The Improvement of Oil Palm Seedling through Shade, Manure and Organic Liquid Fertilizer in Ultisol Media

https://doi.org/10.18196/pt.v11i1.13415

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ABSTRACT

The development of oil palm nurseries in Bengkulu is constrained by plant media, such as ultisol soil, which has low nutrients. Nutrients in ultisol can be equipped by organic matters such as manure and liquid organic fertilizer (LOF). Moreover, the light intensity also could affect seeds growth. This research aimed to determine the improvement of oil palm in pre-nursery as affected by LOF, types of manure application, and shade to obtain the best treatment combination. The research was conducted from June until September 2021 in Beringin Raya, Bengkulu city. The study was arranged in a split-plot design in a completely randomized block design consisting of 3 factors with three replications. The main plot was shade percentage ((N1=50% dan N2=75%), the subplot was liquid organic fertilizer doses ((B1=0%, B2=5% and B3=10%), the sub subplot was the types of manure (P1=cow manure, P2=chicken manure, P3=goat manure, and P4= without manure). The observation was made on the growth components of oil palm seedlings until 3.5 months. There was an interaction between shade, LOF, and types of manure to the number of leaves. There was no interaction between LOF and types of manure. The shade did not affect the growth factors of the seeds. Applying 10% LOF can improve the growth of oil palm seedlings. Chicken manure has the highest variable value on the hump diameter and the number of leaves seedlings.

Keywords: Fertilizer, Growth, Oil Palm, Seedling.

ABSTRAK

Pengembangan pembibitan kelapa sawit di Bengkulu terkendala oleh media tanam berupa tanah ultisol yang sedikit unsur hara. Hara pada ultisol dapat dipenuhi dengan bahan organik yang diaplikasikan berupa pupuk kandang dan pupuk organik cair (POC). Selain itu, faktor intensitas cahaya juga mempengaruhi pertumbuhan bibit. Penelitian ini bertujuan untuk mengetahui peningkatan pertumbuhan kelapa sawit fase prenursery terhadap POC, jenis pupuk kandang dan persentase naungan serta menentukan kombinasi perlakuan yang terbaik. Penelitian dilaksanakan pada bulan Juni sampai September 2021 di kelurahan Beringin Raya, Kota Bengkulu. Penelitian dirancang secara split split plot dalam rancangan acak kelompok lengkap dengan 3 faktor dan 3 kali ulangan. Petak utama adalah naungan (N1=50% dan N2=75%), anak petak berupa dosis pupuk organik cair (B1=0%, B2=5% dan B3=10%) dan anak anak petak adalah jenis pupuk kandang (P1=pupuk kandang sapi, P2=pupuk kandang ayam, P3=pupuk kandang kambing , P4=tanpa pupuk kandang). Pengamatan dilakukan pada komponen pertumbuhan bibit kelapa sawit sampai 3,5 bulan. Hasil menunjukkan bahwa terdapat interaksi persentase naungan, POC dan jenis pupuk kandang pada variabel jumlah daun. Tidak ada interaksi antara POC dan jenis pupuk kandang. Perlakuan naungan tidak memberi pengaruh terhadap pertumbuhan bibit. Pemberian dosis POC 10% dapat meningkatkan pertumbuhan bibit kelapa sawit. Aplikasi pupuk kandang ayam memperoleh nilai tertinggi pada variabel diameter bonggol dan jumlah daun.

Kata kunci: *Pupuk, Pertumbuhan, Kelapa sawit, Bibit.*

INTRODUCTION

The advance of oil palm (*Elaeis guineensis* Jacq) plantations in Bengkulu is supported by a large area. In 2019, the oil palm plantations in Bengkulu province reached 208 627.11 ha, covering Muko-Muko, North Bengkulu, and South Bengkulu (BPS, 2020), with the production of 1 073.50 thousand tons (BPS, 2021a). Bengkulu Province potentially increase oil palm production based on oil palm plantations area. This is evidenced in BPS (2021b) that the area of land cultivated in 2020 was 325.30 thousand ha. So, the land expansion for oil palm plantations from 2019 to 2020 was 116.67 thousand ha.

The planting medium, such as ultisol soils,

Article History
Received: 18 Desember 2021
Accepted: 15 Desember 2022

constrains the work to develop the oil palm seedlings in Bengkulu. The characteristics of ultisol soils in oil palm plantation areas in Bengkulu are low pH (4,35-5,20), low C-organic, and very low nutrient content of N, P, and K-d (Nurmegawati et al., 2020). Acidic soils such as ultisols have high mineral content, and Al inhibits root growth and decreases photosynthesis (Hidayah et al., 2020). The high acidity of the pH and the low availability of nutrients in ultisol require organic matter addition to complete the nutrients needed during the oil palm seedling period.

Organic materials such as manure and Liquid Organic Fertilizers (LOF) can provide macro and micronutrients and increase soil CEC. Liquid Organic Fertilizer to encourages oil palm growth in pre-nursery (Anhar et al., 2021). Effendy et al. (2019) also stated that treating chicken manure with as much as 200 g/polybag significantly affected pre-nursery seedlings growth of oil palm. The organic material using in the pre nursery, like cow manure as much as 360 g/polybag + NPK 4.5 g/polybag could increase the growth of seedlings with the content of organic C, total N, and C/N ratio of 40.94%, 2.33%, and 17.60, respectively (Adileksana et al., 2020).However, the nutrients in manure are not directly available to plants, so it is necessary to combine LOF fertilization with spray application so plants can easily absorb nutrients through leaves. Applying LOF 20 ml/seed in oil palm seedlings (Madusari, 2019) affected growth and increased biomass and leaves greenness. Meanwhile, treating LOF from banana peels at 50 ml/polybag to 100 ml/polybag did not meaningfully affect the growth of pre-nursery oil palm seedlings (Sulardi, 2019).

Besides fertilizing, the oil palm seed needs shading to reduce media evaporation. Based on the standard of seedlings management in 2016, the optimum shading was 60%. That was different from research by Barus et al. (2017), stating that the best growth of oil palm seed was obtained at 25% shade. However, the best concentration of LOF and types of manures for oil palm seedling has not been reported, especially on ultisol media. Thus, this research aimed to regulate the improvement of the growth of oil palm seedlings in pre-nursery as affected by LOF, the types of manure application, and shade to obtain the best treatment combination.

MATERIALS AND METHODS

Study area

The research was conducted from June to September 2021 in Beringin Raya Village, Muara Bangkahulu, Bengkulu City, at 10 m above sea level. This research use seeds from Oil palm Research Center Indonesia, Simalungun varieties.

Experimental design

The study was organized in a split-plot design in a completely randomized block design of 3 factors. The shade as main plot with two percentages (50% and 75%), the concentration of liquid organic fertilizer as subplot, consisting of three treatments, namely 0%, 5% (50 mL/L), and 10% (100 mL/L). The types of manure as sub subplot with four types: cow, chicken, goat, and without manure. There were 24 treatment combinations with three replications to form 72 experimental units using 15 cm x 23 cm polybags.

Making of LOF

LOF was composed of household organic waste. The 50 kg organic waste is composed of 1 L decomposer (EM4) made liquid by 10 L water sugar palm (250 g) in a composter. That was stirred every week until six weeks. Liquid organic fertilizer treatments were given from the 4th week after planting until the 12th week

LOF and Manure application

The LOF was applied once in two weeks with different concentrations according to the treatments. LOF treatment was given five times. The 50 mL/L concentration was divided into five times applications, successively the first to the fifth application: 4 mL, 8 mL, 12 mL, 16 mL, and 14 mL. The 100 mL/L concentration was divided into five times applications, successively the first to the fifth application: 8 mL, 12 mL, 20 mL, 25 mL, and 35 mL. LOF sprayed to under leaf and surface and given at 06.00-07.00 clocks. The manure was given 50 g/polybag one week before planting.

Soil Analysis

The analyzed of soil, LOF, and manure were at the Soil Science Laboratory, Faculty of Agriculture, Bengkulu University.

pH analysis

the pH analysis method was based on Sulaeman et al. (2005). Two shaker bottles were each filled with 10 g of soil. The first bottle was added with 50 ml of ionized water (pH H_2O), and the other was added with 50 ml KCl 1 M (pH KCl). The mixture was then mixed during 30 minutes with a whisk. The soil suspension was scale with a pH meter calibrated apply buffer solution pH 7.0 and pH 4.0.

Total Nitrogen content

Ammonium levels in the extract can be determined by distillation or spectrophotometry. The extract was made alkaline by adding NaOH solution in the distillation method. Next, the liberated NH_3 was bound by boric acid and titrated with a standard H_2SO_4 solution using Conway's pointer. The spectrophotometric used the indophenol blue color generator method (Sulaeman et al. 2005).

Phosphor and Potassium content

Phosphor content was analyzed using the Bray I method (FAO, 2021). A total of 2.5 g of < 2 mm soil was added to 25 mL Bray and Kurt I extractor, and the total of P was gauge using an extracting solution with the mixture of 0.03 M NH4F and 0.025 M HCl shaken for 5 minutes. Two ml of clear extract was added into a test tube. The example and standard series of 10 mL of phosphate dye reagent were added to each, shaken, and let for 30 minutes. The absorbance was scaled using a spectrophotometer at the 693 nm wavelength.

Potassium content was analyzed using the method by Sulaeman et al. (2005). A total of 20 g of soil sample <2 mm was added in a 100 ml shaker bottle and added with 1 mL of activated carbon and 40 mL of Morgan Wolf extract, then shaken for 5 minutes with a shaker at a minimum of 180 shakes min^{-1} Filter with Whatman No.1 filter paper to obtain a clear extract. 1 mL of extract and standard series each was put into a chemical tube and added with 9 ml of 0.25% La solution, then shaken using a tube shaker. K was measured by means of a Flamephotometer with standard series for comparison.

Organic C content

Organic C content was measured using a spectrophotometer (Sulaeman et al. 2005). A total of 0.5 g of the soil of <0.5 mm was put into a flask calculated 100 mL, added with 5 mL $K_2Cr_2O_7$ 1 N, and shaken. 7.5 mL of Concentrated H_2SO_4 was added, shaken, and left for 30 minutes. The dilution was carried out with free water ions until cool and compressed. The next day, the absorbance of the solution was measured with a spectrophotometer at a wavelength of 561 nm.

LOF and manure analysis

Total N, phosphor, and potassium content

The organic N and N-NH_4 present in the sample were destructed with sulfuric acid and selenium mixture to form ammonium sulfate, distilled by

adding base excess, and finally, the distillate was titrated. Nitrogen in nitrate was extracted with water, reduced by devarda alloy, distilled, and finally titrated. The sample was wet oxidized with HNO_3 and $HClO_4$. The extract obtained measured phosphor and potassium using a spectrophotometer and flame photometer, respectively. The method, according to Sulaeman et al. (2005).

Organic C (Walkey and Black)

Organic C in the soil was oxidized by dichromate in an acidic environment. The chromium III formed was equivalent to the oxidized organic C and dignified using a spectrophotometer (Sulaeman et al. 2005).

Seedling growth analysis

Observations were made on the oil palm seedling growth variables, including the seedling height at 4, 6, 8, 10, and 12 weeks after planting (WAP), leaf greenness, the number of leaves, and the width of the leaf and hump diameter.

Statistical analysis

Data analysis was performed using analysis of variance (ANOVA) by SAS. If the ANOVA was significant <0.05, the analysis was carried out using Duncan's Multiple Range Test (DMRT) levels 5 %.

RESULTS AND DISCUSSION

The effect of shade on the growth of oil palm seedlings

Based on anova data, variable number of leaves had an interaction the types of manure and LOF (Table 3). Meanwhile, 50% and 75% shade percentage treatment have no impact to the growth variables of oil palm seedlings. Shade did not affect the growth of oil palm seedlings from the beginning of planting until the 12 WAP. Shading with a percentage of 50% was not significantly different from the shade percentage of 25% for seedling height (Barus et al., 2017). However, the shade needs to be provided because the height of seedlings without shade is much lower than that of shaded ones (Agele et al., 2017). This happens

Table 1. Analysis of N, P, K and organic C of the three types of manure and liquid organic fertilizer (LOF)

Indicator	Cow manure	Chicken manure	Goat manure	LOF
Total N (%)	1.06	0.90	1.20	2.11
P (%)	0.54	0.60	0.79	0.29
K (%)	0.86	0.69	0.96	0.69
Organic C (%)	13.97	15.61	19.13	8.41

Table 2. Results of soil chemical analysis at the initial and after application of manure and LOF

Application	pH	Total N (%)	P available (ppm)	K –dd (me/100 g)	Organic C (%)
Initial soil	4.06	0.12	4.33	0.24	2.61
0% LOF+Cow manure	4.53	0.18	5.46	0.28	2.59
0% LOF+Chicken manure	4.96	0.17	6.83	0.46	2.24
0% LOF+Goat manure	4.3	0.18	5.69	0.40	2.33
0% LOF no manure	4.42	0.14	4.33	0.17	3.19
5% LOF+Cow manure	4.6	0.15	6.39	0.28	2.12
5% LOF+Chicken manure	5.13	0.17	7.87	0.48	2.21
5% LOF+Goat manure	5.16	0.18	4.67	0.36	3.13
5% LOF no manure	4.45	0.14	4.18	0.25	1.20
10% LOF+Cow manure	4.70	0.14	4.67	0.29	2.24
10% LOF+Chicken manure	5.23	0.20	6.64	0.25	2.39
10% LOF+Goat manure	5.07	0.14	5.16	0.39	3.03
10% LOF no manure	4.75	0.16	4.18	0.25	2.84

Table 3. ANOVA analysis on variables of oil palm seedlings as affected by shade treatment, liquid organic fertilizer and manure.

Variable	Shade	LOF	Manure	LOF x Manure	Shade x LOF x Manure	SD
Seed height 4 wap	0,492	13,69*	4,74*	0,786	0,573	1.51
Seed height 6 wap	3,127	11,812*	2,293	0,717	1,357	2.54
Seed height 8 wap	4,664	11,448*	2,692	0,341	1,122	3.48
Seed height 10 wap	4,048	11,862*	3,201*	0,922	0,784	3.15
Seed height 12 wap	7,744	10,296*	4,309*	1,137	1,033	3.61
Leaf greeness	4,410	1,210	14,653*	0,693	0,867	6.46
Hump diameter	1,727	0,233	5,159*	1,324	1,020	0.12
Leaf width	13,512	8,017*	3,084	0,337	0,867	0.79
The number of leaves	1,00	4,571*	13,732*	0,780	2,634*	0.57

Remarks: * = significantly affected based on the level of ANOVA analysis test of 5%.

Table 4. The average of seedling height, hump diameter and the number of leaves as affected by the LOF dose treatment

LOF	Height Seed (cm)					Hump diameter (cm)	Number of leaves
	4 wap	6 wap	8 wap	10 wap	12 wap		
0%	4.64 b	9.17 ab	14.44 b	16.69 b	18.33 b	0.29 a	2.71 a
5%	5.01 b	10.12 b	13.44 b	16.03 b	17.55 b	0.33 a	2.38 b
10%	5.89 a	11.42 a	16.49 a	18.57 a	20.53 a	0.35 a	2.71 a

Remarks: Means followed by the same letters in the same column are not significantly different based on Duncan's test at 5%.

Table 5. Effects of the types of manure on the seedling height, leaf greenness, hump diameter, leaf width and the number of leaves

Kinds of manure	Seed Height (cm)				Leaf greenness	Hump diameter (cm)	Leaf width (cm)	Number of leaves
	4 wap	8 wap	10 wap	12 wap				
Cow manure	4.68 b	13.54 b	15.79 b	17.33 b	31.42 bc	0.30 b	3.29 b	2.44 bc
Chicken manure	6.21 a	16.35 a	18.69 a	20.85 a	39.76 a	0.41 a	4.03 a	3.06 a
Goat manure	5.16 b	15.33 ab	17.47 ab	19.32 ab	32.88 b	0.31 b	3.52 b	2.72 b
No manure	4.68 b	13.93 b	16.45 b	17.73 b	28.57 c	0.28 b	3.36 b	2.17 c

Remarks: Means followed by the same letters in the same column are not significantly different based on Duncan's test at 5%.

because of inhibiting the hormone auxin synthesis at low light intensity. The results of the (Sinuraya, 2019) research also showed that shade provided more significant growth of oil palm seedlings than without shade, with a different value of 29.86% for height and 25.01% for hump diameter. The oil palm seedlings under shade had the best deal on fronds and shot at prenursery compared to those without shades because the shade affects the soil moisture (Agele et al., 2017).

The number of leaves, greenness, and leaf width was not affected by shade. This means that 50% shade was optimal for the growth of oil palm in prenursery.

The effect of LOF and manure on Ultisol

The nutrient content of total N, P, K, and organic C in the three manures was high. Among the types of manure used, goat manure resulted in the highest organic C content, N, P, and K nutrients, followed by cow manure and chicken manure. Liquid organic fertilizers resulted in an increased total N. Nutrient analysis data of N, P, K, and C of organic manure and LOF are presented in Table 1.

Ultisol soil initially had a very acidic pH, low N, P, and K nutrients, and moderate organic C content (Table 2). The application of manure and LOF increased the pH of the ultisol soil compared to before treatments. There was also growing pH

soil in the treatment of LOF only, though the value was not high compared to manure application. The average increase in pH reached 0.75, and the highest pH value was in the combination of 10% LOF and chicken manure with an increase in pH of 1.17. This increase in pH was much higher than the results of Enita et al. (2020a), which was only 0.58 on ultisol soil for oil palm seedlings with the addition of titania compost and lime.

In general, the availability of Nitrogen, Phosphate, and Kalium nutrients after applying manure and LOF were higher than in the initial soil. The highest total Nitrogen was given with 10% LOF + chicken manure, and using 5% LOF + chicken manure increased the available P and K-dd. The nutrient content of N, P, and K in manure and LOF, which was relatively high, contributed to the contribution of nutrients in the soil, increasing nutrient availability increased at treated ultisol soil.

Based on Table 1, chicken manure has a higher organic C content than cow manure. It is known that organic C supports the growth of soil microbes that can increase the availability of soil nutrients. Thus, ultisol media treated with chicken manure have higher N, P, and K nutrient availability than those treated with cow manure. It can be seen in Table 2 that the availability of N, P, and K nutrients after the application of chicken manure was greater.

The availability of N, P, and K nutrients increased after the application of manure and LOF. In contrast, organic C content was not meaningfully dissimilar from the initial soil conditions. There was even a decrease in soil organic C content in the treatment of 5% LOF and chicken manure. This decrease in organic C content was different from the results of Enita et al. (2020b), where there was an increase in organic C content due to the addition of lime and other organic materials that can increase the organic C content.

The effect of LOF on the growth of oil palm seedlings

The liquid organic fertilizers applied influenced the height of seedlings from week four until week 12. In addition, LOF application also affected the number of leaves and leaf width (Table 3). Based on Duncan's test (Table 4), giving LOF at a dose of 10% gave the best height for the growth of oil palm seedlings with significantly different heights compared to those treated with LOF at a dose of 5% at 4, 8, 10 and 12 WAP. Meanwhile, the height of the seedlings treated with LOF at 5% and 0% doses were not significantly different. Applying 10%, LOF could increase the growth of seeds. However, LOF treatment of just 15 mL/L affected frond fresh weight of oil palm seedlings in a different medium (Hout et al., 2019).

The application of LOF affected leaf width and the number of leaf seedlings. The widest leaf width and the highest number of leaves were produced at a dose of 10%. This happens because the LOF was sprayed to under the leaves, then to the top of the leaves and onto the soil surface. Thus, plants can absorb macronutrients and micronutrients in LOF directly through stomata. Leaves can absorb nutrient N in liquid organic fertilizer through open stomata. The high N content in LOF gave good growth to the leaf variable components. Enita et al. (2020a) explain the organic matter have N content which needed in the vegetative phase of oil palm seedlings. Oil palm seedlings need N about 1.5 g/plant at the pre-nursery stage (Tobing et al., 2018). LOF application concentration of 35% obtained the highest N uptake value on leaves oil palm seedlings (Hastuti, 2021). Waruwu et al. (2018) results, LOF application affected leaf greenness according to increasing the concentration of LOF. Although there was no significant difference between the number of leaves from 0% and 10%, the application of 10% liquid organic fertilizer gave more

value to leaf width. Treating 10% (100 mL/L) LOF could provide sufficient nutrients for the growth of pre-nursery oil palm seedlings.

The effect of the kind of manure on the growth of oil palm seedlings

The kind of manure began to show its effect on the height of seedlings in the 4th week and then the 10th and 12th week (Table 3). Manure with the highest seedling height was produced by applying 50 g/polybag chicken manure (Table 5). The research results by Effendy et al. (2019) reported that the application of 200 g/polybag chicken manure affected the growth of oil palm seedlings on ultisol growing media.

The types of manure influenced the greenness of the seedling leaves. Chicken manure produced the best green leaf value for oil palm seedlings. Chicken manure also gave the highest value on the diameter of the hump and the number of leaves of seedlings, followed by goat manure and cow manure. This was in line with the value of the availability of N, P, and K nutrients in ultisol soil, given chicken manure, which was higher compared to those treated with other types of manure. The nutrients in chicken manure were available more quickly in soil than nutrients in other manure (Hartatik & Widowati, 2006). The fulfillment of N, P, and K nutrient requirements will support the growth of oil palm prenursery plants.

The greenness of the leaf and the number of leaves in cow manure were not significantly different from those without manure. Several research results found that the application of cow manure on oil palm pre-nursery did not affect seedling growth. The research results of Darmawan et al. (2020) reported that the application of cow manure up to 45 g/polybag did not affect height, the number of leaves, fresh weight, and dry weight of the seed. However, adding cow manure with some material, such as 0.2 g urea, could provide the best seedling growth of oil palm (Setyawan et al., 2020). The combination of inorganic fertilizers with cow manure has also been investigated by Adileksana et al. (2020), reporting that the treatment of 25% NPK and 75% cow manure gave the best growth for pre-nursery oil palm seedlings. Combining mycorrhizae and cow manure treatment could increase the growth of oil palms (Kartika et al., 2019).

The application of goat manure resulted in seedling growth that was not significantly different from that treated with cow manure. According to Hartatik & Widowati (2006), goat manure in a granular form is tough to decompose, then affects the supply of nutrients and impacts plants in the second growing season.

CONCLUSION

There was no interaction between LOF and the types of manure. However, there were interaction effects of shade, LOF, and the types of manure on the number of leaves. The shade did not have impact to the growth of oil palm seedlings. Applying 10% LOF could improve the advance of oil palm seedlings. Chicken manure has the highest variable value on the diameter of the hump and the number of leaves of seedlings.

ACKNOWLEDGEMENTS

The authors thank the LPPM Bengkulu University for funding this research in the 2021 coaching research scheme.

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