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Processing of Fibre and Its Application as Liquid Organic fertilizer in Oil Palm (*Elaeis guineensis* Jacq.) Seedling for Sustainable Agriculture

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ABSTRACT

Liquid organic fertilizer has been developed to reduce the dependence of cultivated plants on inorganic fertilizers. based Oil palm fruit fiber, as a by-product of processing palm oil mills, potentially used as organic fertilizers. The purpose of this study was to obtain liquid organic fertilizer from fermented oil palm fruit fiber and analyze the effect of the fertilizer on the growth of oil palm seedlings. Two stages of the research were conducted. The first stage was processing the fibre into liquid organic fertilizer by chopping the oil palm fruit fiber and adding local microorganisms as activators. The fermentation process was carried out for 7 days. The second stage was applying fermented organic fertilizer (POC) to the oil palm growing media. The Completely Randomized Design Method was applied with 5 treatments, namely: P0 (subsoil with no fertilizer), P1 (soil + NPK), P2 (soil + 20 ml POC), P3 (subsoil + 40 ml POC), P4 (subsoil + 60 ml POC). The POC was applied once every week for 16 weeks. The results showed that liquid organic fertilizer had a significant effect on the height of palm seedlings at 4 MAP at 20 ml per seed. The oil palm seed growth tend to increase in several parameters observing in plant diameter, plant biomass and leaves greeness. Liquid organic fertilizer obtained from oil palm fruit fiber can be applied as alternative fertilizer in the prenursery. Further research related to the optimization of process producing liquid organic fertilizer and its application to other cultivated plants is highly recommended.

INTRODUCTION

The use of inorganic fertilizers is still dominates in plant cultivation practices, as well as in oil palm plantations. There have been many researches results outlining the negative impacts of using inorganic fertilizers. [1] Parman (2007) stated that the use of inorganic fertilizers in the long term can damage the soil texture, soil microbes and decrease in soil pH which results in a decrease in production. Those impact caused by the inorganic fertilizers application encourages researchers and practitioners to make alternative fertilizers namely organic fertilizer which is expected to be able to increase plant productivity and also reduce the negative impact of inorganic fertilizers [2] (Adnan et al., 2015).

In oil palm processing manufacturer, oil palm fiber is used as a source of boiler fuel [3] (Lau et al, 2007). [4] Rosenani et al. (2016) suggested that an estimated 53 million tons of waste is generated from the activities of oil palm plantations and mills every year and these wastes are rich in potential nutrient content and have agronomic value. [5] Naibaho (1996) stated

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that each unit of loose mass in a palm oil mill will produce solid fruit fiber waste of 10-12% mass and not all solid palm oil waste is utilized as boiler fuel. Increase in CPO (crude palm oil) production, due to the world demand on it, has an impact on the amount of fiber produced from the activities of palm oil processing plants, so that oil palm fruit fibers that have not been utilized have the potential to be reprocessed into useful substances.

Oil palm fruit fiber is one of the palm oil solid waste, which is the result of a press machine. Oil palm fruit fiber is shaped like yarn and contains cellulose, hemicellulose, lignin and N, P and micro nutrients, so it has the potential to be processed into organic liquid fertilizer [6] (Lim et al, 2008). Oil palm fruit fiber is an organic byproduct, so it has the potential as a liquid organic fertilizer. Liquid organic fertilizer is an organic material resulting from fermentation in the form of a solution with more than one element. The advantages of liquid organic fertilizer are that it quickly overcomes nutrient deficiency and is able to provide fast nutrients. In the process of making liquid fertilizer using the fermentation method, microorganisms can be added which can accelerate the fermentation process or improve the quality of fermented products. Effective microorganisms are widely used because in addition to accelerating the fermentation process, these microorganisms have a good influence on the quality of fermented products. According to the results of the study [7] Pauliz (2009) showed that liquid organic fertilizer from oil palm empty fruit bunches with a dose of 156 ml per plant gave higher lettuce fresh weight than inorganic fertilizer treatment. The results of other studies showed that green mustard plants gave a good response to the administration of liquid organic fertilizer from cow manure [8] (Ohorella, 2012).

This research is aimed at making liquid fertilizer from palm fruit fiber by fermentation method and analyzing the role of palm fruit fiber waste as liquid organic fertilizer on the growth of oil palm seedlings in the initial nursery.

EXPERIMENTAL METHOD

This research was conducted in the educational field laboratory of Citra Widya Edukasi Oil Palm Polytechnic Institute in Cibitung, Bekasi, West Java. The materials used were oil germinated oil palm, DXP simalungun varieties obtained from the Oil Palm Research Center (Pusat Penelitian Kelapa Sawit, PPKS) Medan and oil palm fruit fiber waste obtained from PT Kertajaya, PTPN VIII, Malingping, Banten. Laboratory analysis, including analysis of planting media and analysis of liquid organic fertilizer, was carried out at the Laboratory of Soil Research Centers (Center for Research and Development of Agricultural Land Resources, IAARD, Ministry of Agriculture), Bogor. The study was conducted in seven months, starting from November 2016 to May 2017.

This research was conducted using non-factorial Completely Randomized Design (CRD). The treatment tested in this study was P0 (soil without fertilizer addition), P1 (soil + NPK), P2 (soil + 20 ml POC), P3 (soil + 40 ml POC), P4 (soil + 60 ml POC). Each treatment was repeated three times. Liquid Organic fertilizer was produced using raw materials for palm fruit fiber waste which were fermented with the addition of bioactivators for seven days (Figure 1).

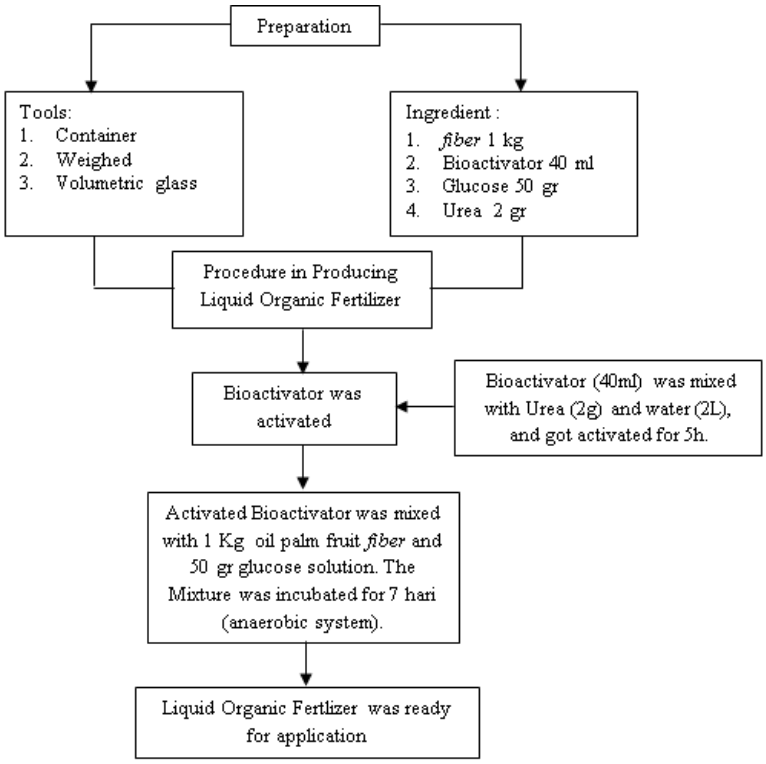

Fig 1. Procedure of liquid organic fertilizer Production.

In prior to the planting, the germinated oil palms were immersed into the fungicide with the active ingredient of 0.2% Mankozeb for 5 minutes and after soaking the seedlings were dried. Planting the oil palm was carried out in the prepared growing media with a depth of 2-3 cm from the surface. Organic liquid fertilizer was sprayed in growing media after the germinate seeds were a month afterplanting (MAP). Application was carried out in the morning once a week until the age of the seedlings was 4 MAP. Weeding in and weeding out was done during the conducted research.

Evaluated parameters in this study were (a). Plant height, measured from the base of the root neck border to the highest leaf tip using a ruler. Measurements were made after 1 MAP at intervals of 1 time a month until the age of seedlings was 4 MAP; (b). Stem diameter, measured using the calipers, was measured 1 cm above the surface in the initial experiment. Measurement of stem diameter was carried out after 1 month after planting at intervals 1 time a month until the age of seedlings is 4 MAP; (c). Plant biomass, analyzed at the end of the experiment (4 MAP). These measurements include fresh and dry weight of shoot and roots. Measurement of fresh and dry weight of those was carried out for the all sample treatments. Plants were oven-dried to constant weight at 80^0C; (d). The greenness of the leaves, measured at the end of the experiment using SPAD meters by taking a pair of leaves to the third leaf then SPAD meters clipped to the end, middle, and bottom of the leaf lamina, then the average value was taken. Analysis of planting media was carried out before and after the study whereas analysis of liquid organic fertilizer was carried out before application to oil palm seedlings. Analysis of planting media and liquid organic fertilizer was carried out to determine the content of Nitrogen (N), phosphorus (P), potassium (K), and pH.

The data in this experiments was the reported as the mean value of three replication of each sample. The Significance of differences between the samples were tested using Duncan's Multiple Range Test (DMRT) test. The

statistical procedure were conducted with Statistical Analysis System (SAS) software package.

RESULTS AND DISCUSSION

Chemical Analysis of Liquid Organic Fertilizers

The results of the analysis of liquid organic fertilizer showed that the nutrients contained in liquid organic fertilizer are in accordance with the standards that have been stated in the quality standards of organic fertilizers. The pH of organic fertilizer is classified as neutral and in accordance with the standard. [9] Ji et al. (2017) in the results of the study showed that the use of liquid organic fertilizer significantly increased root growth of 10.2-77.8% and shoot by 10.7-73.3% when compared to inorganic fertilizers in chrysanthemum plants. The results of the analysis of liquid organic fertilizer can be seen in Table 1.

Table 1. Chemicals of Liquid Organic Fertilizers

	Parameters			
	pH	N	P_2O_5	K_2O
		.....%.....		
POC	7.33	0.01	0.02	0.36

Nitrogen contained in liquid organic fertilizer acts as a constituent of proteins while phosphorus and calcium play a role in spurring the division of meristem tissue and stimulating root growth and development of leaves. As a result the level of nutrient and water absorption by the plant to its optimum limit will be used for cell division, extension and differentiation. Potassium regulates the opening and closing of stomata. The optimal stomata regulation will control plant transpiration and increase the reduction of carbon dioxide which will be converted into carbohydrates. Nutrients of nitrogen, phosphorus and potassium as well as micro elements contained in liquid organic fertilizer will increase plant photosynthetic activity, thereby increasing the carbohydrates produced as food reserves.

Plant height

The application of liquid organic fertilizer showed a significant effect in seedlings at 4 months after planting (MAP). However, liquid organic fertilizer has no significant effect on the height of oil palm seeds at the age of 1-3 MAP. The highest seedling height at 4 MAP was seen in the treatment of 20 ml (25.23 cm) and significantly different from the treatment of NPK. Liquid organic fertilizer significantly increases the height of oil palm seedlings compared to treatments without fertilization. The effect of giving liquid organic fertilizer to seed height can be seen in Table 2.

The application of fertilizers increases the growth of oil palm seedlings compared to treatments without fertilization, this indicates that plant growth is influenced by the availability of nutrients in the growing media. Applying liquid organic fertilizer to the growing medium can provide sufficient nutrients to be absorbed by plants which function to increase plant growth. This is in line with the opinion of [10] Muharam et al. (2011) stated that biological fertilizers and organic

fertilizers had different effects on differences in soil physical, chemical and biological conditions. The greater the organic matter usage were tends to increase the carrying capacity of the soil against plants. In addition, the usage of organic matter can increase nutrient composition in the soil.

Table 2. The effect of liquid organic fertilizer application on oil palm height

Treatment	Age (Month After Planting)			
	1	2	3	4
	---------- Plant height (cm) ----------			
PO (no fertilizer)	6.46	12.96	19.36	20.30b
P1 (NPK)	5.00	11.73	21.00	21.90b
P2 (LOF 20 ml)	7.03	15.06	23.66	25.23a
P3 (LOF 40 ml)	5.83	13.40	22.06	22.96ab
P4 (LOF 60 ml)	5.86	14.33	20.43	21.66b

Note. Means with the same letter within a column are not significantly different using DMRT at $p < 0.05$. LOF = Liquid Organic Fertilizer.

Nutrients contained in liquid organic fertilizer that have been analyzed were supporting the high growth of oil palm seeds. The high content of potassium in liquid organic fertilizer plays an important role in every plant metabolic process, namely in the synthesis of amino acids and proteins from ammonium ions and plays a role in maintaining turgor pressure well so as to enable smooth metabolic processes and ensure continuity of cell elongation [11] Purwowidodo (1992). [12] Ariyanti et al. (2018) stated that increase in potassium, caused by the addition of organic matter, plays an important role in the growth of meristem tissue and strengthens plants so that it is not easy to fall down. In addition, [13] Lakitan (2007) asserts that the high potassium element in liquid organic fertilizer acts as an activator of various enzymes that are essential in photosynthetic and respiration reactions and for enzymes involved in protein synthesis and starch. The greater the content of potassium in the growing media, it encourages plants to continue to photosynthesize to produce photosynthates. Photosynthate formed will be transferred to shoots and plant roots causing cell division in the shoots to become more active and encourage the development of roots so that the growth of plant height increases.

Stem Diameter

The results showed that there was no significant effect of the administration of liquid organic fertilizer on stem diameter parameters. However, if observed at 4 MAP, the treatment of 20 ml organic fertilizer resulted in the highest measurement of stem diameter. Obtaining stem diameter data on the administration of 20 ml and 40 ml liquid organic fertilizer showed a higher value compared to the treatment of NPK fertilizer and without the treatment of fertilizer application. Data on the effect of stem diameter on liquid organic fertilizer can be seen in Table 3.

Table 3. The effect of liquid organic fertilizer on stem diameter

Treatment	Age (Month After Planting)			
	1	2	3	4
	---------- stem diameter (mm) ----------			
PO (no fertilizer)	0.10	4.23	5.70	6.43
P1 (NPK)	0.50	4.43	5.56	6.06
P2 (LOF 20 ml)	0.73	4.50	6.66	7.63
P3 (LOF 40 ml)	0.63	4.03	6.06	7.20
P4 (LOF 60 ml)	0.43	4.10	6.00	6.90

[14] d

Azizah et al. (2018) argue that varieties factor also determines the level of plant growth in the field and in general the high and low production of a plant depends on the variety used. Differences in varieties are expected to play a role in utilizing the environment to achieve high potential results. Based on these results it can be seen that varieties play a role in etermining plant growth in the field. Regarding plant growth, good nutrient uptake can be shown in increasing stem diameter in a plant. Potassium which increases with the addition of liquid organic fertilizer is able to play a role in strengthening plants so it is not easy to fall down [12] (Ariyanti et al. 2018).

Plant Biomass

Liquid organic fertilizer can increase wet weight and dry weight on roots and shoot. The highest dry weight of shoots and roots can be seen in the treatment of 20 ml liquid organic fertilizer. Application of liquid organic fertilizer has a tendency to increase the wet weight and dry weight of roots and shoots in seedlings that are applied to liquid organic fertilizer (20 ml and 40 ml), when compared with seeds without fertilizer and with NPK fertilizer. The results of observations on the administration of liquid organic fertilizer in oil palm seeds can be seen in Table 4.

Table 4. The effect of liquid organic fertilizer on oil palm biomass

Treatment	4 MAP (Month After Planting)				
	Root wet weight	Shoot wet weight	Root dry weight	Shoot dry weight	Shoot Root Ratio
	---------- (gr) ----------				
PO (no fertilizer)	0.296	1,407	0.179	0.416	2.3
P1 (NPK)	1.107	3.174	0.338	0.826	2.4
P2 (LOF 20 ml)	3.132	4.442	0.756	2.915	3.8
P3 (LOF 40 ml)	1.002	3.643	0.304	0.993	3.2
P4 (LOF 60 ml)	0.648	2.905	0.285	0.831	2.9

Measurement of plant biomass shows the ability of plants to absorb nutrients, metabolic reactions and indicate the amount of photosynthesis contained in plants. The higher the biomass, the more photosynthesis contained in it, increasing plant dry weight [15] (Hasanah and Setiari, 2007) and [16] Nurbaiti et al. (2012).

Dry weight is one indicator of plant growth. The high value of dry weight of plants indicates an increase in photosynthesis because the necessary nutrients are sufficient. This is related to photosynthate results which are translocated to all plant organs for plant growth, thus giving a significant influence on plant biomass. [17] Lubis at al. (2014) suggested that plant dry weight reflects the nutritional status of plants and the macro and micro nutrients that play a role in the formation of proteins, fats, carbohydrates and organic matter, depending on the number of cells and the size of cells that make up plants. Measurement of growth of root biomass and shoot biomass, also called root shoot ratio. The root shoot ratio is a calculation of the ratio of shoot and root dry weight to describe the lack of water absorption in plants. [18] Handayani et al. (2014) in his study suggested that the elements P and K had an effect on the development of plant roots, namely in the formation of root systems and stimulating root extension. The high K content in liquid palm oil palm liquid organic fertilizer in this study is able to stimulate root growth so that other parts of the plant, namely the canopy part can develop well. The highest data on root and canopy dry weight were seen in the treatment of 20 ml LOF, and the lowest was in NPK treatment. This is because liquid organic fertilizer is given easily and can stimulate metabolism in plants. [19] Martinez-Alcantara et al. (2016) in his research also proved that fertilizer derived from vegetable ingredients has a high K content.

The presence of K cations in organic fertilizers causes the opening and closing of stomata cells in the leaves, so that photosynthesis can take place and produce photosynthates which are needed for plant growth and development. The results of the study [19] Martinez-Alcantara et al. (2016) shows that the application of liquid organic fertilizer produces an increase in biomass and concentration of nutrients in citrus plants. The photosynthate results formed are translocated to vegetative parts of the plant, for maintenance and formation of new organs, including the broadening of leaves which will expand the surface for photosynthesis, and absorption of nutrients by roots into root dry weight factors.] (Gardner et al 1991). Water availability in plants has an effect on canopy dry weight, and nutrient absorption ability by plants has an effect on root dry weight.

Leaf Greeness

Liquid organic fertilizer does not significantly affect the greenness of the leaves of oil palm. However, it can be seen in table 4, that the application of liquid organic fertilizer produces a higher level of greenness of leaves (P2 and P3) compared to seedlings without treatment and seeds with NPK fertilizer (Table 5.). This is because the N content in the planting medium is low so that the elements contained in the leaves are low, the amount of N in the leaves affects chlorophyll. [21] Lee (2010) explained the results of his research that organic fertilizers and liquid organic fertilizers were the most effective fertilizers in translocating nutrients from sink to source.

Table 5. Leaf greeness value of the liquid organic fertilizer

Treatment	4 Month After Planting (MAP) …… leaf greeness…….
PO (no fertilizer)	34.05
P1 (NPK)	44.85
P2 (LOF 20 ml)	47.52
P3 (LOF 40 ml)	43.22
P4 (LOF 60 ml)	34.05

The results of the study [22] Febrianna et al. (2018) showed that administration of liquid organic fertilizer was able to increase nitrogen uptake in mustard plants as much as 23.80%, and could improve soil chemical properties, such as increasing soil pH, organic C and total N. It was also stated that the available nitrogen is easily absorbed by plants so that the photosynthesis process runs optimally. Nitrogen is an important element in the formation of chlorophyll. The value of leaf greenness level is related to the amount of chlorophyll contained in leaf tissue. The content of chlorophyll is the place where photosynthesis takes place, so the high amount of chlorophyll will provide enough energy for plants to grow optimally [23] (Suharno et al., 2007).

CONCLUSION

The treatment of the application of the liquid organic fertilizer provided the increase on growth in plant height parameters. The role of liquid organic fertilizer from oil palm fruit fiber can increase the growth of oil palm seedlings. Liquid organic fertilizer from oil palm fiber fiber waste has the potential to be an alternative to replacing inorganic fertilizers in nurseries.

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