgor pressure and causes cell enlargement and division disruption, inhibiting growth in plant tissues (Damosarkoro et al., 2003).

Stem Circumference Increase

Table 5, The mean value of plant stem circumference (cm) in tillage with different frequency NPK fertilization

Soil Processing	NPK Fertilization Frequency (times)	Stem Circumference Increase (cm)	Average
without processing	2	18.33 abcd	14.08 b
	3	16.33 cd	
	4	12.00 de	
	5	9.67 e	
plow 1 time	2	23.00 ab 21.67 abc	20.46 a
	5		
	3	20.17 abc	
	4	17.00 bcd	
plow 2 times	3	23.67 a	22.11 a
	5	21.47 abc	
	4	21.63 abc	
	2	21.67 abc	
Average	2	21.00 a	
	3	20.06 ab	
	5	17.60 bc	
	4	16.88 c	

Numbers followed by the same letter in the same column show no significant difference according to the Tukey Advanced Test (BNJ) at the 5% significance level.

Table 5 shows that the fertilization frequency of 3 times in tillage 2 times resulted in a greater increase in stem circumference and was different from the fertilization frequency of 5, 4, and 3 times without tillage and the fertilization frequency 4 times in tillage 1 time, but not different from other combinations. The main plot of tillage 1 time and 2 times resulted in a larger and different value of stem circumference without tillage. Subplots of 2 times fertilization produced a greater volume in stem circumference than 4 and 5 times fertilization, but not different from 3 times fertilization.

The 2 and 3 times NPK fertilization frequency in tillage impacts the stem circumference increase because when the plants are transplanted, the plants will need time to adapt so that the growth focus is on the roots of the plant and the growth of the base of the stem. Oil palm plants also require a recovery time of 7 months after transplanting. According to Goh and Hardter (2010), plants experience transplant shock during the initial 7 months after transplanting, and seedlings need time to develop an adequate root system. Following the opinion of Pahan (2013) also states that at the age of 1-2 years, the growth of oil palm plants tends to enlarge the base of the stem, which afterward tends to increase the plant height more quickly.

Increase in the Number of Fronds

Table 6 The average increase in the number of fronds (fronds) in tillage with different frequency NPK fertilization

Soil Processing	NPK Fertilization Frequency (times)	Increase in the Number of Fronds (fronds)	Average
without processing	5	10.33 a	11.25 a
	4	10.67 a	
	3	12.00 a	
	2	12.00 a	
plow 1 time	5	12.00 a	11.92 a
	4	10.67 a	
	3	12.67 a	
	2	12.33 a	
plow 2 times	5	11.00 a	11.50 a
	4	11.67 a	
	3	12.00 a	
	2	11.33 a	
Average	5	11.11 a	
	4	11.00 a	
	3	12.22 a	
	2	11.89 a	

Numbers followed by the same letter in the same column show no significant difference according to the Tukey Advanced Test (BNJ) at the 5% significance level.

Table 6 shows the fertilization frequency in different tillage results in no difference in fronds quantity. The main plot of tillage for all treatments produced no different values for the number of fronds. Subplots of fertilization at all frequencies produced no different number of fronds.

The NPK fertilization frequency in tillage has not been able to increase the number of fronds of oil palm plants because it is suspected that there is influence from environmental factors. Sukmawan et al. (2015) stated that rainfall is an environmental factor that can affect plant growth and development; during the dry season, water absorption is limited or stopped, causing the absorption of N and P elements to be limited or stopped resulting in inhibition of plant metabolism. According to Adam et al. (2011), frond production in the first year after transplanting is low and will reach a maximum in the second year.

4. CONCLUSION

Based on the results of research that has been done, it can be concluded:

1. NPK fertilization with a frequency of 2 times in Luku soil processing 2 times results in increased plant vegetative growth (increased stem circumference).
2. The main plot of Luku tillage 2 times increased leaf nutrient content (leaf N content) and plant vegetative (plant height gain and stem circumference increase).
3. Subplots of NPK fertilization with a frequency of 2 times increased plant growth (increased stem circumference).
4. NPK fertilization with a frequency of 2 times in Luku soil processing 2 times resulted in increased leaf nutrient levels and the best growth of oil palm plants compared to other combinations.

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