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Micro Nutrient Content and Growth of Oil Palm (*Elaeis guineensis* Jacq) Applied to Oil Palm Liquid Waste Using the Biopori Method

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ABSTRACT

The area of oil palm plantations in Indonesia has been raising continually, therefore, raising of Palm oil factory. Each Palm oil factory produces liquid waste (LWPOF) in large numbers that can be utilized. The aim of this research was to study the main effect of LWPOF application and the number of biopores and their interactions on micro nutrient content and oil palm growth. The research was conducted in oil palm plantations at the Faculty of Agriculture, Riau University from June to December 2019 in the form of experiments arranged according to completely randomized factorial design. The first factor is the LWPOF dosage which consists of 3 levels (7,5 liters, 10 liters, and 12,5 liters) and the second factor is the amount of biopores consisting of 3 levels (2, 4, and 6), repeated 3 times and there were 3 experimental plants, so that 81 units of experimental plants were obtained. The parameters observed consist of leaf micro nutrient content, plant height increase, number of fronds, midrib width, and thickness of oil palm fronds. From the experiment, known that 7,5 liters plant increases the nutrient content of copper, and the LWPOF dosage of 12,5 liters increase the height, number, width and thickness of oil palm fronds, while the number of biopores 2 and 6 increas leaf manganese nutrient content. 7,5 liters of planting followed by the number of biopores in 6 biopores increase the nutrient content of manganese in the leaves and the number of midribs of oil palm plants.

Key words: *Liquid Waste of Oil Palm Factory, Biopore Holes, Oil Palm Plants, Micronutrients*

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) Is one of the main plantation commodities in Riau, the total area of oil palm plantations reached 2,400,876 hectares consisting of 1,354,504 hectares of people's plantations (PR), 91,854 hectares of state plantations in 2015. (PN) and 954,519 ha of private plantations (Ditjen Perkebunan. 2015) and in Riau, the area of oil palm plantations reaches 1.5 million hectares. The productivity of oil palm plantations in Riau is classified as low, it was shown in 2015 the People's Plantations only reached 15 tonnes/ ha/year, State plantations 19 tonnes/ha/year and private plantations 24 tonnes/ha/year (Ditjen Perkebunan, 2015) the average ranges from 29-31 tonnes/ha/year.

The unachievable potential per hectare of oil palm FFB is due to environmental factors, one of them is soil conditions. According to Abdurachman et.al. (2008), generally dry land such as inceptisols and ultisols have low soil fertility levels and have levels of micro elements such as iron (Fe) and manganese (Mn) varying from low to moderate. (Kidanu et.al., 2009) Micro nutrient elements are nutrient elements as important as macro nutrient elements for plants, although in this case they only need a small amount (Heriansyah, 2020).

To maintain the availability of micro nutrients in the soil, it can be done by adding micro nutrients through fertilizers. Fertilizer can be used to utilize waste from the palm oil factory itself. Large amounts of palm oil mills effluent (LCPKS) are generated from palm oil processing, totaling 600 l/ton FFB. Meanwhile, according to the Directorate General of Plantation (2015), the number of palm oil mills in Riau about 140 with a capacity of 6,660 tons of FFB/hour, so that within 1 hour of processing 399,600 liters of Liquid waste or Palm Oil Mill Effluent (POME) or around 399.6 M3 are obtained. LCPKS contains micro nutrient content which is quite good, that is an alternative to maintain the availability of micro nutrients in inceptisol soil.

To apply POME, it can be done with a biopore infiltration hole system. According to Fitriani (2017), making biopore infiltration holes have the benefit of absorbing water, overcoming drought by storing water underground and improving the soil ecosystem. The purpose of this study was to determine the micro nutrient content in oil palm plants were applied the biopore method.

MATERIALS AND METHODS

This research was conducted in the experimental garden of the Faculty of Agriculture, Riau University, Binawidya Campus Km 12.5 Simpang Baru, Tampan, Pekanbaru with an altitude of 15-16 m above sea level. Meanwhile, leaf tissue analysis was carried out at the Soil Laboratory of the Faculty of Agriculture, Riau University. The materials used in this study were Tenera (DxP) Socfindo, 10 years old oil palm plantations, palm oil mill liquid waste (POME) from aerobic ponds in the Surya DumaGroup PKS Sir Lukut The waste treatment pond as much as 8,100 liters. The tools used in this study were hoe, bucket, machete, liter, tape measure, drill bit, paralon pipe as a biopore tube with 12 holes of 1 inch infiltration, writing tools and rope. For plant tissue analysis, the tools used analytical balance, digestion tube, tube shaker, dispenser, test tube, UV spectrometer, atomic absorption spectrometer..

This research was conducted experimentally using a factorial Completely Randomized Design (CRD) consisting of 2 factors, namely the POME dosage and the number of biopore holes. Each factor consisted of 3 treatments and was repeated 3 times, each experimental unit consists of 3 plants, there were 81 experimental plant. The first factor shown the dosage of POME consisting of S1: LCPKS dosage of 7.5 liters/plant/2 weeks, S2: POME dosage of 10 liters/plant/2 weeks, and S3: LCPKS dosage of 12.5 liters/plant/2 weeks. The second factor shown the number of biopore holes consisting of B1: 2 Biopores/Plant holes, B2: 4 Biopores/Plant holes and B3: 6 Biopores/Plant holes.

The research implementation includes: analysis of the initial soil physical and chemical properties, land clearing, plotting, plant selection and labeling, making biopore holes, procuring POME, and giving treatment.

The variables of observation consist of vegetative parameters and leaf micro nutrient content. Vegetative parameters consist of the increase of the height of the oil palm plantations, the number of fronds, the width of the fronds and the thickness of the fronds. Meanwhile, the micro nutrient content of the leaves analyzed included the nutrient content of boron (B), copper (Cu), zinc (Zn), iron (Fe) and Manganese (Mn).

Observation data were analyzed using analysis of variance. To find out the difference in treatment, it was further tested with an honest real difference test at the 5% real level. The analysis results are presented in tabular form.

RESULT AND DISCUSSION

Soil Chemical Properties

Some of the soil chemical properties analyzed on the land before the study includes soil pH, organic C, total N, total P2O5, total K2O and soil CEC and compared with the criteria of the Soil Research Center (1983) are presented in Table 1.

Table 1. Values of some initial soil chemical properties

Parameters of soil properties	unit	Value	Criteria	Class
pH H_20	-	4,91	Acid	S2
pH KCl	-	4,54	Neutral	S2
C Organic	(%)	3,72	High	S1
N-Total	%	0,25	Moderate	S2
P_2O_5	Mg/100g	25,58	High	S1
K_2O	Mg/100g	23,38	Moderate	S2
CEC	Me/100g	16,72	Moderate	S2

Source: Soil Research Center (1983)

Table 1 shows the pH value of the soil in the research area is acidic, total N, total K2O and CEC are classified as moderate and in the S2 soil class, while the Organic C content and total P2O5 value are classified as high criteria and in the S1 soil class. Therefore, based on the soil suitability criteria of the Soil Research Center, (1983), the land used belongs to class S2. The soil used in the research area was inceptisol soil which was in class S2 relatively high organic matter and moderate to high nutrient content and productivity. Sudirja et. al, (2007) stated that generally the fertility and chemical properties of Inseptisols are relatively low, but efforts can still be made to improve them with appropriate handling and technology.

Composition and Nutrient Content of POME

The composition and nutrient content of POME are presented by Table 2.

Table 2. POME composition and nutrient content

Parameter	Unit	Score	Standard
pH	-	7,48	4 – 9*
Temperature	^{0}C	30	-
BOD	Ppm	3.804	<5000*
COD	Ppm	8.612	<10000*
Total Solid	Ppm	26.109	<12500*
Suspended Solids	Ppm	24.864	<12500*
Total Volatile Solids	Ppm	14.144	<12500*
Ammonical-Nitrogen	Ppm	69,9	<500*
Total Nitrogen	Ppm	444	30 – 60**
Phosporus	Ppm	177	30 – 60**
Potassium	Ppm	2.612	30 – 60**
Magnesium	Ppm	575,5	-
Boron	Ppm	18,7	125 – 2500**
Iron	Ppm	54,8	5-50**
Manganese	Ppm	3,2	250-5000**
Zinc	Ppm	4,4	250 – 5000**
Copper	Ppm	3,2	5 – 20**

*: Peraturan Gubernur Riau no.35 Tahun 2007
** :Peraturan Menteri Pertanian No.70/Permentan/SR.140/10/2011

Table 2 shows the composition of POME such as pH, BOD, COD, and Ammonical nitrogen content in accordance with applicable liquid waste standards, while total solid, suspended solid, and volatile solid have higher value based on the standards set by the Governor of Riau regulation no. . 35, 2007. The nutrient content of N, P and K from LCPKS has met the criteria for liquid organic fertilizer, while the nutrients B, Fe, Mn, Zn and Cu have not met the criteria for liquid organic fertilizer based on Regulation of the Minister of Agriculture No.70 / Permentan / SR .140/10/2011. Elia et., Al, (2015) stated that this liquid waste contains organic material and nutrient elements which can be used as a source of organic fertilizer for plants. Meanwhile, the nutrients B, Fe, Mn, Zn and Cu are below the standard liquid organic fertilizer for application to oil palm plants, it is necessary to concern the dosage given. It can meet the nutrient needs needed by plants, this opinion is also supported by (Pramana & Heriko , 2020) and (Heriansyah, 2019)

Boron (B) Nutrient Content in Leaves

results of variance shown the dosage of POME application, the number of biopore holes in the plant and their interaction was not significantly affect the boron nutrient content of oil palm leaves. Further test analysis using the Tukey Test method at the 5% level of the boron leaf nutrient content of oil palm plants is presented by table 3.

Table 3.Boron Nutrient Content in Oil Palm Leaves Applied with Oil Palm Liquid Waste with the Biopore Method (Ppm)

Pome (liters/plant)	Biopori (hole / plant)			Average
	2	4	6	
7,5	**16,77 a**	16,27 a	15,43 a	**16,16 A**
10	14,97 a	15,60 a	16,30 a	15,62 A
12,5	15,90 a	15,17 a	15,87 a	15,64 A
Average	**15,88 A**	15,68 A	15,87 A	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level

Table 3 shows that the dosage of POME 7.5, 10 and 12.5 liters per plant and the number of biopore holes 2, 4, and 6 planting holes and their interaction show no significant effect on the boron nutrient content of oil palm leaves and are in the category low. In accordance Kurniawan, et al., (2020) explained that the condition of the boron content in plants in adequate conditions 20 ppm with a deficiency limit below 16 ppm, so that when adding via POME, the boron content in leaves does not increase significantly and even tends to decrease.

Copper (Cu) Nutrient Content in the Leaves

results of variance shown the application of POME had a significant effect on the nutrient content of copper in the leaves of oil palm plants, while the number of biopore holes and their interaction had no significant effect on the nutrient content of copper in the leaves of oil palm plants. The results of further tests using the Tukey Test method at the 5% level of the copper nutrient content in oil palm leaves are presented by Table 4.

Table 4.Copper Nutrient Content in Oil Palm Leaves Applied with Oil Palm Liquid Waste with the Biopore Method (ppm).

POME (liters/plant)	Biopori (hole/plant)			Average
	2	4	6	
7,5	**7,37 a**	5,90 a	6,20 a	**6,49 A**
10	5,47 a	4,77 a	6,23 a	5,49 B
12,5	5,47 a	5,63 a	5,53 a	5,54 B
Average	**6,10 A**	5,43 A	5,99 A	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level

Table 4 shows that giving POME dosage of 7.5 liters per plant has a significant effect on the copper nutrient content of plant leaves compared to higher dosage (10 and 12.5 liters), contrast the number of biopore holes 2, 4, and 6 planting holes and The interaction both of them show no significant effect on the copper nutrient content of the same plant leaves and is classified in moderate conditions (Lubis & Widanarko, 2011). leaf. According to Salisburry & Ross (1992), the copper content adequate conditions is 6 ppm with a deficiency limit below 4.8 ppm and an excess of 7.2 ppm.

Zinc (Zn) Nutrient Content in the Leaves

The results of variance shown the dosage of POME application, the number of biopore holes in the plantations and their interaction was not significantly affect the zinc content of oil palm leaves. Further test analysis using the Tukey Test method at the 5% level of the zinc nutrient content of oil palm leaves is presented by Table 5.

Table 5.The content of zinc in the leaves of oil palm plants applied to oil palm liquid waste using the biopore method (ppm).

POME (liters/plant)	Biopore (hole/plant)			Average
	2	4	6	
7,5	21,23 a	13,43 a	16,70 a	17,12 a
10	14,63 a	17,73 a	19,77 a	17,38 a
12,5	21,60 a	15,73 a	16,30 a	**17,88 a**
Average	**19,16 a**	15,63 a	17,59 a	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level

Table 5 shows the dosage of POME 7.5, 10 and 12.5 liters per plant and the number of biopore holes 2, 4, and 6 planting holes and their interaction show no significant effect on the zinc content of oil palm leaves which is the same and classified as the medium category. It caused the leaves of the oil palm plant have reached their optimum condition, they were not increasing significantly. Saragih, et al., (2019) stated the zinc content adequate conditions 20 ppm with a deficiency limit below 16 ppm and an excess of 24 ppm. When there are sufficient nutrients, the increase in concentration resulting from fertilization does not affect nutrient content or growth.

Iron (Fe) nutrient content in leaves

The results of variance shown the application dosage of POME, the number of biopore holes in the plantations and their interaction was not significantly affect the iron content of oil palm leaves. Further test analysis using the Tukey Test method at the 5% level of the iron nutrient content of oil palm leaves is presented by table 6.

Table 6. Iron Nutrient Content in Oil Palm Plant Leaves Applied to Oil Palm Liquid Waste with the Biopore Method (ppm).

POME (liters/plant)	Biopore (hole/plant)			Average
	2	4	6	
7,5	116,70 a	115,30 a	104,37 a	112,12 A
10	92,80 a	92,80 a	95,20 a	93,60 A
12,5	109,13 a	92,87 a	155,23 a	**119,08 A**
Average	106,21 A	100,32 A	**118,27 A**	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level

Table 6 shows the dosage of POME 7.5, 10 and 12.5 liters per plant and the number of biopore holes 2, 4, and 6 planting holes and their interaction show no significant effect on the iron nutrient content of oil palm leaves which is the same and classified as the medium category. It caused iron nutrients in the soil are high and the addition of organic matter through POME increases the absorption of iron nutrients. In addition, the iron nutrient content in the leaves of oil palm plants has reached an optimum condition, so the addition of iron nutrients does not increase significantly. Sastrosayono, (2003). stated the iron content adequate conditions 100 ppm with a deficiency limit below 80 ppm and an excess of

120 ppm. When there are sufficient nutrients, the increase in concentration resulting from fertilization does not affect nutrient content or growth.

Manganese (Mn) Nutrient Content in Leaves

The results of variance shown the treatment of the number of biopore holes in the plantations and their interaction with the dosage of the POME application in the plant had a significant effect, on the other hand, the application dosage of POME had no significant effect on the nutrient content of manganese in the leaves of oil palm plants. Further test analysis using the Honest Significant Difference (BNJ) method at the 5% level of the nutrient content of manganese in the leaves of oil palm plants is presented by table 7.

Table 7.Manganese Nutrient Content in the Leaves of Oil Palm Plants Applied to Oil Palm Liquid Waste with the Biopore Method (Ppm)

POME (liters/plant)	Biopore (hole/plant)			Average
	2	4	6	
7,5	196,07 a	78,77 b	196,23 a	**157,02 A**
10	127,70 ab	127,43 ab	127,30 ab	127,48 A
12,5	129,43 ab	85,47 b	**225,17 a**	146,69 A
Average	151,07 A	97,22 B	**182,90 A**	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level

Table 7 shows that the number of biopore holes 2 and 6 holes per plant and the interaction both of their treatments shown the application of POME dosage of 12.5 liters per plant followed by the number of 6 biopore holes had a higher manganese nutrient content and had a significant effect compared to the number of holes. biopores and other treatment combinations, on the other hand, the application dosage of POME for planting shown the same manganese content of oil palm leaves (no significant effect). However, it known the manganese nutrient content in plants has already high conditions. Salisburry & Ross (1992) stated the manganese content adequate conditionsd50 ppm with an excess limit of 60 ppm. Jones (2012) states that the normal concentration in plant tissue is generally between 50 ppm.

Oil Palm Plant Height Increase

The results of variance analysis shown the application of POME with the biopore method had a significant effect on the height added value of oil palm plants. The results of further tests using the Tukey Test method at level of 5% on the height increase of oil palm plants are presented by Table 8.

Table 8.Height of Oil Palm Plants Applied to Oil Palm Wastewater with the Biopori Method (cm).

POME (liters/plant)	Biopore (hole/plant)		
	2	4	6
7,5	415,91 d	417,06 cd	417,87 abc
10	418,11 abc	417,18 bcd	421,27 abc
12,5	421,28 abc	**422,61 a**	421,96 ab

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level.

Table 8 shows that giving POME dosage of 12.5 liters per plant with 4 biopore holes had a significant effect on increasing plant height compared to lower dosage (7.5 liters and 10 liters) and the number of biopore holes 2 and 6.Increase high growth plants dosage of 12.5 liters per plant because the amount of waste applied is greater. It contributes more growth of oil palm plants. The applied waste contains relatively high levels of organic matter and nutrients so that it can improve soil properties and provide nutrients needed in the process of plant metabolism. In addition, POME also plays a role in increasing the biodiversity of ground cover plants, increasing the biodiversity of soil macrofauna and micro fauna. Sutanto (2006) stated the addition of organic matter, the physical, biological and chemical properties of the soil will be better.

Number of Oil Palm Plant Fronds

The results of variance shown the application dosage of POME and its interaction with the number of biopore holes per plant had a significant effect on the number of oil palm fronds, while the number of biopore holes had no significant effect on the width of the number of oil palm fronds. Further test analysis using the Tukey Test method at the 5% level of the number of palm oil midribs is presented by Table 9.

Table 9. Amount of Oil Palm Fronds Applied to Oil Palm Wastewater with the Biopore Method

POME (liters/plant)	Biopore (hole/plant)			Average
	2	4	6	
7,5	42,11 ab	37,33 bc	38,00 bc	39,15 B
10	39,33 bc	42,78 ab	34,22 c	38,78 A
12,5	41,00 ab	38,56 bc	**46,33 a**	**41,96 A**
Average	40,81 A	39,56 A	39,52 A	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level.

Table 9 shows that giving POME dosage of 12.5 liters per plant has a significant effect on the number of palm fronds compared to lower dosage (7.5 and 10 liters per plant), on the contrary the number of biopore holes 2, 4 and 6 planting holes shows the number of fronds. oil palm trees (no significant effect). Meanwhile, the interaction both of them show the application of POME dosage of 12.5 liters and the number of biopore holes in 6 planting holes increased the number of oil palm fronds compared to other combinations. The significant increases in the number of oil palm fronds at dosage of 12.5 liters per plant was due to the greater amount of waste applied, thus contributing to a greater contribution to the growth of oil palm plants. The applied waste contains relatively high levels of organic matter and nutrients. It can improve soil properties and provide nutrients needed in the process of plant metabolism.

Oil Palm Plant Frond Width

The results of variance shown the dosage of POME application had a significant effect on the width of the palm fronds, while the number of biopore holes in the plantations and their interaction was not significantly affect the width of the palm fronds. Further test analysis using the Tukey Test method at level of 5% to the width of oil palm fronds is presented by Table 10.

Table 10. Width of Oil Palm Fronds Applied to Oil Palm Wastewater with the Biopore Method (cm)

POME (liters/plant)	Biopore (hole/plant)			Average
	2	4	6	
7,5	6,46 a	6,98 a	6,82 a	6,75 B
10	6,73 a	7,00 a	6,57 a	6,77 B
12,5	7,79 a	7,11 a	7,28 a	7,39 A
Average	6,99 A	7,03 A	6,89 A	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level

Table 10 shows that giving POME dosage of 12.5 liters per plant has a significant effect on the width of the palm fronds compared to the lower dosage (7.5 and 10 liters per crop), in contrast the number of biopore holes 2, 4 and 6 planting holes shows the width of the midrib. oil palm plantations (no significant effect). Meanwhile, the interaction both of them show the higher dosage of POME given, and the less number of biopore holes in the plant, it tends to increase the width of oil palm fronds. The real width of oil palm fronds at dosage of 12.5 liters per plant is due to the greater amount of waste applied. It contributes more vegetative growth of oil palm plants. Muqorobin (2017) reported the midrib width of oil palm plants that were applied with POME had a better correlation than those were applied with other organic fertilizers. Pahan (2012) also stated that one of the factors of affecting the width of the midrib is the nutrient status in the soil.

Thickness of Oil Palm Plant Fronds

The results of variance shown the dosage of POME application had a significant effect on the thickness of palm fronds, while the number of biopore holes and their interaction was not significantly affect the thickness of palm fronds. Further test analysis using the Tukey Test method at level of 5% to the thickness of the midrib of oil palm plants is presented by Table 11.

Table 11. Thickness of Oil Palm Fronds Applied by Oil Palm Liquid Waste Using the Biopore Method (cm)

POME (liters/plant)	Biopore (hole/plant)			Average
	2	4	6	
7,5	3,23 a	3,49 a	3,41 a	3,38 B
10	3,37 a	3,50 a	3,29 a	3,38 B
12,5	3,90 a	3,72 a	3,64 a	3,75 A
Average	3,50 A	3,57 A	3,45 A	

The numbers followed by the same lowercase or uppercase letters in the same row and column are not significantly different according to the Tukey test at the α 5% level

Table 11 shows that giving POME dosage of 12.5 liters per plant has a significant effect on the thickness of oil palm fronds compared to lower dosage (7.5 and 10 liters per plant), in contrast the number of biopores 2, 4 and 6 planting holes and their interaction shows palm frond thickness (no significant effect). The thickness of oil palm fronds is significantly at dosage of 12.5 liters per plant because the amount of waste applied is quite large, It is be able to provide the nutrients needed by oil palm plants. The applied waste contains high enough nutrients and organic material to support plant metabolic processes and the activity of soil microorganisms. It can improve soil properties. The width of oil palm fronds is influenced by the nutrient element phosphorus, and the POME applied contains high levels of phosphorus, namely 177 mg/l.

CONCLUSION

Based on the results of the research has been carried out, the following conclusions can be drawn:

1. The main effect of POME dosage of 7.5 liters per plant increase the nutrient content of copper in the leaves of oil palm plants, compared to higher dosage (10 and 12.5 liters per plant) and POME dosage of 12.5 liters per crop increases, the number of fronds. , midrib width and midrib thickness of oil palm plants compared to lower dosage (7.5 and 10 liters per plant).
2. The main effect of biopore holes with the number of 2 and 6 planting holes increase the nutrient content of manganese in the leaves of oil palm plants, and the number of biopore holes does not have a significant effect on the vegetative growth of oil palm plants.
3. The interaction of the application of POME with the dosage of 12.5 liters per plant followed by the number of biopores in 6 planting holes increased the nutrient content of manganese in the leaves and the number of palm leaves, and POME with the dosage of 12.5 liters per plant followed by the number of biopores in 4 planting holes. increased plant height increase compared to other treatment interactions.

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