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Effect of Various Distances from Land Application (LA) Channels on Soil Physical and Chemical Properties in PTPN V Sei Buatan Oil Palm Plantation

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ABSTRACT

Land application (LA) uses liquid waste from the palm oil industry to fertilize palm oil plants in palm oil plantation areas. This study aims to analyze the seepage distance of Palm Oil Mill Liquid Waste (LCPKS) from the LA channel on the physical and chemical properties of the Soil, as well as compare productivity between land given and those not given LCPKS. The research was conducted at PTPN V Artificial Sei Garden for three months, from January to March 2021; sampling was conducted on land granted by LA and NLA. LA land was taken at distances of 1 m (LA1), 2 m (LA2) and 3 m (LA3) from the LCPKS application channel with depths of 0-30 cm and 30-60 cm, which were taken zigzag three times and then analyzed in the laboratory. The physical properties of the Soil, soil chemistry and productivity obtained are intact soil extraction (bulk density, permeability, moisture content and porosity) and non-whole soil extraction (cation exchange capacity, C-Organic, N, P, K). The data obtained were analyzed using the ANOVA test and BNT test. The results showed that the closer to the flatbed, the better the physical and chemical properties of the Soil, thus affecting bulk density, permeability, moisture content, porosity, cation exchange capacity (CEC), C-Organic, Total N, P available, K available, pH, Na, Ca, and Mg and productivity on land given LCPKS is higher than not given.

Keywords**:** *LCPKS, Land Application, physical and chemical of Soil, productivity*

1. INTRODUCTION

Indonesia's economy greatly benefits from the significant role of palm oil as a plantation commodity. This is due to its ability to produce vegetable oil, which is in high demand by the industrial sector (BPS, 2019). The palm oil industry in Indonesia has been experiencing growth, evidenced by the expansion of oil palm plantations in 2018. covering an area of 14.33 million hectares and producing 42.9 million tons of CPO. Moreover, in 2019. the area of oil palm plantations increased by 1.88% to 14.60 million hectares, resulting in a 12.92% rise in CPO production to 48.42 million tons (BPS, 2019).

In addition to the production of CPO, palm oil also generates waste in the form of solid, liquid, and gas (Banuwa and Pulung, 2007). To mitigate the environmental impact, the liquid waste from palm oil mills can be utilized as fertilizer (Zulkarnain, 2014). Specifically, it can be employed as an organic fertilizer known as land application effluent deposits (Basuki et al., 2015). Land Application (LA) refers to using liquid waste from the palm oil industry as fertilizer for oil palm plants within the plantation area.

Waste generated from palm oil production in LA contains essential nutrients such as N, P, and K. As a result, it can serve as a substitute for fertilizer, thereby reducing the need for additional fertilizers and helping to prevent environmental pollution. The liquid waste from palm oil mills, LCPKS, can be distributed among oil palm plants and function as an organic fertilizer. Its application leads to an increase in total N by 0.164%, P-available by 151.26 ppm, and K-exchange by 0.90 me/100 g, compared to situations where LCPKS is not used (which have 0.158% N-total, 7.78 ppm P-available, and 0.098 me/100 g K-exchange). By providing LCPKS at a rate of 2 kg per plant on red and yellow podzolic Soil, the leaf area and leaf length of oil palm seedlings can be increased by 23.53 cm and 244.55 cm2. respectively, over six months, in comparison to situations where LCPKS is not applied (which have 5.90 cm and 53.26 cm2 respectively) (Tampubolon et al., 2019). According to Askrindayani (2006), the distance of 60 cm from the applying liquid waste of a palm oil mill has the greatest impact, with the levels of N-total, P-available, K-exchange, and CEC decreasing as the distance from the ditch increases. Applying liquid waste of palm oil mill has been found to significantly enhance the chemical properties of the Soil at a distance of 3 m from the oil palm plants (Banuwa and Pulung, 2007). Furthermore, the levels of soil nutrients at a depth of 30-60 cm have been observed to increase when palm oil mill liquid waste is used, as compared to control conditions (Bakri and Widiastuti, 2015). The objective of this research is to analyze the impact of the distance between the seepage of liquid palm oil mill waste and the land application channel on the physical and chemical properties of the Soil, as well as to compare the productivity of land that receives LCPKS with that which does not.

2. MATERIAL AND METHOD

Research Time and Place

This research was conducted at the PTPN V Artificial Sei Garden, Siak Highway KM 55. Sawit Permai Village, Dayun District, Siak Regency, Riau Province. Soil analysis was conducted at the Soil Science Laboratory, Faculty of Agriculture, Riau University, Jalan Bina Widya km 12.5. Simpang Baru Village, Tampan District. The research and data collection period was three months, from January to March 2021.

Tools and Materials

The tools used in this research include hoes, sample rings, Tumbilang, knives, machetes, rolling meters, rulers, writing tools, documentation tools, ovens, analytical scales, and tools for analyzing Soil's physical and chemical properties in the laboratory.

The materials used are soil samples taken on land provided with LA and NLA on oil palm plantations in the PTPN V Sei Buatan plantation, aluminium foil, plastic bags, label paper, neat rope, and chemicals for analysis of physical and chemical properties of Soil in the laboratory.

Research Method

The research method used is a survey and primary and secondary data collection. Primary data include bulk density, permeability, water content, soil texture, porosity, pH, cation exchange capacity (CEC and base saturation, C-Organic content, N content, P content, K content, and exchangeable bases (K, Na, Ca, Mg). Secondary data are location maps, climate, topography, plantation history, and other supporting data obtained from PTPN V Sei Buatan.

Determining the research location used the purposive sampling method: taking samples by selecting locations according to the research objectives. Three sample points were taken on land that was given LA, namely 1. 2. and 3 meters from the flatbed leading to the oil palm tree, and one point on land that was not given LA or NLA, where each point was sampled at a different depth, namely 0- 30 cm and 30-60 cm. The research stages can be seen in the following picture.

Data Analysis

The data obtained is tabulated, compared, and analyzed using the ANOVA test. If the results of the analysis of variance show significant differences, then proceed with the BNT test.

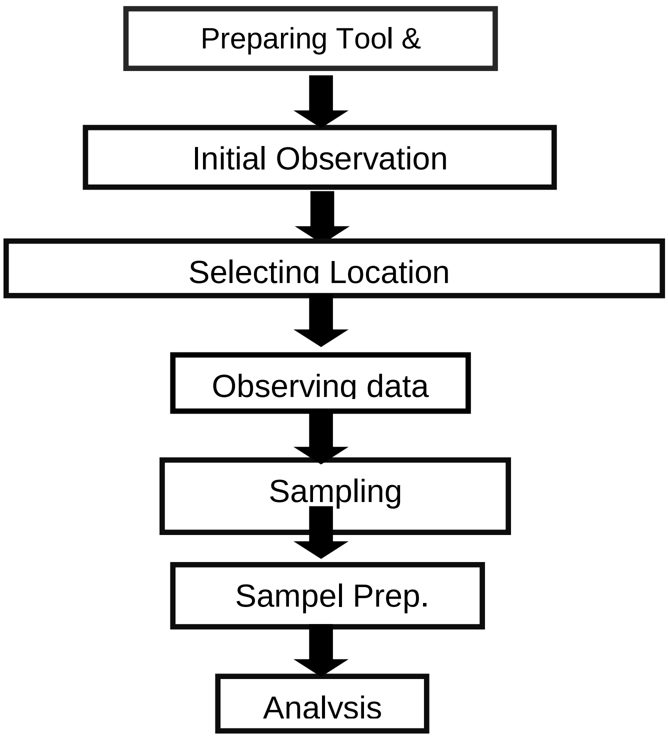

Figure 1. Research Stages

3. RESULT AND DISCUSSION

3.1 Bulk Density

Liquid palm oil mill waste (LCPKS) has been proven to reduce bulk density compared to land not given LCPKS. The lowest BD values were found at 1 and 2 meters from the flatbed. Further test results showed that treatments at distances of 1. 2. and 3 meters and different depths had no significant effect on bulk density. LCPKS application tends to reduce Soil BD compared to without LCPKS application. This is because the more waste is applied, the more organic material is contributed to the Soil. Organic matter in the Soil acts as an adhesive (binder) of soil particles so that soil aggregation is good; soil pore space increases and BD decreases (Silalahi and Nelvia, 2017).

Table 1. Soil Bulk Density at a Depth of 0-30 cm and 30-60 cm

Treatment	*Bulk density* (g/cm^3)	
	0-30 cm	30-60 cm
1 m from *flatbed*	0.92a	1.23b
2 m from *flatbed*	0.92a	1.14a
3 m from *flatbed*	1.04b	1.24b
Non-land application	1.24c	1.19a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level

Bulk density is an indication of soil density. The denser the Soil, the higher the BD value of the Soil, which means it is more difficult for water to pass through or for plant roots to penetrate. Denser Soil has a greater BD than the same Soil but is less dense. Generally, the top layer of mineral soil has a lower BD than the Soil below. Bulk density plays a role in infiltration, soil density, permeability, water management, structure, and soil porosity. The BD value of mineral soil ranges from 1-0.7 g/cm3. while organic Soil generally has a BD between 0.1-0.9 g/cm3. Typically, BD ranges from 1.1-1.6 g/cm3. Some Soil types have a BD of less than 0.90 g/cm3 (for example, Andosol soil), and some even have less than 0.10 g/cm$^{3.}$ for example, peat soil (Kurniawan, 2018).

3.2 Permeability

According to Chaniago's research in 2009. the application of LCPKS on oil palm plantation land has been found to enhance soil permeability. The study revealed that the 2007 application resulted in a permeability rate of 2.69 cm/hour, while the 2008 application showed a permeability rate of 3.39 cm/hour. This increase in permeability can be attributed to the small pore spaces in clay-textured soils. Various factors influence soil permeability, such as texture, structure, aggregate stability, porosity, pore size distribution, pore continuity, and organic matter content. Soil permeability is enhanced when Soil grains aggregate into crumbly formations, decomposed plant root holes create channels, organic matter is present, and soil porosity is high (Mulyono et al., 2019).

Table 2. Soil Permeability at a Depth of 0-30 cm and 30-60 cm

Treatment	Permeability (cm/hour)			
	0-30 cm	Class	30-60 cm	Class
1 m from *flatbed*	6.52b	Rather Fast	5.60c	Fair
2 m from *flatbed*	8.42c	Rather Fast	5.67c	Fair
3 m from *flatbed*	8.28c	Rather Fast	4.27a	Fair
Non-Land Application	5.80a	Fair	4.97b	Fair

Source: Mulyono et al., (2019)

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

According to Djufri et al. (2019), the speed of soil permeability is influenced by the organic matter content, soil texture, and soil structure. Soil with a sand texture will permeate faster than soil with a dust and clay texture. As seen from Table 2. the soil texture of treatments LA1. LA2. and LA3 with a depth of 0-30 cm is sandy loam. Meanwhile, the NLA treatment with a depth of 0-30 cm and the LA1. LA2. LA3. and NLA treatments with a depth of 30-60 cm are sandy clay loam. Clay-textured Soil generally produces Soil that has a slow permeability value.

3.3 Water Content

The water content is lower if the distance of the Soil from the liquid waste application channel is farther and higher if the distance of the Soil from the LCPKS application channel is closer. This is because organic material is porous; when added to the Soil, it will create pore space so that the weight of the Soil decreases. Stable soil pore space makes it easier for water to flow downwards and be absorbed by the soil matrix to increase the Soil's ability to hold water (Adrinal et al., 2018).

Table 3. Soil Water Content at a Depth of 0-30 cm and 30-60 cm

Treatment	Water Content (%)	
	0-30 cm	30-60 cm
1 m from *flatbed*	30.74c	23.38b
2 m from *flatbed*	25.75a	22.13a
3 m from *flatbed*	22.93a	20.20a
Non-land application	27.73b	21.82a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

Oil palm liquid waste contains organic matter, where soil organic matter can improve the physical properties of the Soil, one of which is improving the rate of water movement and total pore space, which are interrelated or directly proportional. The higher the total pore space in the Soil, the more water will escape downwards, and the lower the total pore space in the Soil, the more water traffic will be hampered. The more roots there are or the more active root development, the infiltration rate also increases, which aligns with the percentage of soil pores. High total soil pore space and low soil bulk weight also affect the field capacity water content. If the Soil has a low unit weight value and a high total pore space, the Soil is loose, so water can easily enter the Soil, resulting in a higher soil water content. The optimal water content for plants' and microorganisms' lives is around field capacity (Silalahi and Nelvia, 2017).

3.4 Porosity

Porosity is lower if the distance of the Soil from the liquid waste application channel is farther away and higher if the distance of the Soil from the liquid waste application channel of the palm oil mill is closer. This is because porosity is influenced by soil organic matter. Based on research by Surya et al. (2017), organic material can increase soil porosity by 17.66%. Every 1% application of organic material increases soil porosity by 21.87%. The higher the organic matter, the lower the soil volume weight and the higher the total soil pore space.

Table 4. Soil Porosity at Depths of 0-30 cm and 30-60 cm

Treatment	Porosity (%)	
	0-30 cm	30-60 cm
1 m from *flatbed*	65.28c	53.33a
2 m from *flatbed*	65.37c	56.98a
3 m from *flatbed*	60.75b	55.47a
Non-land application	53.21a	55.16a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

Organic matter can increase the activity of microorganisms in the Soil, where these soil microorganisms influence the increase in total porosity through the mineralization process. Apart from the Soil, these microorganisms also come from waste-decomposing microorganisms used for LCPKS processing, where the quantity of microbes increases with the addition of waste sludge (Silalahi and Nelvia, 2017). High organic matter content can improve the quality of Soil's physical properties by stimulating soil biological activity and forming a stable soil structure. Soil organic matter helps the soil granulation process, which can result in a decrease in soil density and reduce the level of soil compaction. The more soil granulations formed, the more pore space will be available (Surya et al., 2017).

3.5 Soil pH

The application of organic materials, such as empty bunches in oil palm plantations, can reduce soil acidification through the release of alkaline cations while retaining soil nutrients. Therefore, adding organic matter will be very beneficial for improving the fertility of acidic soils with high Al and Fe saturation concentrations. The intake of organic material will undergo a decomposition or turnover process to produce organic acid compounds (humic acid and fulvic acid). Humic acid and fulvic acid from the decomposition of organic matter play an important role in reducing Al in the soil so that the production of H+ ions due to Al hydrolysis decreases. The carboxyl group (-COOH) and hydroxyl group (OH-) found in organic acids will increase the activity of the OH- ion. This ion will neutralize the concentration of H+ ions in the soil solution, thereby increasing the soil pH. The application of organic materials, such as empty bunches in oil palm plantations, can reduce soil acidification through the release of alkaline cations while retaining soil nutrients. Therefore, adding organic matter will be very beneficial for improving the fertility of acidic soils with high Al and Fe saturation concentrations (Farrasati et al., 2019).

Table 5. Soil pH at a depth of 0-30 cm and 30-60 cm

Treatment	Hydrogen Potential (pH)	
	0-30 cm	30-60 cm
1 m from *flatbed*	7.58c	7.23c
2 m from *flatbed*	5.99b	4.84b
3 m from *flatbed*	5.86b	4.75b
Non-land application	4.39a	4.17a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

The pH value of the Soil where LCPKS was applied increased compared to NLA soil. This is because the type of waste in liquid form makes this waste easily mixed, and the elements bind more quickly. In general, nutrients are easily absorbed by roots at a pH around neutral because the nutrients dissolve easily in water at this pH. The pH value can decrease if the organic material has not been completely decomposed and will increase if the organic material has been completely decomposed. Adding continuous organic material that decomposes more quickly is one solution that can be applied because it can increase soil pH so that soil fertility increases (Farrasati et al., 2019).

3.6 Cation Exchange Capacity

The highest Cation Exchange Capacity for a depth of 0-30 cm was found in the LA1 treatment, namely 13.69. where the CEC was included in the low criteria. Meanwhile, they are included in the shallow criteria for treatment LA2. LA3. and NLA, namely 5.77. 9.66. and 5.26. The CEC for a 30-60 cm depth for all treatments shows a value of <5 (Table 4.7), where the CEC is included in the shallow criteria. It can be said that the CEC at the observation location is classified as very low. This is because one thing that influences the CEC value of soil is its humus content and the type of clay minerals it contains. Soils dominated by Al and Fe oxide-hydrate fractions usually have a low negative charge on the colloid surface, so the CEC value of the Soil is typically low. This condition is often found in wet tropical climates' mineral soils (dry land). On the other hand, soils that have moderate to high organic matter usually have a relatively higher soil CEC than soils that are low in organic matter. Based on this, the cause of the low CEC of the soil at the observation location is that the soil has a low organic matter content (Sufardi et al., 2017).

Table 6. Soil CEC at a depth of 0-30 cm and 30-60 cm

Treatment	Cation Exchange Capacity (KTK)	
	0-30 cm	0-30 cm
1 m from *flatbed*	13.69b	13.69b
2 m from *flatbed*	5.77a	5.77a
3 m from *flatbed*	9.66a	9.66a
Non land application	5.26a	5.26a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

Soil organic matter tends not to influence the CEC increase under pH <5.55 optimally. Low C-organic values (<1%) and minimal clay content will impact CEC values because the fraction of soil organic matter with a negative charge decreases. This impacts weak humus complexes with exchangeable base cations and unstable humus complexes. In addition, dissociation of functional groups such as carboxyl and phenolic hydroxyl inhibits the cation exchange process. in the Soil so that CEC tends not to increase (Farrasati et al., 2019). Factors that can increase CEC are based on the amount of clay and organic material. Low clay content (8.28%) causes low CEC (Darlita et al., 2017).

3.7 Base Saturation

The highest base saturation for a depth of 0-30 cm was in the LA1 treatment, 99.0. and the lowest was in the LA3 treatment, 43.8. The highest KB for a depth of 30-60 cm was in the LA1 treatment, 110.1. and the lowest was in the LA3 treatment, 33.4. This is due to the illuviation of cations such as Ca, Mg, K, Na to deeper horizons. Base saturation is closely related to soil pH; if the base saturation is high, the soil pH is high because the higher the base saturation, the more alkaline cations are in the Soil and the smaller the number of acidic cations. If the base saturation is low, many acid cations are strongly adsorbed in the soil colloids (Arabia et al., 2012).

Table 7. Soil Base Saturation at Depths of 0-30 cm and 30-60 cm

Treatment	Base Saturation	
	0-30 cm	0-30 cm
1 m from *flatbed*	99.0b	99.0b
2 m from *flatbed*	51.2a	51.2a
3 m from *flatbed*	43.8a	43.8a
Non-land application	81.2b	81.2b

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

The KB calculation results show that Soil's KB value also varies between soil types. The percentage of soil base saturation was not in line with the CEC of the Soil. The CEC value of Soil is usually positively correlated with base saturation because the higher the CEC, the higher the level of base cations in the Soil will also be higher. However, in the case of this land, it turns out that low CEC is not always accompanied by lower CEC for land (Sufardi et al., 2017). The KB criteria at a depth of 0-30 in the LA1 treatment is 99.0%, and the NLA treatment is 81.2%, included in the very high criteria. LA2 and LA3 treatments are included in the medium criteria. The KB criteria at a depth of 30-60 cm in the LA1 treatment is 110.1%, and the NLA treatment is 74.5%, included in the very high criteria. LA2 treatment is included in the medium, and LA3 treatment is in the low criteria. It can be said that birth control at the observation location is relatively high.

KB is an indicator that shows whether a soil is fertile or not. The soil fertility level can be determined based on the KB value of the land. The top horizon tends to have a pH value close to neutral, so the KB percentage indicates a neutral soil reaction. This can be attributed to the presence of organic material in the top horizon, although not in large quantities. Organic materials can cause a neutral response in acidic Soil. On the other hand, organic materials cause an acidic reaction in alkaline Soil. Based on the results of the KB analysis, it can be said that the Soil at the research location is classified as Soil with low fertility (Andalusia et al., 2016).

3.8 C-Organic Levels

Further test results showed that the application of LCPKS at different distances and depths had a significant effect on c-organic levels. The closer the Soil is to the LCPKS application channel, the higher the c-organic levels. The high levels of c-organics are caused by the presence of dissolved and solid organic substances originating from LCPKS. Organic materials contain carbon (C) levels that can reach around 48%-58% of the total weight of organic materials (Silalahi and Nelvia, 2017).

Table 8. C-Organic Soil at a Depth of 0-30 cm and 30-60 cm

Treatment	C-Organic (%)	
	0-30 cm	0-30 cm
1 m from *flatbed*	11.25d	11.25d
2 m from *flatbed*	7.56c	7.56c
3 m from *flatbed*	4.98b	4.98b
Non land application	0.98a	0.98a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

The highest c-organic content at a depth of 0-30 cm was found in the LA1 treatment, namely a distance of 1 meter from the LCPKS application channel, namely 11.25%, where the c-organic content was included in the very high criteria. Meanwhile, the NLA treatment, namely 0.98%, is included in the very low criteria. The highest c-organic levels at a depth of 30-60 cm were found in the LA2 treatment, namely a distance of 2 meters from the applying liquid waste of palm oil mill channel, namely 3.06%, included in the high criteria. The NLA treatment, namely 0.56%, is included in the low criteria. According to Nurrohman et al. (2018), the content of organic matter (C-organic) in the Soil reflects the quality of the Soil, where the organic matter content is said to be very low if <2% and low if >2%. The organic matter content ranging from 2-10% is critical.

The closer the Soil is to the LCPKS application channel, the higher the c-organic levels. The high levels of c-organics are caused by the presence of dissolved and solid organic materials originating from LCPKS. Organic materials contain carbon (C) levels that can reach around 48% -58% of the total weight of organic materials. If organic material has undergone decomposition, several carbon compounds will be produced, such as $CO2$. $CO3^{-2}$. $HCO3^{-}$, $CH4$. and C. Among these simple carbon compounds, $CO2$ is the most abundant. The farther the Soil is from the LCPKS application channel, the lower the c-organic levels. The organic material has decomposed by providing liquid palm oil waste. The decomposition process of organic matter produces simpler compounds, $CO2$ and $H2O$, which can reduce the organic matter content of the Soil (Silalahi and Nelvia, 2017).

3.9 Nitrogen Levels (N)

The highest N content at 0-30 cm depth was found in the LA1 treatment, namely 0.40%, where the N content was included in the medium criteria. Treatments LA2. LA3. and NLA are included in the low criteria. The highest N content at 30-60 cm depth was found in the LA1 treatment, namely 0.10%, where the N content was included in the low criteria. Treatments LA2. LA3. and NLA are included in the shallow criteria. It can be said that the N levels at the observation location are relatively low. Low levels of N in oil palm plantation soil are caused by N being lost easily through leaching or evaporation (Darlita et al., 2017). The decrease in nitrogen levels can be caused by several factors, namely leaching nutrients on the soil surface (leaching), binding to illite clay minerals, and absorption by plants and microorganisms.

Table 9. Soil N levels at a depth of 0-30 cm and 30-60 cm

Treatment	Nitrogen (%)	
	0-30 cm	0-30 cm
1 m from *flatbed*	0.41c	0.41c
2 m from *flatbed*	0.19b	0.19b
3 m from *flatbed*	0.12a	0.12a
Non land application	0.08a	0.08a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

Inhibition of the infiltration process may result in surface flow during rain. This flow can transport Soil so that the Soil is easily eroded. The erosion process causes soil fertility to decrease because there has been transportation and leaching of nutrients in the topsoil. The population size per hectare also influences low N levels in the Soil. The higher the density and number of plants, the higher the competition between plants in obtaining nutrients, especially N, which plants easily absorb.

N loss through leaching commonly occurs in soils with a coarse texture, very little organic matter content, and low cation exchange capacity (CEC). Low levels of N and other nutrients can occur in Soil that has a high acidity level (pH 5.5), this is common in Soil cultivated in the agricultural sector. As much as 97-99% of N in Soil exists as organic complexes and slowly becomes available to plants through the decomposition of microorganisms. So, it is quite difficult to predict when N will be available, how much it will be available, and what will happen to N when it is available (Tarigan, 2018).

3.10 Phosphorus (P) Level

Further test results showed that the application of LCPKS at different distances and depths had a significant effect on P levels. The highest P levels for a depth of 0-30 cm were found in the LA1 treatment, 1135.2%, and the lowest in the NLA treatment, 63.7%. P levels at a 0-30 cm depth for each treatment were>35 (Table 10), where P levels are included in the very high criteria. The highest P levels for a depth of 30-60 cm were found in the LA1 treatment, 222.8%, and the lowest in the NLA treatment, 14.9%. P levels at a depth of 30-60 cm for each LA treatment are >35. where P levels are also included in the very high criteria. Meanwhile, the NLA treatment, namely 14.9%, is included in the low criteria. It can be said that the P levels at the observation location are classified as very high. This could be because the P levels contained in LCPKS are not yet available to plants, so the absorption of phosphorus by plant roots is not optimal. Most P in Soil is generally unavailable to plants even in the most ideal field conditions. The main problems in acid soils are P deficiency, high P fixation, and Al, Mn, and sometimes Fe toxicity. P deficiency is generally severe due to the strong binding of these elements to the Soil, such as type 1:1 clay minerals and Al and Fe oxides, as well as the reaction between P and Al, so that the P element is not available to plants (Fazrin et al., 2014).

Table 4.11. Soil P levels at a depth of 0-30 cm and 30-60 cm

Treatment	Phosphorus (%)	
	0-30 cm	0-30 cm
1 m from *flatbed*	1135.2d	1135.2d
2 m from *flatbed*	683.0c	683.0c
3 m from *flatbed*	546.6b	546.6b
Non-land application	63.7a	63.7a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

The difference in content between total P and available P is that phosphorus tends to react with soil components to form relatively insoluble compounds, so they are unavailable to plants. Phosphate fixation is one of the obstacles to soil fertility in soils whose minerals are influenced by variable loads. In addition, the sand-dominated soil texture causes P to be easily leached into the lower layers (Darlita et al., 2017).

The presence of the P nutrient is also closely related to soil pH. The higher the soil acidity level, the less available the P element becomes. Phosphorus is a nutrient that easily binds with other elements. Most of the P is bound by soil particles; some is organic; only a very small amount is available in the soil solution (Rosmalinda and Susanto, 2018).

3.11 Productivity

The characteristics and factors influencing production must be understood to obtain optimal production, and optimal results must be strived for. Productivity results are related to the effect of providing organic materials from liquid palm oil mill waste, which affects bunch weight as one of the yield component parameters. Data on the average weight of fruit bunches for the 2016 Planting Year observed from January to March 2021 shows that applying liquid palm oil waste can significantly increase the average weight of fruit bunches.

Table 4.11. Productivity

Treatment	Number of bunches/principals	Productivity (ton/ha)	average bunch weight
Land application	1.81a	2.76a	8.26b
Non land application	1.98b	2.03a	5.09a

Note: Numbers followed by the same lower case letters are not significantly different according to the BNT test at the 5% level.

The decline in producing fresh fruit bunches (FFB) can be attributed to difficulties meeting water requirements. Prolonged periods of drought are one of the factors contributing to a decrease in the sex ratio of oil palm plants, as well as an increase in the number of female aborts. These changes in the sex ratio and the increased occurrence of fallen flowers ultimately reduce the productivity of oil palm plants. Consequently, the decrease in plant productivity directly impacts the quantity of palm oil mill waste generated. When the amount of waste from the factory decreases, the benefits derived by the plants from the application of this waste also diminish, making it insufficient to alleviate water deficits in the plants (Prayitno et al., 2008). According to Mangoensoekarjo and Toyib (2007), the formation of flowers is heavily influenced by the availability of nutrients and water. In cases where the plant lacks sufficient water and nutrients, the flowers tend to fall or abort. The susceptibility to flower abortion typically occurs approximately five months before the opening of the flowers.

4. CONCLUSION

Based on research that has been carried out, it can be concluded that the closer to the flatbed, the better the physical and chemical properties of the Soil, a distance of 1 m from the flatbed is better than other distances so that it affects bulk density, permeability, water content, porosity, capacity. Cation exchange (CEC), C-Organic, Total N, available P, available K, pH, Na, Ca, and Mg, as well as productivity on land given LCPKS is higher compared to land not shown, which affects the weight of fruit bunches per principal and production results.

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