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Improvement Of Soil Chemical Properties In Oil Palm Plantations At Supra Matra Abadi Aek Nabara Estate With The Application Of Empty Oil Palm Bunches

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ABSTRACT

Oil palm is a plant greedy for water and nutrients that can ultimately reduce soil conditions both from water and nutrients in the soil; for this reason, it is necessary to improve soil conditions. The application of EFB can be one of the solutions to overcoming the problem. This study aims to determine the Influence of Empty Fruit Bunch on improving the Chemical Properties Of Soil Planted By Oil Palm At Supra Matra Abadi Aek Nabara Estate. This research was conducted at Afdeling III Supra Matra AbadiAek Nabara Estate. This research was conducted for five months. This research method used a Factorial Randomized Block Design (RBD), which consisted of 2 factors. The first factor was soil depth which consisted of 0-15 cm, 15-30 cm, 30-60 cm, and 60-90 cm. The second factor is the application of empty fruit bunches, which consists of no EFB application (control) and the application of empty fruit bunches: 370 kg/tree. The results showed that giving empty fruit bunches to oil palm plantations can increase soil fertility. The application of EFB affects the pH values of the soil, Potassium, Magnesium and Calcium. And the depth of the ground, given the application of EFB, negatively affects soil fertility. This means that if the soil's depth increases, soil fertility tends to decrease as well as it should.
Keywords: *Nutrients, Oil Palm, Fertility, Chemistry, Soil*

1. INTRODUCTION

Oil palm (Elaeis guineensis Jacq.) is a plantation commodity that has a crucial role in the Indonesian economy. The Directorate General of Plantations in 2018 reported that the progressive development of the palm oil industry in Indonesia had spiked massively, particularly the increase in land area and oil palm production. Long-term investment in oil palm plantations is the basis for the high interest of farmers in opening new land for oil palm plants that are growing annually. In 2020, the area of oil palm plantations in Indonesia reached 14,586,597 ha, with a production of 44,759,147 tons of Crude Palm Oil (CPO) and 8,951,829 tons of Kernel Palm Oil (PKO) production of (Biro Pusat Statistik, 2021). Besides abundant production, it also generates waste in empty fruit bunches of 23% for every ton of FFB. From the ample amount, it needs to be applied as a soil amendment to improve soil health chemically.

Oil palm is a plant greedy for water and nutrients, which in turn can reduce soil conditions both from water and nutrients in the soil, so it is necessary to improve soil conditions by employing fertilization. Using inorganic fertilizers continuously will cause a decrease in soil quality and residue and kill soil organisms (FAO, n.d.). In addition, the technology used to overcome this problem is by planting cover crops, liming, and applying organic matter. Organic matter obtained in oil palm plantations is still often considered waste and is a potential source of nutrients for oil palm plants as a soil enhancer, one of which is the empty stalks of oil palm.

Empty palm fruit bunches are the leading waste from the palm oil processing industry. The basis of one ton of fresh fruit bunches (FFB) processed will produce 0.21 tons (21%) of crude palm oil (CPO) and 0.05 tons (5%) of palm kernel oil (PKO). The production process of 1 ton of palm oil produces 6.5% palm shell waste, 4% palm sludge, 13% fiber, and 23% empty palm oil stubs (Mandiri, 2012).

Empty palm fruit bunches are a source of organic matter, rich in nutrients N, P, K and Mg. According to Herawan and Rivani (2013), those empty palm fruit bunches are estimated at 23% of the total processed fresh fruit bunches. Empty palm fruit stalks contain pH (H_2O) 6.45, P (total) 1.54%, K (total) 1.42%, C-organic 16.55%, N-total content 0.97% and the C/N ratio is 17.06 (Harahap et al., 2020). The nutrient content can be used as a substitute for fertilizer in oil palm plants. Using empty stalks can save synthetic fertilizers by up to 50% (Sawit, 2012). In addition, Empty palm fruit stalks also contain 45.95% cellulose, 22.84% hemicellulose, and 16.49% lignin (Adiguna & Aryantha, 2020). These organic compounds can help improve soil structure and increase the soil's ability to absorb water and nutrients. The availability of empty fruit bunches in the field is relatively large, with an increase in the number and capacity of palm oil mills to absorb the fresh fruit bunches produced (Murniati, 2015).

From the research, Sinuraya & Lubis (2011) reported that applying empty palm oil stalks could increase the decomposition and mineralization process so that the soil's physical, chemical and biological content increases with a dose of 25 tons/ha. In addition, empty saplings can reduce soil temperature, retain soil moisture and reduce nutrient losses through leaching processes and surface runoff or prevent erosion in areas of high rainfall (Pahan, 2006). However, these two studies did not explain the correlation between soil depth and soil chemical properties.

This study aims to determine the effect of empty fruit bunches on improving the chemical properties of the soil planted with oil palm at PT. Supra Matra Abadi Aek Nabara Gardens

2. MATERIALS AND METHOD

2.1. Time and Place

This research was conducted in Afdeling III, PT. Supra Matra Abadi (SMA) Aek Nabara Gardens, Bilah Hulu District, Labuhanbatu Regency, North Sumatra, with an astronomical position of 99'56"40°E to 99'58"40°E and 1'59"20°N to 2'0'40°N. This research was conducted for five months, starting from 21 February 2022 – 21 July 2022.

2.2. Tools and Materials

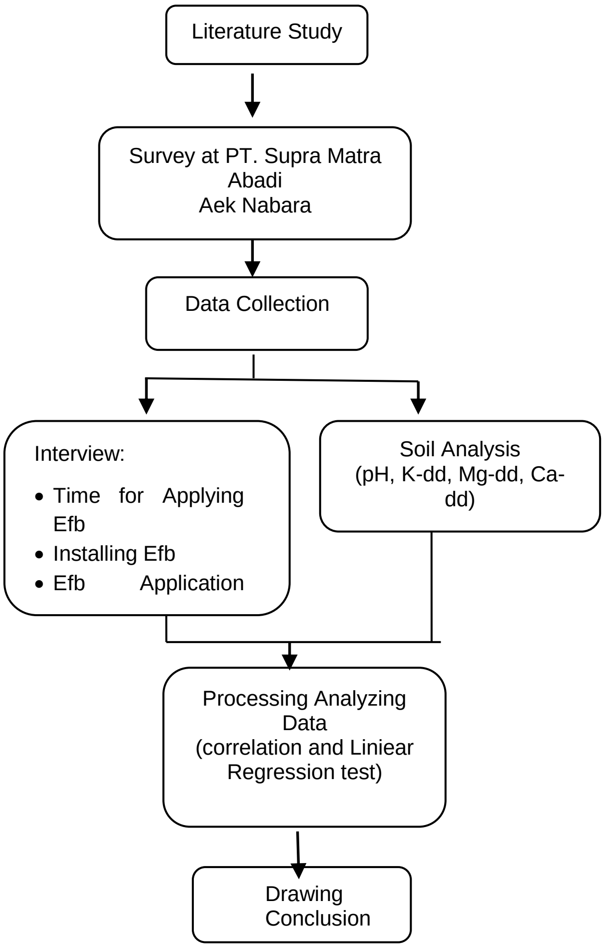
The tools used are digital cameras, stationery equipment, dump trucks, tractors, J-hook, jute, buckets, machetes, hoes, hack, wheelbarrows (rickshaws), and analytical scales. The materials used in the fieldwork practice are empty sheets and soil samples.

2.3. Research Method.

This study used a factorial randomized block design (RBD) with two factors. The first factor is the depth of the soil which consists of 0-15 cm, 15-30 cm, 30-60 cm, and 60-90 cm and the second factor is the application of empty slats consisting of no EFB application (control) and the application of empty slats: 370 kg /principal

2.4. Stages of Research

This study uses several stages presented in Figure 1.



3. RESULT AND DISCUSSION

3. Soil's Chemical Properties

The nutrient content of the soil indicates the condition of soil fertility. The soil nutrients measured here are the essential nutrients which consist of macro and microelements. In this activity, only three macronutrients are measured. These elements are Potassium (K), Magnesium (Mg), and Calcium (Ca). The results of soil fertility analysis on PT. Supra Matra Abadi Aek Nabara can be seen in table 1 below:

Table 1. EFB Trial Result Data Increases Soil Fertility

Depth (cm)	The EFB application at Gawangan Mati				Without EFB Application			
	pH (unit)	K (cmol/kg)	Mg (cmol/kg)	Ca (cmol/kg)	pH (unit)	K (cmol/kg)	Mg (cmol/kg)	Ca (cmol/kg)
0-15	5.5	0.88	1.22	0.83	4.8	0.07	0.04	0.21
15-30	5.7	0.99	0.22	0.22	4.9	0.09	0.03	0.08
30-60	5.6	0.47	0.06	0.09	4.8	0.05	0.03	0.09
60-90	5.4	0.32	0.04	0.08	4.9	0.06	0.02	0.08

Table 1 shows that the soil without the application of EFB has a pH value of 4.8-4.9 units (acid). The result is because at PT. Supra Matra Abadi location has high humidity, temperature and rainfall. If Al and Fe react with water to produce hydrogen, thereby increasing the concentration of H^+, this most importantly causes the soil pH to react sour (Septyani et al., 2020); the reaction is as follows:

$Al^{3+} + 3H_2O \rightarrow AL(OH)_3 + 3H^+$ or

$Fe^{3+} + 3H_2O \rightarrow Fe(OH)_3 + 3H^+$

Furthermore, the research location has a low percentage of exchangeable bases (k, mg, and Ca) because these elements are easily washed away by rainwater, which allows leaching to occur into the deeper layers of the soil (Wihardjaka, 2015).

3.1. pH of soil

Soil acidity is an indicator of soil fertility because it can reflect the availability of nutrients in the soil. Soil reactions indicate the acidity or alkalinity of the soil, which is expressed in pH (Taisa et al., 2021). Based on the criteria for assessing soil fertility, the soil pH ranges (from <4.5) and is classified as very acidic (agricultural research and development agency, Ministry of Agriculture, 2012). Soil pH analysis is presented in the figure below.

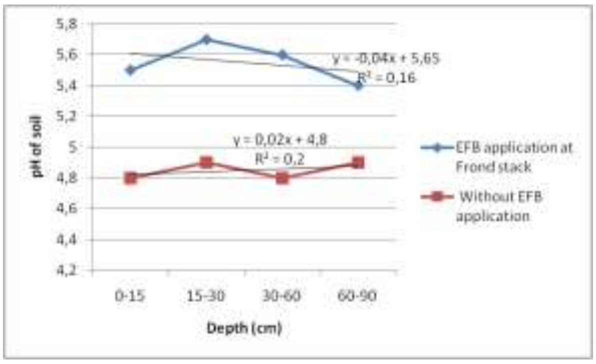


Figure 2. Relationship between soil depth and soil pH

The picture above shows that the relationship between EFB application and soil pH is moderate; the percentage is 40%. Likewise, the relationship without EFB application with soil pH is average, and the portion is 44.7%. In the picture above, the sample using the EFB application has a regression coefficient of -0.04 and is negative, which means that if the soil depth increases by 1 unit, the soil pH will decrease by 0.04 and vice versa. This is caused by the mineralization process, which releases hydrogen into carboxyl compounds to produce more acid, lowering the pH (Septiana *et al.,* 2019). After applying EFB on dead lines, soil pH increased by 0.7 units (4.8 to 5.5). This is due to the organic acids formed from the decomposition of organic matter, which also produces oxides which cause an increase in the pH value (Septyani *et al.*, 2020).

3.2. Potassium (K)

The results of the analysis of Potassium (K) in oil palm plants using the EFB application on dead weeds and without the EFB application can be seen in the image below.

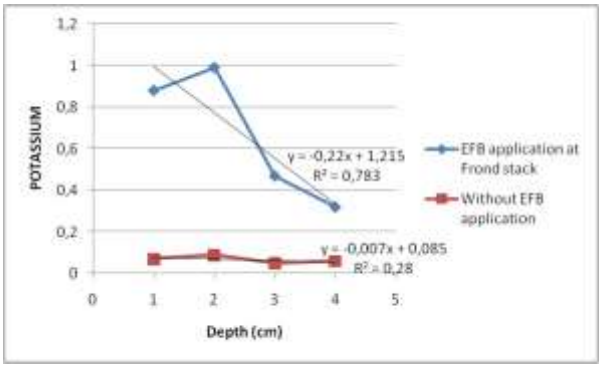


Figure 3. Correlation between soil depth and potassium

Table 2. Alkali linear equations are interchangeable

Interchangeable Alkali	Linear equations	R^2
K-dd	y = -0.22x + 1.215	0.783
Mg-dd	y = -0.37x + 1.31	0.721
Ca-dd	y = -0.238x + 0.9	0.745

In figure and table 2 it can be seen that the relationship between EFB application and Potassium (K) is Very Strong; the percentage is 88.5%. Likewise, the relationship without the EFB application with Potassium is moderate, and the portion is 52.9%. In the picture, the sample that uses the EFB application has a regression coefficient of -0.22 and is negative, which means that if the soil depth increases by 1 unit, Potassium will decrease by 0.22 and vice versa. This is because element K is easily washed away by rainwater, allowing leaching in deeper soil layers (Wihardjaka, 2015). After the application of EFB on the dead sheet, Potassium has increased compared to without the application of EFB. The highest potassium increase occurred in the empty straw at a depth of 15-30 cm of 0.90 cmol/kg followed by an increase in potassium content in the application of straw at a depth of 0-15 cm of 0.81cmol/kg. this can show that the placement of empty stalks can increase potassium. This is due to a decomposition process that takes place quickly at the soil surface to a depth of 30 cm, which causes potassium to grow; this is supported because of the high elemental K content contained in empty stacks (Fauzana *et al.*, 2019)

3.3. Magnesium (Mg)

The results of the analysis of Magnesium (Mg) in oil palm plants using the EFB application on dead weeds and without the EFB application can be seen in the image below.

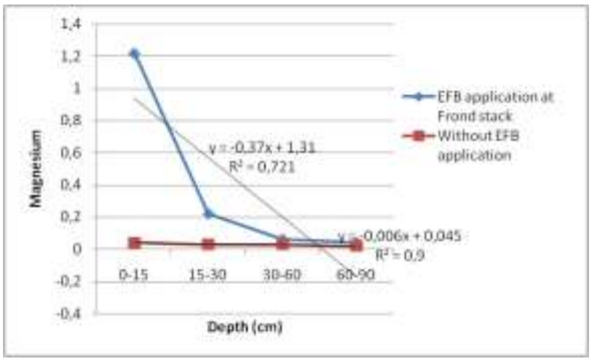


Figure 4. Relationship between soil depth and magnesium

The picture above shows that the relationship between the application of EFB and Magnesium (Mg) is very strong; the percentage is 84.9%. Likewise, the relationship without applying EFB with Magnesium is very strong, and the portion is 94.8%. The picture shows that the EFB application sample has a regression coefficient of -0.37. It is negative, meaning that if the soil's depth increases by 1 unit, then Magnesium will decrease by 0.37 and vice versa. This is due to the leaching of basic cations such as Mg-d, which occurs from the top layer to the bottom layer (Erikson et al., 2021). In this figure, the coefficient of determination using the EFB application is 0.721 or 72.1%. That is, the ability of the EFB application to explain/explain from Magnesium is 72.1% (Magnesium is 72.1% affected by the EFB Application). Other factors explain the remaining 27.9% change in Magnesium. After applying EFB to the dead sheet, Magnesium has increased compared to without EFB application. The highest increase in potassium occurred in the application of empty strands at a depth of 0-15 cm at 1.18 cmol/kg. due to a decomposition process that takes place rapidly on the soil surface to a depth of 30 cm, which causes magnesium to increase,

3.4. Calcium (Ca)

The results of the analysis of Calcium (Ca) in oil palm plants using the EFB application on dead weeds and without the EFB application can be seen in the image below.

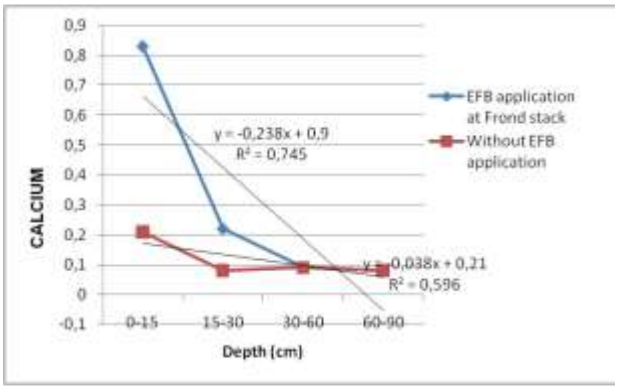


Figure 5. Relationship between soil depth and soil pH

The picture above shows that the relationship between EFB application and Calcium (Ca) is very strong; the percentage is 86.3%. Likewise, the relationship without the EFB application with Calcium is Strong, and the portion is 77.2%. In the picture, the sample using the EFB application has a regression coefficient of -0.238 and is negative, which means that if the soil depth increases by 1 unit, then calcium will decrease by 0.238 and vice versa. Allows leaching from the top layer to the bottom layer. In the figure, the coefficient of determination using the EFB application is 0.745 or 74.5%. That is, the ability of the EFB application to explain/explain calcium is 74.5% (the EFB Application influences 74.5% of calcium). Other factors explain the remaining 25.5% change in calcium. After applying EFB to dead space, calcium has increased compared to without EFB application. The highest calcium increase occurred at 0-15 cm depth of 0.62 cmol/kg followed by an increase in calcium content in the application of straw at a depth of 15-30 cm of 0.14cmol/kg. This can show that placing empty stilts can increase calcium due to a decomposition process that takes place quickly at the soil surface to a depth of 30 cm, which causes calcium to rise.

4. CONCLUSION

1. Giving empty stubs (EFB) to oil palm plantations can increase soil fertility. EFB application affects soil pH values, Potassium (K), Magnesium (Mg) and Calcium (Ca).
2. And the soil depth given by the EFB application negatively affects soil fertility. This means that if the soil's depth increases, soil fertility tends to decrease as well as it should.

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