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Applying Bioporic Liquid Palm Industry Waste and Effect on Palm Oil Plant Growth and Dystrudepts Soil Physical Properties

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ABSTRACT

This study seeks to determine the impact of palm oil wastewater, the number of biopore holes, and their interaction on oil palm plant growth and Dystrudepts soil physical properties. This study was carried out between December 2019 and April 2019. This research was conducted using a 3x3 factorial experiment with a Randomized Block Design; each treatment was replicated three times, and each experimental unit contained three plants for 81 experimental plants. The first variable was the dosage of palm oil effluent, which consisted of 7.5 liter/plant/2 weeks, 10 liters/plant/2 weeks, and 12.5 liters/plant/2 weeks. The second factor had three levels: two biopore holes/plants, four biopore holes/plants, and six biopore holes/plants. Analysis of variance (ANOVA) was applied to the data. If the treatment is markedly different, a second test is conducted using the 5% level of the Honest Significant Difference (BNJ) test. (1) Palm oil mill effluent at a concentration of 7.5 liters/plant increased the total pore space. The effluent from a palm oil mill at a rate of 12.5 liters per plant decreases BD and PD while increasing final plant height, midrib length, leaf length, and chlorophyll content. (2) Adding two biopores per plant increased plant height, midrib length, and leaf width. The presence of four biopores per plant decreased BD and PD and increased leaf length and chlorophyll content. Six openings per plant biopores have an effect on increasing the total pore space, and (3) The interaction between LCPKS doses of 12.5 liters/plant and the number of biopores of 6 holes/plant decreases BD and increases total pore space, plant height, frond length, leaf length, and leaf breadth.

Keywords*: Dystrudepts, LCPKS, Biopori, Oil Palm, soil physical properties*

1. INTRODUCTION

The increase in national crude palm oil (CPO) from 2000 to 2018 demonstrates that Indonesia's palm oil processing industry has grown quite rapidly. In 2016, CPO production reached 35.57 million tons; in 2017, it increased to 38.17 million tons, representing an 18% increase (GAPKI, 2018).

The production of crude palm oil (CPO) from fresh fruit bunches (FFB) generates liquid and solid refuse. Each processing of one ton of FFB yields 23%, or 230 kilograms, of empty palm fruit bunches, 6.5%, or 65 kilograms, of shell waste, 4%, or 40 kilograms, of damp decanter solid (oil palm mud), and 4%, or 40 kilograms, of fiber (fiber). up to 13% or 130 kg of solid refuse and up to 50% of liquid waste (Mandiri, 2012). According to Fauzi et al. (2014), the quantity of liquid waste produced by Palm Oil Mills (PMKS) is between 600 and 700 liters per ton.

LCPKS is an organic material rich in nutrients such as nitrogen, phosphorus, potassium, magnesium, and calcium. Each ton of effluent from a palm oil mill contains 1,56 kg of Urea, 0.25 kg of TSP, 2.50 kg of MOP, and 1 kg of Kiserit (Putri, 2011). LCPKS has a high chance of being utilized in oil palm plantations due to its ability to improve soil structure, increase root growth, increase organic matter content (BO), improve soil pH, increase soil water absorption, increase soil moisture, and increase cation exchange capacity (Syailendra, 2009).

Low soil pH, low organic matter content, and low nutrient content, particularly phosphorus (P), are characteristic of acidic soils, of which Dystrudepts soil is a member. According to Abdurachman et al. (2008), arid land typically has low soil fertility (low NPK). In all Inceptisol soil strata, the number of exchangeable bases ranges from moderate to high. The absorption complex is dominated by Mg and Ca ions, while the K ion content is relatively modest. The cation exchange capacity (CEC) ranged from moderate to high in all strata. Base saturation (KB) ranges from minimal to high (Damanik *et al*., 2010).

Utilizing biopore infiltration openings is one of the soil conservation methods used to enhance and enhance soil quality. Biopori infiltration openings enhance the soil's capacity to absorb water and prevent surface water runoff, the primary cause of soil erosion (Brata and Nelistya, 2008).

According to Fitriani (2017), biopore infiltration holes can improve soil ecosystems because they function as a medium that can accelerate the process of spreading organic matter into the soil, which is utilized by the organisms in the soil. N, P, K, and Mg assimilation from the application of bioporous palm oil mill effluent and their effect on the soil physical properties of Dystrudepts are still very limited.

This study seeks to determine the effect of palm oil wastewater, the number of biopore holes, and their interaction on the growth of oil palm plants and the physical properties of Dystrudepts soil.

2. MATERIAL AND METHODS

Research Location

This study was conducted in the experimental garden of the Faculty of Agriculture at the University of Riau's Binawidya Campus, 12.5 Simpang Baru Village, Tampan District, Pekanbaru. The soil type of the study area is Dystrudepts, which has the following characteristics: alluvial plain physiography, flat topography (0 to 3 %), and an elevation of 10 meters above sea level. The climate in the study region is type A (Schmidt and Ferguson) and D1 (Oldeman) (Nasrul *et al*., 2002).

The plants utilized were Tenera (DxP) oil palms from Marihat, planted in 2010. Nutrient absorption and soil physical properties were analyzed at the Soil Laboratory of the Faculty of Agriculture at the University of Riau. This study was carried out between December 2019 and April 2019.

Experimental design

The 3x3 factorial experiment utilized a random block design, each treatment was replicated three times, and each experimental unit contained three plants, for a total of 81 experimental plants. The first factor is the palm oil effluent dosage, which consists of three levels: S1: LCPKS dose of 7.5 liters/plant/2 weeks, S2: LCPKS dose of 10 liters/plant/2 weeks, and S3: LCPKS dose of 12.5 liters/plant/2 weeks. The second factor has three levels: B1: two biopore holes per plant, B2: four biopore holes per plant, and B3: six biopore holes per plant.

Research Implementation

Land Preparation

The research site's Inceptisol-type soil was planted with oil palm varieties of Tenera (DxP) Marihat, planting year 2010, in a 9-by-9-by-9-meter equilateral triangle planting pattern. The length of the research area was determined to be 126 meters, and its breadth was 33.6 meters, with a total of 81 plants. Using a hoe and a machete, the area of the disc and the spaces on the research plants were cleared of weeds. The plant location was prepared four weeks before the LCPKS application.

1. Plant Preparation

The plants used were the Tenera variety (DxP), planted in 2010. The plants were selected for good and uniform growth and labeled. Plant material preparation was carried out four weeks before the LCPKS application.

2. Preparing Biopori Infiltration Holes

Before installing the biopori tool, a hole was dug in the soil with a radius of 6.35 cm and a depth of 40 cm using PVC conduit. The capacity of the instrument per biopore hole is 5L/hole. Directions for creating a hole for the biopore tool commencing from the north, east, south, and west (Appendix 3). The biopore tool is inserted into the planting hole erect or parallel to the planting hole at a distance of 1 meter from the planting hole, and its circumference is covered with soil until it is flush with the soil surface. Three weeks were required to prepare the biopore absorption tube prior to the LCPKS application.

3. Preparing LCPKS

The palm oil mill liquid waste utilized originates from the palm oil mill outlet pool of First-Resources Group, PT. SIR Lukut (4th pool), also known as an anaerobic pond where the COD, BOD, and pH levels have attained usable levels. The waste is collected with a pail and placed in a drum before being transported to the research area. Two weeks were spent preparing LCPKS prior to its application to plants.

4. Administering treatment

Utilizing a one-liter funnel, LCPKS is inserted into the biopore hole of the plants following the treatment concentration. In the treatment without biopores, LCPKS is evenly distributed on the plant plate, one meter away from the plant. LCPKS is offered between 16:00 and 17:30.

5. Maintenance

Weed control is performed every two weeks as part of the routine maintenance. Mechanical pest control is carried out by directly capturing UPDKS pests and horn beetles that attack plants and destroying the pests found. The control of plant disease (Ganoderma boninense) is accomplished by applying systemic fungicide (Benomil at a dose of 5gr/plant) via sprayer. Every two weeks, pest and disease control intervals are carried out.

Research Parameter

1. Plant's growth parameter

a. Final plant height (cm)

The final plant height measurement is taken with the aid of a clinometer, which is used at a distance of 3 meters from the oil palm plant and is directed to the end of the last perfectly opened frond in order to acquire a viewing angle. The height of plants was measured at the conclusion of the study. The plant height is then determined using the formula.:

$$\textbf{Height} = a \times \tan \alpha + c$$

With:

a : The distance between the oil palm plantations using clinometer

tan α : the angle formed on the clinometer

c : clinometer height from ground level

b. Stem Length (cm)

The length of the frond was measured by measuring the length of the frond on the 17th leaf. The frond length was measured from the first leaf to the tip of the leaf using a tape measure. The length of the frond was measured at the end of the study.

c. Leaf Length (cm)

The length of the leaflets was measured by measuring the length of the leaflets on the 17th midrib using a tape measure. Measurements were made at the end of the study.

d. Leaf Width (cm)

The width of the leaflets was measured by measuring the width of the leaflets on the 17th leaf midrib. Using a tape measure, this measurement was carried out on the two leaflets on the left and right of the lizard's tail area. Measurements were made at the end of the study.

e. Chlorophyll content

Leaf chlorophyll measurements were carried out using a benchtop leaf area meter or Licor. Measurements were made on the 17th leaf at the end of the study.

2. Soil Physical Properties

a. Bulk Density (BD)

The unit weight or unit weight can be calculated, namely the soil's dry weight divided by the soil's volume.

b. Particle Density (PD)

The specific gravity of the granules or the specific gravity of the particles is the ratio between the mineral components and the soil's organic matter.

c. Total Pore Space (TRP)

Total pore space is the volume of all pores in a volume of soil expressed as a percentage. The total pore space is calculated using the following formula:

$$\textbf{Total Pore Space} = (1-BD)/PD \times 100$$

3. RESULT AND DISCUSSION

a. Plant Growth

1) Final Plant Height (cm)

The results of the BNT follow-up test for oil palm final crop height after applying LCPKS in a bioporous manner on Dystrudepts soil are shown in Table 1.

Table 1. Final plant height (cm) of oil palm after applying LCPKS using biopores on Dystrudepts soil.

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	473,47 ab	371,66 ab	359,11 b	401,41 A
10	390,07 ab	465,70 ab	365,81 ab	407,19 A
12,5	476,40 ab	360,69 b	510,33 a	449,14 A
Average	446,65 A	399,35 A	411,75 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

Table 1 reveals that the LCPKS doses were 7,5, 10, and 12.5 liters per plant, the number of biopore holes were 2, 4, and 6 per plant, and the interaction between the two yielded the same plant height (not a distinct one). The final crop height of oil palm ranged from 401.41 cm to 449.14 cm and tended to increase as LCPKS concentrations increased. The increase in plant height was due to the increased dose of waste applied, which contributed more to the ultimate height of the oil palm crop. The applied waste contains sufficient organic matter and nutrients to enhance the soil's properties and provide essential nutrients for plant metabolic processes. The entire amount of nitrogen in the soil significantly affects plant height growth. According to Widhiastuti et al. (2006), applying LCPKS to plantation areas can increase the total amount of nitrogen in the soil by up to 46%. According to Syarief (1986) in Tambunan (2016), the availability of nitrogen elements, which play a role in cell division, influences plant height growth. Nitrogen can stimulate the development of plant stems, thereby promoting plant growth.

Adding the number of biopore holes did not significantly affect the final plant height. However, it is known that the number of biopores in 2 holes/plant has a higher oil palm final plant height compared to 4 and 6 holes/plant (Table 1).

Table 1 demonstrates that the interaction between the LCPKS dose of 12.5 liters/plant and the number of biopores in 6 holes/plant resulted in a higher ultimate plant height than the other treatment combinations. This is due to an increase in the dosage of LCPKS containing nitrogen, which will contribute to an increase in the total nitrogen content of the soil, aiding the process of photosynthesis, which significantly impacts plant growth and development. Nitrogen, according to Lakitan (2000), substantially influences plant growth and development. According to Rizqiani et al. (2017), plants use the nutrients they absorb to promote cell division and the formation of new cells to produce organs like leaves, stems, and roots. The large number of biopores can facilitate the uniform distribution of LCPKS throughout the plant and improve nutrient delivery. The greater the number of biopore holes, according to Tambunan et al. (2019), the greater the dissemination of LCPKS. Additionally, soil aeration improves, allowing plant roots to develop more.

2) Stem Length (cm)

The results of further tests of BNT length of palm fronds after applying bioporous LCPKS to Dystrudepts soil are shown in Table 2..

Table 2. Palm frond length (cm) after applying LCPKS using biopores on Dystrudepts soil

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	548,89 a	520,56 a	502,44 a	523,96 A
10	519,44 a	559,44 a	508,89 a	529,26 A
12,5	549,00 a	523,56 a	569,89 a	547,48 A
Average	539,11 A	534,52 A	527,07 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

According to Table 2, the LCPKS doses were 7, 10, and 12.5 liters/plant, the number of biopore holes was 2, 4, and 6 holes/plant, and the interaction between the two did not produce substantially different frond lengths (no significant effect). However, the length of palm fronds tends to increase as the dose of LCPKS and the number of planting biopore openings increases. This is because LCPKS serves as an organic matter and nutrient source for plants. According to Muqorobin (2017), the more LCPKS given will increase the length of the midrib to a certain extent. In addition, the length of the frond is also strongly influenced by plant genetic factors. According to Fauzi (2002) apart from nutrients, the amount of fronds also depends on the age and genetic characteristics of the plant.

A comparable length of fronds was observed despite increased biopores (Table 2). The number of biopores with two holes per plant can enhance the midrib length relative to other biopore numbers. This is likely due to the fact that plant genetic factors have a greater influence over palm frond length. According to Corley and Tinker (2003), after fronds open entirely, frond growth tends to be slow, and plant genetic conditions also influence the variations of frond length.

The combination of the LCPKS dose of 12.5 liters/plant and the number of biopores of 6 planting openings produced the longest fronds. This is because applying LCPKS can serve as a nutrient source for plants and the biopore holes encircling oil palm plants can enhance soil properties. Rohman (2018) states that oil palm plants treated with LCPKS will produce superior plant growth compared to other organic and inorganic fertilizers, although the difference is not statistically significant. Tambunan et al. (2019) found that frond length increased proportionally to the number of biopore pores.

3) Leaf Length (cm)

The results of the BNT follow-up test for oil palm leaf length after applying LCPKS in a bioporous manner to Dystrudepts soil are shown in Table 3.

Table 3. Leaf Length (cm) after applying LCPKS using biopores on Dystrudepts soil

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	77,17 a	77,53 a	79,70 a	78,13 A
10	75,05 a	81,73 a	74,71 a	77,16 A
12,5	78,33 a	82,29 a	83,72 a	81,45 A
Average	76,85 A	80,52 A	79,38 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

Table 3 shows that the LCPKS doses were 7.5, 10 and 12.5 liters/plant, the number of biopore holes were 2, 4 and 6 holes/plant and the interaction between the two produced the same length of leaflets (no significant effect). This is caused by administering various doses of LCPKS and several biopore holes that have not been able to impact the length of the leaflets.

But overall, it can be seen that the more doses of LCPKS given, the longer the length of the young palm leaves will also be longer.

The LCPKS dose of 12.5 liters per plant produces leaflets that are longer than the other LCPKS concentrations (Table 3.). This is because the greater the LCPKS concentration, the greater the availability of nutrients for leaf growth. According to Tambunan et al. (2019), LCPKS contains 1,495 mg/l of nitrogen, making it a N source for plants. LCPKS can have a beneficial effect on the vegetative nature of oil palm plants. According to Sutarta et al. (2003), N can enhance the length and width of plant leaves.

The treatment of the number of biopores on the length of the leaflets was no different. However, the number of biopores with 4 holes/plant had the longest leaf length compared to the other biopore treatments.

Compared to the other treatment configurations, the LCPKS dose of 12.5 liters/plant and the number of biopores of 6 holes/plant produced the longest leaf length. Tambunan et al. (2019) reported that the greater the concentration of LPCKS and the greater the number of biopore holes, the longer the leaflets become.

4) Leaf Width (cm)

The results of the BNT follow-up test for the width of the palm fronds after the application of LCPKS in a bioporous manner on Dystrudepts soil are shown in Table 4.

Table 4 demonstrates that the LCPKS concentrations of 7.5, 10 and 12.5 liters per plant, the number of biopores of 2, 4, and 6 holes per plant, and their interactions resulted in the same leaf width (no significant difference). However, the greater the dose of LCPKS administered and the number of biopores, the greater the leaflets' width. Giving LCPKS at a dose of 12.5 liters/plant results in wider leaves, measuring 5.59 cm, than other LCPKS treatments. While the number of biopores with two openings per plant has a larger leaflet width than the number of other biopores.

Table 4. The width of the leaflets (cm) of oil palm after applying LCPKS in a bioporous manner on Dystrudepts soil

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	5,34 a	5,18 a	4,59 a	5,04 A
10	5,02 a	5,28 a	5,10 a	5,14 A
12,5	5,63 a	5,14 a	6,01 a	5,59 A
Average	5,33 A	5,20 A	5,23 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

The interaction between the dose of LCPKS (12.5 liters/plant) and the number of biopores (6 holes/plant) resulted in a wider leaf width than the other treatment combinations. This is because the higher the concentration of LCPKS administered, the greater the increase in plant nutrients, and the greater the number of biopore holes, the more evenly the administered LCPKS will be distributed, making it more accessible to plant roots. Treatment of the number of biopores can increase soil porosity, and adding LCPKS can increase soil biota activity and plant nutrients. According to Tambunan et al. (2019) giving LCPKS using the biopori method had a good effect on the width of the leaflets. According to Widhiastuti (2006) applying LCPKS to oil palm plantation soil functions as organic fertilizer. Wahyudi (2018) added LCPKS stores nutrients in 2 ways: through humus particles and stores nutrients as part of the chemical composition of the organic matter itself.

5) Chlorophyll content

The results of the BNT follow-up test for the chlorophyll content of oil palm leaves after the application of bioporous LCPKS to Dystrudepts soil are shown in Table 5.

Table 5. Chlorophyll content (µg/mL) of oil palm leaves after bioporous LCPKS application on Dystrudepts soil

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	58,98 a	62,68 a	61,22 a	60,96 A
10	70,39 a	68,63 a	64,84 a	67,96 A
12,5	65,07 a	72,87 a	66,10 a	68,01 A
Average	64,81 A	68,06 A	64,06 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

Table 5 demonstrates that the LCPKS dosages were 7.5, 10, and 12.5 liters/plant, the number of biopores were 2, 4, and 6 holes/plant, and their interaction resulted in the same chlorophyll content (no significant effect). However, administration of LCPKS at a dose of 12.5 liters/plant with a biopore density of 4 holes/plant resulted in a higher chlorophyll concentration than the other treatment combinations, namely 72.87 g/mL. This is caused by the extremely high nitrogen content of LCPKS. According to Leiwakabessy et al. (2003), providing a large amount of N will increase plant vegetative growth and the darkening of the leaves. According to Mahyudin et al. (2019) the provision of organic matter can facilitate N uptake by plants, namely nitrate and ammonium. These two elements accelerate the formation of green leaves (chlorophyll) for photosynthesis to accelerate vegetative growth (plant height, budding, increase in size and stem diameter). In addition, magnesium is also a chlorophyll-forming element (Amin et al., 2015), the magnesium content in LCPKS is 575.5 mgL. According to Dwijoseputro (1980), the factors that influence the formation of chlorophyll are heredity, light, oxygen, carbohydrates, nitrogen, magnesium, iron, water and temperature. Nitrogen, magnesium and iron are imperative in the formation of chlorophyll.

b. Soil physical properties

1) *Bulk Density*

The results of the BNT Bulk Density (BD) test after applying LCPKS in a bioporous manner to Dystrudepts soil are shown in Table 4.10.

Table 6. Bulk Density (BD) after applying LCPKS in a bioporous manner to Dystrudepts soil

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	1,09 a	1,06 a	1,10 a	1,08 A
10	1,13 a	1,12 a	1,24 a	1,16 A
12,5	1,08 a	1,09 a	1,03 a	1,07 A
Average	1,10 A	1,09 A	1,12 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

Table 6 shows that the administration of LCPKS doses of 7.5, 10 and 12.5 liters/plant, the number of biopores 2, 4 and 6 holes/plant, and the interaction of the two produced the same BD (no significant effect). However, increasing the dose of LCPKS followed by increasing biopore holes can reduce BD.

The LCPKS dose of 12.5 liters/plant has a lower BD value than other LCPKS doses. This is because the organic matter in the soil acts as an adhesive (binder) for soil particles so that aggregation becomes better and the bulk density decreases. The research results by Yulnafatmawita et al. (2008) showed that adding organic matter can reduce bulk density. According to Silalahi and Nelvia (2017), the LCPKS application tends to reduce BD values. The research results of Maysarah and Nelvia (2018) also show that applying a mixture of OPEFB and LCPKS can reduce bulk density.

The number of biopores with four openings per plant has a lower BD than the other biopore numbers. This is because biopore openings can increase soil moisture and water content, thereby enhancing root development. According to Wawan (2020), bulk density is an indicator of soil density; the denser a soil is, the greater its BD, which indicates that it is more difficult for the soil to transmit water or be penetrable by plant roots.

Compared to other treatment combinations, the LCPKS dose of 10 liters per plant in conjunction with the number of biopores in 6 planting openings can reduce BD. This is because LCPKS is a source of nutrients for plant roots and the formation of biopores can increase soil water content and precipitation. According to Nazari et al. (2015), moist soil conditions in biopori holes promote the migration of plant roots, particularly the active roots of the tertiary and quartet root types toward water and nutrient sources.

2) Particle Density

The results of the BNT Particle Density (PD) further test after applying LCPKS in a bioporous manner to Dystrudepts soil are shown in Table 7.

Table 7 shows that the LCPKS doses are 7.5, 10, and 12.5 liters/plant, the number of biopores is 2.4 and 6 and the interaction between the two produces PD which is not different. However, the higher the dose of LCPKS, the lower the PD. The LCPKS dose of 12.5 liters/plant has a lower PD value than other LCPKS doses. This is because LCPKS contains high organic matter. According to Wawan (2020), Particle Density is directly proportional to bulk density. If the organic matter content is high, the PD will be low.

Table 7. Particle Density (PD) after applying LCPKS in a bioporous manner to Dystrudepts soil

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	2,11 a	2,04 ab	1,93 ab	2,03 A
10	1,74 ab	2,02 ab	2,08 ab	1,95 A
12,5	2,02 ab	1,60 b	1,98 ab	1,87 A
Average	1,96 A	1,89 A	2,00 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

The LCPKS dose of 12.5 liters/plant combined with the number of biopores in 4 planting holes had a higher PD value than the other treatment combinations. According to Silalahi and Nelvia (2017) the LCPKS application tends to reduce the PD value. According to Madjid (2010) the organic matter content in the soil greatly affects the grain density of the soil, as a result the surface soil usually has a smaller particle density than the subsoil.

3) Total Pore Space

The results of the BNT follow-up test for Total Pore Space (%) after applying LCPKS in a bioporous manner on Dystrudepts soil are shown in Table 8.

Table 8. Total Pore Space (%) after applying LCPKS in a biopore manner on Dystrudepts soil

LCPKS dosage (liter/plant)	Number of Biopores (holes/plants)			Average
	2	4	6	
7,5	48,00 a	48,00 a	42,59 ab	46,20 A
10	35,01 ab	44,75 ab	40,42 ab	40,06 A
12,5	45,84 ab	31,76 b	48,00 a	41,87 A
Average	42,95 A	41,50 A	43,67 A	

Note : The numbers followed by the same lowercase letter or the same uppercase letter in the same row and column are not significantly different according to the Honest Significant Difference test at the α level of 5%.

Table 8 displays that the LCPKS dose is 7.5, 10, and 12.5 liters/plant, the number of biopores is 2, 4, and 6 holes/plant, and the total pore space does not differ substantially (no significant effect). Nevertheless, the LCPKS dose of 7.5 liters per plant had a greater total pore space than the other treatment concentrations. Organic matter's condition has a significant effect on the total pore space. According to Baver (1956), the presence of organic matter in the soil will cause the soil to become a habitat because the organic matter will occupy the space between the soil particles, making the soil porous. Picouly (1998) also added that organic matter plays a role in attaching soil particles, which leads to an increase in the stability of the soil structure, so that a crumb and axle structure is formed.

The quantity of biopores with six holes per plant tends to have a greater total pore space than the other biopore treatments. This is because the biopore pores created can be utilized as a technology for soil and water conservation. According to Wawan (2020), the organic matter content, soil structure, and soil texture influence soil porosity. A reduction in bulk density will result in an expansion of the total pore space. According to Victorianto (2014), biopore pores absorb water from the surface of the ground. Fitriani (2017) added that the decomposition of organic matter and the activities of soil macrofauna can create soil pores in biopore openings.

Combining the LCPKS dose of 7.5 liters/plant with the number of biopores of 2 and 4 planting holes/plant and the LCPKS dose of 12.5 liters/plant with the number of biopores of 6 planting holes produced the same total pore space value of 48.00%. This is because LCPKS can serve as a source of organic matter that can enhance the physical properties of the soil. According to Silalahi and Nelvia (2017), applying LCPKS can increase the total pore space of the soil. Organic matter also enhances the activity of microorganisms in the soil, and these soil microorganisms influence the increase in total porosity through the mineralization process by creating biopore holes (Rao, 1982).

4. CONCLUSION

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

1. At a dose of 7.5 liters per plant, palm oil mill liquid effluent increases the total pore space. The effluent from a palm oil mill at a rate of 12.5 liters per plant decreases BD and PD while increasing final plant height, midrib length, leaf length, and chlorophyll content.
2. Two biopores per plant increased the mature plant's height, midrib length, and leaf width. The number of biopores in four openings per plant decreased BD and PD, while increasing leaf length and chlorophyll content. Six biopores per plant affect the expansion of total pore space.
3. The interaction between the dose of LCPKS (12.5 liters/plant) and the number of biopores (6 holes/plant) decreased BD and increased total pore space, final plant height, midrib length, leaf length, and leaf breadth.

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