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The Effects of Soil Amended with Solid Fibrous Waste on the Morphological Quality of Oil Palm (*Elaeis guineensis* Jacq.) Seedling

Sylvia Madusari[1*]
[1]*Citra Widya Edukasi Oil Palm Polytechnic Insitute, Jalan Gapura No.8, Rawa Banteng, Cibuntu, Cibitung, Bekasi 17520, Indonesia*

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ABSTRACT

Organic materials as industrial by-products are potentially used as alternative growth media composites with the aim of reducing the use of top soil and improving the quality of plants in the nursery. Mesocarp of palm fruit (fiber) and coconut fiber powder (cocopeat) are rich in plant nutrients. Composting of these by-products will be helpful in recycling and re-use of biodegradable waste useful for growing media. This research use Completely Randomized Design (CRD) one factor consist of 4 treatment. The treatment were (a). P0 = sub soil 100% (control), (b). P1 = 50% mesocarp fiber composts + 50% sub soil, (c). P3 = 50% cocopeat composts + 50% sub soil, and (d). P3 (mesocarp fiber 1 kg + cocopeat fiber 0.5 kg + 0.5 kg cattle dung) composts + sub soil 50 %. Growing media that consists of 50% mesocarp fiber and 50% sub soil (P2) was suitable as growing medium in early seedling. Compost of mesocarp fiber has the content of C-organic 52,28%, N 1,37%, C / N ratio 38,11%, P_2O_5 0,47%, K_2O 0,89%, Mg 0,23%. The use of composted mesocarp fiber media mixed with 50% sub soil showed significant effect on the growth of seed diameter of oil palm seedlings at age 3 MAP.

INTRODUCTION

Nurseries is a main factor affecting the increase in production and quality of plantations. Limitations of top soil is one of the problems that occur during the nursery, this can be seen from the growing use of growing media. ITTO (2006) states that top soil widely used as seedling medium should be limited in order to avoid negative impacts on environmental balance.

Waste in the form of organic matter has the potential to be used as a growing medium because of its crumb, so has the ability to bind water and is a space for aeration. Organic waste in the form of palm fruit fiber (*Elaeis guineensis* Jacq.) and coconut fiber powder (*Cocos nucifera*) are widely produced as by-products in the processing industry. As an illustration, palm fruit fiber (Mesocarp) is a waste processing plant fresh fruit bunches (FFB). Waste palm fibers are produced by 10 to 12% of the mass of Fresh Fruit Bunches (FFB). Pricilia (2014) mentioned that in PT Bahana Karya Semesta, the production of mesocarp fiber in one month could reach 1,122.14 tons with the number of TBS 8,997 tons. As for coconut fiber, Adiyati (1999) stated that in Indonesia, coconut fruit waste from the processing or stripping produced per year reaches about 19.05 million m^3 consisting of 35% fiber and 65% coconut coir powder.

Utilization of palm oil waste, in the form of palm fruit fiber and coconut, in the form of cocopeat, can be done to reduce the limitations of growing media top soil. Lim et al. (2009) mentioned that palm fruit fiber contains 0.8% Nitrogen, 0.1% phosphorus, 0.5% Potassium, 0.5% Calcium and Zinc 9.8%. Cocopeat is a coconut husk (Setiawan, 2017) containing 2-13% short coconut fiber of approximately 2 cm (Cresswell, 2009) and has a high enough essential mineral content, namely Calcium,

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Magnesium, Potassium, Sodium, and Phosphorus which is needed by plants and can neutralize the soil acidity (Prayugo, 2007).

Organic materials derived from waste generated from the processing of oil palm and coconut are potentially useful ingredients to improve soil fertility. Organic materials containing fiber have a very high C : N ratio. Sreekala et al. (1997) illustrates that palm fruit fibers contain 19% lignin and 60% cellulose, while cocopeat contains 40-45% lignin and 32-43% cellulose. The C : N ratio can be derived through the composting process. Singh et al. (2010) states that composting is an appropriate method for converting fibrous material into compost that can be used as a growing medium. Planting media in the form of soil mixtures and organic materials that have been composted is a good planting medium for plant growth (Fatimah and Handarto, 2008). Compost is the result of decomposing of organic materials that can be used as a growing medium. The growing medium generated from the composting process is useful as a growing medium that has a structure to maintain aeration balance. Lim et al., (2009) composting palm fruit fibers by utilizing microorganisms derived from POME's liquid waste. The time required for composting this palm fiber is 50 days with a C : N ratio of 12.6%. In the composting process, decomposed organic material will be able to release macro and micro nutrients that can be absorbed by plants, so that through the process of composting organic waste can be utilized as a soil enhancer and applied as growing media. The results of Yunindanova (2013) study suggests that the utilization of palm fiber compost and empty palm oil can increase the growth of tomato plants and produce high harvesting weight. In the Yau and Murphy (2000) study, which was conducted in greenhouses, it was described that the use of cocopeat compost provided good vegetative growth in tomato plants, and resulted in the highest value in root dry weight and production, compared to non-composted cocopeat use.

The objective of this study was to examine the role of composts of fiber from mesocarp and cocopeat as a soil amended for growing oil palm seedlings in order to get a good growth alternative media for oil palm seedlings in early nurseries.

EXPERIMENTAL METHOD

The study was conducted in plant house of Citra Widya Edukasi Polytechnic Institute, Rawa Banteng, Cibuntu, Bekasi, West Java., from Januari to June (6 months period). The germinated oil palm seeds were obtained from PT Mekar Unggul Sari, Cileungsi, Bogor. The bioactivator for composting process was obtained from PT Rekayasa Hayati, Bandung Institute of Technology. Cocopeat fiber (Cf) and cow manure (Cm) were collected in from cow farm in Cibitung, Bekasi and mesocarp fiber (Mf) used in this study was obtained from PT Kertajaya, PTPN VIII, Malingping Banten, West Java.

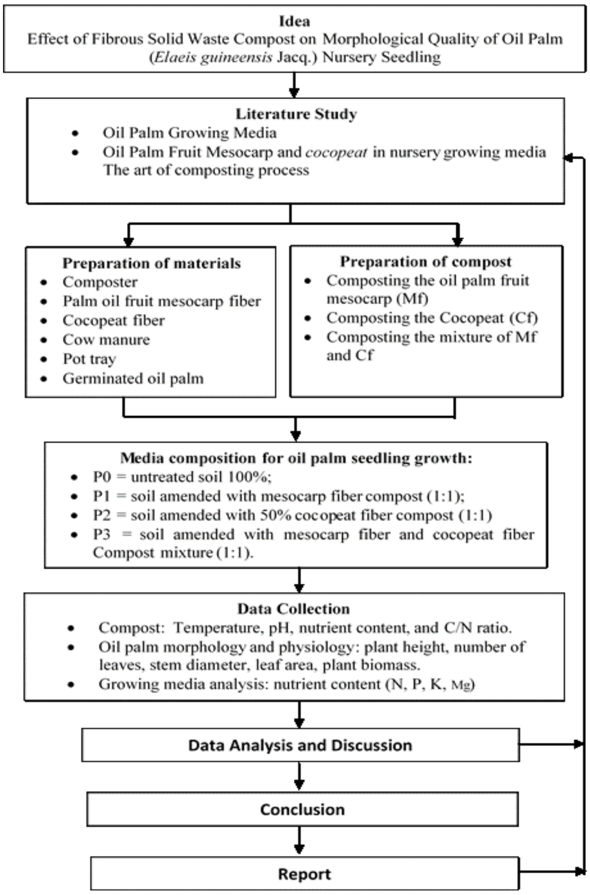

Fig. 1. Research Flow Chart

A. Experimental design

In this study the method used was Completely Randomized Design (CRD) with four treatments. The treatments were (a). P0 = untreated soil 100%; (b). P1 = soil amended with mesocarp fiber compost (1:1); (c). P2 = soil amended with 50% cocopeat fiber compost (1:1) and (d). P3 = soil amended with mesocarp fiber and cocopeat fiber Compost mixture (1:1).

Composting process.

The mesocarp fiber (Mf), cocopeat fiber (Cf), and Mf and Cf mixture was boiled first before the decomposition process. After boiling the fiber drained until there was no water content in the material. A total of 2 kg of material was inserted into a basket that has been coated by a black plastic bag and covered with a storage sac containing wood powder to retain moisture during the composting process. Each basket was labeled according to the treatment profile that has been determined to facilitate the observation process. The composting period was done for 5 weeks.

Growing Media Preparation.

Growing media was prepared by mixing the mature compost with sub soil. The mixture was inserted into container of pot tray which had been prepared in accordance with each treatment, and as the control, the growing media was 100% sub soil.

Cultivation Preparation.

Oil palm germinated seeds were soaked into the fungicide with Mankozeb active ingredients with concentration of 0.2% for 10 minutes then aerated and afterwards planted 2-3 cm from the growing media surface.

Plant Maintenance.

Watering done twice a day to meet the field capacity. Control of weeds above ground level was cleaned up when weeds begin to grow.

B. Data Collection

Observations on the composting process in this study were conducted for 5 weeks, which included: (a). Temperature, compost temperature measurement was done every 3 days, (b). Degree of acidity (pH), carried out at the beginning and end of composting, (c). Compost Content Analysis, including N, P, K, and C : N ratio.

Observation of morphology and physiology of growth of oil palm seedlings were: (a). Plant height (cm), (b). Number of Leaves (strands), and (c). The stem diameter (cm) is measured once a month for three months, whereas (d). Leaf Area (mm^2) and (e). Plant biomass, were measured at the end of the study at the age of 3 months after planting (MAP).

C. Data Analysis

The result of quantitative research was analyzed using variance at real level of 0.05, and if there is any real difference then it is done further test with Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Temperature and pH of compost

Temperature is one type of indicator in the composting process. In Figure 1. showed that during the composting process the temperature was decreasing along with the time of composting. At the beginning of composting the temperature ranges from 31.87 - 33.2^{0}C, while at the end of composting the temperature ranges from 29.04 - 29.31^{0}C.

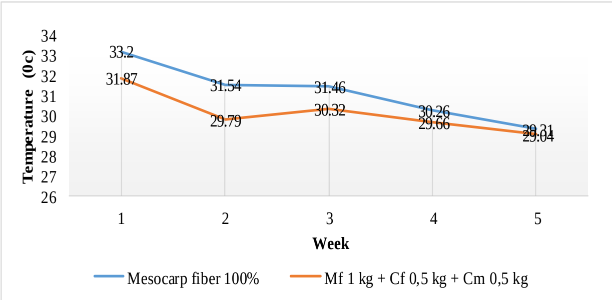

Fig. 2. Changes in temperature during the composting process

The highest temperature achieved in the first week of composting. The temperature then was declining at the fifth week of composting indicate that in the composting process occurs the decomposition process of highly active organic matter (Isroi 2009 and Diaz et al., 2002). Microorganisms in the composting process decomposed organic matter. After most of the material has decomposed, the temperature gradually decreases. At that time there was maturity of the compost. According to Thambirajah *et al*. (1995), Salundik and Simamora (2006), the temperature was very influential on the composting process because it is associated with the type of microorganisms involved.

Acidity is an important factor in the composting process. Changes in pH in the composting process showed the presence of microorganisms in degrading organic materials. Changes in pH during composting can be seen in Figure 2. Increased pH values identified at the end of composting at week 5. Organic matter reform is no longer a dominant process and there has been the formation of ammonium compounds that can increase the pH value. Temperature changes during the composting process (Fig. 1) visible before week 2 to 5th week of temperature have decreased and indicating reduced organic acid yields may decrease the pH of the composting process. Meunchang et al., (2005) suggest that pH value decline in the early stages of the composting process is due to the activity of microorganisms that produce organic acids and the reduction of ammonium ions (NH_4^+). Composting of some agricultural wastes showed also a decrease in pH in the first five days reached 7.5 and increased steadily to enter the 15th day (Kulcu and Yaldiz 2004).

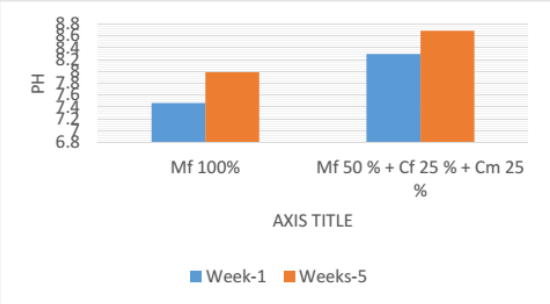

Fig. 3. Changes in pH during the composting process

Nutrient of compost

Composting of organic materials aim to reduce the C : N ratio contained in mesocarp fiber. The organic material of mesocarp fiber before being composted has a high value of C : N ratio that was 167.6%.

Table 1. Chemical analysis of the materials

Material	C-organic	N	C/N ratio	P	K
	……. (%) …….				
Mesocarp fiber	54.46	0.32	167.7	0.02	0.78
Kompos *Mesocarp fiber*	52.3	1.37	38.11	0.47	0.89

C : N ratio is an indicator in the process of mineralization of nutrient immobilization by microbial decomposers of organic matter. The value of C : N ratio of organic matter will decrease after composting for 5 weeks, so the value of C : N ratio of mesocarp fiber produced was 38,11%. The value of C: N ratio found in mesocarp fiber will affect the nutrient content to be produced that is N, P, K, and C-organic. Observation of the physical condition of the compost showed the color change to brownish black and rough and weak texture. The nutrient content of mesocarp fiber and its compost can be seen in Table 1. Nutrient content of N, P, K and C-organic based on the results compile in Table 1. Have compost quality standard and can be used as growth medium of oil palm seedlings. SNI (2004) states that the compost quality standard has the following criteria: pH (6,8-7,49), N (> 0,4%), C (9,80-32%), P (> 0, 10%), K (> 20%).

Plant height

The results of the research in Table 2. showed that the highest growth response of oil palm seedlings with composted growth medium (mesocarp fiber 50%: sub soil 50%) at age 2 MAP and 3 MAP giving better response than seedlings with sub soil growth medium, because the nitrogen content contained in the compost media was higher (1.37%) compared with nitrogen content in sub soil (0.08%).

Table 2. The average height of oil palm seedlings on various growing media.

Treatment	Months After Planting (MAP)		
	1	2	3
	Plant Height (cm)		
Sub soil 100%	5.45	10.28	15.13
Compost of *Mesocarp fiber*: *Sub soil (1:1)*	6.10	13.33	18.45
Composts of *cocopeat fiber*: *Sub soil* (1:1)	6.43	12.68	16.38
Composts of (Mf 1 kg + Cf 0,5 kg + Cm 0,5 kg) : *Sub soil* (1:1)	4.25	8.05	9.98

Note: Mf = mesocarp fiber, Cf = Cocopeat fiber, Cm = Cow manure.

Nitrogen is useful for spurring vegetative growth in plants, especially increasing plant height. Sholikah et al., (2013) states that nitrogen is able to increase protein levels contained within the plant body, improving the quality of plants that have produced leaves, improving the development of microorganisms in the soil and the occurrence of protein formation. This substance can spur growth (increase the height of plants and the number of leaves). Hardjowigeno (2010) states that nitrogen is a functioning element in improving vegetative growth in plants one of which is plant height.

Stem diameter

During 3 months observation (Table 3), it can be seen that the highest stem diameter of palm seedlings was found in growing media treatment (50% sub soil + 50% mesocarp fiber compost) that is 5.50 cm (3 MAP) and the lowest was on 100% sub soil growth medium that is 1.82 cm (1 MAP).

Table 3. The average diameter of oil palm seedlings on various growing media.

Treatment	Months After Planting (MAP)		
	1	2	3
	Stem diameter (cm)		
Sub soil 100%	1.82	2.40ab	3.42ab
Compost of *Mesocarp fiber*: *Sub soil (1:1)*	3.18	3.80ab	5.50a
Composts of *cocopeat fiber*: *Sub soil* (1:1)	2.97	4.07a	4.57a
Composts of (Mf 1 kg + Cf 0,5 kg + Cm 0,5 kg) : *Sub soil* (1:1)	2.45	1.95b	2.20b

Note. : Means with the same letter within a column are not significantly different using LSD at $p < 0.05$. Mf = mesocarp fiber, Cf = Cocopeat fiber, Cm = Cow manure

At the end of the observation (3 MAP) showed that the highest stem diameter growth of palm seedlings were in 50% sub soil: 50% mesocarp fiber growing media (50.55 cm) and the lowest growth of stem diameter of palm seedlings were found in growing media of (Mf 1 kg + Cf 0.5 kg + ks 0.5 kg) 50%: Sub soil 50% that is 2.20 cm. Soil amended with compost of mesocarp fiber can increase the stem diameter of oil palm seedlings. The content of nutrients in the compost (Table 1) as a medium for growing oil palm seedlings that can increase the growth of oil palm stem diameter due to the higher content of P and K. Leiwakabessy (1998) states that the elements of P and K can play a role in increasing the growth of stem diameter in plants, especially as a network that connects between roots and leaves. The main factor of giving various types of compost as a medium grows by showing the highest growth of stem diameter.

In observation of plant height parameters and stem diameter between the addition of compost mesocarp fiber and cocopeat fiber, it appears that plant height and diameter on the use of cocopeat fiber compost in the growing medium tends to be lower than the composted plant mesocarp fiber on growing media. It is suspected that the tannin content in cocopeat can cause plant growth to be inhibited. Cocopeat in addition to containing nutrients N, P, K, Ca, Mg and Na, also contain pectin, hemicellulose, and tannin (Prayugo, 2007). Sugiarti (2011) proposed the results of his research that the giving of compost cocopeat produce low growth in seedling jabon.

Leaf Amount and Leaf Area

The highest number of leaves at the age of 3 MAP seedlings was in growing media composition of 50% mesocarp fiber : 50% sub soil and 50% cocopeat fiber compost: 50% sub soil. The lowest leaf growth rate was found in growing media of 50% compost treatment (Mf + Cf + kot.sapi): 50%Sub soil which was 1.75 strands (Table 4).

Table 4. Number of Leaf and Leaf Area of Oil Palm Seed at 3 MAP.

Treatment	3 Months After Planting (MAP)	
	Number of Leaf	Leaf Area (cm^2)
Sub soil 100%	2.25	38.28
Compost of *Mesocarp fiber*: *Sub soil (1:1)*	3	41.42
Composts of *cocopeat fiber*: *Sub soil* (1:1)	3	43.38
Composts of (Mf 1 kg + Cf 0,5 kg + Cm 0,5 kg) : *Sub soil* (1:1)	1.75	35.35

Note. Mf = mesocarp fiber, Cf = Cocopeat fiber, Cm = Cow manure

Leaf area at 3 MAP showed that the leaf area on the compost treatment of 50% cocopeat fiber : 50% sub soil was 43.38 cm^2, wider than the leaf area of the plant growing in 100% subsoil treatment, 50% Mf compost: 50% subsoil and 50% compost (Mf 1 kg + Cf 0,5 kg + Cm 0,5 kg): Sub soil 50%. Perwitasari et al. (2012) states that the leaf area is related to the physiological process of plant growth. The longer the age of the plant the larger the area of plant leaves. The increase in leaf area is related to leaf area index, which is one of the important components used to know the formation of biomass (Gusmayati E and Sholahuddin, 2015).

In the process of nutrient composting is released into available elements that can be utilized by plants. Landis et al. (2014) explains that C: N ratio is an indicator of the degree of availability of nitrogen. Carbon stored in cellulose is useful as a source of energy and is easily decomposed by microorganisms. Nitrogen is stored in the cell so it is not available to plants. Carbon nutrients are gradually reduced due to the decomposition process, causing the population of planting microorganisms gradually decreases due to death. This condition causes nitrogen to be released and can be used for plant growth. Nitrogen nutrient content in plants is useful to help the process of green leaf or chlorophyll. Needs of nutrients needed by sufficient plants, can affect the increase in the area of plant leaves (Andri *et al*. 2016).

Plant Biomass

Plant biomass observations showed in Table 5. describe that wet weight of root and shoot as well as root weights of root and seeds of oil palm seedlings grown on media containing cocopeat compost (50% cocopeat : 50% sub soil) were higher than those of oil palm seedlings grown on media plant containing compost mesocarp fiber (50% mesocarp fiber : 50% sub soil). The fibres of cocopeat extremely has a better balance between air and water capacity which is systematically can be applied in all areas of growing media (Schmilewski, 2008 and Fornes *et al.* 2003). This media was showed a good usage of potting media for the propagation of young plants (Schmilewski, 2008).

Table 5. The influence of various growing media on plant biomass

Treatment	3 Months After Planting (MAP)			
	Wet Weight		Dry Weight	
	Root	Shoot	Root	Shoot
	........g........			
Sub soil 100%	0.99a	2.28a	0.21a	0.55a
Compost of *Mesocarp fiber*: *Sub soil (1:1)*	0.55a	1.38a	0.04b	0.28a
Composts of *cocopeat fiber*: *Sub soil* (1:1)	0.88a	1.59a	0.21a	0.34a
Composts of (Mf 1 kg + Cf 0,5 kg + Cm 0,5 kg) : *Sub soil* (1:1)	0.93a	1.90a	0.17a	0.40a

Note : Means with the same letter within a column are not significantly different using LSD at $p < 0.05$. Mf = mesocarp fiber, Cf = Cocopeat fiber, Cm = Cow manure

The results of Treder (2008) showed that lily plants grown on cocopeat medium produce dry weight and wet leaves and flowers. This is in line with the wet weight and dry weight generated by oil palm seedlings in this study (Table 5), which is grown on cocopeat-containing media, indicates a higher rate than other plant-growing treatments. Treder (2008) further explains that plants grown on growing media containing cocopeat significantly result in better root system development. Yau and Murphy (2000) concluded from the results of his research that tomato plants grown on composted cocopeat planting media provide better results compared with tomato plants grown on cocopeat planting media without composting. Yulia *et al.* (2018) explain that cocopeat can increase water availability, soil structure and oxygen which can increase root volume and water and nutrient uptake so as to encourage physiological process and growth metabolism of plant shoot. This can increase the dry weight on roots and shoot of the plant seedlings.

CONCLUSION

The use of composted fibrous solid waste of 50% mesocarp fiber which was mixed with 50% soil sub soil showed significant effect on the growth of stem diameter of oil palm seedlings at age 3 MAP. Growing media of 50% mesocarp fiber compost and 50% sub soil can be used as a medium for oil palm seedlings in early nurseries.

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