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Effect of Type and Concentration of Liquid Organic Fertilizer on the Growth of Oil Palm Seedlings (*Elaeis guinensis* Jacq) in *Main Nursery* on Subsoil Soil Layer

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ABSTRACT

The main purpose of this study is to determine the effect of various types and concentrations of liquid organic fertilizers (POC) on the growth of oil palm seedlings in the lower layer of oil palm seedlings in the main nursery. This research was carried out at KP2 Instiper Yogyakarta in the villages of Kalikuning and Maguwoharjo, Special Region of Yogyakarta, from January 15 to April 15, 2025. The method applied was in the form of a two-factor factorial design with a Complete Random Design (RAL), using control and concentration of POC of 20%, 30%, and 40% as variables, with the type of POC (lamtoro, market waste, eco farming) as another factor. A total of 48 seedlings from 12 treatment combinations and 4 replicates were made. Variant analysis (ANOVA) at a significance level of 5% was used to detect differences, then further DMRT tests at the same level to determine the real differences. Root weight (wet and dry), leaf chlorophyll content, leaf area, and POC type and level showed significant interactions. The 40% market waste POC concentration is most optimal for wet root weight and chlorophyll content, while dry root weight is best at 30% and 20% concentrations. The largest leaf area is achieved with a concentration of 40% of POC waste markets, eco farming, and lamtoro. The three types of POC have a similar effect on plant height, stem diameter, root length, number of fronds, and weight of wet and dry shoots. A POC concentration of 40% indicates an advantage over 30%, 20%, and control in the number of fronds and the weight of shoots both wet and dry.

KEYWORDS: liquid organic fertilizer, concentration, subsoil, *main nursery*

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INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq) is a major plantation commodity in Indonesia that has large export potential, high economic value, and production output exceeds other vegetable oil-producing crops, so its development opportunities are very promising. In January 2024, the initial stock of CPO was recorded at 3.146 million tons, with CPO and PKO production of 4.634 million tons (GAPKI, 2024). The nursery stage greatly determines the success of cultivation, one of which is through fertilization to replenish the lost nutrients. However, the regular application of inorganic fertilizers can damage soil fertility and then make it hard (Hadisuwito, 2007), so organic fertilizers are needed to improve structure, increase permeability, and reduce dependence on inorganic fertilizers (Lingga, 2008).

Organic fertilizers, both solid and liquid, can be made from a variety of materials, including nitrogen-rich lamtoro plants (N 3.84%; P 0.2%; K 2.06%) and able to bind free nitrogen from the air (Septirosya *et al*., 2019). Market waste, which consists of leftover vegetables, fruits, and other organic matter, also contains elements N, P, and K, but if not managed can pollute the environment (Paramita) *et al*., 2012). Its processing through fermentation can produce liquid organic fertilizer (Anggraini *et al*., 2019) which is rich in macro-micronutrients and is able to improve the physical, chemical, and then biological properties of the soil (Supardi *et al*., 2020).

Eco Farming is a liquid organic fertilizer that is commercially marketed and increases the effectiveness of soil management while supporting sustainable production through decomposing microorganisms that act as bioactivators. The use of this fertilizer strengthens plant resistance to pests, accelerates harvest time, improves soil structure, and increases yield without damaging the environment, while improving product quality and quantity (Kurniawan, 2021).

MATERIALS AND METHODS

This research was carried out in Kalikuning Village, Sleman, Yogyakarta, with an altitude of 180 meters above sea level. The conditions of the research site include annual rainfall of 1,332 mm, temperatures ranging from 26 to 32 °C, and relative humidity between 70 to 80%. The average rainfall per month reaches 111.0 mm. The duration of the research lasted for 3 months, starting from December 2024 - February 2025. The tools used include measuring tapes, analytical balances, calipers, buckets, machetes, and ovens. The materials used are in the form of four-month-old oil palm seedlings from the main seedbed, polybags measuring 35 x 35 cm, plastic, bamboo, undersoil soil, and liquid organic fertilizer made from lamtoro leaves, eco farming, and market waste.

The experimental design applied a two-factor Complete Random Design (RAL) with a factorial pattern. The first factor is in the form of liquid organic fertilizer (POC) type with three treatments: P0 for lamtoro, P1 eco farming, and P2 market waste. The second factor is in the form of POC levels with four levels, namely D0 (control/NPK 6 g/plant), D1 (20%), D2 (30%), and D3 (40%). The total number of seeds used reached 48, coming from 12 treatment combinations that were repeated 4 times. Fertilizer is applied every two weeks from the transplant period to the end of the experiment. The data were analyzed using ANOVA at a significance level of 5%, then DMRT was then tested at a similar significance level to identify meaningful differences.

The parameters observed included the increase in seedling height, stem diameter, number of fronds, leaf area, root length, fresh/dry root weight, fresh/dry bud weight, C/N ratio of liquid organic fertilizer, and leaf chlorophyll content. Measurements of height, number of fronds, and stem diameter were taken at regular intervals, while leaf area, root length, and weight of fresh/dried roots and shoots were calculated at the end of the research. The chlorophyll content was measured in the final stage of the research, while the C/N ratio was analyzed in the laboratory using POC samples.

RESULTS AND DISCUSSION

The output of the study showed that there was a real interaction between the types of POC concentration to the parameters of fresh root weight, dry root weight chlorophyll content, and leaf area. This means that the two factors work together for the growth of oil palm seedlings in *the main nursery.*

Table 1. The effect of type and concentration on the fresh weight of roots (g) of oil palm seedlings in *the main nursery.*

		Fresh weight of the roots	Heavy dry roots	Chlorophyll	Leaf area
Lamtoro	Control	22,75c	8,75c	23,25d	658,00e
	20%	24,00bc	11,75c	48,50a	779,50c
	30%	22,75c	17,00ab	39,50bc	813,50ab
	40%	33,00b	12,50bc	49,50a	829,50a
Eco Farming	Control	17,75d	8,75cd	22,75d	725.25d
	20%	25,50bc	14,50abc	38,25bc	820,25a
	30%	25,50bc	15,50ab	43,75ab	789,25bc
	40%	27,50bc	13,25bc	36,50c	827,25a
Market Waste	Control	10.75e	5,25d	29,25d	741.50d
	20%	21,50c	18,00a	39,75bc	793,50bc
	30%	31,50b	19,00a	46,00ab	793,75bc
	40%	46,50a	13,00bc	50,25a	842,75a

The results of the study show that there is a real interaction between the concentration of liquid organic fertilizer and several plant growth parameters. At the fresh weight of the roots, the best treatment combination was obtained at the market waste POC with a concentration of 40%, while the lowest treatment was indicated by the market waste POC with a control concentration. Furthermore, in the dry weight of the roots, there is also a real interaction, where the best treatment combination is market waste POC with a concentration of 20% and 30% which is not significantly different from eco farming POC at a concentration of 20% and 30%. The lowest treatment combination was shown by all types of POC at the control concentration.

A real interaction was also seen in the chlorophyll levels of the leaves, with the best treatment combination at the concentration of 20% and 40% lamtoro POC, as well as the market waste POC at 30% and 40% concentrations. In contrast, all sorts of POCs at the control concentration showed the lowest results. Meanwhile, in the area of leaves, there is also a real interaction, where the best treatment is shown by POC eco farming at concentrations of 20% and 40%, POC lamtoro at concentrations of 30%

and 40%, and POC of market waste at concentrations of 40%. The treatment with the lowest results was indicated by POC lamtoro at the control concentration.

Based on the variety, there is a real interaction between types and then the concentration of POC in the growth of oil palm seedlings in *main nursery* on the parameters of fresh root weight, root dry weight, leaf chlorophyll content, and leaf area. The best treatment on the fresh weight of the roots was obtained from POC market waste 40%, on the dry weight of the root from POC market waste 30% and 20%, on the chlorophyll content of the POC of market waste 40% followed by POC lamtoro 40% and 20%, as well as on the leaf area of POC of market waste, POC *eco farming* 40%, and POC lamtoro 40%. According to Nugroho *et al*., (2022)The POC waste market contains macronutrients (N, P, K) and active microorganisms that accelerate the decomposition of organic matter thereby increasing nutrient uptake by the roots, supporting root growth, fresh and dry root weight, and nutrient availability in the rhizosphere. Healthy roots increase nitrogen uptake which is essential for chlorophyll, where high chlorophyll levels signal good photosynthesis efficiency and support crown growth and leaf expansion. Widodo *et al*., (2021) confirms that good root development guarantees a supply of nutrients to the leaves, thereby increasing chlorophyll levels and leaf area reflecting optimal photosynthetic capacity.

Table 2. The effect of POC concentration on seedling growth in *the Main Nursery.*

Parameter	POC Concentration			
	Control	20%	30%	40%
Increase in seedling height	14,67p	15,25p	12,17p	13,75p
Increase in stem diameter	19,13p	19,57p	17,20p	16,00p
Increase in the number of fronds	8,50q	8.75pq	9.17pq	9,50p
Root length	40,42p	48,41p	44,79p	45,44p
Fresh Weight Title	27,75r	58,00q	61,58pq	70,25p
Dry weight title	19,46r	26,21qr	33.08pq	35,33p

Note: Based on the Duncan multiple range test at a significance level of 5%, numbers followed by the same letter in a column or row show no significant difference

The results of the analysis showed that the concentration of POC contributed to the number of fronds, the fresh weight of the crown, then the dry weight of the crown, with a concentration of 30% and then 40% giving better results than 20% and control. This concentration is able to provide optimal nutrients and stimulate soil microbial activity to accelerate the decomposition of organic matter, thereby increasing the availability of nitrogen, phosphorus, and potassium which are important for vegetative growth (Widiastuti *et al*., 2020). A concentration of 30% is enough to significantly increase the number of fronds and crown biomass.

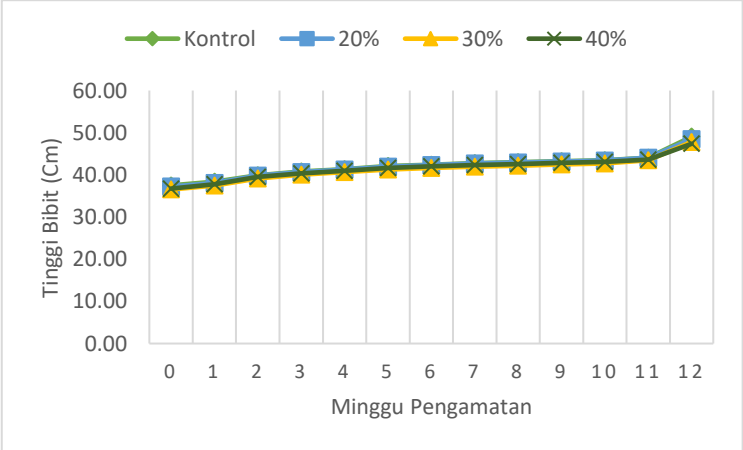

Figure 1. The effect of liquid organic fertilizer concentration on the rate of increase in the height of oil palm seedlings (cm) in *the main nursery.*

It can be seen that the rate of increase in the height of oil palm *seedlings in* all POC concentrations shows almost the same increase in seedlings, namely from weeks 1-9 showing slow growth, then increasing slowly until week 12, while the POC concentration of 30% shows faster growth than the concentration of POC control, 20%, and 40%.

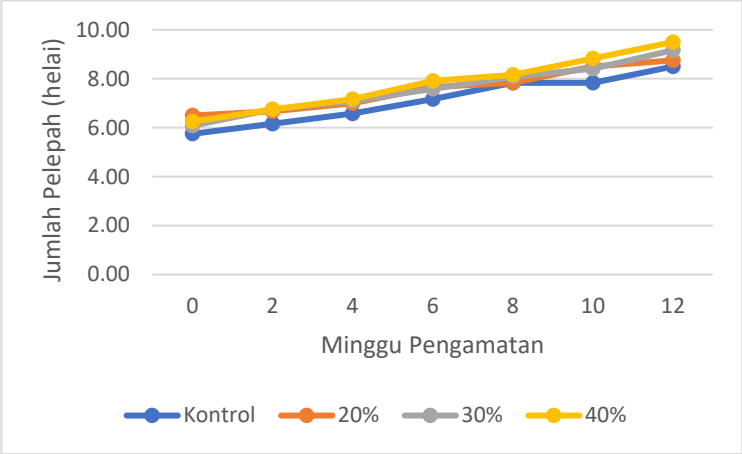

Figure 2. The effect of POC concentration on the rate of increase in the number of fronds (strands) in oil palm seedlings in *the main nursery.*

It can be seen that the rate of increase in the number of palm oil seed fronds *main nursery* all POC concentrations showed an increase in the number of fronds from weeks 1-12, while the POC concentration of 40% showed the most increase in the number of fronds at week 12 compared to the control POC concentrations, 20%, and 30%.

Nitrogen, phosphorus, and potassium play a role in the formation of meristematic tissues, leaf development, and the accumulation of crown biomass. The fresh weight of the crown reflects the water content and accumulation of the assimilate, while the dry weight of the crown indicates the total biomass resulting from photosynthesis (Prasetya & Hadi, 2019). The increase in nitrogen as well as growth hormones such as cytokinins and auxins from POC stimulates the formation of new shoots and leaves (Sari *et al*., 2021). This condition creates a synergistic relationship between the fresh and dry weight of the crown and the number of fronds, where optimal nutrient availability and physiological activity at a POC concentration of 40% favors greater crown growth, more fronds, and higher plant biomass.

Table 3. The effect of POC on oil palm seedlings in *the Main Nursery*.

Parameter	Kind of POC		
	Lamtoro	*Eco Farming*	Market Waste
Increase in seedling height	15,81a	12,31a	13.75a
Increase in stem diameter	19,11a	17.15a	17.66a
Increase in the number of fronds	8,69a	9,00a	9,25a
Root length	44,06a	41,66a	48,57a
Fresh Weight Title	56,88a	51,19a	55,13a
Dry weight title	30,81a	26,75a	28,00a

Note: In the Duncan multiple range test at a significance level of 5%, values that have identical letters in columns and rows show no significant difference.

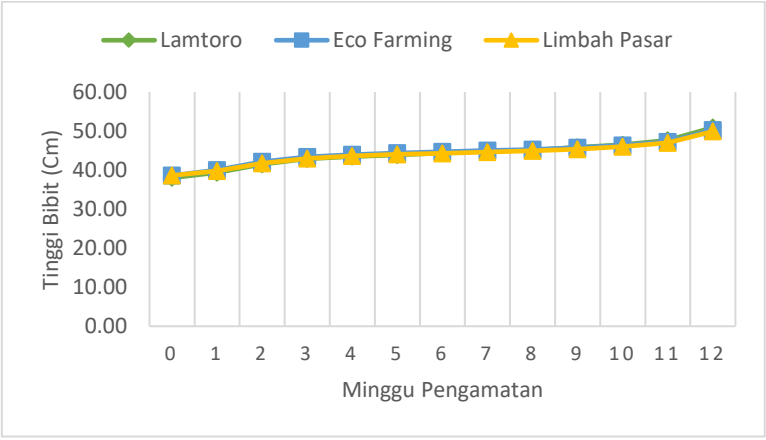

Figure 3. The effect of liquid organic fertilizer on the rate of increase in the height of oil palm seedlings in *the main nursery*.

It can be seen that the rate of increase in the height of oil palm *seedlings in* all kinds of POCs shows almost the same increase in the height of seedlings, namely from weeks 1-9 showing slow growth, then increasing slowly until week 12, while POC lamtoro shows faster growth than POC *eco farming* and market waste.

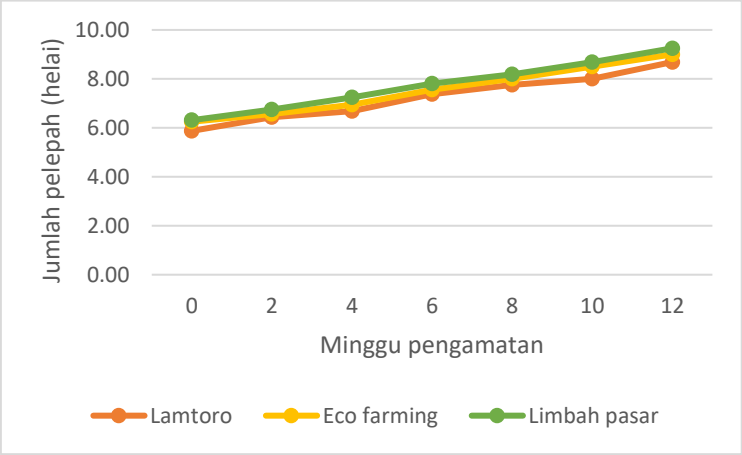

Figure 4. The effect of liquid organic fertilizer on the rate of increase in the number of fronds (strands) in oil palm seedlings in *the main nursery*.

It can be seen that the rate of increase in the number of fronds of oil palm seedlings *in all* kinds of POCs shows an increase in the number of fronds that is almost the same, from weeks 1-12, while the POC of market waste shows an increase in the number of fronds that is the most compared to POC lamtoro and *eco farming*.

Table 4. Laboratory test results of C/N POC lamtoro, *eco farming*, and market waste

No	Liquid Organic Fertilizer	C/N	Test method
1	Lamtoro	1,467	SNI 13-4720-1998; SNI 2803:2010
2	*Eco Farming*	16,95	SNI 13-4720-1998; SNI 2803:2010
3	Market Waste	0,656	SNI 13-4720-1998; SNI 2803:2010

Research on oil palm seedlings in primary nurseries shows that different types of liquid organic fertilizer (POC) have a similar impact on growth rate, stem diameter, root length, number of fronds, and weight of fresh and dry shoots. This similarity is due to the ability of the three types of POCs to provide essential nutrients that are relatively balanced and easily absorbed by plants, so that despite the different raw materials, they are all able to meet basic nutrient needs during the vegetative phase and produce a uniform growth response.

Chemically, lamtoro's POC has a C/N ratio of 1.467, market waste POC of 0.656, and POC *eco farming* 16.95. Low C/N ratio in lamtoro POC and market waste indicates a high nitrogen content that is easily decomposed so that it is quickly available to plants (Fitriani *et al*., 2020). Meanwhile, although POC *eco farming* has a higher C/N ratio, is still safe and is able to release nitrogen gradually without inhibiting its availability. Nitrogen plays an important role in the formation of amino acids, proteins, enzymes, and chlorophyll that support the growth of leaves, stems, and other plant tissues (Gardner *et al*., 2008).

Nitrogen is an important element that forms amino acids, proteins, enzymes, and chlorophyll that support photosynthesis and vegetative growth of plants. The availability of sufficient nitrogen from POC will optimize the development of the crown, which further affects the increase in plant height, stem diameter, and number of fronds. (Blessed are you) *et al*., 2021). Thus, although the raw materials of POC are different, they are able to provide essential nutrients effectively, so the growth of oil palm seedlings shows similar results. POC can replace NPK inorganic fertilizer in oil palm nurseries *main nursery* in the best 40% dose.

CONCLUSION

Based on the results of the research and analysis, the conclusions are:

1. There was a significant interaction between the type and concentration of POC on the parameters of root fresh weight, root dry weight, leaf chlorophyll content, and leaf area. The best treatment was obtained on POC market waste with a concentration of 40% for the fresh weight of the roots and chlorophyll levels, and concentrations of 30% and 20% for the

dry weight of the roots. The highest leaf area is achieved by POC waste market, *eco farming*, and lamtoro at a concentration of 40%.

2. The use of various types of POC, namely POC lamtoro, POC *eco farming*, and POC market waste, has the same effect on the growth of oil palm seedlings on the parameters of plant height, stem diameter, number of fronds, root length, fresh weight of the crown, then dry weight of the crown.
3. Feeding POC with a concentration of 40% gave the best growth results in the parameters of frond, crown fresh weight, and crown dry weight compared to 30%, 20%, and control concentrations. This POC can replace NPK of 6g/polybag of oil palm in the *main nursery*

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