

Soil Mounding Practices Towards Yield Performances of Oil Palm on Peat Soil

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Abstract— The peat soils are high in organic matter and have very fertile soil for oil palm cultivation. This study was focusing on the effectiveness of soil mounding practices in oil palm plantation sector under peat soil field based on their yield performance. The secondary data has been taken at P.T Nafasindo Acheh Singkil, Indonesia. The data was analyzed by using Sigma Plot and Microsoft Excel software. Soil mounding application is one of the best management practices that can help to increase the oil palm production in peat area. The tendency of the oil palm to become lean and falling are very high if the oil palms are planted in the peat soil area. The roots of the palm tree also will appear on the ground of the soil surface. So, these practices have been done to prevent the oil palm to lean and to fall. Furthermore, these practices can enhance root growth and the root can uptake enough nutrient for the oil palm uptake. This study found that there is a significant difference in the yield and nutritive value of the oil palm when soil mounding is applied. It is difficult to manage the oil palm plantation under peat soil area, but with a good management practice, especially soil mounding the products of the oil palm from that area can compete for the yield production from mineral soil area.

Keywords— oil palm; soil mounding; peat soil; yield performance

I. INTRODUCTION

The primary sources for the economy in Indonesia come from oil palm plantation and oil palm processing. Seventy percent of land that has been used for oil palm plantation is located at Kalimantan and Sumatra. The total oil palm production in Indonesia is around 8 million hectare, and this number is forecasted rises to 13 million hectares by 2020 [1]. The most prominent company that contributes to the country are Wilmar Group and Sinar Mas.

Soil mounding is one of the proper management practices that can be applied in the oil palm plantation in peat soil area. Peat soil contains at least 65% organic matter or has less than 35% of mineral soil [2]. The oil palms that are planted on the peat oil area are not easy to manage because of their soil physical and chemical properties [3]. So, if the oil palm is planted on the peat soil, without a proper and correct management practice, the possibility of the oil palm being lean and lastly fell are very high. This is due to the root structure of the oil palm. The palm roots cannot hold the soils because of the peat soil structure. The peat soil has high organic matter content for nutrients, high porosity for good water holding and has high saturated hydraulic conductivity [4]. Mounding is the process of putting the soil on the ground surface of the plants. Usually, the height of the mound is 20cm -30cm width 100cm. The soil mounding application can help to reduce the mineralization in the

humus layer [5]. Soil mounding application is a critical practice to prevent the oil palm to lean and finally slowly fell. Without soil mounding application, the roots of the palm will appear above the ground. This is due to; the peat soil is very quick to run off caused by the structure which is high porosity and less compact. So, when the soil mounding is applied, it will help to enhance root development. The peat also low in bulk density. When the soil mounding is applied with the depth of 0-10 cm, it can help to increase bulk density [6].

There are several types of soil mounding technique which are:- i) Inverted humus mound by taking the soil from the forest floor, and the underlying mineral soils are removed from that site. The forest floor layers have been removed and add the scoop of the mineral soil. It will help to increase the nutrients of the soil [7]. Thus, the plant can uptake more nutrient. This mounding is not recommended in the high drought possible area. Mineral mound by this technique the mound is suitable for the area that has low rainfall area. The place that has very fertile soil is not suitable to apply this technique. Mixed mound where mixed the forest floor layer with the mineral soil, then put it below the tree. This technique is suitable for the average rainfall area and has medium fertile soil.

The main problem, when the organization plant the palm in the peat area is, the palm tends to have a severe yield

problem. This is due to; the palm cannot get enough sunlight because the higher the palms grow, the slender the palm will be, because the root cannot hold the soil. So, the oil palm cannot get enough sunlight for photosynthesis process. The more the palm became lean; the more roots will appear on the ground of the soil. So, the roots development will be retarded. Besides, soil mounding practices should be implemented in peat soil area to enhance the root growth development of the oil palm and to ensure that the oil palm will be erect to get enough sunlight.

The study will be a significant endeavor in promoting the best management practices that can be applied in the oil palm plantation in peat area. Peat area has a very high organic matter and nutrients. Most of the oil palm plantations in Indonesia are planted on the peat area. Without a good management practice, the oil palm plantation in peat area will be unsuccessful. Most of the plantation does not implement this method because during planted the oil palm seedlings on the field, they use the hole in hole planting technique. It is a proper planting technique, to prevent the oil palm from becoming lean and fell, but after a few years, when the oil palm grows up, the oil palm will be lean too. So, it is the excellent time to do or apply soil mounding technique.

Therefore, this study was done to evaluate the increasing percentage of yield and nutritive value after soil mounding practices. This research also aims to identify the effectiveness of soil mounding practices based on the yield and nutritive value of oil palm at the peat.

II. MATERIAL AND METHOD

A. Location of Study

This study conducted at Kota Aman Estate and Bungara Estate is located at Aceh Singkil, Indonesia under Nafasindo Company. The total oil palm production in Indonesia is about 8 million hectare, and this number is forecasted rises to 13 million hectares by 2020 [1].

B. Data Collection and Analysis

The secondary data was collected from Kota Aman Estate and Bungara Estate is located at Aceh Singkil, Indonesia. The data then were analyzed using Microsoft Excel and Sigma Plot Software under Nafasindo Company.

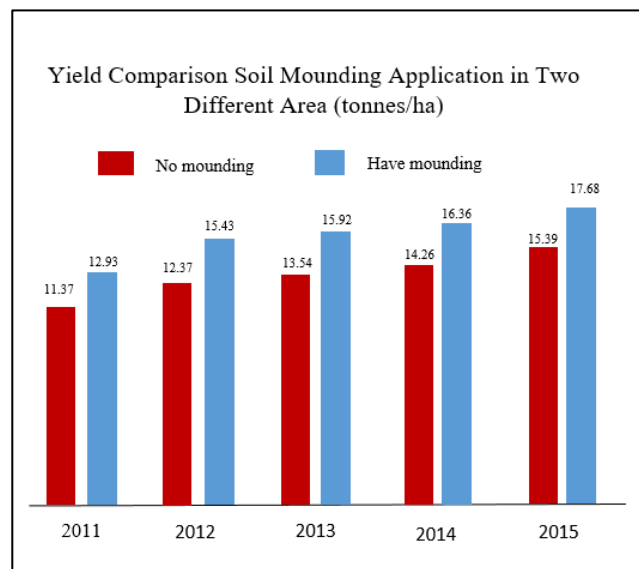
C. Parameter

The parameters that were collected are the yield per hectare for the past five years (2011 – 2015) at area soil mounding was done and another area where are without soil mounding practices. The nutrient N, P and K value (percentage) also were collected to compare whether the soil mounding is affected the yield performance of oil palm itself.

III. RESULT AND DISCUSSION

Fig. 1 show the comparison of the soil mounding application in two different areas. From the graph, the result shows that area where are apply with soil mounding management practices give a higher yield in 2015 (17.68 tonnes/ha) compare to the area without soil mounding which is the lowest was in 2011 (11.37 tonnes /ha). The maroon color on the bar graph represents the area that does not apply

soil mounding (Bungara Estate). The blue color on the bar graph represents the area that applied soil mounding (Kota Aman Estate). The yield of the oil palm per year increase from year to year but, in the area that applied soil mounding shows higher yield from year to year compared to the area that does not apply soil mounding. The result was analyzed by using Sigma plot software shows that there was significantly different when the estate applied the soil mounding in the peat area, with the P value is 0.014 at 95% interval.



Significantly difference at $P \leq 0.05$

Fig. 1 Yield comparison soil mounding application in two different areas

TABLE I
THE ANOVA TABLE FOR THE YIELD OF AREA THAT APPLIES SOIL MOUNDING

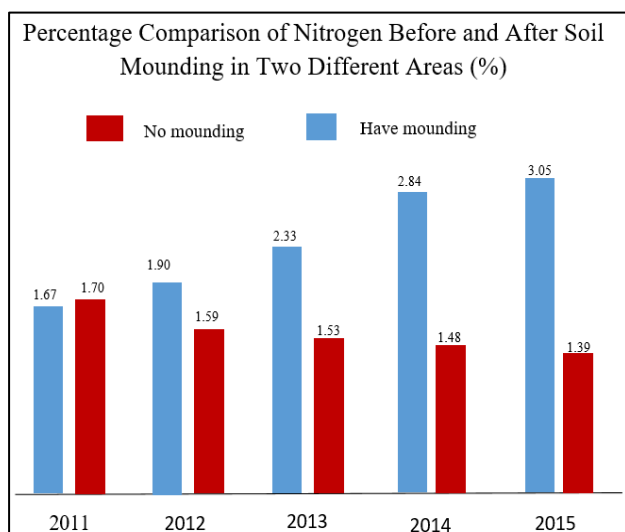
Analysis of Variance:					
	DF	SS	MS	F	P
Regression	1	8.922	8.922	27.357	0.014
Residual	3	0.978	0.326		
Total	4	9.900	2.475		

Table 1 shows that there was significantly different when the estate applied the soil mounding in the peat area, with the P value is 0.014 to get the significant value; the P-value must below than 0.05.

The yields of oil palm are rapidly increased after soil mounding, and it can help the palm tree grow more erect. This is due to the oil palm roots developments much more vigorous and able to be an anchor and hold the oil palm more firmly. Thus, since the palm more erect, they will get more sunlight for photosynthesis and finally increased the yield production of the oil palm.

Fig. 2 shows the comparison of the percentage of the Nitrogen in the palm tree based on leaf analytical result on front number 17th. From the graph, the result showed, after soil mounding practices are applied, more Nitrogen can be uptaken by the palm tree which is the highest was 3.05% in 2015. The percentage of the Nitrogen in the area that does not apply soil mounding is a decline from the year 2011 to 2015, and the lowest percentage was 1.39% in 2015. The

percentage of the Nitrogen in the area that applied soil mounding is steadily increased from the year 2011 to 2015. The data was analyzed by using Sigma plot software shows that there was a significant difference when the estate applied the soil mounding in the peat area, with the P value is 0.08 at 95% interval.



Significantly difference at $P \leq 0.05$

Fig. 2 Comparisons % of N before and after soil mounding in two different areas

TABLE II

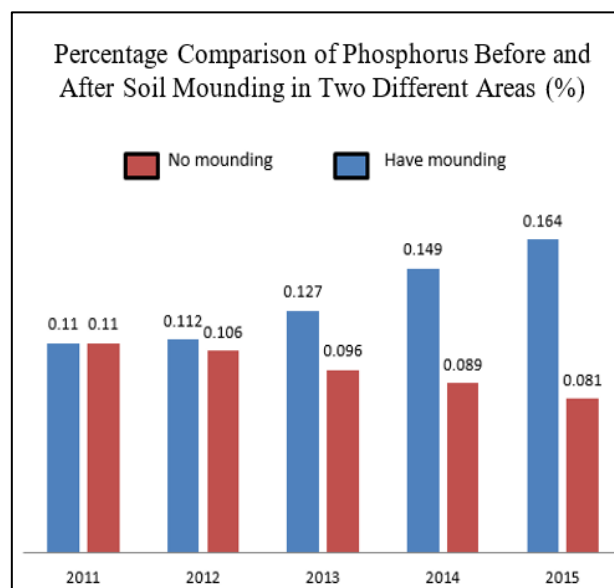
THE ANOVA TABLE OF PERCENTAGE OF N WHEN APPLY SOIL MOUNDING

Analysis of Variance:					
	DF	SS	MS	F	P
Regression	1	1.298	1.298	40.049	0.008
Residual	3	0.0972	0.0324		
Total	4	1.395	0.349		

Table 2 shows that there was significantly different when the estate applied the soil mounding in the peat area, with the P value is 0.08 to get the significant value; the P-value must below than 0.05.

The function of N is to increase the growth rate and fruiting rate of the oil palm [8] and also act as carbohydrate supplier [9]. Even the amount of N is high in peat area, but the pH of that soil is very low around 2.8-4.5 which are acidic [9] and not suitable for oil palm production. The N that present in the organic soil is mostly in organic form and very high in the shallow peat soil.

Fig. 3 shows the comparison of the percentage of the Phosphorus in the palm tree based on leaf analytical result on front number 17th. From the graph, we can see, after soil mounding practices are applied, more Phosphorus can be uptaken by the palm tree. The percentage of the Phosphorus in the area that does not apply soil mounding is a decline from the year 2011 to 2015. The percentage of the Phosphorus in the area that applied soil mounding is increased rapidly from the year 2011 to 2015. From the analysis data by using the sigma plot software, it shows that there was significantly different when the estate applied the soil mounding in the peat area.



Significantly difference at $P \leq 0.05$

Fig. 3 Comparisons of P before and after soil mounding in two different areas

TABLE III

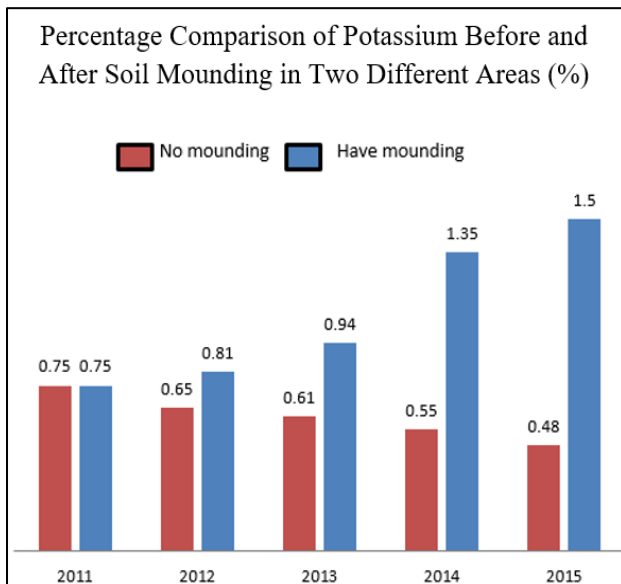
THE ANOVA TABLE OF PERCENTAGE OF P WHEN APPLY SOIL MOUNDING

Analysis of Variance:					
	DF	SS	MS	F	P
Regression	1	0.00216	0.00216	99.273	0.002
Residual	3	0.0000652	0.0000217		
Total	4	0.00222	0.000555		

Table 3 shows that there was significantly different when the estate applied the soil mounding in the peat area, with the P value is 0.02 to get the significant value; the P-value must below than 0.05.

The percentage of nutritive value (N, P, K) in the palm tree after soil mounding practices rapidly increased from year to year and automatically the yield of oil palm (tonnes/ha) showing the great increasing from 2011 until 2015. The important of P elements in oil palm crops is to enhance the root growth [10], and that element also helps to transfer the energy and storage [11].

The function of Potassium (K) is to help to maintain the osmotic balance, photosynthesis process and also the phloem transport system [9]. Fig. 4 shows the comparison of the percentage of the Potassium in the palm tree based on leaf analytical in the laboratory. From the graph, we can see, after soil mounding practices are applied, more Potassium can be uptaken by the palm tree in the year 2015 (1.5%). The percentage of the Potassium in the area that does not apply soil mounding is a decline from year to year and the lowest was 0.48% in 2015. The percentage of the Potassium in the area that applied soil mounding is increased rapidly from year to year.



Significantly difference at $P \leq 0.05$

Fig. 4 Comparison % of K before and after soil mounding in two different areas

TABLE IV
THE ANOVA TABLE OF PERCENTAGE OF K WHEN APPLY SOIL MOUNDING

Analysis of Variance:					
	DF	SS	MS	F	P
Regression	1	0.0363	0.0363	20.398	0.020
Residual	3	0.00534	0.00178		
Total	4	0.0417	0.0104		

Significantly difference at $P \leq 0.05$

Result from the analysis data by using the sigma plot software it shows that there was significantly different when the estate applied the soil mounding in the peat area, with the P value is 0.020 at 95% interval.

The organic soil has low nutrient retention capacity and high Potassium (K) and Zinc (Zn) fixation. The amount of Nitrogen (N) is high, but the pH of the soil is very low (pH 2.8-4.5) [12]. The peat soil also the most prominent CO_2 emission that will contribute to the Green House Gas (GHG) to the environment. Thus, the peat area should be managed and utilized wisely to reduce GHG emission.

Based on the result shown, the yields of the oil palm are rapidly increased after soil mounding. This is due to several factors that can help the increasing of the yield. The tendency of the oil palm being lean is very high, because of the soil physical and chemical properties of the peat soil. When the soil mounding is applied, it can help the palm tree grow straight usually. So, when the palm trees become erect, more sunlight can be absorbed for photosynthesis. The higher the photosynthesis rate, the higher the production of the oil palm. Apart from that, by implementing the mounding practices, it will help the roots develop more vigorous and able to anchor the oil palm tree to be firm.

As a result of root development, the result also shows the increase in percentage in the nutritive value in the plant. When the palm tree become lean, and the roots of the palm will appear and exposed above the ground. The exposure of

the roots to sunlight may eventually kill the root cell and will damage the roots, once the root is damaged the root cannot uptake the nutrients from the soil. Soil mounding practices can help to enhance the root growth. So, new roots will help to absorb the nutrient back from the soil. Finally, the palm tree will get enough nutrients, and the yield of the palm will increase. The roots are very crucial in plant development because it acts as an anchor for the plant, as the door for water and nutrient absorption and also as the storage of food and nutrient for the plants.

The percentage of nutritive value (N, P, and K) in the palm tree after soil mounding practices rapidly increased from year to year. So, automatically the yield of the oil palm (ton/ha) show a significant increase from the year 2011 to the year 2015. This is due to the function of the N, P, K as an essential role for the growth performance of oil palm tree. The nitrogen that presents in the organic soil is mostly in organic form. The Nitrogen contents are high in the shallow peat soil [13]. The most crucial element that needs by the plant is Nitrogen; it will enhance the growth of the palm tree and act as carbohydrate supplier [9]. The second element that important in the plant is Phosphorus. It will help to transfer the energy and storage. Next is Potassium and it will help to maintain the osmotic balance, photosynthesis process and also the phloem transport system[9]. The yield of oil palm is highly dependent on the nutrient content in the plant. The increasing of oil palm nutrient content will increase yield productions. Soil mounding will help to prevent from the nutrient leaching. Peat soil unable to hold the nutrient longer due to the structure which is very loose. This structure will fasten the nutrient to leach and water to volatile during hot or drought season.

IV. CONCLUSION

In conclusion, soil mounding is one of the best management practices that can be applied in the peat area estate. This management practices can be applied to all oil palm tree in a different age. If the soil mounding practices are applied at the young palm tree, it can help to prevent the oil palm being lean, and the root of the oil palm appear on the ground of the soil. Besides, if the soil mounding practices are applied at the matured palm tree that is lean, and the root of the palm tree is already apparent on the ground, it can help to make the oil palm stand erect and enhance the root formation of the palm tree.

Nowadays, there are limitations to plant the oil palm in the mineral soil. This is due to the oil palm is the primary economic sources for our country. So, to increase the area of the oil palm plantation, the private or public company should open their estate plantation in the peat area. To ensure the success of the plantation, the company can apply good management practices to avoid any problem. The main things that the company have to do are manage the excellent and systematic land preparation. Next, the oil palms that are planted in the peat area should use "hole in hole" planting technique. This is due to the soil structure in the peat soil is very loose, and the root of the oil palm is fibrous roots. So, the oil palm roots cannot hold the loose soil tightly. It is difficult to manage the oil palm plantation in the peat area, but with proper management practices, the products of the

oil palm from the peat area can compete for the production of the oil palm in the mineral soil.

The company that is lacked experience on how to manage the oil palm in the peat area. Then they faced the problem on the decreasing of oil palm yield because of the oil palm tree become lean and slowly falling. So, the oil palm estate can handle their problem by applied the soil mounding practices. The oil palm plantations that are appropriately managed their estate also can apply this technique to prevent any future problems.

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