Density of microbe as biofertilizer candidate on fibric peat in oil palm plantation area at Kubu Raya District, West Kalimantan

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Abstract. Characteristics of fibric peat are high fiber content and low pH 2-3. The presence of soil bacteria affects the fertility of fibric peat. This study aims to analyze density of soil bacteria in the fibric peat layer in the area of oil palm plantations. Bacteria as biofertilizer candidate were isolated by pour plate method on media Carboxymethylcellulose (CMC), Pikovskaya, Nitrogen fixing bacteria (Nfb), and Tryptic Soy Agar (TSA). Fibric peat at oil palm plantation contain $8.4 \times 10^5$ CFU/g cellulolytic bacteria, $2.86 \times 10^4$ MPN/g nitrogen-fixing bacteria, $3.48 \times 10^5$ CFU/g phosphate solubilizing bacteria, $5.6 \times 10^4$ CFU/g cellulolytic fungi and $6.5 \times 10^5$ IAA producing bacteria. Those functional bacteria can be developed as biofertilizer agents to improve the fertility of peat soil.

Keywords: Density of soil bacteria, fibric peat, biofertilizer agents

1. Introduction
Indonesia has the most extensive peatlands among tropical countries, which are spread across the islands of Sumatra, Kalimantan and Papua [10]. The area of peatlands in Kalimantan is dominated in West Kalimantan with an area of 1,680,134 ha [35]. Kubu Raya Regency is the largest peat area in West Kalimantan (58%) [34]. In these areas, 69.5% are still forest and others are occupied as rice fields, plantation of oil palm, pineapples, crops and so on [34].

Peat soils have characteristics that can affect the level of fertility. Some physical characteristics of peat soils need to be known include water content. Peat soil water content ranges from 100-1300% [26]. In general, tropical peatlands have a pH between 3-5, containing organic acids that are poisonous so that they have a low fertility rate [30]. Peat soil microbial communities are involved in the biogeochemical transformation of C, N, P, S and affect the structure and productivity of the plant communities that grow in the peat area [12]. The level of peat maturity is distinguished by the level of decomposition of the original plant material or fibers, namely fibric, hemic and sapric peat [35]. Fibric is the initial stage of peat decomposition, which is dominated by plant fires. Hemic is a transitional stage of peat decomposition between fibric and sapric. Sapric is an advanced stage of decomposition.
of organic matter [19]. The highest thickness of fibric peat is around 200-300 cm, saprik 0-50 cm and hemic 50-200 cm [22]. At present, there is very limited information about the distribution and function of soil microbes in peatland ecosystems, while these microbes have an important role in soil fertility. Peatland constraints for agricultural development are low nutrient content and high water content. The phosphate element in peatlands is bound with Fe or Al in the range 0: 17 to 0: 33, so that phosphate is available and only 30% can be absorbed by plants [17].

Organic peat and soil are classified based on the level of damage or decomposition. The level of damage is measured by the Von Post Scale. The Von Post scale is a broad measure used to measure peat decomposition [14]. Determination of the level of peat decomposition based on the Von Post scale consists of 10 levels/degrees of decomposition written H1-H10 [1]. According to Wahyunto [35], the level of maturity or weathering level of peat soil is distinguished based on the level of decomposition of the original plant material or fiber. Fibric Peat (raw), i.e. peat with an early weathering rate (still young) and more than ¾ of its volume in the form of crude fiber. Characteristics, if the peat is squeezed with the palm in a wet state, then the fiber content left in the palm after squeezing is three quarters or more (> ¾), brown.

Peat soils have specific microbial diversity. These microbes have an important role in the decomposition of organic matter [30]. Plants in acid soils can only absorb N in the form of NO\textsuperscript{3-} [23]. Nutrients phosphorus (P) and nitrogen (N) in the soil are very important available for plant growth, so microbes such as bacteria can be used to increase the nutrients available to plants. According to [29] phosphate-solubilizing bacteria (BPF) and nitrogen-fixing bacteria (BPN) are known to be able to provide P and N to be utilized by plants. By knowing the diversity and microbial activity at the level of peat maturity, it can be developed to improve its ability to fertilize the soil. Soil microbes have many benefits including providers of nutrients, especially nitrogen, producing growth regulators such as cytokinins, gibberellins, and indole acetic acid (IAA), and can dissolve phosphates which are bound to become available, as well as biocontrol agents.

2. Materials and Methods

2.1 Locations of peat soil sampling

The sampling location is located in Teluk Bakung Village, Ambawang District, Kubu Raya Regency. The total area of the village is 7553 ha, with peat depths varying to more than 3 m. The level of peat maturity also varies fibric, hemic and sapric. In this region consists of swamp/peat forest, mixed plantations, and gardens, oil palm plantations, shrubs and rivers. The distance from Kubu Raya city to Teluk Bakung Village is around 38 km. Geographical location 0° 20’ 43˝ latitude and 109°15’ 48˝ east longitude. The village has an average temperature of 27.1 °C, average humidity of 86%, air pressure (mb) 1012.20, wind speed (knots) 4, rainfall (mm3) 223 and sun exposure 55% [8].

2.2 Sampling of peat soil

Peat soil samples were taken in Teluk Bakung Village, Ambawang District, Kubu Raya District with a purposive random sampling method based on the level of peat maturity. Soil samples were taken at three points in the area of shrubs overgrown with oil palm plants. At each point, three replications of soil were taken which were composite samples. The soil in peatlands was leveled and cleared from the grass and litter. The peat soil drill was stuck vertically on the ground then rotated clockwise. The drill was pulled out of the ground and placed above the soil surface perpendicularly, then the soil was removed from the drill and transferred into a PVC pipe coated with aluminum foil. The same method was taken for other locations [2].
2.3. Chemical Physical Analysis of Peat and Determination of Peat Maturity

The characteristics of peat soil analyzed include the grade of soil maturity, chemical analysis, and physical analysis to determine the peat soil content. Chemical analysis was carried out to determine total N levels, available P, organic C, C / N ratio and (CEC) of soil, soil pH and soil temperature. Determination of the grade of peat maturity is done by two methods. Methods for determining peat maturity in the field: 100 g of peat soil was then squeezed in the palm. Peat fibers left in the palm were observed and grouped with the following criteria: Fibric peat soil with the following criteria: Fibric peat (raw) was peat that has not been weathered, the original material was still recognizable, brown in color and when squeezed the fiber content was left in palms more than two-thirds the original amount. The method for determining peat maturity in the laboratory was as follows: One hundred grams of peat was taken and put into a 10 ml volume syringe. The syringe pump was pressed and the volume when the peat cannot be compressed was recorded. Peat from the syringe was moved into a 100 mesh sieve. Water was sprayed into the filter to rinse the fine peat. After that, the remaining crude fiber was transferred into the syringe and compressed, then the volume of crude fiber is recorded. Fiber content was calculated by formula 1 [31].

\[
\text{Fiber Levels} = \left( \frac{V_2}{V_1} \right) \times 100\% ........ (1)
\]

Information :
- \( V_1 \) = volume of peat before filtering
- \( V_2 \) = peat volume after filtering

2.4. The microbial density of biofertilizer candidates

Peat soil sample as much as 25 g was suspended with 225 mL of sterile saline (0.85% NaCl) homogenized for one hour. One milliliter of suspension from the \( 10^{-1} \) dilution series is introduced at nine milliliters of 0.85% NaCl and then diluted to \( 10^{-7} \) Each suspension of soil was taken 0.1 mL and inoculated aseptically on CMC (Carboxymethylcellulose) Agar, Prikovskaya medium using pour plate method [17,18], and Nfb Agar and Tryptic Soy Agar [24] medium with tryptophan 200 µg / ml using the spread plate method ([4]). The culture was incubated at 30-31 °C for 72 hours, for mold growth to be incubated for 7 days. CMC agar medium which were overgrown with bacteria were counted by the number of colonies using the total plate count (TPC) method and purification (by spread plate) on the CMC agar medium and incubated for 3-5 days. The Nfb agar medium overgrown with diazotrophic bacteria would change color from green to blue, the number of bacterial colonies was counted and purified (spread plate method) on Nfb medium enriched with yeast extract (0.05 g/L) [24,25]. Non symbiotic nitrogen-fixing bacteria were analyzed quantitatively by the most probable number (MPN) using five series of tubes consisting of 30 tubes containing Nfb medium. As much as 1 ml of soil...
suspension from dilution $10^{-1} - 10^{-6}$ was put into each tube containing semi-solid Nfb (Nitrogen Fixing Bacteria) media, each dilution was repeated five times then incubated at room temperature 25 °C -30 °C for 7 days. Nitrogen-fixing activity was indicated by the formation of white ring-shaped pelicle / membrane on the media, then the media turns blue. The number of non-symbiotic nitrogen-fixing bacterial cells was determined based on Mc.Grady table.

3. Results and Discussion

3.1. Sampling and determining the level of peat maturity Area

The sampling area was a dry peat area because it was located some distance from the Kapuas river. The area was a forest peat area that had just been cut down for oil palm plantations, which had been drained. This drainage aimed to reduce high water content, create an unsaturated state for plant root respiration, and washed off some organic acids and increase peat decomposition [33]. This drainage was used for the determination of sampling points. A distance of 100 m from the drainage was taken from peat soil samples, then the next 100 m and so on up to three sampling points. The description of the sampling area (Table 1).

| Location description | Information |
|----------------------|-------------|
| Location 1           | Open peat area formedly logged for less than one year to be planted with oil palm, distance from drainage 100 m. |
| Location 2           | Open peat areas that have been logged over for more than a year and have been planted with ferns, which will be planted with oil palm plants. |
| Location 3           | Open peat areas that have been logged over for more than two years, have been overgrown with ferns and planted oil palm. |

Figure 2. Three peat soil sampling points in the scrub area which is an oil palm plantation area.a) The first point of sampling location, b) The second point of sampling location, c) The third point of sampling location.

Peat soil samples taken are fibric peat, with a depth of > 300 cm. The area is a very deep peat area (> 300 cm) [20]. The characteristics of the peat fibric as shown in Table 2.
Table 2. Description of fibric peat soils in shrubs / palm areas in Teluk Bakung Village, Ambawang District, Kubu Raya Regency

| Characteristics of fibric peat | Description |
|-------------------------------|-------------|
| Peat that hasn't rotted at all | Peat releases clear water, plant residues are easily identified, no amorphous material is available |
| Peat is almost completely rotted | Peat gives off clear enough or a little yellowish enough, plant residues are easily identified, no amorphous material is available |
| Very little peat decays | Peat releases brown turbid water but if it is squeezed there is no part of the peat coming out of the finger, the plant remains are still easily identified, no amorphous material is visible |
| Peat which had a high fiber content | When it is squeezed more than 75% of the fiber is still left |

The characteristics of brown fibric peat and plant residues are still visible. Peat thickness in this area is classified as very deep peat> 300 cm deep (Figure 3).

Figure 3. Drilled fibric peat soil a) fibric peat soil, b) fibric peat squeeze results

3.2 Chemical Physical Analysis of Fibric Peat Soil
3.2.1 Chemical Analysis of Fibric Peat Soils

1. Soil pH

Conversion of secondary peat forests into shrubs planted with oil palm causes an increase in soil pH. The increase in pH value is insignificant and is still classified in the very acidic category (3.06). Increased pH of secondary peatland soils that are converted to oil palm plantations despite a very short life span, namely from one, two and three years (Table 3.1). This is consistent with the results of research by [27], which states that transitional peat that is converted into oil palm plantations for more than 10 years has increased soil pH but is still classified as very acidic (3.43). Increasing the pH value of the soil which is still classified as very acid is suspected due to the decomposition process that is being knitted on peatlands.

Tropical peat soils have low mineral content with organic matter content of more than 90%. Chemically peat reacts acidly (pH below 4). The level of acidity of peat is closely related to the content of organic acids, namely humic acid and fulvic acid [5,28]. Organic materials that have undergone decomposition have carboxyl and phenol reactive groups that are weak acids. It is estimated that 85-95% of peat soil acidity is caused by the two carboxyl and phenol groups. Peat soil
acidity tends to decrease with peat depth. Source of acidity or which plays a role in determining acidity in peat soils is pyrite and organic acids. After experiencing reclamation, the pH of peatlands decreases compared to before reclamation [29].

C-organic
Conversion of secondary peat forests into shrubs used as oil palm plantations resulted in the degradation of C-organic content and ground organic matter but still in the very high category (56%). Degradation of oil palm / shrubs aged 61 years by 57.68%, age 2 year 56.49% and age above 3 years 56, 16% (Table 3.1). The organic content is very high. [32], who explained that the peatlands that were utilized as plantations had C-organic content classified as very high (15.49 %).

This degradation is thought to occur due to the decomposition activity of soil microorganisms, erosion and subsidence that occur due to activities on peatlands. The condition of drained peatlands can change the condition of anaerobic peat to aerobic. This increased the activity of microorganisms remodel soil organic matter. Besides that the drainage system on peatlands also causes erosion of soil organic matter by the water flow. This is by the statement [11,12], which explains that changing anaerobic conditions to aerobes on peatlands increases the activity of microorganisms to remodel soil organic matter. [16], adding that opening drainage channels on peatlands causes erosion of organic matter. Degradation of organic matter causes insignificant changes in soil pH and is still classified as very acidic. This results in a microorganism which overhaul soil organic matter and N-fixing can not work optimally. [9], explained that the activity of microorganisms is greatly influenced by the soil's pH conditions. In soils that have acidic pH, the activity of microorganisms is very low.

3. N-total
The N-total content in the area in the three locations is no difference and is classified as low (1.88%). (Table 3.1). Secondary peat forests converted to shrubs turned into oil palm plantations experience changes in N-total content, but are still in the moderate category (0.47-0.24%). In oil palm plantations aged 26 years [27]. [27] said that the fertilizer treatment given to oil palm plantations on FMD soils greatly affected the availability of total N-content of the soil. This results in a microorganism which overhaul soil organic matter and N-fixing can not work optimally. [32], explained that the activity of microorganisms is strongly influenced by the soil's pH conditions. In soils that have acidic pH, microorganism activity is very low. [9], explained that the degradation of organic matter that occurred in monoculture plantations with the commodity of tea greatly influenced the availability of N-total in the soil. The availability of N for plants on peat soils is generally low, although the analysis of total N is generally relatively high because it comes from N-organic. Comparison of C and N content of peat soils is relatively high, generally ranging from 20-45 and increasing with increasing depth [3].

4. P-available
The $P_{2}O_{5}$ content of three fibric peat location in the former mining area of the forest to be planted with oil palm had a fairly high content ( 50.75 ppm)( Table 3.1). Conversion of secondary peatland forests to shrubs used as oil palm plantations causes changes in the content of P-available in the soil. Secondary peat forest has a high P-content available (40 ppm), smaller than fibric peat in shrubs or in oil palm plantations. P-available at three location points experienced differences, possibly influenced by fertilizer application when taking samples. P- available fibric peat is smaller than hemic and sapric peat [20]. The element phosphorus (P) in peat soils is mostly found in the form of P-organic, which undergoes a process of mineralization into P-inorganic by microorganisms [6]. Most of the P-organic compounds are in the form of phosphophosphate esters, some in mono and diester form. The esters that have been identified consist of inositol phosphate, phospholipids, nucleic acids, nucleotides, and sugar phosphates. The first three compounds are dominant [6].

The organic P-fraction is estimated to contain 2.0% P as nucleic acid, 1.0% Atekasas phospholipid, 35% inositol phosphate, and the rest has not been identified. In the soil, the release of inositol phosphate is very slow compared to other esters, so that this compound accumulates a lot, and its level in the soil occupies more than half organic P or about a quarter of the total P of the soil. Inositol
hexaphosphate compounds can react with Fe or Al to form salts that are difficult to dissolve, as well as to Ca.

Research on untreated, drained Histosol soils, which contain high levels of minerals including ferrous iron (Fe\(^{3+}\)) and high Ca, will reduce mobility and phosphate degradation. Fulvic acid is associated with P at 12% of the total P, phosphate residue in a row of 13; 29; and 8% of the total P soil in Histosol is cultivated, not cultivated, and is inundated. This is due to the higher storage and supply of P in sapric peat soils than fibric.

5. Cation exchange capacity
CEC on fibric peat at all three locations ranged from 122 cmol (+) / kg, the value was very low (Table 3.1). Cation Exchange Capacity (CEC) of peat soils is greater than mineral soils. CEC of peat soils based on weights between 90 - 200 cmol (+) kg (weight) -1, but based on soil volume only ranges from 8- 60 cmol (+) kg (volume) -1 [5]. KB on fibric peat at all three locations ranged from 0.12 % was very low (Table 3.1). The peat exchange cation capacity (CEC) is high, so base saturation (KB) was very low. According to [9], the exchange capacity of ombrogenic peat soils in Indonesia is largely determined by the fraction of lignin and humic compounds (Table 3). Peat soils in Indonesia, especially ombrogenic peat soils, have a composition of peat-forming vegetation dominated by woody material. Woody materials generally contain a lot of lignin compounds which in the process of degradation produce phenolic acids.

High CEC shows high peat sorption capacity, but sorption power is weak, so K, Ca, Mg, and Na cations that do not form a coordination bond will be easily washed away. Naturally, peat soil has a low fertility rate, because it contains low levels of nutrients and contains a variety of organic acids which are partly toxic to plants. However, these acids are an active part of the soil, which determines the ability of peat to retain nutrients.

6. Base cation (Ca, Mg, K, Na and Al)
In three sampling locations, the value is very low (Table 3.1). Oligotrophic peat, like many found in Kalimantan, has very low base cations such as Ca, Mg, K, and Na, especially on thick peat. The thicker the peat, the lower the bases it contains and the reaction of the soil becomes acidic [20]. The low content of Ca, Mg, K, and Na is thought to be due to the condition of the peat which is always saturated with water and only comes from the accumulation of organic matter so there is no addition of mineral elements. Al content of the three sampling locations had 0.12 cmol(+)/kg, the Al content is relatively low. (Table 3.2). In general peat soils had low to moderate Al content, decreasing with soil pH[13].

3.2.2 Physical Analysis of Fibric Peat Soils
The physical characteristics of peat that are important in their use for agriculture include water content, bulk density (BD), particle density, total porosity, conductivity and total fiber content.

The third sample of peat peat water content was around 396 %. This water content was classified as moderat. BD in the three locations of fibric peat averaged 0.15 g / cm\(^3\) (Table 3.2). Peat soil water content ranges from 100 - 1,300% of its dry weight, meaning that peat can absorb water up to 13 times its weight. Thus, to a certain extent, the peat dome was able to drain water into the surrounding area. High water content causes BD to be low, peat to be soft and low load-bearing power [10]. BD of peat topsoil varied from 0.1 to 0.2 g / cm\(^3\) depending on the level of decomposition. Fibric peat which was generally located in the lower layer has BD 0.1 g / cm\(^3\), but coastal peat and peat in the river flow can have BD> 0.2 g / cm\(^3\) due to the influence of mineral soil. Oil palm plantation peat and ex-fire peat have BD 0.3 g / cm3, while forest peat had BD 0.15 g / cm\(^3\) [26].

The three fibric peat sampling locations had a total porosity of around 92 %, particle density of 1.78 g/cm\(^3\) and total fiber content 71 %. Total fiber content was high. Peat had the low bearing capacity or bearing capacity because it had a large total porosity so that the particle density was low and the weight was light. The total porosity for fibric / hemic soil is 86-91% (volume) and for hemic /
sapric material 88-92%, or an average of about 90% by volume [35]. Fibric peat had a high intact fiber content, at a location where one year old forest peat would have a higher fiber content compared to locations that were over two years old. Drainage caused the decomposition process to increase due to aerobic conditions, thereby reducing the level of intact fiber [7]. The conductivity of the three sampling sites had 20.7 cm/hour (Table 3.2). Peat at decomposition of the fibric level had very fast hydraulic conductivity, in contrast to peat that had completely decomposed, the movement of water was very slow with decreasing pore space of the peat material and the amount of water retention in the material.

Table 3.1. Chemical properties of peat soils in shrubs (palm), Teluk Bakung Village (Location 1,2,3), Ambawang district Kubu Raya Regency

| Parameter              | Scrub / oil palm | Fibric (Location 1) | Fibric (Location 2) | Fibric (Location 3) |
|------------------------|------------------|---------------------|---------------------|---------------------|
| pH                     | 2.98             | 2.96                | 3.06                |
| C-Organic (%)          | 57.68            | 56.16               | 56.49               |
| N-total (%)            | 1.88             | 1.88                | 1.89                |
| P₂O₅ (ppm)             | 17.71            | 91.39               | 43.16               |
| Ca (cmol(+)/kg)        | 1.65             | 0.94                | 1.62                |
| Mg (cmol(+)/kg)        | 0.61             | 0.46                | 0.66                |
| K (cmol(+)/kg)         | 0.23             | 1.20                | 0.82                |
| Na (cmol(+)/kg)        | 0.39             | 2.05                | 1.64                |
| CEC (cmol(+)/kg)       | 124.29           | 121.02              | 121.74              |
| KB (%)                 | 2.31             | 3.84                | 3.90                |
| Al-dd (cmol(+)/kg)     | 0.12             | 0.12                | 0.12                |
| H-dd                   | 1.78             | 1.90                | 2.06                |

Fibric peat has high intact fiber content, at a location where one-year-old forest peat will have a higher fiber content compared to locations that are over 2 years old. Drainage causes the decomposition process to increase due to aerobic conditions, thereby reducing the level of intact fiber [7] (Table 4).

Table 3.2. Physical properties of peat soils in shrub (palm) Teluk Bakung Village (Location 1,2,3), Ambawang District, Kubu Raya Regency

| Parameter              | Scrub / oil palm | Fibric (Location 1) | Fibric (Location 2) | Fibric (Location 3) |
|------------------------|------------------|---------------------|---------------------|---------------------|
| Bulk density (g / cm3) | 0.14             | 0.16                | 0.15                |
| Water content pF (% Grav) | 441.52          | 397.61              | 349.80              |
| Particle density (g / cm3) | 1.82            | 1.77                | 1.76                |
| Total Porosity (%)     | 92.29            | 90.96               | 91.49               |
| Conductivity (cm / hour) | 21.78           | 11.5                | 28.70               |
| Total fiber content (%) | 80.00            | 73.00               | 60.00               |

3.3 The density of Fibric Peat Soil Microbes

The abundance of microbes present in fibric peat soils in shrubs/oil palm areas varied. Microbes that were counted as biofertilizer candidates are cellulolytic fungi, cellulolytic bacteria, IAA producing bacteria, non-symbiotic nitrogen-fixing bacteria, and phosphate solubilizing bacteria. The abundance of these microbes was $8.4 \times 10^5$ CFU/g cellulolytic bacteria, $2.86 \times 10^4$ MPN/g nitrogen-fixing bacteria,
3.48x10^5 CFU/g phosphate solubilizing bacteria, 5.6 x 10^4 CFU/g cellulolytic fungi and 6.5 x10^5 CFU/g producing IAA (Figure 4). The abundance of microbes (cellulolytic fungi, cellulolytic bacteria, IAA producing bacteria, phosphate solubilizing bacteria and non-symbiotic nitrogen fixing bacteria were not significantly different). The highest abundance was owned by cellulolytic bacteria, followed by IAA-producing bacteria, phosphate solubilizing bacteria, cellulolytic fungi, and non-symbiotic nitrogen-fixing bacteria. The previous study reported that the total bacterial population varied with locations such as the peat location near the Barambai beach at 0.89x10^5 CFU / g and the peat location in the Pawalutan forest area at 38.01 x 10^5 CFU/g, while the total mushroom population at the Barambai location is 2.56x10^4 CFU / g and the location in Pawalutan totaling 10.60 x10^5 CFU / g. In general, the total number of bacteria and fungi is more in the forest area and there is a decline in forests that are converted to rice fields or oil palm fields [15]. Nitrifying bacteria population varies from 0.33x10^3 MPN/g at the Wanaraya location and 4.43x10^3 MPN/g at the Peat location. Nitrifying bacterial populations decline in forest peat and coastal peat that are converted to rice fields or oil palm fields [13,15]. In the Protected Forest Area of Teluk Pakedai, Kubu Raya Regency, namely peat fibric 4.86x10^6 CFU/g, hemic 4, 36X10^6 CFU/g and sapric 6.33X10^6 CFU/g [21].

Microbial abundance in fibric peat in the sampling areas was classified as moderate compared to peat in other areas [15,21]. There are 5 types of microbes studied, namely cellulolytic fungi, cellulolytic bacteria, phosphate solvent bacteria, IAA producing bacteria and non-symbiotic nitrogen-fixing bacteria, these microbes can grow with chemical and physical factors that are less fertile. The obtained microbes can be developed as biofertilizers in fibric peat developers.

4. Conclusions
Based on the results of the study it can be concluded that the scrub fibric peat to be planted with oil palm has soil chemical and physical properties which have a low fertility rate and have an abundance of microbes that were classified as moderate. The density of microbes as biofertilizer candidate were 8.4x10^5 CFU/g cellulolytic bacteria, 2.86x10^4 MPN/g nitrogen-fixing bacteria, 3.48x10^5 CFU/g phosphate solubilizing bacteria, 5.6x10^4 CFU/g cellulolytic bacteria and 6.5x10^5 CFU/g IAA producing bacteria.
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