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Peat–Sand Media Enrichment with Organic Fertilizers for Swamp Jelutung Seedling Growth

Penggunaan Pupuk Organik Pada Campuran Media Gambut dan Pasir untuk pertumbuhan bibit Jelutung Jawa

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Abstract

The propagation of jelutung rawa (*Dyera lowii*) seedlings currently relies on generative techniques using seeds, while vegetative methods such as cuttings and tissue culture have not yet been developed. The experiment was conducted using a Completely Randomized Design (CRD) with five treatments and five replications, yielding a total of 25 experimental units. The treatments consisted of: control (peat + sand), compost, poultry manure, cattle manure, and goat manure. Data were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) at the 5% significance level. The results demonstrated that organic fertilization significantly affected leaf number, leaf area, and leaf dry weight, while no significant effect was observed on stem height and stem diameter. Compost treatment produced the most favorable outcomes, with an average of 10.2 leaves, a leaf area of 42.84 cm², and a leaf dry weight of 0.133 g. Goat manure also showed strong performance, yielding an average of 8.8 leaves, a leaf area of 30.16 cm², and a leaf dry weight of 0.0936 g.

Article Information

Keywords:
Peat; Swamp jelutung (*Dyera lowii*); Sand; Organic fertilizer

Pembibitan jelutung rawa saat ini umumnya masih dilakukan secara generatif menggunakan biji. Teknik perbanyakan vegetatif, seperti stek dan kultur jaringan, belum berkembang secara optimal. Penelitian ini akan mengkombinasikan media tanam gambut dan pasir sebagai media tanam utama. Selanjutnya pupuk organik yang terdiri dari pupuk kompos dan pupuk kandang (sapi, kambing dan ayam) sebagai media tambahan. Rancangan percobaan yang digunakan dalam penelitian ini adalah RAL. Terdiri dari 5 perlakuan dan 5 ulangan, sehingga terdapat 25 satuan percobaan. Selanjutnya, dilakukan sidik ragam atau uji f untuk mengetahui pengaruh tiap perlakuan terhadap parameter pengamatan. Hasil penelitian menunjukkan pupuk organik berpengaruh nyata terhadap jumlah daun, luas daun, berat kering daun dan tidak berpengaruh nyata terhadap tinggi batang dan diameter batang. Pupuk organik yang optimal untuk pertumbuhan bibit jelutung rawa adalah pupuk kompos dan pupuk kambing. Pupuk kompos memiliki rata-rata jumlah daun yaitu 10,2 helai, luas daun 42,84 cm^2, dan berat kering 0,133 gr. Sedangkan pupuk kambing memiliki rata-rata jumlah daun 8,8 helai, luas daun 30,16 cm^2, dan berat kering 0,0936 gr

Kata kunci:
Gambut, Jelutung rawa, Pasir, Pupuk Organik

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A. INTRODUCTION

Swamp jelutung (*Dyera lowii*), belonging to the family Apocynaceae and the genus *Dyera*, is a tree species native to Indonesia. Naturally, this species is found along riverbanks, swamps, and peat swamps in regions such as Riau, Jambi, South Sumatra, and the provinces of West, Central, and South Kalimantan. Historically, *Dyera lowii* has been recognized as a tree of high economic value. Its latex, unlike that of the rubber tree (*Hevea brasiliensis*), has traditionally been utilized as a raw material for chewing gum, insulation, and medical equipment. In addition to latex, the wood of jelutung has also been widely harvested as raw material for the manufacture of furniture and household furnishings. (Tata, 2015).

Swamp jelutung (*Dyera lowii*) is a native tree species (indigenous species) with high potential for the development of productive and environmentally friendly plantation forests on peatland ecosystems. Peat soil represents the most suitable growing medium for jelutung growth. By definition, peat soil contains at least 20% organic matter and is characterized by a high capacity to supply nutrients. Peatlands are water-saturated soils formed from partially decomposed plant residues and organic tissues. According to the FAO classification, peat soil is identified by the presence of a peat layer exceeding 40 cm in thickness and containing at least 30% organic matter.

Indonesia possesses some of the largest peatland areas in the tropics, distributed across several major islands. The largest proportion of peatlands is found in Sumatra (41.4%), followed by Papua (23%), Kalimantan (22.8%), Sulawesi (1.6%), and Halmahera–Seram (0.5%). These ecosystems play a critical role in carbon storage, biodiversity conservation, and the provision of suitable substrates for native tree species such as swamp jelutung. (Utami, 2018). Peat media contains high levels of C-organic, N, P, Ca, and Mg. These characteristics indicate that peat is a suitable growing medium and can optimally support plant growth in nursery conditions. (Setyawati et al., 2023).

Many communities, particularly in Jambi Province, cultivate swamp jelutung; however, their knowledge regarding its cultivation remains limited. Public awareness about jelutung cultivation is still very minimal, even though jelutung is a multipurpose species that, when cultivated, can provide highly promising yields. The cultivation of a plant is not sufficient if one only understands its primary growing medium; it is also necessary to determine the appropriate mixtures or combinations of media that can be effectively used together with peat. Evinola (2019) state that sand is considered a good planting medium for seedling cultivation because it contains large pores, allowing it to become easily wetted and to dry quickly through the process of evaporation. The sand medium has high porosity; although it does not contain nutrients, plant roots can still penetrate the medium easily. Herlina et al (2023) state that the characteristic of sand as a planting medium, which dries quickly, facilitates the transplantation of seedlings of sufficient age into other media. The relatively heavy weight of sand also helps maintain stem stability. However, sand is rarely used as a sole planting medium. Instead, it is commonly combined with other growing media. Therefore, in this study, sand was combined with peat soil. In addition to peat, sand is also suitable to be combined with organic fertilizers, as its high porosity can enhance root development, while its adhesive property helps support seedling establishment.

Currently, the propagation of swamp jelutung (*Dyera lowii*) still relies on generative techniques using seeds, as vegetative methods such as cuttings and tissue culture have not yet been mastered. The use of high-quality seedlings is a key factor in achieving high productivity. One of the critical aspects influencing this success is the application of fertilizers. This study combines peat soil and sand as the main growing media, supplemented with organic fertilizers including compost and animal manures (cattle, goat, and poultry) as additional media components.

B. METHOD

The experimental design used in this study was a Completely Randomized Design (CRD), consisting of five treatments with five replications. The treatments were as follows:

G_0 = Peat + Sand (Control)
G_1 = Peat + Sand + Compost
G_2 = Peat + Sand + Poultry Manure
G_3 = Peat + Sand + Cattle Manure
G_4 = Peat + Sand + Goat Manure

The growing media used were peat, sand, compost, and animal manures (poultry, cattle, and goat). Prior to use, the sand medium was sterilized by sieving. The planting media were prepared with a ratio of 2:1:1 kg (peat:sand:organic fertilizer), whereas for the control treatment (G0), the ratio was 2:1 kg (peat:sand). The media mixtures were placed into polybags and left for one week to ensure uniform blending.

The observed parameters in this study included stem height increment, number of leaves, leaf area, leaf color, stem diameter, and specific leaf dry weight. Stem height of swamp jelutung seedlings was measured at the time of transplanting into the growing medium and remeasured after 10 weeks. At the beginning of the experiment, each seedling was marked 2 cm above the surface of the growing medium as a zero reference point for height measurement. The number of leaves was recorded by counting all leaves from transplanting until 10 weeks after planting, expressed as the number of leaf blades. Leaf area was measured on the first, second, and third leaves from the shoot apex after 10 weeks. The measurement was carried out by weighing the leaf, attaching it to a sheet of paper with known weight and area, cutting the paper according to the leaf shape, and reweighing the cut-out paper. Leaf area was then calculated using the following formula: Leaf area = (Weight of leaf cut-out × Paper area) / Paper weight. Leaf color was observed after 10 weeks by comparing the first, second, and third leaves from the shoot apex with a standard leaf color chart. Stem diameter was measured after 10 weeks using a vernier caliper. Specific leaf dry weight was determined for the first, second, and third leaves from the shoot apex of each seedling using an analytical balance.

The study employed a Completely Randomized Design (CRD) with five treatments and five replications. Each replication consisted of one plant sample, resulting in a total of 25 experimental units. Data were analyzed using analysis of variance (ANOVA) or the F-test to determine significant differences among treatments, followed by Duncan’s Multiple Range Test (DMRT) at the 5% significance level.

C. RESULTS AND DISCUSSION

The results of the analysis of variance indicated that the application of organic fertilizers had a significant effect on leaf number, leaf area, and specific leaf dry weight, as presented in Table 1. Based on the leaf color scale chart, organic fertilizers produced variations in leaf coloration across treatments. On the other hand, other observed parameters showed that organic fertilizers had no significant effect on stem height increment and stem diameter, as presented in Table 2.

Leaf number, leaf area, and specific leaf dry weight

Table 1. Effect of Organic Fertilizers on the Average Leaf Number, Leaf Area, and Specific Leaf Dry Weight of Jelutung Rawa (*Dyera lowii*) Seedlings

Treatments	Leaf Number	Leaf Area	Specific Leaf Dry Weight
G_0 = Peat + Sand (Control)	9,2 ^{ab}	19,64 ^{b}	0,0572 ^{b}
G_1 = Peat + Sand + Compost	10,2 ^{a}	42,84 ^{a}	0,133 ^{a}
G_2 = Peat + Sand + Poultry Manure	7,8 ^{b}	28,07 ^{ab}	0,0884 ^{ab}
G_3 = Peat + Sand + Cattle Manure	8,4 ^{b}	19,07 ^{b}	0,0564 ^{b}
G_4 = Peat + Sand + Goat Manure	8,8 ^{ab}	30,16 ^{ab}	0,0936 ^{ab}

Explanation: Numbers followed by the same lowercase letter are not significantly different at the 5% level according to the DNMRT test.

The results of this study showed that seedlings treated with compost fertilizer produced the highest number of leaves compared to other treatments. This response is most likely due to the nitrogen (N) content in compost, which plays a central role in leaf development. According to Marutani & Clemente (2021) dan Kebede et al (2023) nitrogen promotes plant growth and improves plant quality by enhancing leaf production. Similarly, goat manure treatment produced results that were not significantly different from compost application. This can be attributed to the fact that goat manure contains relatively high levels of essential nutrients, particularly nitrogen, which supports optimal growth.. Kebede et al (2023) dan Erfina et al (2023) reported that goat manure has higher nitrogen content and moisture levels compared to cattle manure, making it more effective in supplying nutrients to the planting medium. Nitrogen is a key component of amino acids, proteins, and enzymes, which are crucial for cell division and enlargement. In plants, nitrogen plays a major role in vegetative growth, especially in stem and leaf development. Both compost and goat manure are classified as organic fertilizers; however, they differ in nutrient composition, decomposition rate, and nutrient release pattern. Compost generally contains a more balanced nutrient profile and improves soil structure, whereas goat manure provides a higher nitrogen content that can be absorbed by plants more rapidly. Therefore, comparing these two organic materials can help identify which source is more efficient in enhancing seedling growth.

The analysis of variance presented in Table 1 revealed that organic fertilizer application had a significant effect on the leaf area of swamp jelutung (*Dyera lowii*) seedlings. Among the treatments, compost fertilizer produced the highest leaf area compared to other organic fertilizers. This result can be attributed to the ability of compost to improve soil structure. Susetya (2019) compost enhances soil aggregation, aeration, and drainage, thereby improving overall soil structure. Moreover, the presence of soil organic matter increases the water-holding capacity, ensuring sufficient water availability for plants. Consequently, seedlings grown in soil enriched with organic matter tend to develop larger leaf areas due to improved water supply. In addition to its role in improving soil structure, compost also provides a substantial supply of nitrogen. Previous studies by Suruban et al (2022) and Elfeel & Abohassan (2016) demonstrated that the high nitrogen content in compost significantly influences the leaf area index (LAI).

Plant dry weight is a reliable parameter to assess seedling growth performance, as it reflects the accumulation of photosynthetic products and the overall efficiency of physiological activities within the plant (Lime et al., 2024). The analysis of variance presented in Table 1.1 showed that compost fertilizer significantly differed from goat manure and the control treatment in terms of dry weight of swamp jelutung (*Dyera lowii*) seedlings. This indicates that the nutrient composition of compost can provide a more balanced supply of macro- and micronutrients essential for seedling growth. Compost generally contains more stable levels of nitrogen (N), phosphorus (P), and potassium (K), along with a more favorable C/N ratio compared to fresh manure. Adequate nitrogen supply from compost is crucial for protein and chlorophyll synthesis, thereby enhancing photosynthesis and promoting biomass accumulation in leaves (Syafria, 2023). Phosphorus plays a central role in energy formation (ATP), supporting vital physiological processes, while potassium contributes to photosynthetic efficiency and the translocation of photosynthates to plant tissues (Lingga & Marsono, 2019). The synergy of these nutrients explains the observed increase in leaf dry weight under compost treatment compared to other organic fertilizers. Although both compost and goat manure contain essential nutrients (N, P, and K), the difference lies in their nutrient stability and release patterns. Compost releases nutrients more gradually, maintaining sustained nutrient availability that supports continuous leaf development, whereas goat manure releases nitrogen rapidly, which may promote early growth but less sustained biomass accumulation.

Leaf Color

Table 2. Effect of Organic Fertilizers on Leaf Color of Swamp Jelutung (*Dyera lowii*) Seedlings

Reflications	Treatments				
	G_O	G_1	G_2	G_3	G_4
1	5	13	13	11	11
2	13	14	14	10	11
3	12	13	13	12	14
4	12	14	10	12	13
5	12	14	13	10	14

Based on the analysis using a leaf color chart (scale 1–18), the average seedlings of swamp jelutung treated with organic compost fertilizer (G1) exhibited leaf colors predominantly at scales 14 and 13, corresponding to dark green and green, respectively. Seedlings treated with goat manure fertilizer (G3) were mainly observed at scales 11 (sea green), 10 (medium sea green), and 12 (moss green), while those treated with cattle manure (G4) were at scales 13 (green), 11 (sea green), and 14 (dark green). The application of chicken manure fertilizer (G2) resulted in leaves at scales 14 (green), 10 (medium sea green), and 13 (green). Meanwhile, the control treatment (G0), without organic fertilizer, showed lighter leaf colors at scales 12 (moss green), 5 (lime green), and 13 (green).

Figure 1. the leaf color measurement was conducted using a Leaf Color Chart (LCC).

In this study, the leaf color chart served as a qualitative indicator of chlorophyll content, reflecting differences in nutrient availability and photosynthetic performance. Green-colored leaves indicate a high chlorophyll content. The leaves of swamp jelutung seedlings treated with organic fertilizers, namely compost and manure, showed higher chlorophyll accumulation. The sufficient magnesium (Mg) content in organic fertilizers stimulates the formation of chlorophyll. According to Lakitan (2018) magnesium is an essential element in chlorophyll formation. Magnesium is considered a vital nutrient because it binds with ATP, enabling ATP to function in various biochemical reactions. In addition, magnesium serves as an activator of several enzymes involved in photosynthesis, respiration, and the synthesis of DNA and RNA. Similarly, Salisbury & Ross (1995) state that magnesium (Mg) is a crucial factor in chlorophyll formation. Magnesium deficiency leads to chlorosis, which begins in the lower stems and is subsequently followed by the death of entire leaf sections. Leaf yellowing does not occur uniformly but starts from the edges, while the veins remain green. According to Lakitan (2018) nitrogen deficiency causes leaves to appear less fresh green, tending toward yellowish in color. If the deficiency persists continuously, the lower leaves will turn completely yellow and eventually fall off.

Stem Height and Diameter

Table 3. Effect of Organic Fertilizers on the Average Stem Height and Diameter of Swamp Jelutung (*Dyera lowii*) Seedlings

Treatments	Diameter (mm)	Stem Height (cm)
G_0 = Peat + Sand (Control)	0,29	3,74
G_1 = Peat + Sand + Compost	0,38	5,26
G_2 = Peat + Sand + Poultry Manure	0,34	4,94
G_3 = Peat + Sand + Cattle Manure	0,32	3,92
G_4 = Peat + Sand + Goat Manure	0,34	4,36

Based on the analysis presented in Table 1.3, the effect of organic fertilizers on the stem height and diameter of swamp jelutung (*Dyera lowii*) seedlings did not show a significant influence. This is presumed to be due to the relatively short duration of the study, which limited the observation of stem diameter growth, making it less apparent. Swamp jelutung is a woody plant that can reach up to 60 m in height with a diameter of up to 260 cm. Therefore, with a longer observation period, the effects on stem height and diameter would likely become more evident. Macro-nutrients such as nitrogen (N), phosphorus (P), and potassium (K) in organic fertilizers are generally present in complex forms, requiring more time to decompose and become available for plant uptake (Brady & Weil, 2016). Consequently, during the early growth phase, the available nutrients may not be sufficient to exert a significant effect on vegetative growth parameters such as stem height and diameter.

In addition, swamp jelutung exhibits a relatively slow growth pattern, particularly in stem diameter, so the response to organic fertilizer application may only become apparent after a longer growth period. During the early growth phase, photosynthates are primarily allocated to leaf formation rather than stem growth, which explains why plant height and stem diameter often show no significant differences. This finding is consistent with the study by Rotowa et al (2025) which reported that the application of organic fertilizers to the growing media of several woody plant species did not result in significant effects.

D. CONCLUSION

The application of organic fertilizers had a significant effect on the growth of swamp jelutung (*Dyera lowii*) seedlings in terms of leaf number, leaf area, and leaf dry weight, but did not significantly affect stem height and diameter, while also producing variations in leaf coloration. Based on the findings of this study, the organic fertilizers that provided the most optimal effects on the growth of swamp jelutung seedlings were compost and goat manure.

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