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Study on the Improvement of Coastal Marginal Soil after Amendment with EFB Compost and Growth of Young Oil Palm

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Abstract: The oil palm requires considerable high rate of fertilizers application to produce good yield. High rainfall intensity in coastal marginal soil increases nutrient loss due to the poor water retention and high porosity properties. This results in leaching of excess chemical fertilizer to underground water bodies causing high nutrient enrichment in waterway. Empty Fruit Bunches (EFB) is one of the waste products from palm oil extraction process and can be converted into EFB compost for improving soil physical properties by increasing the organic matter. This research was conducted to study the improvement of soil physical properties of coastal marginal soil amended with EFB compost for the growth of young oil palm. Three types of treatments were applying 100% NPK and combination of 50% EFB compost+50% NPK onto oil palm trees with age of 2 years old planted in coastal marginal soil replicated four times three times over the year at 3 months interval. A Complete Randomized Block Design (CRBD) was used as the experimental design. The parameters were soil bulk density, soil texture and soil moisture. The growth was determined by height and bole diameter of the palm. The result of soil moisture content did not provide evidential improvement in soil's water holding capacity and moisture availability of the soil differences. Similarly, the change in soil bulk density values also were not indicative of any noteworthy observation. Overall, EFB compost aided adding organic matter to the soil, however, this did not cause substantial effects towards soil texture. Changes in palm height and bole diameter also did not give significant result in both treatments. Statistically, the result showed insignificant differences in all the parameters studied from the three treatments applied. It can be concluded that there is no drastic improvement in soil physical properties of coastal marginal soil observed in soil amendment using EFB compost over a period of 1 year study.

Key words: Oil palm, coastal marginal soil, EFB compost, soil physical properties, soil texture, improvement

INTRODUCTION

Over the last few decades, palm oil (*Elaeis guineensis*) has continually grown to become one of the most important economic commodities in Malaysia. Palm oil production is vital for Malaysia economy which is the world's second-largest palm oil producer after Indonesia. Over the past four decades, palm oil has made remarkable and sustained growth in the world global market and it is projected that the average annual production of oil palm in Malaysia will reach 15.4 million tonnes in the period of 2016-2020 (Abdullah and Sulaiman, 2013). The oil palm requires considerable high rate of fertilizers application to produce good yield. Due to shortage of prime land for oil palm cultivation, marginal areas have been used. Cultivation of oil palm in marginal areas with inherently severe limitations results in low crop productivity and is neither a sustainable nor viable option (Sharma, 2013). Coastal soils have poor nutrient status, low soil organic matter and very little water holding capacity which are the major constraints limiting oil palm production (Pirker and Mosnier, 2015). In addition, high rainfall intensity in coastal marginal soil increases nutrient loss due to the poor water retention and high porosity properties resulting in leaching of excess chemical fertilizer to underground water bodies causing high nutrient enrichment in waterway. Empty Fruit Bunches (EFB) biomass is one of the waste products from palm oil extraction process and can be converted into EFB compost for improving soil physical properties by increasing the organic matter (Good and Beatty, 2011; Mohammadi *et al*., 2012). This research was conducted to study the improvement of soil physical properties that includes bulk density, soil moisture

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percentage and soil texture of coastal marginal soil amended with EFB compost on for the growth of young oil palm based on plant height and bole diameter.

MATERIALS AND METHODS

Experimental site and design: The experimental site was in a small holder farm of 1 year old oil palm at Rombongan, Lundu, Sarawak with coastal marginal soil. The experimental used was a Completely Randomized Block Design (CRBD) with two treatments replicated five times. The treatments were: 1.100% NPK chemical fertilizer and 50% NPK and 2, 50% EFB. Preliminary study had indicated that 100% EFB was not able to improve growth in oil palm, thus was excluded as one of the treatments.

Soil sampling: The soil samples were collected from two sampling points per oil palm with a soil auger of diameter of 5.4 cm at depths of 10-30 cm referred as horizon A, horizon B and horizon C, respectively at the sampling site. The soil taken were placed in a sealed plastic bag and then brought back to the laboratory. All soil samples were left in the laboratory to be air dried.

Determination of soil moisture: A 100 g of soil samples wet weight was weighed using digital scale from all treatments. The weighed soil samples were put inside an envelope and placed into a drying oven at 80°C for 3 days. After 3 days, the 100 g soil sample were weighted again to obtain its dried weight. The soil moisture was calculated based on this equation:

$$\text{Soil moisture\%} = \frac{\text{Loss in weight}}{\text{Oven dry weight of soil}} \times 100$$

Determination of soil bulk density: The bulk density of soil sample was determined by calculating the dried weight of soil sample over volume of soil sample. The radius and height of auger which were 2.7 and 10 cm consecutively were used to find soil sample's volume suing the formula: $\pi r^2 h$ was formula to acquire the soil sample's volume. The bulk density was calculated using this equation:

$$\text{Soil bulk density}\left(\frac{g}{cm^3}\right) = \frac{\text{Oven dried weight of soil}}{\text{Volume of soil}}$$

Determination of soil texture: The 50 g of soil sample from each treatment was were weighed and put into 500 mL beaker. Then 500 mL of distilled water and three drops of dishwasher liquid were added into the

beaker, stirred for 1 min. After 10 min a layer of sand was measured using digital calliper, second layer of silt was measured 30 min later, third layer of silt was measured after 24 h. The percentage of each soil type were calculated using this equation:

$$\text{Sand\%} = \frac{\text{Depth of sand}}{\text{Depth of total soil}}$$

$$\text{Silt\%} = \frac{\text{Depth of silt}}{\text{Depth of total soil}}$$

$$\text{Clay\%} = \frac{\text{Depth of clay}}{\text{Depth of total soil}}$$

Palm height and diameter: The height of young oil palm was measured from the base of oil palm until the tip of leaf at top endby using measurement tape and ruler. The palm bole diameter was measured from 1 cm off the groundusing measuring tape and ruler.

RESULTS AND DISCUSSION

The results were observed and discussed. Table 1 shows the Analysis of Variances (ANOVA) of means of soil physical properties of the treatments at $\alpha = 0.05$.

Soil moisture: Figure 1a shows the mean percentage of soil moisture of the two treatments followed similarly pattern at an increasing rate from 3-9 months. However, there were no significant difference between the two treatments as indicated by ANOVA with a p value of 0.651 shown in Table 1. Soil moisture content increased as depth increased for Treatment 2 significantly as ANOVA indicated a p-value of 0.008. According to Reid (2004), there are two main sources of moisture loss which are drainage and evaporation. Coastal sandy soil is quick to drain water because of low water holding capacity and smaller surface area to retain water. Celik *et al*. (2004) stated that water content of soils increases by 86 and 56% by amending soil with compost and manure.

Soil bulk density: Figure 1b shows the mean percentage of soil bulk density of the two treatments

Table 1: Analysis of Variances (ANOVA) of means of soil physical properties of the treatments at $\alpha = 0.05$

			Soil texture		
ANOVA	Soil moisture	Bulk density	Sand%	Silt%	Clay%
Treatment	0.651	0.111	0.039	0.047	0.436
Horizon	0.008	0.256	0.122	0.842	0.028

*Significant (S) if $\alpha<0.05$ and Not Significant (NS) if $\alpha>0.05$

Table 2: Soil texture using soil texture triangle based on sand %, silt % and clay % of soil from treatments: 1) 100% NPK and 2) 50% NPK and 50% EFB over a period of nine months

		Treatment			
		100% NPK		50% NPK and 50% EFB	
Months	Soil texture%	Percentage	SD	Percentage	SD
3	Sand	85.44	6.918	82.04	6.293
	Silt	7.47	5.898	10.17	6.523
	Clay	7.09	3.780	7.79	4.229
	Type of soil	Loamy sand		Loamy sand	
6	Sand	88.41	6.977	88.53	8.339
	Silt	5.31	3.748	6.17	5.915
	Clay	6.28	5.228	5.30	4.591
	Type of soil	Sand		Sand	
9	Sand	92.26	4.0945	89.88	3.936
	Silt	4.10	3.20	4.85	3.182
	Clay	3.64	2.159	5.27	3.158
	Type of soil	Sand		Sand	

followed similarly pattern at month 3, 6 and 9. Generally, the bulk density was lower in the combination of 50% NPK and 50% EFB which was observed to have decreased at month 9 despite an increase in month 6. There was no significant effect on the bulk density between the two treatments and also depth of soils as shown in Table 1 Application of compost decreases bulk density and increasing soil pore volume (Leroy *et al*., 2007).

Soil texture: Table 2 shows the Soil texture using soil Texture Triangle based on sand, silt and clay percentage to determine the soil type from treatments: 100 percentage NPK; 50% NPK and 50% EFB over a period of the 9 months.

There was significantly difference in sand and silt percentage between the two treatments as shown in Table 1. This occurred at month 9 where sand had drastically increased in the NPK treatment. Similarly, there was also significantly difference in clay percentage in the horizon attributed to the NPK treatment whereby there was a reduction in clay percentage at month 9. In general treatments had no effect on soil texture and soil types but compost addition had reduced the sand component. Compost addition to the soil improved soil structure and aggregate stability as the organic matter in the compost bind mineral particle together.

Palm height: Figure 2a shows the mean height of palm over 9 months with similar growth pattern and no significant difference between the two treatments

a

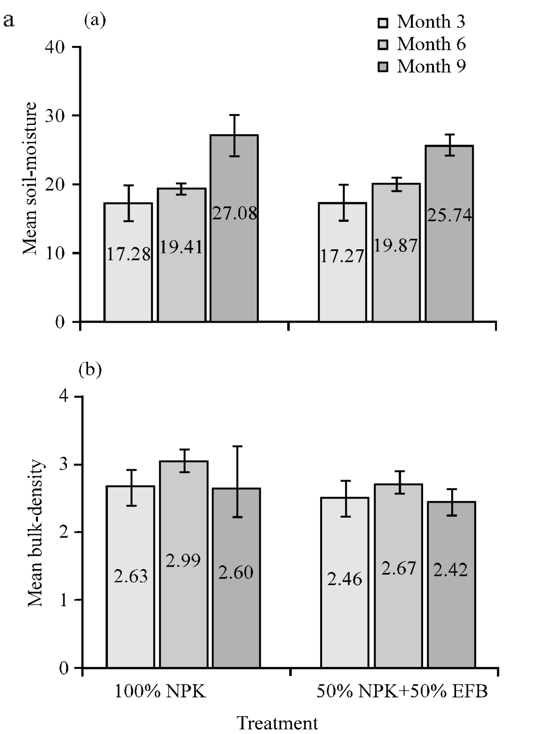

Fig. 1: The mean percentage of soil moisture: a) the mean bulk density and b) obtained at month 3, 6 and 9 of the two treatments: 100% NPK and combination of 50% NPK and 50% EFB, ANOVA showing no significant difference at = 0.05; p-value of 0.651 and 0.111, respectively; Error bars +/- 2 SE

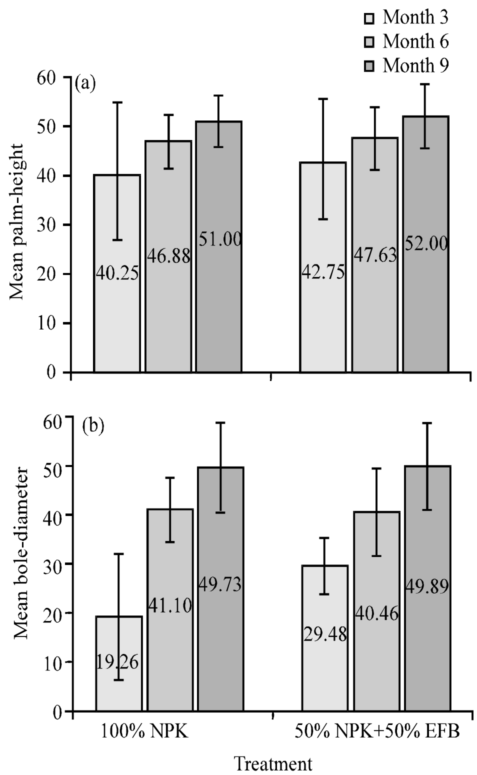

Fig. 2: The mean palm height (a) and the mean bole diameter (b) of the two treatments: 100% NPK and combination of 50% NPK and 50% EFB over a period of 9 months, ANOVA showing no significant difference at a = 0.05; p-value of 0.659 and 0.603, respectively; Error base +/- 2 SE

as ANOVA indicating a p-value of 0.659. Figure 2b shows the mean bole diameter of the palm with also similar growth pattern and no significant difference between the two treatments as ANOVA indicating p-value of 0.603. Both responses to 100% NPK treatments at month 3 were slower compared to 50% NPK and 50% EFB. The reduction of NPK to 50% had not drastically reduced the growth, since, Duong (2013) stated that application of compost will increase soil nutrient content though plant N and P uptake from compost could be lower due to the mineralisation process of the microbial immobilization of N.

CONCLUSION

There is no substantial improvement between soil physical properties of the coastal marginal soil with the addition of compost. However, the growth of young oil palm based on palm height and diameter of bole was maintained despite the reduction of the chemical fertilizer with the balance of nutrient source from EFB compost.

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