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Application of Sludge and Manure on Subsoils as Medium of Palm Oil Seedling (*Elaeis guineensis* Jacq)

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Abstract

An experiment to study the effect of sludge and manure application and their interaction on the response of palm oil seedling in main nursery, physical and chemical properties of subsoil has been conducted. The experiment was carried out in experimental farm of Agricultural Faculty,UISU,located at Medan Johor District in elevation at ± 45 m above sea level. The research design is Factorial Randomized Block Design. Treatments tested is consisting of 4 levels of sludge application namely 0% (0 kg /polybag), 5% (0.5 kg/polybag), 10% (1 kg/polybag), and 15% (1.5 kg/polybag) and 4 levels of manure applicationnamely 0% (0 kg /polybag), 5% (0.5 kg/polybag), 10% (1 kg/polybag) and 15% (1.5 kg/polybag).Variables observed are root fresh weight and root dry weight as well as some soil properties such as water holding capacity, C-organic, total N, C/N ratio, soil pH, and Cation Exchange Capacity (CEC). The results shows that the application of sludge was significantly affect on C-organic, total N, and CEC, and water holding capacity. The sludge application also significantly increases the root dry and fresh weight. Meanwhile the application of manure significantly increase water holding capacity (WHC), organic C (C), pH, cation exchange capacity (CEC). The growth of palm oil seedling significantly increases as indicated by the increase of root dry and fresh weight. Good medium of palm oil seedling were obtained in composition consisting of 1.5 kg sludge/polybag and 1.5 kg manure/polybag mixed with subsoil material.

Keywords: Sludge; Manure; Subsoils; Palm Oil Seedling; CEC; WHC; pH; Fresh Root Weight; and Dry Root Weight.

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1. Introduction

Good and healthy seedling is needed to produce health palm oil (*Elaeisguineensis*Jacq). Preparation of good planting medium is an attempt to get healthy and uniform seedlings. Generally, good media is top soil at a depth of around 0-20 cm [2,4,6]. The soils material has a number of good properties such as high soil organic matter, crumb structure and good fertility that can support the growth of seedlings [7]. However, the use of top soil has an impact on soil and environment. The use of top soil will reduce topsoil and damage land resources and as result is land degradation and environmental damage. To overcome this problem, the use of subsoil is an alternative for palm oil nursery media. But the soil material from subsoil has several constraints, among others low organic matter content, the structure is not good, low nutrients and others [9]. Therefore, the soil properties should be improved in advance to support the growth of palm oil seedlings in the nursery. Generally, the addition of organic matter, compost and manure to the soil will improve the quality of the soil physic-chemical properties as have been reported by researchers [1;3;5;8;10;11]. However researches on the use of sludge (BL), sugar mill waste and manure (PK) for subsoil is still limited as well as the utilization. Therefore, the purpose of this study is to examine the use of BL and PK to improve subsoil properties as a medium for palm oil seedlings.

2. Materials and Methods

This research was conducted at Field Experiment, Faculty of Agriculture, UISU located in the district of Medan Johor, Medan in altitude ± 45 m asl. The materials used is consisted oftopsoil (top soil) and sub-soil, each taken at a depth of around 0-20 and 20-50 cm, certified palm oil seed Marihat 4 months old; sludge material (BL) from PTPN II Sei Semayang, cow manure (PK) from Telaga Sari Village, Tanjung Morawa, insecticides used is Confidor 5 WP, Fungicide is Victory 80 WP. Sub soil, BL, and PK was analyzed in laboratory to determine the properties. This experiments use a factorial randomized block design. The treatments were consisted of two factors, namely : (1) sludge (BL) application, consisted of 4 levels : 0% (0 kg/polybag), 5% (0.5 kg/polybag), 10% (1 kg/polybag), and 15% (1.5 kg/polybag) and (2) PK application, consisted of 4 levels : 0% (0 kg/polybag), 5% (0.5 kg/polybag), 10% (1 kg/polybag) and 15% (1.5 kg/polybag). Subsoil is weighing around 10 kg and filled in polybags according to the number of treatment. Material of BL dan PK is weighed 0.5 kg; 1 kg and 1.5 kg. Experimental unit is made by means materials of BK and BL, both individually or in combination, mixed evenly with the soil in accordance with the treatment. Each treatment was made duplicate. Palm oil seeds is planted in each of the polybags that had been treated by BL and PK. Plant maintenance activities is include: watering, replanting, fertilization, mechanically/manualypest and weed control and chemically disease control. Watering is done in the morning or afternoon on a regular basis, especially at the beginning of seedlings transplanting into polybags. Seedlings that grow abnormally until 2 weeks after planting is replaced with the same age seedling. The observed parameters is soil physical and chemical properties such as : N-total (Kjeldahl), C-organic (Black), CEC (NH4OAc 1 N pH7,0), soil moisture content, pHH_2O (1: 1). The observed plants parameters are fresh root weight (seeds removed from polybag, thoroughly washed, dried and then the roots, stems, and leaves separated); dry roots weight (roots that have been separated is inserted into the paper bag that had been hollowed and then heated in an oven at 105 ° C for 24 hours), and then weighed.

3. Results and Discussion

3.1. Soil Properties, BL and PK

The results of subsoil analysis, BL and PK materials is presented in Table 1. The table shows that subsoil has very low nutrients (N) and C-organic and low P, K and Mg. These conditions indicate the quality of soil is not good for plant growth. If this condition is not improved, the lack of nutrients and C-organic can be a factor inhibiting for plant growth.

Table 1: Analysis Results of Some Soil Properties, BL, and PK

Properties	Material Properties		
	Soil	BL	PK
Nitrogen (%)	0.02 **	0.31	1.24
C-Organic (%)	0.06 **	5.09	15.28
C/N	3,00	16,42	12,32
P-Bray II (ppm)	8.97 *	0.33	0.42
K-exchangable (me/100g)	0.14 *	0.27	0.38
Mg (me/100g)	0.59 *	0.29	0.53
Water Contend (%)	-	4.79	13.92

*Note : ** very low , * low*

Table 1 also shows that BL and PK containing relatively high of N and C-organic, as well as containing nutrients such as P, K and Mg required by plants. Therefore, application of BL and PK is believed able to improve the soil physical and chemical properties and in turn improve soil quality for good growing medium for palm oilseedlings.

4. Effect of BL and PK on the Soil Properties

4.1. Effect of BL and PK on N-total

Effect of BL and PK on N-total is decribed in Figure 1. Figure 1 shows that application of BL and PK increase the content of N-total with the regression equation as follow:

$$Y_N = 0{,}09 + 0{,}08BL \quad R^2 = 0{,}76 \quad n=48.$$

$$Y = 0{,}14 + 0{,}003PK; \quad R^2 = 0{,}01$$

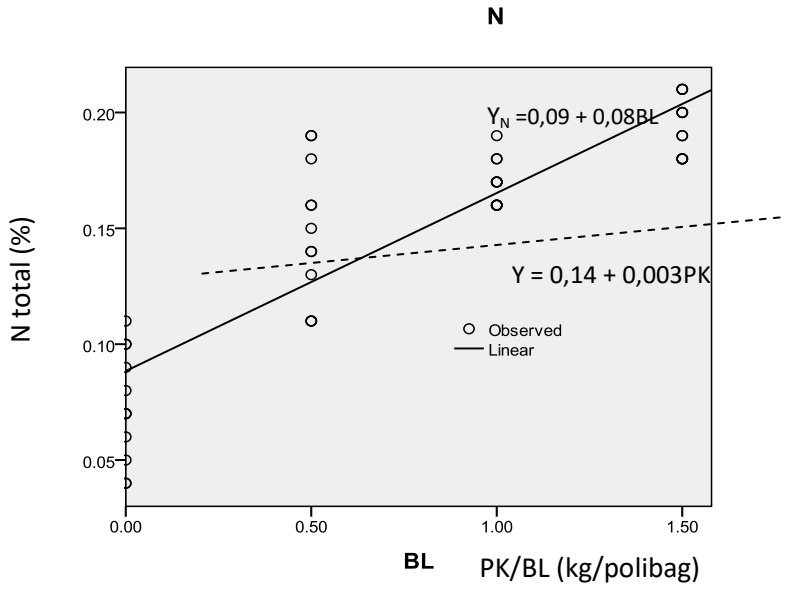

Figure 1: Effect of BL and PK on N total

Increased of N-total as a result of BL application is higher than PK at the dose of 1.0 to 1.5 kg / polybag. This condition can be caused by: (1) N compound in BL material in the form of organic compounds (proteins) are relatively higher as shown by the value of C/N material 16.42, higher than the C/N of PK materials (12, 32). (2) the potential of N-organic mineralization on BL material is higher than PK materials. These occur because sugar/carbohydrates content in BL is higher as energy source to supports the growth and activity of soil microbes to process Nmineralization, (3) high content of N-organic compounds in BL material, through the mineralization process, can increase N total greater than can be supplied by PK materials.

4.2. Effect of BL and PK on Soil C-organic

Effect of BL and PK on soil C-organicis decribed in Figure 2. Figure 2 shows that application of BL and PK increase the content of soil C-organi. Effect of BL is greater than the PK at a dose of 1.0-1.5 kg / polybag with the regression equation as follow:

$$Y = 0{,}82 + 0{,}85BL;\ R^2 : 0{,}67;\ n=48$$

$$Y = 1{,}27 + 0{,}25PK\ \ R^2 = 0{,}06,\ n=48$$

The high of C-organic on BL is because BL has C/N ratio higher (16.42) than C/N ratio on PK (12.32).As result,potential C-organic on BL is higher so that by weathering process can contribute higher C-organic or increasing at dose above 0.50 kg.

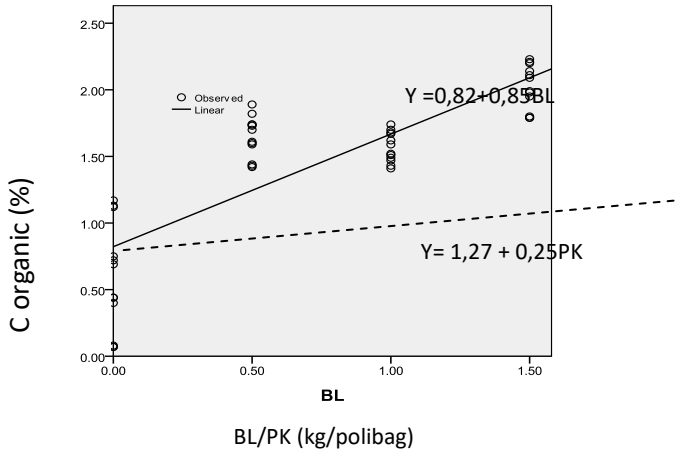

Figure 2: Effect of BL and PK on Soil C-organic

4.3. Effect of BL and PK on soil CEC

Effect of BL and PK on soil CEC is presented in Figure 3. The figure shows that the CEC increases with increasing of BL and PK application. Increasing CEC value due to the application of BL is higher (R^2 = 0.84) compared to PK (R^2 = 0.12) at a dose range of 1.0 to 1.5 kg / polybag. Relationship between BL application and CEC is described by the regression equation Y = 8.05 + 8,64BL,R^2 = 0.84; while for PK is Y = 12.1 + 3,24PK, R^2 = 0.12. Increased CEC, either by BL or PK application, is caused by and along with the increase of soil C organic as shown in Figure

4.4. Effect of BL and PK on Water Content

Effect of BL and PK application on water content is presented in Figure 4. Figure show that the soil water content increases with increasing doses of PK and BL.

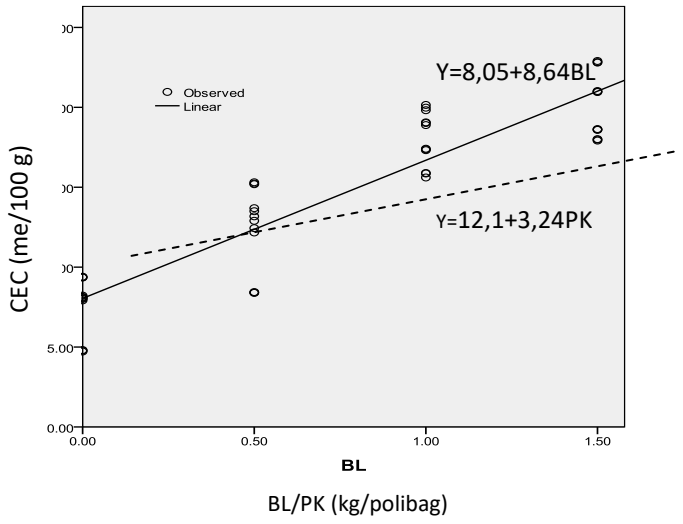

Figure 3: Effect of BL and PK on CEC

Increased of water content due to application of BL is higher than PK. This difference is shown by the

regression model that describes the relationship between BL with the water content, namely Y_{KA} = 15.33 + 1,41BL, R^2 = 0.45 n = 48 where the coefficients b (1.41) is higher than the coefficient b (0.56) of PK, namely Y_{KA} = 15.96 + 0,56PK, R^2 = 0.072

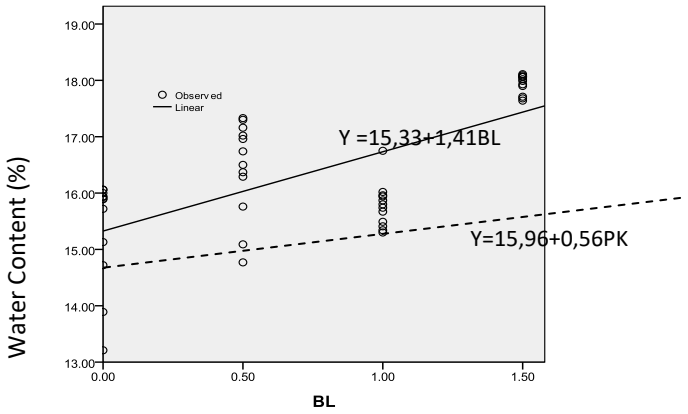

Figure 4: Effect of BL and PK on Water Content

5. Effect of BL and PK on Correlationamong Soil Properties

Correlation among the soil properties under the effect of BL and BK application ospresented in Table 2. The table shows that between the soil properties has a very close relationship, except for pH with N-total. This phenomenon indicates that application of BL and PK change the soil properties and among soil properties affect each other.

Table 2: Correlation (r) between N-total, C-0rganic, pHH_2O, Water Content, and CEC under treatment of PK and BL

Variable		C-0rganic	pH_{H2O}	Water Content	KTK
N-total	Pearson Correlation	.940**	**.188**	.644**	.805**
	Sig. (2-tailed)	.000	.201	.000	.000
C-0rganic	Pearson Correlation	1	.337*	.740**	.820**
	Sig. (2-tailed)		.019	.000	.000
pH_{H2O}	Pearson Correlation		1	.436**	.299*
	Sig. (2-tailed)			.002	.039
Water Content	Pearson Correlation			1	.614**
	Sig. (2-tailed)				.000

***. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed). N=48*

A very close relationship, as shown in Table 2, were found between C-organic with pH (0.337 *), water content (0.740 *) and CEC (0.820 *). The relationship indicates that C-organicdetermine the pH (Figure 5), moisture content (Figure 6), and CEC (Figure 7).

All three soil properties are increased with an increase in C-organic content. Therefore, application of BL and PK is potential in improving the sub soil qualitya medium for palm oil nurseries.

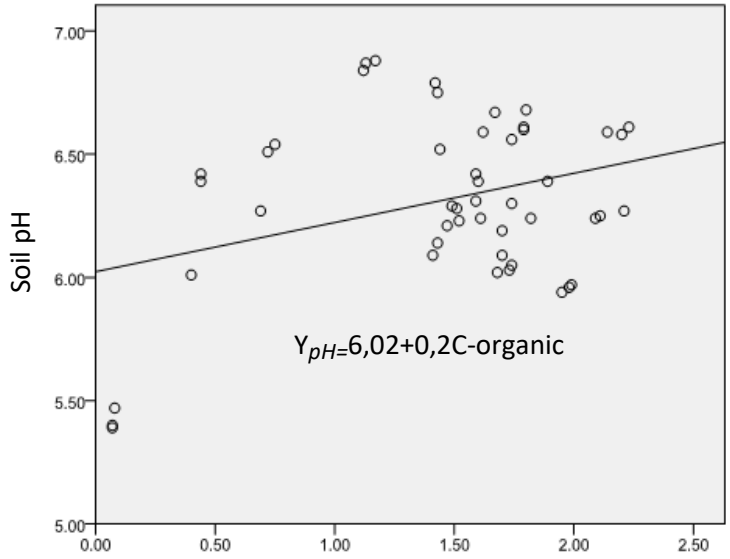

Figure 5: Effect of C-organic content on the soil pH under BL and PK application

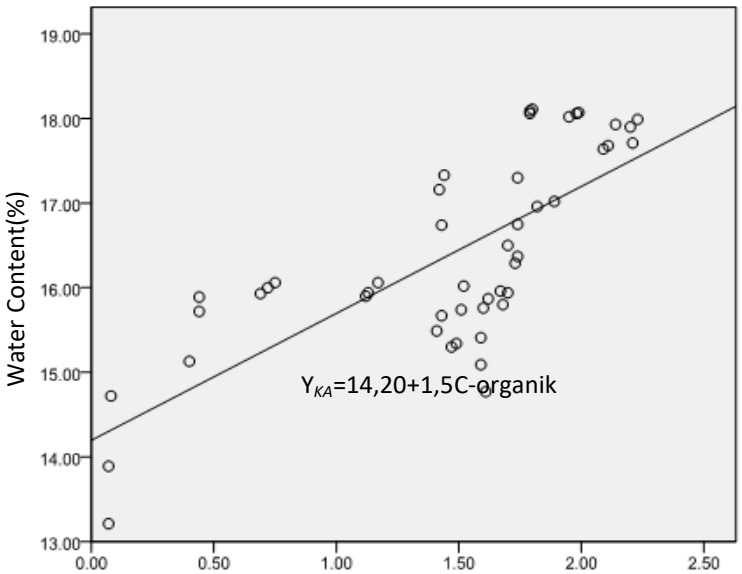

Figure 6: Effect of C-organic content on the water content under BL and PK application

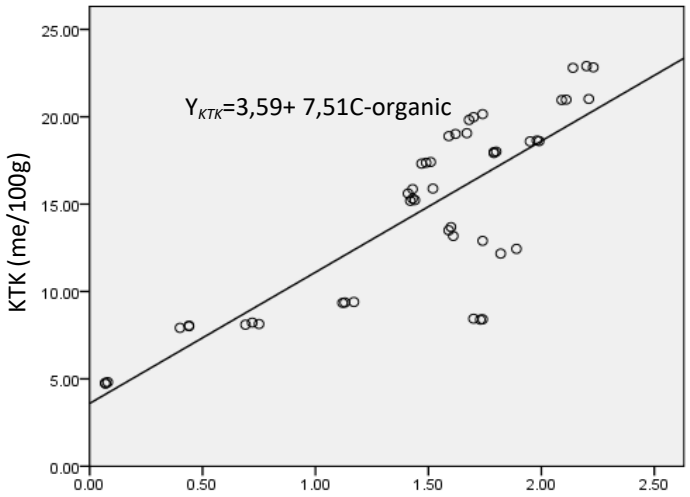

Figure 7: Effect of C-organic content onCEC under BL and PK application

6. Effect of BL and PK on Palm Oil Seedling

6.1. Effect of BL on Root Fresh Weight

Effect of BL and PK on the root fresh weight of palm oil seedlings is presented in Figure 8. The figure shows that the root fresh weight increase due to application of BL and PK. The increase in root fresh weight is higher on BL apllication at doses of 1.0 -1.5 kg / polybag than that PK; however PK application at doses of <1.0 kg / polybag is relatively higher than that BL, but the increase is relatively lower.

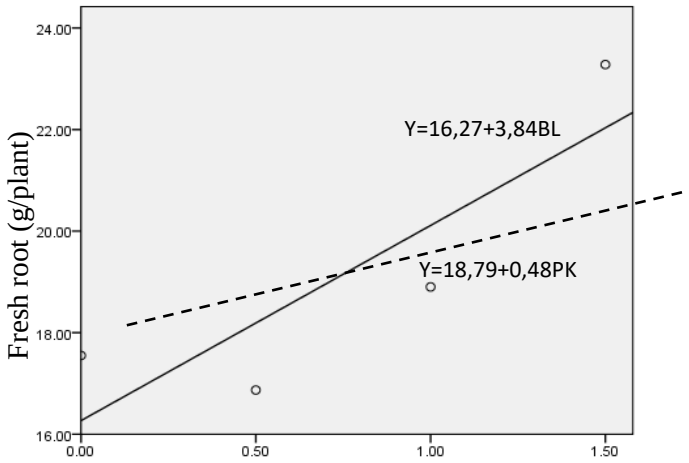

Figure 8: Effect of Sludge (BL) and Manure (PK) on the roots fresh weight of palm oil seedlings

The hugher effect of BL than PK is indicated by coefficient b (0.48) of PK is lower than coefficient b (3.84) in BL.

6.2. Effect of BL and PK on Root Dry Weight

Effect of BL and PK treatment on root dry weight is presented in Figure 9. The figure shows that the application

of BL and PK linearly increase the dry root weight with equation : y = 16:27 + 3.84 (PK), r = 0.86 and Y = 18:55 + 0,238BL r = 0:55, respectivelly. In the interaction, the effect of PK is stronger than BL that do not significantly increase the root dry weight.

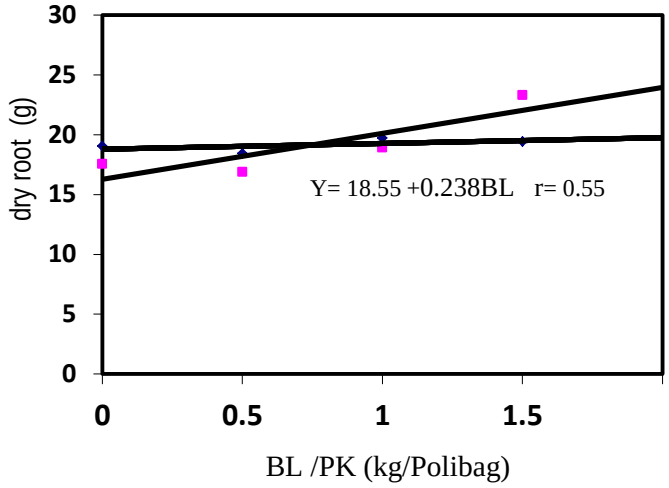

Figure 9: Effect of BL and PK Interaction on Root Fresh Weight per Palm oilSeed

The high influence of PK on the root dry weight may be caused by the nutrient content (N, P, K and Mg) on PK is relatively higher so that more and faster can be used to meet the needs of plants.

7. Conclusions and Recommendations

7.1. Conclusions

1. The analysis results of the nutrient content in PK IS higher than BL
2. Application of BL and PKincrease the levels of C-organic, CEC, pH, and soil water content
3. In the combination of BL and PK treatment, there is close correlation between the soil properties such as C-organic with pH, C-organic with water content, and C-organic with CEC.
4. BL and PK treatment increase the palm oil growth
5. In the interaction, the effect of BL is stronger than PK on some soil properties (C-organic, CEC, and Soil Water Content) at a dose of 1.0 to 1.15 kg / polybag; and the opposite occurs for root dry weight.
6. The combination of PK and BL material composition to obtain good growing medium is 1.0 kg / polybag.
7. BL and PK can be used to improve the quality of subsoil for palm oil seedlings media.

7.2. Recommendations

1. Given that BL and PK is an organic material which can affect the physical properties, but it may take a long time, it is advisable to extend the period of study or conducting reserch on the effect of treatment residues.
2. For the application purpose, according to this study, it is recommended a combination of BL and PK 1.0 kg / polybag for sub soil

3. To produce acceptable agro-technology product and applicable by the user, it is advisable to formulate BL and/or PK and conduct further testing for its effectiveness in improving the physical and chemical properties of soil as a medium of palm oil nursery or other use.

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