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Research Paper

The Effect of Manure and Humic Acid on the Growth of Cork Tree (*Thespesia populnea*) Seedlings

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ABSTRACT: *Beach sand has high salinity and low nutrient content. Mixing cow manure and humic acid into a sand-based growing medium can enhance tree seedling growth. This research aimed to analyze the effect of mixing cow manure and humic acid into a sand-based growing medium on the growth of cork tree (Thespesia populnea) seedlings. The research used a factorial completely randomized design with 2 factors. The first factor was cow manure consisting of 4 levels (0 g, 100 g, 120 g, 150 g). The second factor was humic acid consisting of 3 levels (0 ml, 5 ml, 15 ml). The results showed that cow manure dosage significantly affected to the seedling height, seedling diameter, root length, root dry weight, shoot dry weight, and seedling quality index. A dose of 100 g of manure had the best effect on the growth of cork tree seedlings compared to other doses of manure. The application of humic acid significantly affected to the root length with the best dose being 15 ml. An interaction occurred between the doses of manure and humic acid and affected to the root length. The best root growth (34.9 cm) occurred in the combination treatment of 100 g of cow manure and 15 ml of humic acid.*

KEYWORDS: *Cow manure, Humic acid, Sand beach, Seedling growth*

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I. INTRODUCTION

Beach sand is a soil with high salinity and low nutrient content. Tree seedlings grown in beach sand generally fail to grow optimally, necessitating improvements to this growing medium. The physical and chemical properties of beach sand are inadequate to support proper seedling growth. This is due not only to limited nutrient availability but also to the sand's excessively porous nature, which makes it unable to bind and retain nutrients and water (Indriyanto, 2022). Furthermore, Indriyanto (2022) stated that among the requirements for a good seedling growth medium is the ability to provide and bind nutrients, as well as retain water. Efforts to improve the growth medium for tree seedlings can be done by adding manure, humic acid, and other amendments (Mustaqimah et al., 2020).

Cow manure is a soil amendment that can add nutrients and improve water retention for plant life and growth (Rahayu, 2020). Furthermore, Rahayu (2020) states that cow manure is a complete source of nutrients, including macronutrients such as N, P, and K, and micronutrients such as Ca and Mg, to meet the needs of plant growth.

Furthermore, humic acid is a compound produced from the decomposition process of organic matter that can be used as a soil conditioner so that plants can survive in critical growing areas and environments (Prayudyaningsih & Sari, 2016). According to Khaled & Fawy (2011), humic acid can reduce evapotranspiration, increase water holding capacity, strengthen soil aggregates to prevent erosion, and increase the soil's cation exchange capacity (CEC).

Land rehabilitation requires tree species that are adaptable to critical land, fast-growing, local, and resistant to environmental constraints (Indriyanto, 2017; Indriyanto, 2010), as well as the availability of quality tree seedlings (Indriyanto, 2022). The cork tree (*Thespesia populnea*) is a species of tree that naturally lives in coastal ecosystems and is associated with other species of trees such as the coastal hibiscus tree (*Hibiscus tiliaceus*) which plays an important role in protecting coastal areas (Aulya et al., 2020). The use of cork trees (in Indonesia it is called waru laut tree) for coastal rehabilitation is a method of selecting the right tree species because its natural habitat is in coastal areas.

Based on the description above, the identified problems are high salinity and low nutrient content in beach sand. Therefore, the use of beach sand as a growing medium for tree seedlings requires improvement by incorporating soil amendments to accelerate seedling growth. Therefore, this research aimed to analyze the dosage of cow manure and humic acid that best affected the growth of cork tree seedlings in a growing medium made from beach sand.

II. METHODS

Research Site and Time

This research was conducted from September 2024 to January 2025. The research location was the Greenhouse, Integrated Field Laboratory, Faculty of Agriculture, University of Lampung. Preparation of several materials and data analysis were conducted at the Silviculture and Forest Protection Laboratory, Department of Forestry, Faculty of Agriculture, University of Lampung. The air temperature inside the greenhouse during the research ranged between 24.6°C and 30.7°C, with an average temperature of 27.3°C. Humidity ranged between 58% and 95%, with an average humidity of 83%.

The tools used for this research include digital scales, sprayers, measuring cups, thermohygrometers, rulers with 1 mm accuracy, shovels, digital calipers, pot trays measuring 3.5 cm × 3.5 cm, sieves with a density of 20 mesh and plastic measuring cups. The materials used in this research are cork tree (*Thespesia populnea*) seeds, sand media, 20 cm × 20 cm polybags, cow manure, and liquid humic acid.

Experimental Design

The research method used is a factorial in a Completely Randomized Design (CRD) with 2 factors. The first factor is cow manure (P) consisting of 4 levels, namely 0 g, 100 g, 120 g, and 150 g. The second factor is humic acid (A) consisting of 3 levels, namely 0 ml, 5 ml, and 15 ml. Each treatment was repeated 5 times, the number of experimental units was 60 units, each experimental unit consisted of 1 tree seedling, so the number of sea hibiscus tree seedlings used was 60 seedlings.

The variables observed included seedling height, seedling stem diameter, root length, root dry weight, shoot dry weight, and seedling quality index. The seedling quality index is calculated using Dickson's formula (Indriyanto, 1999).

The observation data were tested for homogeneity of variance using Levene's test. Analysis of variance was then performed, and the average values of the treatments were compared using Duncan's Multiple Range Test (DMRT). All tests were conducted at the 5% significance level.

III. RESULT AND DISCUSSION

The results of statistical analysis of all research variables showed that cow manure significantly affected to seven variables, namely seedling height, seedling stem diameter, root length, root dry weight, shoot dry weight, and seedling quality index. Humic acid significantly affected to one variable, namely root length. There was an interaction between cow manure and humic acid that significantly affected to root length. The recapitulation of the results of the analysis of variance is presented in Table 1.

Table 1. Results of the analysis of variance for each research variable in the treatment of cow manure and humic acid doses.

Variable	Dose of cow manure (P)		Dose of humic acid (A)		Interaction of cow manure and humic acid doses (P x A)	
	F_{count}	$F_{0.05\ (3, 48)}$	F_{count}	$F_{0.05\ (2, 48)}$	F_{count}	$F_{0.05\ (6, 48)}$
Seedling height	5.87 *	2.79	0.79 ns	3.19	1.88 ns	2.29
Seedling diameter	4.92 *	2.79	0.39 ns	3.19	1.16 ns	2.29
Root length	3.49 *	2.79	3.53 *	3.19	2.32 *	2.29
Root dry weight	5.21 *	2.79	2.76 ns	3.19	1.38 ns	2.29
Shoot dry weight	3.53 *	2.79	1.72 ns	3.19	0.26 ns	2.29
Seedling quality index	4.34 **	2.79	0.69 ns	3.19	0.15 ns	2.29

Remark: *= significant different
ns= not significantly different

The results of the analysis of nutrient content in beach sand and cow manure that used as seedlings growing media are presented at Table 2.

Table 2. Nutrient content of sand beach and cow manure

Nutrient content	Sand beach	Cor manure
C-organik (%)	0.16 vl	10.83 vh
N-total (%)	0.03 vl	2.60 vh
P-tersedia (% P2O5)	5.71 vl	0.38 vl
K-total (% K2O)	0.24 l	1.66 vh
pH	7.88 n	-
Mg-dd (me/100g)	9.24 vh	-
Ca-dd (me/100g)	2.40 l	-
Na-dd (me/100g)	4.59 vh	-
C/N	5.30 l	4.16 vl

Source: Soil Science Laboratory, University of Lampung
Remark: vh= very high; h= high; m= moderate; l=low; vl= very low; n= neutral

Seedling Height

Seedling height is an important variable in determining seedling growth conditions. The results showed that the dose of cow manure significantly influenced seedling height. A dose of 100 g of cow manure (treatment P_1) had the best effect on the height of 3-month-old cork tree seedlings (Figure 1). The average height of cork tree seedlings in treatment P1 was 22.06 cm.

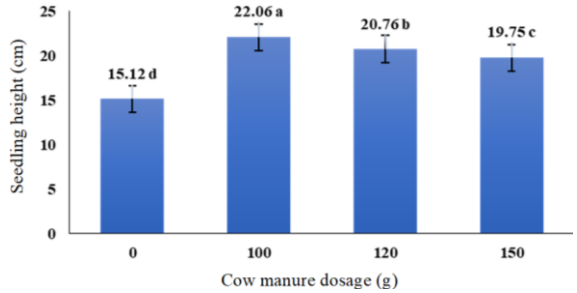

Figure 1. The main effect of the dose of cow manure on the height of 3-month-old cork tree seedlings.
Remark: $DMRT_{0.05}$= 0.223. The average value followed by the same letter means that it is not significantly different, conversely the average value followed by different letters means that it is significantly different at the 5% level of significance.

Applying cow manure can increase nutrient availability in the seedling growing medium and improve root absorption of nitrogen (N). Nitrogen is essential for vegetative growth, such as height growth. In addition to nitrogen, other elements such as phosphorus and potassium in cow manure also play a crucial role in plant growth. The combination of these three nutrients, namely nitrogen, phosphorus, and potassium can support optimal seedling growth. Yuliana et al. (2015) stated that cow manure contains not only macronutrients but also micronutrients, which help meet nutrient requirements for plant growth and development.

The availability of nutrients in a certain amount in the growing medium according to the needs of the plant within its tolerance range can have a positive effect on optimal growth. Meanwhile, if the availability of nutrients approaches and/or exceeds the maximum or minimum limit of the tolerance range, it will have a negative effect, resulting in not achieving optimal growth (Indriyanto, 2017). The results of this research prove that the application of cow manure has a better effect on the height of cork tree seedlings compared to without the application of cow manure (Figure 1). The best growth of cork tree seedlings at a dose of 100 g cow manure compared to other doses of cow manure with an increase in seedling height of 46% compared to without the application of manure (P_0).

Seedling Stem Diameter

Seedling stem diameter is an easily observed indicator of seedling growth. Research results show that the dose of cow manure significantly affects the stem diameter of cork tree seedlings (Table 1). The dose of cow manure that best affected the stem diameter of cork tree seedlings was 100 g, with an average seedling stem diameter of 3.12 mm (Figure 2). Seedling stem diameter is an easily observed indicator of seedling growth. Research results show that the dose of cow manure significantly affects the stem diameter of cork tree seedlings (Table 1). The dose of cow manure that best affected the stem diameter of cork tree seedlings was 100 g, with an average seedling stem diameter of 3.12 mm (Figure 2). When compared with the control (without cow manure), the treatment with a dose of 100g of cow manure resulted in a difference in the stem diameter of the sea hibiscus

seedling of 0.7 mm or 28.92%. This means that the 100g cow manure treatment increased the stem diameter of the cork tree seedlings by 28.92%.

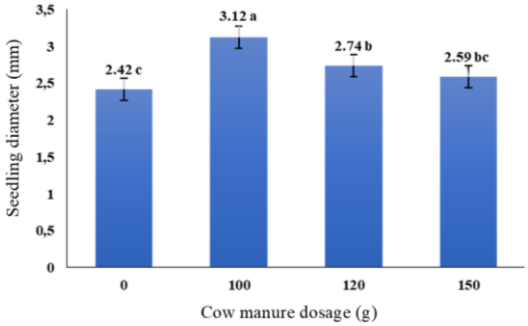

Figure 2. The main effect of the dose of cow manure on the stem diameter of 3-month-old cork tree seedlings.
Remark: $DMRT_{0.05}$= 0.054. The average value followed by the same letter means that it is not significantly different, conversely the average value followed by different letters means that it is significantly different at the 5% level of significance.

In general, plant growth is influenced by the availability of nutrients and water, which are absorbed by the roots and then reached the leaves, where photosynthesis occurs. Adequate nutrient availability is necessary to support growth, such as increasing the stem diameter of the plant (Wasis & Fitriani, 2022). Applying cow manure can increase the stem diameter of plant because cow manure is rich in nutrients such as nitrogen, phosphorus, and potassium which are needed by plants for optimal growth (Novitasari & Caroline, 2021). According to Simatupang (2019), nitrogen in cow manure can accelerate and increase the growth of plant stem diameter because nitrogen can help the formation of proteins and enzymes that support cell division and enlargement. Furthermore, Wasis & Fitriani (2022) stated that the presence of phosphorus and potassium plays a crucial role because phosphorus supports the development of a strong root system. This allows plants to absorb nutrients and water more optimally, generally resulting in better plant growth and larger stem diameters.

Root Length

Root length is one criterion for determining the extent of root coverage in seeking water and nutrient sources. Research results show that the dose of cow manure significantly affected the root length of cork tree seedlings. Comparison of the average root length of cork tree seedlings from each dose of cow manure shows that the best root growth occurred when 100 g of cow manure was given with an average root length of 24.36 cm. When compared with the control (without the provision of cow manure), the provision of 100 g of cow manure caused a 29% increase in the growth of the roots of cork tree seedlings. The root length of cork tree seedlings in each cow manure treatment is presented in Figure 3.

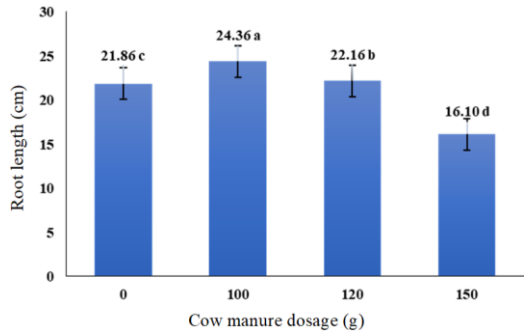

Figure 3. The main effect of the dose of cow manure on the root length of 3-month-old cork tree seedlings.
Remark: $DMRT_{0.05}$= 0.384. The average value followed by the same letter means that it is not significantly different, conversely the average value followed by different letters means that it is significantly different at the 5% level of significance.

Furthermore, the analysis of the main effect of humic acid dosage treatment significantly affected the root length of cork tree seedlings. The best root growth occurred with the application of humic acid at a concentration of 15 ml. The average root length of sea hibiscus seedlings in the 15 ml humic acid dosage treatment was 24.4 cm. When compared to the control (without humic acid administration), the 15 ml humic acid dosage treatment caused an increase in root length growth of 3.73 cm or 18.04% (Figure 4).

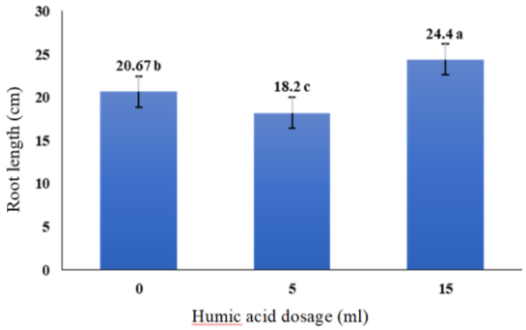

Figure 4. The main effect of humic acid dose on the root length of 3-month-old cork tree seedlings.
Remark: $DMRT_{0.05}$= 0.114. The average value followed by the same letter means that it is not significantly different, conversely the average value followed by different letters means that it is significantly different at the 5% level of significance

Humic acid is best applied in growing media with high salinity, as it acts as an organic material, enabling plants to survive in critical environments (Prayudyaningsih & Sari, 2016). Khaled & Fawy (2011) suggest that adding humic acid can reduce evapotranspiration, increase soil water holding capacity, and increase soil cation exchange capacity (CEC).

A simple analysis of the effect of cow manure doses on various doses of humic acid is presented in Table 2. Based on the results of this analysis, it can be stated that the administration of cow manure at various doses of humic acid has a significant effect on the root length of cork tree seedlings.

Table 2. The simple effect of cow manure doses at various doses of humic acid on the root length of 3-month-old cork tree seedlings

Cow manure dosage (g)	Root length (cm) at each dose of humic acid (ml)			$DMRT_{0.05}$
	0	5	15	
0	22.5 b	15.7 c	26.2 a	
100	21.0 b	18.4 c	34.9 a	0.408
120	22.8 a	23.1 a	20.6 b	
150	16.4 a	16.0 ab	15.9 b	

An interaction between the doses of cow manure and humic acid significantly affected the root length of cork tree seedlings (Figure 5). This means that the dose of cow manure will affect the root growth of cork tree seedlings depending on the dose of humic acid. Conversely, the dose of humic acid will affect the root growth of cork tree seedlings depending on the dose of cow manure.

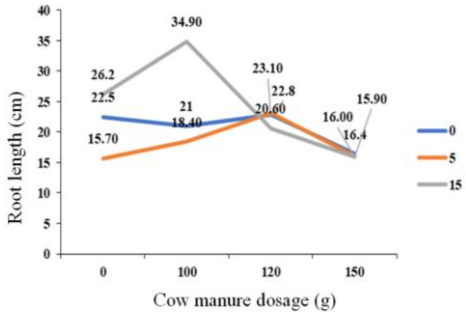

Figure 5. Illustration of the interaction between cow manure and humic acid which influences the root length of cork tree seedlings.

The root growth of cork tree seedlings was influenced by two experimental factors: the dose of cow manure and the dose of humic acid. As a result of these two factors, the best root length for 3-month-old cork tree seedlings occurred in a growing medium supplemented with 100 g of cow manure and 15 ml of humic acid. The root length of the cork tree seedlings in this growing medium was 34.9 cm.

The application of cow manure and humic acid gave a good response to the growth of the roots of cork tree seedlings. The combination of these two treatments had a significant effect on root growth because cow manure increased nutrient availability and improved the structure of the seedling growth medium (Wasis &

Fitriani, 2022). Meanwhile, humic acid plays a role in increasing the ability to absorb cations and nitrates (Rahayu et al., 2021). In addition, cow manure has a high cellulose content, is able to improve water absorption and the availability of nutrients in seedling growing media (Hartatik & Widowati, 2010). Therefore, these two components have a positive effect on the growth of cork tree seedlings.

Dry Weight of Root

The dry weight of the roots referred to here is the weight of the oven-dried roots at a temperature of 105° C. The results of statistical analysis show that the main effect of the dose of cow manure on the dry weight of the roots of the best cork tree seedlings occurred at a dose of 120 g of cow manure. The average dry weight of the roots of cork tree seedlings in the treatment of a dose of 120 g of cow manure was 0.320 g (Figure 6).

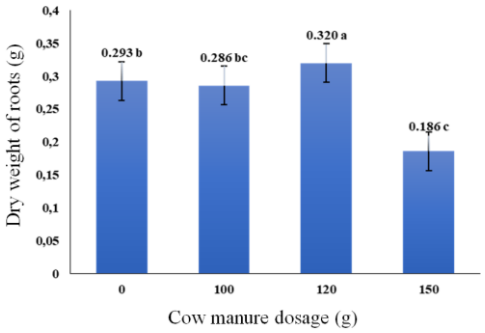

Figure 6. The main effect of the dose of cow manure on the dry weight of the roots of 3-month-old cork tree seedlings.

Remark: $DMRT_{0.05}$= 0.025. The average value followed by the same letter means that it is not significantly different, conversely the average value followed by different letters means that it is significantly different at the 5% level of significance.

Root dry weight is the root biomass that indicates root growth and the storage of net photosynthates in the plant roots. High root dry weight occurs due to the availability of nutrients in the seedling growth medium. Application of cow manure can increase growth by adding nutrients needed by plants, also improving the porosity and biological properties of the growth medium (Mukti et al., 2024). However, excessive cow manure can lower the pH, which worsens soil chemical reactions and nutrient uptake by plant roots, thus negatively impacting growth (Wasis & Fitriani, 2022). Therefore, a high dose of cow manure (150 g) resulted in lower root dry weight compared to a dose of 120 g, and even lower than the control (without cow manure).

Dry Weight of Shoots

The results of the analysis of the main effect of cow manure dosage showed a significant difference in the dry weight of the shoots of cork tree seedlings (Figure 7). The application of cow manure with a dose of 100 g in the growing medium had the best effect on the dry weight of the shoots of cork tree seedling compared to other doses of cow manure.

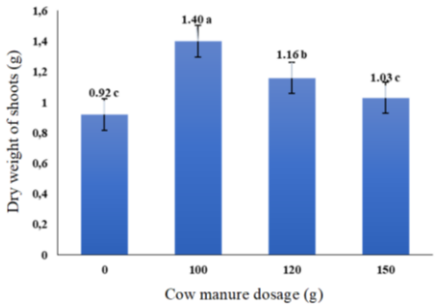

Figure 7. The main effect of the dose of cow manure on the dry weight of the shoots of 3-month-old cork tree seedlings.

Remark: $DMRT_{0.05}$= 0.139. The average value followed by the same letter means that it is not significantly different, conversely the average value followed by different letters means that it is significantly different at the 5% level of significance.

The addition of cow manure in the seedling growth medium significantly affected to the dry weight of cork tree seedling shoots because cow manure contains complete nutrients, both macronutrients and micronutrients (Erlangga et al., 2023; Mukti et al., 2024; Wasis & Fitriani, 2022). The macronutrients contained in cow manure, such as nitrogen, are utilized by the plant to enhance the growth of vegetative organs such as leaves, stems, and roots. This is in accordance with the results of research which proved that the application of cow manure to the seedling growth medium had a positive effect on the dry weight of the shoots of the cork tree seedlings compared to the control (without the application of cow manure). The dose of cow manure that had the best effect on the dry weight of the shoots of the cork tree seedlings was 100 g with an average dry weight of the shoots of the cork tree seedlings of 1.40 g (Figure 7).

Sutedjo (2020) stated that cow manure contains nutrients with a composition of 0.40% nitrogen (N), 0.20% phosphorus (P), and 0.10% potassium (K) available, so it can be used to meet nutritional needs in the process of better plant growth.

According to Nahak et al. (2020), plant dry weight is a growth variable that indicates the amount of nutrients absorbed into the plant per unit weight of biomass. The higher the dry weight, the better the plant growth.

Seedling Quality Index

Seedling quality index is one of the variables used to indicate the physiological quality of tree seedlings (Indriyanto, 2022). The main effect of cow manure dosage on the quality index of cork tree seedlings at 3 months of age. The application of cow manure to the growing medium had a better effect than the control (without cow manure). The dose of cow manure that had the best effect on the quality index of cork tree seedlings was 100 g with a seedling quality index of 6.74 (Figure 8).

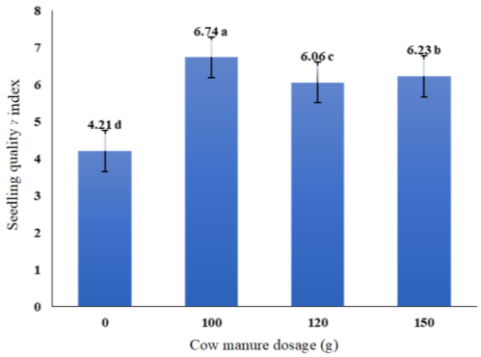

Figure 8. The main effect of the dose of cow manure on the seedling quality index of 3-month-old cork tree seedlings.

Remark: $DMRT_{0.05}$= 0.403. The average value followed by the same letter means that it is not significantly different, conversely the average value followed by different letters means that it is significantly different at the 5% level of significance.

According to Indriyanto (1999), a high seedling quality index indicates a balance in the translocation of photosynthesis products to the upper organs (stems, leaves) and to the roots of the seedlings. The balance in the translocation of photosynthesis products to the seedling organs causes a balance in the growth of the upper organs and roots of the seedlings.

A higher seedling quality index indicates better physiological quality and readiness for planting in the planting area (Indriyanto, 2022). Wulandari & Susanti (2022) stated that tree seedlings are ready for planting if they have a seedling quality index of more than 0.09. The quality index of cork tree seedlings in the research was 6.74, indicating excellent physiological quality (Figure 8). Good seedling quality positively influences the seedlings' ability to adapt and grow well in the planting area (Yustika et al., 2022).

IV. CONCLUDING REMARK

Conclusion

The dose of cow manure significantly affected the growth of cork tree seedlings, namely on seedling height, seedling stem diameter, root length, root dry weight, shoot dry weight, and seedling quality index. A dose of 100 g of cow manure had the best effect on all seedling growth parameters compared to the control (without cow manure), doses of 120 g and 150 g.

The dose of humic acid significantly affected the root length of cork tree seedlings. A dose of 15 ml of humic acid had the best effect on root length of cork tree seedlings compared to the control (without humic acid) and a dose of 5 ml.

There was an interaction between cow manure and humic acid that significantly affected the root length of cork tree seedlings. The best root length was achieved with a combination of two factors: 100 g of cow manure and 15 ml of humic acid.

Recommendation

Further research is needed on the use of cow manure and other amendments, such as charcoal or rice husk charcoal on beach sand as a growing medium for cork tree seedlings. Similar research is also needed for other coastal forest tree species.

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REFERENCES

[1]. Anindya, W., Palupi, D., & Budisantoso, I. (2024). Efektivitas pertumbuhan dan hasil tanam beberapa kultivar kedelai (Glycine max (L.) Merr.) dengan pemberian polietilena glikol (PEG) untuk simulasi cekaman kekeringan. *Al-Kauniyah: Jurnal Biologi*, *17*(1), 133–143.
[2]. Aulya, N. R., Noli, Z. A, & Suwirmen, S. (2020). The growth of coastal cottonwood (*Hibiscus tiliaceus* Linn.) seedlings by inoculating arbuscular mychorrhiza fungi (AMF) on sand beach planting media. *Jurnal Biologi.* 8(2) : 36-41.
[3]. Badan Standardisasi Nasional. (2018). Standar Nasional Indonesia 8420 Bibit Tanaman Hutan. Jakarta. 12 p.
[4]. Hartatik, W. & Widowati, L.R. (2010). *Pupuk Kandang.* Jakarta: Departemen Pertanian.
[5]. Indriyanto. (1999). Pengaruh periode penyapihan dan media penyapihan terhadap kualitas pertumbuhan bibit mahoni. Buletin Kehutanan, Fakultas Kehutanan Universitas Gadjah Mada. Yogyakarta, (39): 12-20.
[6]. Indriyanto. (2010). *Pengantar Budidaya Hutan*. 2nd ed. Jakarta: PT Bumi Aksara. 234 p.
[7]. Indriyanto. (2017). *Ekologi Spesies Pohon*. 1th ed. Yogyakarta: Plantaxia. 303 p.
[8]. Indriyanto. (2022). *Teknik dan Manajemen Pesemaian*. 1th ed. Yogyakarta: Plantaxia. 310 p.
[9]. Khaled, H. & Fawy, H. A. (2011). Effect of different levels of humic acids on the nutrient content, plant growth, and soil properties under conditions of salinity. *Soil and Water Research*. 6(1): 21-29.
[10]. Mukti, R. P., Setyawati, E. R., & Santoso, T. N. B. (2024). Pengaruh dosis pupuk kandang sapid an macam pupuk P terhadap pertumbuhan bibit kelapa sawit (Elaeis guineensis Jacq.) di main nursery. Agroforetech, 2(3): 1229-1234. https://jurnal.instiperjogja.ac.id/index.php/JOM
[11]. Mustaqimah, N. M., Nurhatika, S, & Muhibbudin, A. (2020). Pengaruh waktu inokulasi mikoriza arbuskular pada campuran media tanam Amb-07 dan pasir pantai terhadap pertumbuhan dan karbohidrat padi (*Oryza sativa* L.) var. inpari 13. *Jurnal Sains Dan Seni ITS*, *8*(2), 49–56.
[12]. Nahak, Y. F., Ndiwa, A. S., Pelondo'u, M. E. (2020). Pengaruh komposisi media tanam (sekam padi bakar dan pupuk kandang sapi) terhadap pertumbuhan bibit jati putih (*Gmelina arborea* Roxb). *Kehutanan Berkelanjutan*, 2(02): 233-241.
[13]. Novitasari, D., & Caroline, J. (2021). Kajian efektivitas pupuk dari berbagai kotoran sapi, kambing, dan ayam. In Prosiding Seminar Teknologi Perencanaan, Perancangan, Lingkungan dan Infrastruktur. P: 442-447.
[14]. Prayudyaningsih, R. & Sari, R. (2016). Aplikasi fungi mikoriza arbuskula (FMA) dan kompos untuk meningkatkan pertumbuhan semai jati (*Tectona grandis* Linn.f.) pada media tanah bekas tambang kapur. *Jurnal Penelitian Kehutanan Wallacea*, *5*(1), 37–46.
[15]. Rahayu, D. (2020). *Pengaruh Pemberian Pupuk Kandang Kotoran Sapi pada Media Tanam Tanah, Pasir dan Serbuk Kayu terhadap Pertumbuhan Tanaman Cabai Rawit (Capsicum frutescens* L.*)*. Fakultas Sains dan Teknologi Universitas Islam Negeri Sunan Ampel. Surabaya. 73 p.
[16]. Rahayu, R. D., Mindari, W, & Arifin, M. A. M. (2021). Pengaruh kombinasi silika dan asam humat terhadap ketersediaan Nitrogen dan pertumbuhan tanaman padi pada tanah berpasir. *Soilrens,* 19(2): 23-32.
[17]. Simatupang, B. (2019). Pengaruh jenis klon aplikasi pupuk pelengkap cair gandasil D terhadap pertumbuhan diameter batang bibit okulasi karet (*Hevea brasiliensis* Muell. Arg). *Jurnal AgroSainTa,* 3 (1): 21-28.
[18]. Wasis, B. & Fitriani, A. S. (2022). Pengaruh pemberian pupuk kandang sapi dan cocopeat terhadap pertumbuhan *Falcataria mollucana* pada media tanah tercemar oli bekas. *Journal of Tropical Silviculture,* 13(3): 198-207.
[19]. Wulandari, A. S., & Susanti, S. (2012). Aplikasi pupuk daun organik untuk meningkatkan pertumbuhan bibit jabon (*Anthocephalus cadamba* Roxb. Miq.). *Jurnal Silvikultur Tropika*, 3(2): 137–142.
[20]. Yuliana, Y., Rahmadani, E., & Permanasari, I. (2015). Aplikasi pupuk kandang sapi dan ayam terhadap pertumbuhan dan hasil tanaman jahe (*Zingiber officinale* Rosc.) di media gambut. *Jurnal Agroteknologi*. 5(2): 37-42.
[21]. Yustika, V., Indriyanto, & Asmarahman, C. (2022). Evaluasi mutu bibit tanaman hutan di pesemaian PT Natarang Mining Kabupaten Tanggamus. *Journal of Tropical Upland Resources,* 4(2): 69-81.