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Utilization of Coconut Pulp (*Cocos nucifera*) as a Mixture of Planting Media for Vegetative Growth of Oil Palm Seedlings (*Elaeis guineensis* Jacq.) at the Main Nursery

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Abstract

Until now, topsoil has generally been used as a growing medium for seedling propagation. However, the increasing scarcity of topsoil and ongoing soil extraction can degrade environmental quality. Therefore, an alternative material is needed that can be used as a component of a growing medium mixture without compromising seedling growth. Based on this, research on the utilization of coconut husk as an additive to the growing medium for the vegetative growth of oil palm (Elaeis guineensis Jacq.) seedlings in the main nursery is necessary. The method used in this study was a non-factorial completely randomized design (CRD), with coconut husk as a treatment mixed into topsoil. The coconut husk treatment factor (M) consisted of five levels: M0 = Control + Topsoil (100%), M1 = Topsoil + Coconut Husk (90%: 10%), M2 = Topsoil + Coconut Husk (80%: 20%), M3 = Topsoil + Coconut Husk (70%: 30%), and M4 = Topsoil + Coconut Husk (60%: 40%). The study used five replicates with six plants per plot, for a total of 150 plants. The data analysis was followed by Duncan's Multiple Range Test (DMRT) at α = 5%. The parameters observed included plant height (cm), stem diameter (mm), number of leaves (sheets), and total leaf area (cm^2). The results indicate that using coconut husk that has not been fully decomposed (ripe) as a component of the growing medium can lead to a decreased (negative) vegetative growth response in oil palm (*Elaeis guineensis* Jacq.) seedlings in the main nursery. Conversely, fully decomposed (mature) coconut husks used as part of the growing medium promote better vegetative growth in oil palm seedlings.

Keywords: Alternative, Decomposition, Maturity, Response, Topsoil

1. Introduction

Oil palm (*Elaeis guineensis* Jacq.) is a strategic plantation commodity in Indonesia, significantly contributing to the national economy through foreign exchange earnings, employment, and as a raw material for the food, energy, and oleochemical industries. Oil palm productivity is largely determined by the quality of seedlings produced during the nursery phase. Therefore, nursery management, especially during the main nursery stage, is crucial for producing healthy, uniform, and vigorous seedlings before planting in the field (Hapsoh et al., 2020).

The vegetative growth of oil palm seedlings during the main nursery phase is influenced by various factors, one of which is the growing medium. A good growing medium must provide sufficient nutrients, good aeration and drainage, water retention, and support for root development (Rosenani et al., 2016; Khairani et al., 2024).

Topsoil is currently the most common growing medium for seedlings. However, the increasingly limited availability of topsoil and ongoing soil extraction can degrade environmental quality. Sabrina et al. (2024) reported that the continuous extraction of topsoil from plantation areas for use as a growing medium causes topsoil depletion, highlighting the need for alternative growing media for oil palm nurseries. Therefore,

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alternative materials are needed that can be used as part of a growing medium mixture without compromising seedling growth quality.

One organic material with potential is coconut pulp. Coconut pulp is a waste product from coconut milk processing, which is quite abundant in Indonesia and still contains organic matter, fiber, and several nutrients beneficial for plants (Adi et al., 2018). The organic content in coconut pulp can improve soil structure, increase porosity and water-holding capacity, support soil microorganism activity, and gradually supply nutrients for plants (Hafsah et al., 2020).

With its organic matter, fiber, and nutrient content, coconut pulp can serve as an alternative growing medium component that supports optimal media conditions and vegetative growth of oil palm seedlings. Therefore, using coconut pulp as a growing medium during the main nursery phase is expected to promote the healthy growth of oil palm (Elaeis guineensis Jacq.) seedlings. Additionally, utilizing this waste as a growing medium aligns with sustainable agriculture principles by converting organic waste into economically valuable products.

Several studies show that adding organic matter to oil palm nursery media can improve seedling vegetative growth. Research by Nurahmi et al. (2024) reported that the composition of organic-enriched planting media significantly affected seedling height, stem diameter, fresh weight, and dry weight of oil palm seedlings compared to using soil alone. These results indicate that adding organic matter can improve the physical properties of the media, thus optimizing seedling growth. Another study by Ardiansyah et al. (2023) showed that the use of various oil palm waste-based planting media in the pre-nursery phase significantly affected seedling growth. The use of organic matter as a component of the planting media has been shown to improve media quality by improving aeration, water retention capacity, and the availability of nutrients needed by plants during the early growth phase. Research by Badal et al. (2024) also showed that the use of organic waste bokashi as a planting media mixture positively affected the growth of oil palm seedlings in the nursery phase. The addition of organic matter to the planting media improves the quality of the media, supporting better plant height, leaf number, and root development compared to media without organic matter. In addition to improving the physical properties of the media, the addition of organic materials also serves as a gradual source of nutrients. Ariyanti et al. (2018) explained that the use of organic materials in oil palm nurseries can reduce dependence on inorganic fertilizers while increasing the efficiency of nutrient utilization during the seedling growth phase. Although various studies have shown the effectiveness of different types of organic materials as planting media mixtures, the use of coconut pulp as a planting media mixture in oil palm main nurseries remains relatively limited. This is despite coconut pulp containing fiber and organic materials that can improve the physical properties of the planting media while also providing a source of organic nutrients. Information regarding the most appropriate proportion of coconut pulp mixture in the planting media still requires further study to obtain a composition that can optimally support the vegetative growth of seedlings. Based on this description, research on the use of coconut pulp as a planting media mixture for the vegetative growth of oil palm seedlings (*Elaeis guineensis* Jacq.) in the main nursery is necessary. The results of this study are expected to provide scientific information regarding the use of coconut pulp waste as an effective, economical, and environmentally friendly planting media mixture to support the production of quality oil palm seedlings.

2. Material and Methods

This research was conducted at the Plantation Practice Land of the Indonesian Palm Oil Technology Institute (ITSI) Medan with coordinates 3.616077; 98.711721, Percut Sei Tuan District, Deli Serdang Regency, North Sumatra, with an altitude of 30 meters above sea level (masl). The materials used in this study were DxP Simalungun variety oil palm seeds, topsoil, coconut dregs, 40 x 40 cm polybags, fence netting, bamboo, 2 x 1 m research banners, polybag labels, observation sheets, Azoxystrobin fungicide 200 g/l (Amistartop), Lambda-cyhalothrin insecticide 25 g/l (Matador), treatment plot stakes and water. The tools used were a hoe, 15 l watering can, 40 and 60 cm roller ruler, 10 kg digital scale, 20 l bucket, 2 mm soil sieve, digital caliper, 10 m rolling meter, 1 l hand sprayer and documentation camera.

The research method used in this study is a Non-Factorial Completely Randomized Design (CRD) with coconut dregs treatment as a mixture of topsoil planting media. The coconut dregs treatment factor used as a mixture of planting media (M) consists of five treatment levels, namely: M0 = Control + Top Soil (100%), M1 = Top Soil + Coconut dregs (90% : 10%), M2 = Top Soil + Coconut dregs (80% : 20%), M3 = Top Soil + Coconut dregs (70% : 30%), M4 = Top Soil + Coconut dregs (60% : 40%). The study used 5 replications, with 6 plants per plot, so that the total number of plants was 150. The results of the significant data analysis will be continued with the Duncan Distance Test (DMRT) at $\alpha = 5\%$ (Gomez and Gomez, 1984). Data were analyzed using Microsoft Excel (version 2021). Observed parameters were plant height (cm), stem diameter (mm), number of leaves (leaflets), and total leaf area (cm^2). Observations were conducted weekly for four months.

The implementation of this research was carried out by preparing the research land; namely, the land was cleared of weeds that grew wild using a hoe and machete until the surface of the land was in a clean condition. The research

area was then divided into 25 plots to place polybags with the help of a 10 m roll meter. Each plot was made with a length of 115 cm, a width of 80 cm, and a height of 15 cm, while the distance between plots was set at 50 cm so that the plot arrangement was more orderly in accordance with the research design. The bamboo fences, with a length of 150 cm each, were cut into 12 stems according to the research needs that stood upright as fence supports; then the fence netting was installed around the research land area with a fence height of 130 cm. The planting material used in this study was 3-month-old DxP Simalungun variety oil palm seedlings obtained from the PPKS partner nursery located in Aek Pancur, Medan. The coconut dregs planting medium was first dried in the sun until dry. At the same time, the topsoil was sieved to separate the remaining roots, rocks, and other impurities so that a more homogeneous medium was obtained. Next, the coconut dregs and topsoil were mixed according to the specified treatment composition. The planting medium mixture is then placed in 40 x 40 cm black polybags, filling them approximately 1 cm below the rim. Oil palm seedlings are planted in the prepared planting holes. Plant maintenance includes watering, weeding, and pest and disease control.

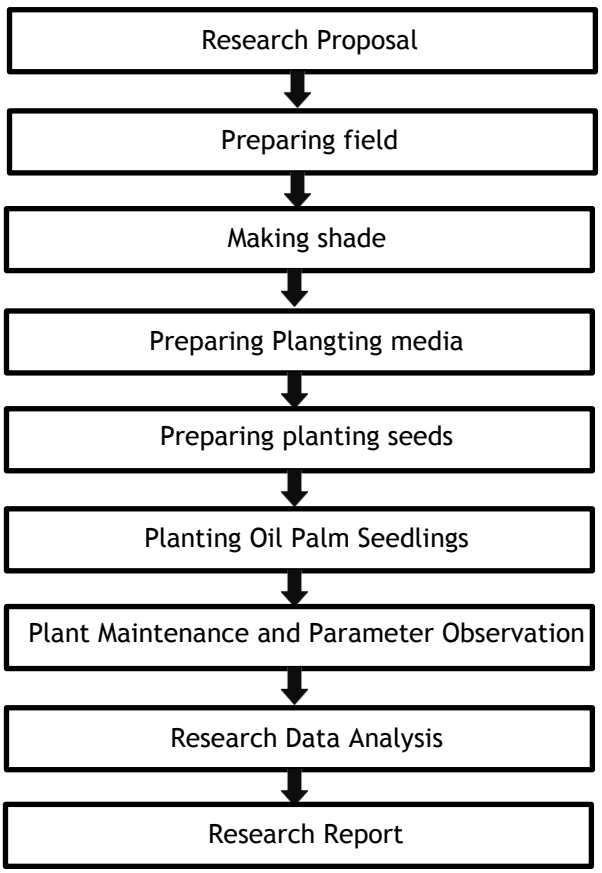


Figure 1. Research Flowchart

3. Results and Discussion

The results of observations carried out every week until 16 Weeks After Planting (MST) can be seen in the Table 1.

The results of observations in Table 1 of the average plant height up to 16 MST show that with the treatment of increasing the proportion of coconut dregs used as a mixture of topsoil planting media from 0% to 40%, it can be seen that the response of plant height decreased (negative). This probably happened because the coconut dregs had not been decomposed perfectly (ripe), so that the average plant height decreased significantly compared to the control (M0 = Control + Top Soil (100%). Increasing the proportion of coconut dregs of the planting medium from 0% to 40% caused the average plant height to decrease compared to the control treatment (Top Soil 100%). This condition is thought to occur because the coconut dregs used had not undergone a complete decomposition process, so that they were not yet able to provide nutrients available to plants. In addition, during the decomposition process of immature organic materials, microorganisms utilize nitrogen elements for decomposition activities (nitrogen immobilization), so that the availability of nitrogen for plants is reduced and has an impact on inhibiting vegetative growth, especially plant height. The results of this study are in line with the research of Ariyanti et al. (2022), which reported that the use of composted organic materials provided a better response to the growth of oil palm seedlings compared to the use of organic materials that were not ready to be used as planting media. This is also the same result, which shows that the level of maturity of organic materials is an important factor in supporting the growth of oil palm seedlings. Immature organic matter can also lead to nitrogen or oxygen limitations for plants in the early stages of growth (Lazicki et al., 2020). This condition can inhibit the vegetative growth of seedlings, particularly plant height. Therefore, the maturity level of organic matter is an important factor to consider before using it as a planting medium.

Table 2 shows the average stem diameter up to 16 weeks after planting (WAP), showing a similarity in the data trend model for plant height observations. With the addition of coconut pulp of the topsoil planting medium from 0% to 40%, the stem diameter response trend also decreased (negative). The stem diameter response follows the same pattern as plant height, decreasing as the proportion of coconut pulp of the planting medium increases from 0% to 40%. The decrease in stem diameter is thought to result from incomplete decomposition of coconut pulp, leading in suboptimal nutrient mineralization. During the decomposition process, microorganisms utilize available nitrogen to decompose organic matter, resulting in nitrogen immobilization, which reduces nutrient availability for plants. This condition causes suboptimal stem tissue formation, resulting in smaller seedling stem diameters compared to the control treatment. The results of this study are in line with the research of Nurahmi et al.

(2024), which states that the composition of the planting media significantly affects the diameter of the base of the oil palm seedling stem, and planting media with good physical properties and nutrient availability result in higher stem diameter growth. Similarly, similar results are in line with these results, Suhadi et al. (2025) reported that the use of compost as organic material in oil palm nursery media can increase vegetative growth, including stem diameter, because mature compost can improve the physical properties of the media, increase the activity of beneficial microorganisms, and provide nutrients gradually for seedling growth. Thus, immature organic materials tend not to support optimal stem diameter growth.

Table 1. Results of Observations of Average Plant Height (cm) Up to 16 MST.

Treatment		Plant Age (WAS)				
		0	4	8	12	16
Mixed Media (M)	M0	22.27 ∓0.93	25.17 ∓0.70 a	27.05 ∓0.55 a	33.97 ∓0.93 a	45.87 ∓1.38 a
	M1	21.77 ∓0.62	23.53 ∓0.82 b	25.07 ∓1.04 b	29.40 ∓1.73 b	38.18 ∓2.47 b
	M2	21.93 ∓1.15	23.23 ∓0.86 b	24.53 ∓0.95 b	28.25 ∓1.31 b	37.12 ∓1.85 b
	M3	21.80 ∓0.93	23.55 ∓0.80 b	24.75 ∓1.02 b	27.78 ∓1.31 b	35.73 ∓1.94 b
	M4	21.58 ∓0.78	23.05 ∓0.78 b	24.27 ∓0.63 b	25.55 ∓1.12 c	32.22 ∓1.65 c
Average		21.87 ∓0.10	23.71 ∓0.04	25.13 ∓0.26	28.99 ∓0.45	37.82 ∓0.42
Sig.		tn.	**	**	**	**

Description: The same letters in the same column are not real according to Duncan's Range Test with α= 5%.

Table 2. Observation Results of Average Stem Diameter (mm) Up to 16 MST.

Treatment		Plant Age (WAS)				
		0	4	8	12	16
Mixed Media (M)	M0	5.23∓0.46	6.49 ∓0.52	10.55 ∓0.56 a	15.88 ∓0.50 a	20.33 ∓0.54 a
	M1	5.41 ∓0.24	6.33 ∓0.19	7.85 ∓0.20 b	12.29 ∓0.46 b	17.00 ∓0.64 b
	M2	5.55 ∓0.69	6.69 ∓0.70	8.09 ∓0.58 b	12.28 ∓0.75 b	16.37 ∓0.90 b
	M3	5.36 ∓0.21	6.43 ∓0.16	7.87 ∓0.38 b	11.85 ∓0.73 b	16.12 ∓0.75 b
	M4	5.16 ∓0.39	6.08 ∓0.46	7.58 ∓0.33 b	10.80 ∓0.58 c	14.68 ∓0.67 c
Average		5.34 ∓0.16	6.40∓0.20	8.39 ∓0.21	12.62 ∓0.31	16.90 ∓0.37
Sig.		tn.	tn.	**	**	**

Description: The same letters in the same column are not real according to Duncan's Range Test with α= 5%.

Table 3. Observation Results of the Average Number of Leaves (Sheets) Up to 16 MST.

Treatment		Plant Age (WAS)				
		0	4	8	12	16
Mixed Media (M)	M0	2.80 ∓0.27	4.37 ∓0.40 a	6.57 ∓0.25 a	9.43 ∓0.43 a	11.60 ∓0.45 a
	M1	2.80 ∓0.14	3.93 ∓0.19 b	5.37 ∓0.38 b	7.47 ∓0.58 b	9.87 ∓0.72 b
	M2	2.83 ∓0.12	3.90 ∓0.15 b	5.33 ∓0.29 b	7.47 ∓0.51 b	10.07 ∓0.28 b
	M3	2.90 ∓0.09	3.97 ∓0.07 b	5.23 ∓0.19 b	7.37 ∓0.27 b	9.80 ∓0.32 b
	M4	2.77 ∓0.19	3.90 ∓0.25 b	5.17 ∓0.20 b	6.93 ∓0.45 b	9.10 ∓0.61 c
Average		2.82 ∓0.08	4.01 ∓0.14	5.53 ∓0.09	7.73 ∓0.16	10.09 ∓0.17
Sig.		tn.	*	**	**	**

Description: The same letters in the same column are not real according to Duncan's Range Test with α= 5%.

Table 4. Observation Results of Average Total Leaf Area (cm ^{2}) Up to 16 MST.

Treatment		Plant Age (WAS)				
		0	4	8	12	16
Mixed Media (M)	M0	185.63 ∓10.15	592.11 ∓48.20 a	1783.34 ∓83.50a	5751.27 ∓312.22a	12313.45 ∓643.10a
	M1	182.08 ∓34.04	429.98 ∓38.82b	968.30 ∓124.91 b	2795.66 ∓505.45b	7443.25 ∓948.46b
	M2	178.69 ∓11.88	431.63 ∓62.01 b	906.64 ∓102.86 bc	2566.40 ∓467.32 b	6956.79 ∓725.71bc
	M3	188.42 ∓12.26	425.58 ∓38.98b	865.00 ∓105.18 bc	2432.31 ∓395.76bc	6287.72 ∓899.17 c
	M4	164.76∓18.07	422.42 ∓47.26 b	819.61∓ 60.14c	1964.69 ∓368.48c	4760.36 ∓861.15 d
Average		179.92∓8.80	460.34 ∓24.09	1068.58 ∓42.96	3102.06 ∓146.12	7552.31 ∓861.15
Sig.		tn.	**	**	**	**

Description: The same letters in the same column are not real according to Duncan's Range Test with α= 5%.

Likewise, Table 3 average number of leaves and Table 4 average total leaf area up to 16 MST have similarities in

the data trend model in plant height observations that with the treatment of adding the proportion of coconut dregs used as a mixture of topsoil planting media from 0% to 40%, the response data trend model also decreases (negative). Increasing the proportion of coconut dregs in the topsoil planting media mixture to 40% tends to decrease the number of leaves and the total leaf area of oil palm seedlings. This is thought to be caused by changes in the physical properties of the planting media: a higher proportion of organic material increases water retention but reduces aeration and mineral nutrient availability for plants. As a result, the formation of new leaves and expansion of leaf area are less than optimal, which can be seen in the total leaf area as in Figure 2 below.

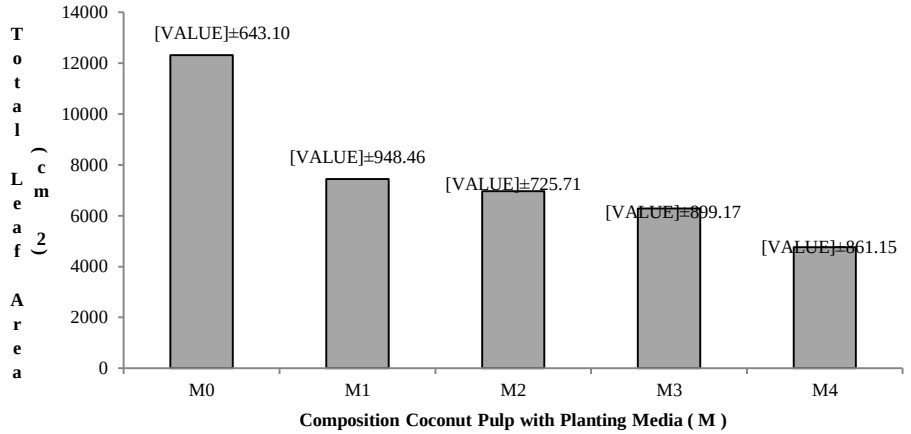


Figure 2. Effect of Coconut Pulp Composition with Planting Media on the Total Leaf Area of Oil Palm Plants in the Main Nursery

Previous research also showed similar results, where these findings are in line with the research of Maryani et al. (2025), who reported that the use of cocopeat in oil palm nursery media needs to be given in the appropriate proportion because excessive composition does not always produce the best vegetative growth, especially in the parameters of the number of leaves and leaf area. The same is conveyed in the research of Lukita et al. (2023) that the addition of fibrous organic materials does not always mean that the higher the proportion is better; the plant response depends on the media composition.

4. Conclusion

The use of under-decomposed (ripe) coconut pulp as a planting medium can lead to a decreased (negative) vegetative growth response in oil palm (Elaeis guineensis Jacq.) seedlings in the main nursery. In contrast, fully decomposed (ripe) coconut pulp as a planting medium provides a better vegetative growth response for oil palm seedlings.

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