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Research Paper

The Effect of Cow Manure Application on Beach Sand to the Growth of Cork Tree (*Thespesia populnea*) Seedlings

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ABSTRACT: *Coastal land is a type of sandy and/or rocky land, thus it is included in the marginal land category. This marginal land is characterized by extreme environmental conditions, such as high salinity, high erodibility, and other resource limitations. Efforts that can be made to overcome the nature of marginal land in coastal areas are by adding cow manure. The research aimed to analyze the effect of adding cow manure to a growing medium in the form of beach sand on the growth of cork trees. The research was conducted using a Completely Randomized Design (CRD). The treatment consisted of adding cow manure to 1,000 g of beach sand at doses of 0 g, 120 g, 160 g, and 200 g. Thus, the composition of the seedling growing medium consisted of: 1,000 g of beach sand + 0 g of cow manure, 1,000 g of beach sand + 120 g of cow manure, 1,000 g of beach sand + 160 g of cow manure, and 1,000 g of beach sand + 200 g of cow manure. Each treatment was repeated 5 times. The research variables included: seedling height, stem base diameter, number of leaves, and root length. Analysis of variance and DMRT (Duncan's Multiple Range Test) were performed at a 5% significance level. The results showed that the dose of cow manure significantly affected seedling height, stem base diameter, seedling leaf number, and root length of 3-month-old cork tree seedlings. A dose of 200 g of cow manure had the best effect on seedling height, seedling leaf number, and root length of 3-month-old cork tree seedlings. Doses of 200 g and 160 g of cow manure had the same effect on stem diameter of 3-month-old cork tree seedlings, but were better than doses of 120 g and 0 g of cow manure (without cow manure). Thus, cow manure can be used as one of the ingredients to improve the growth of cork tree seedlings in beach sand as a growing medium.*

KEYWORDS: *Cow manure, Growth, Sand beach, Seedlings*

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I. INTRODUCTION

Coastal forests are a type of forest ecosystem located in dry coastal areas with sandy or rocky soil conditions, and located above the high tide line (Indriyanto, 2017). Due to the coastal location of coastal forest ecosystems, the soil conditions often have high salinity levels. Coastal forests are quite common in tropical regions. Coastal forests have ecological functions for nature as well as socio-economic benefits that can be felt directly and indirectly by the community (Wardhani & Poedjirahajoe, 2020).

Natural disasters frequently occur in coastal areas. This causes coastal land to be categorized as marginal land, with high sand salinity and low fertility. Marginal land presents a management challenge that requires improvement efforts to increase productivity. Although beach sand is a contributing factor to the emergence of marginal land in coastal areas, this land has significant potential for utilization (Nasution et al., 2023).

Other problems that occur around the coast include erosion and abrasion, as well as high salinity. Coastal erosion and abrasion often occur in coastal areas with unstable physical conditions. These conditions are more likely to occur in coastal areas without vegetation (Arif & Hamdi, 2022). High salinity can also be caused by climate change, such as high temperatures (Sari et al., 2022).

One way to improve the quality of sandy coastal land is by applying compost or other organic fertilizers as soil amendments (Mustaqimah et al., 2020). Commonly used organic materials include cow manure and compost. According to Ginting et al. (2020), cow manure contains a high level of nutrients, including 1% N,

2.8% P2O5, and 0.4% K2O, as well as micronutrients. Hariyanto et al. (2025) also stated that organic fertilizer is very suitable for improving land quality because it contains complete nutrients, both macro and micro nutrients, and even contains bioactive compounds and growth regulators. Thus, the application of manure can also increase low cation exchange capacity and can increase the macro and micro nutrients needed for plant growth.

In general, the use of one or a combination of organic fertilizers can support the presence of microbes in the soil, such as phosphate-solubilizing bacteria and nitrogen-fixing bacteria, which are beneficial in sustainably maintaining and increasing land productivity (Waruwu et al., 2024). The presence of microbes in the soil plays a crucial role in supporting the nutrient cycling process (Ginting et al., 2023). The presence of microbes in the soil will also help improve soil structure and increase water retention capacity, thereby accelerating the process of nutrient absorption by plants (Mare et al., 2024).

In addition to applying organic fertilizer to tree growing media and sandy soil, tree species selection is also a key factor in improving the success of coastal sandy land rehabilitation. Some tree species that can be selected for coastal sandy land rehabilitation include: the coast she-oak (*Causaria equisetiafolia*) (Jamilah et al., 2020; Mutmainnah et al, 2022; National Academy of Sciences, 1980), the tropical almond (*Terminalia catappa*) (National Academy of Sciences, 1980), and the cork tree (*Thespesia populnea*) (Noh et al., 2021). Therefore, research is needed on the addition of cow manure and liquid fertilizer to beach sand as a growing medium for sea hibiscus seedlings. The study aims to analyze the effect of cow manure and liquid fertilizer doses on the growth of cork tree (*Thespesia populnea*) seedlings.

II. METHODS

Research Site and Time

This research was conducted from November 2024 to February 2025. The research site 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 26°C and 29°C, with an average temperature of 27°C. The air relative humidity ranged between 69% and 91%, 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, and cow manure.

Experimental Design

The research method used is Completely Randomized Design (CRD). The object of the research was cork tree seedlings. The seedling growth medium used was beach sand. The treatment consisted of adding cow manure to 1,000 g of beach sand at doses of 0 g, 120 g, 160 g, and 200 g. Thus, the composition of the seedling growth medium consisted of: 1,000 g of beach sand + 0 g of cow manure, 1,000 g of beach sand + 120 g of cow manure, 1,000 g of beach sand + 160 g of cow manure, and 1,000 g of beach sand + 200 g of cow manure. 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 cork tree seedlings used was 60 seedlings.

The variables observed included seedling height, seedling stem diameter, amount of seedling leaves, and seedling root length.

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

A recapitulation of the results of the analysis of variance of all research variables is presented in Table 1. The research variables analyzed for variance include: seedling height, seedling stem diameter, number of seedling leaves, and seedling root length of three-month-old cork tree seedlings. Based on the results of the analysis of variance in Table 1, it shows that the dose of cow manure has a significant effect on all research variables.

Table 1. Results of the analysis of variance for each research variable in the treatment of cow manure doses on the growth of cork tree seedlings.

Variable	Treatment of cow manure doses	
	F_{count}	$F_{0.05\ (3,\ 48)}$
Seedling height	8.71 *	2.79
Seedling stem diameter	7.64 *	2.79
Amount of seedling leaves	4.27 *	2.79
Seedling root length	2.96 *	2.79

Remark: *= significant different
ns= not significant different

Analysis of the chemical properties of beach sand and cow manure has been carried out to determine the condition of the nutrient content and chemical reactions. The results of the analysis of nutrient content and chemical reactions in beach sand and cow manure that used as seedlings growing media are presented in Table 2.

Table 2. The conditions of nutrient content and chemical reactions in beach sand and cow manure that used as growing media for cork tree seedlings.

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

Beach sand contains insufficient macronutrients for plant growth. It contains very low levels of N, P, and Mg, and low levels of K and Ca. Cow manure contains very high levels of N and K, while P is very low. Applying cow manure to beach sand as a growing medium for plants is essential because it improves its physical, chemical, and biological properties (Mwadalu et al., 2020; Sriyanto et al., 2015; Wasis & Fitirani, 2022). The macronutrients N, P, and K are crucial for stimulating plant growth, particularly during the seedling phase, as this is when plants actively develop and develop vegetative organs. These three elements have different but complementary functions.

Seedling Height

The application of different doses of cow manure significantly affected the height of 3-month-old cork tree seedlings. A dose of 200 g of cow manure had the best effect on the height of cork tree seedlings compared to doses of 160 g, 120 g, and 0 g (without cow manure). The height of 3-month-old cork tree seedlings in the 200 g cow manure treatment was 18.34 cm. Thus, it is proven that cow manure is useful for improving the quality of the growing media for tree seedlings and has a positive effect on increasing the height of cork tree seedlings. A comparison of the average height of cork tree seedlings between cow manure treatment doses is presented in Figure 1.

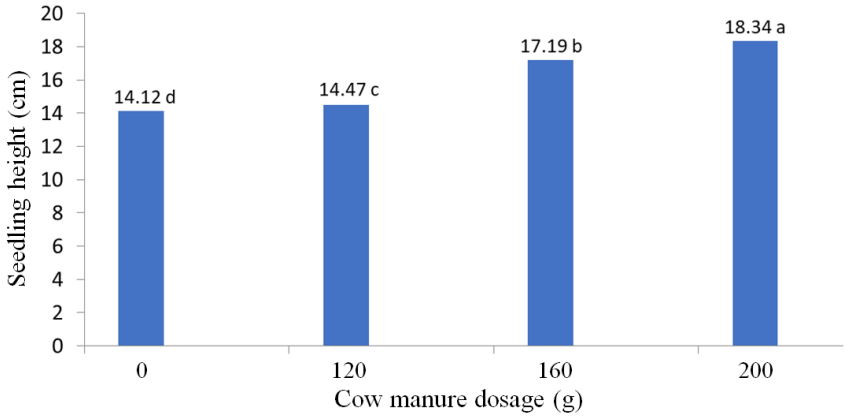

Figure 1. The effect of the dose of cow manure on the height of 3 month old cork tree seedlings in a growing medium consisting of beach sand.

Remark: $DMRT_{0.05}$= 0.252. 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 growing medium is one of the environmental or external factors that influence the growth of tree seedlings (Wasis & Fitirani, 2022). Every plant requires environmental factors within its tolerance range for optimal growth (Indriyanto, 2017a). Therefore, adding cow manure to the growing medium, which consists of beach sand, is an effort to improve the physical, chemical, and biological properties of the growing medium to meet the tolerance range for plant needs. Plant height increase is vegetative growth driven by sufficient nitrogen availability (Sriyanto et al., 2015). Cow manure plays a role in improving the physical, chemical, and biological properties of the growing medium (Sriyanto et al., 2015). Therefore, adding cow manure to the growing medium will increase nutrient availability, including nitrogen availability, so the dose of cow manure affects the height of cork tree seedlings.

Seedling Stem Diameter

Changes in the diameter of the seedling stem indicate lateral growth in the plant stem. The treatment of cow manure doses has a positive and significant effect on the growth of the stem diameter of cork tree seedlings. The higher the dose of cow manure, the better the growth of the cork tree stem diameter. The application of cow manure to the growing medium in the form of sand has a better effect on the stem diameter of cork tree seedlings compared to the control (not given fertilizer). The effect of the doses of 160 g and 200 g of cow manure is not significantly different on the diameter of cork tree seedlings, however, the effect of this dose is better than the doses of 120 g and 0 g of cow manure. A comparison of the average stem diameter of cork tree seedlings due to the treatment of the dose of cow manure in the growing medium in the form of sand is presented in Figure 2.

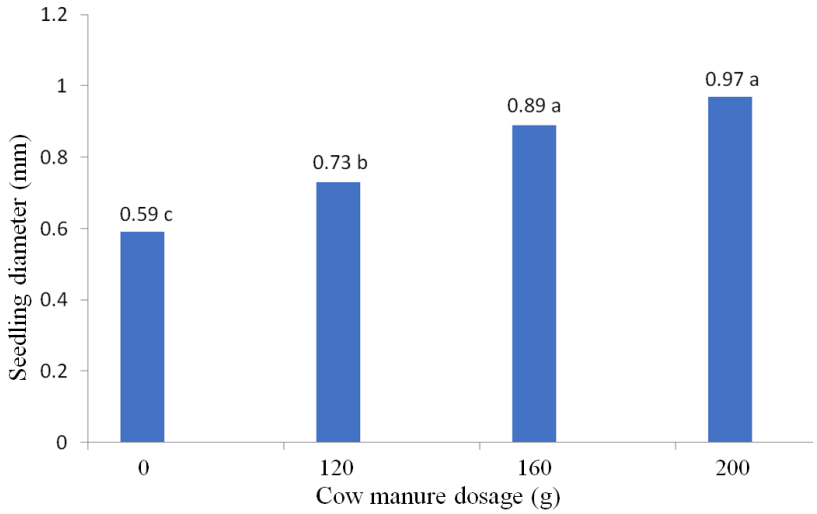

Figure 2. The effect of the dose of cow manure on the seedling stem diameter of 3 month old cork tree seedlings in a growing medium consisting of beach sand.

Remark: $DMRT_{0.05}$= 0.124. 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.

Stem diameter growth occurs due to the activity of the lateral cambium, which produces secondary xylem toward the inside and secondary phloem toward the outside. This process causes the stem to enlarge or thicken, known as secondary growth, which can be indicated by an increase in stem diameter (Indriyanto, 2022). This growth is influenced by the availability of nutrients in the growing medium. As stated by Wasis & Fitriani (2022), plant diameter growth is greatly influenced by the availability of nutrients in the growing medium. Adding manure to the growing medium will increase nutrient availability, both macro and micronutrients.

The manure used contains very high levels of N and K (Table 2). Adequate nutrient availability increases cell division activity in the cambium. Then, the lateral cambium produces more secondary xylem, increasing the stem diameter. Potassium (K) is an essential macronutrient that plays a role in regulating various plant physiological processes, including water balance, turgor pressure, enzyme activation, stomatal regulation, and photosynthesis. Adequate K availability supports cell expansion and tissue formation, allowing optimal vegetative growth, including stem and crown growth (Ragel et al., 2019).

Amount of seedling leaves

The number of leaves of cork tree seedlings was influenced by the dose of cow manure. The highest number of leaves of cork tree seedlings was found in the sand-based growing medium supplemented with 200 g of cow manure compared to 0 g, 120 g, and 160 g of cow manure. A comparison of the average number of leaves of cork tree seedlings in each cow manure-based growing medium treatment is presented in Figure 3.

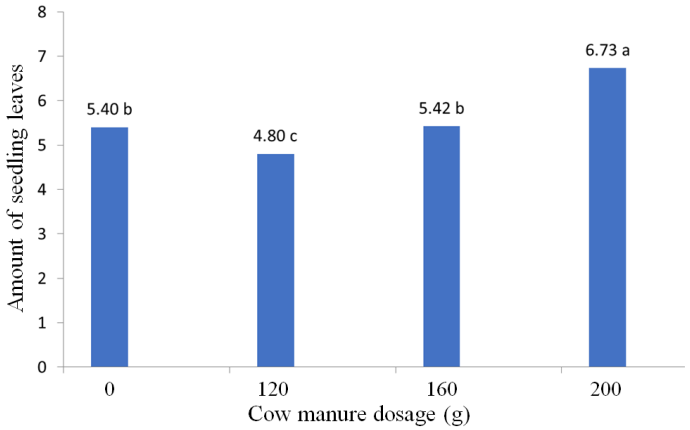

Figure 3. The effect of the dose of cow manure on the amount of seedling leaves of 3 month old cork tree seedlings in a growing medium consisting of beach sand.

Remark: $DMRT_{0.05}$= 0.318. 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 application of 200 g of cow manure resulted in a higher number of leaves for cork tree seedlings compared to doses of 0 g, 120 g, and 160 g. This result suggests that the 200 g dose of cow manure provided sufficient nutrient availability for the plants, particularly nitrogen, which plays a role in chlorophyll formation, protein synthesis, and vegetative tissue growth. Furthermore, the addition of organic matter improved the physical properties of the sand medium, thereby increasing its water-holding capacity, aeration, and nutrient retention capacity. These conditions support increased photosynthetic activity and the formation of new leaves. This finding aligns with Gole et al. (2019) findings that increasing the dose of cow manure can increase the number of plant leaves, leaf area, and growth of mustard greens. Application of cow manure at a certain dose can increase the number of sweet corn leaves (Nurmalasari et al., 2024). Application of organic matter based on cow manure at a certain dose results in sufficient nutrient availability for vegetative growth, increases nitrogen uptake by plants, and increases leaf number (Haouvang et al., 2017; Park et al., 2024). This indicates that the application of organic matter, such as cow manure at an optimal dose, can increase photosynthetic assimilation, thus increasing leaf number (Santari et al., 2024).

Plants in the seedling phase require sufficient nitrogen to support leaf formation, stem elongation, and shoot growth. Furthermore, chlorophyll formation requires nitrogen, and adequate nitrogen also helps improve

the plant's ability to photosynthesize (Martin et al., 2002; Qiang et al., 2023). If nitrogen is deficient, plants typically exhibit slow growth, pale green or yellowish leaves, and smaller plant size (Qiang et al., 2023).

The low number of leaves in cork tree seedlings when given 120 g of cow manure compared to 0 g (without manure) is thought to be related to the plant's response to changes in media conditions and the decomposition process of organic matter. At a dose of 120 g, the addition of cow manure does not provide optimal nutrient availability, while the decomposition process of organic matter can cause temporary immobilization of nitrogen elements by microorganisms. This condition can inhibit leaf formation in seedlings (Li et al., 2026). Conversely, the application of 160 and 200 g of cow manure is thought to be able to provide organic matter and nutrients in more adequate amounts and improve the physical condition of the beach sand media, especially in retaining water and nutrients around the roots. Better root conditions allow for more optimal absorption of water and nutrients, thus supporting leaf formation. Thus, the response of leaf number to cow manure administration shows a non-linear pattern, so that the 120 g dose is not able to support the growth of cork tree seedlings, while the 160 and 200 g doses provide conditions that are more supportive of the growth of cork tree seedlings at the age of 3 months.

Seedling root length

The application of cow manure to the sand growing medium significantly affected the root length of cork tree seedlings. Doses of 120 g, 160 g, and 200 g of cow manure had a better effect on the root length of cork tree seedlings compared to a dose of 0 g (without manure). A dose of 200 g of cow manure had the best effect on the root length of cork tree seedlings with a root length of 27.02 cm compared to doses of 0 g, 120 g, and 160 g of cow manure with root lengths of 22.73 cm, 23.27 cm, and 23.37 cm, respectively. The comparison of the average root length of cork tree seedlings between treatments of cow manure doses in the sand growing medium is presented in Figure 4.

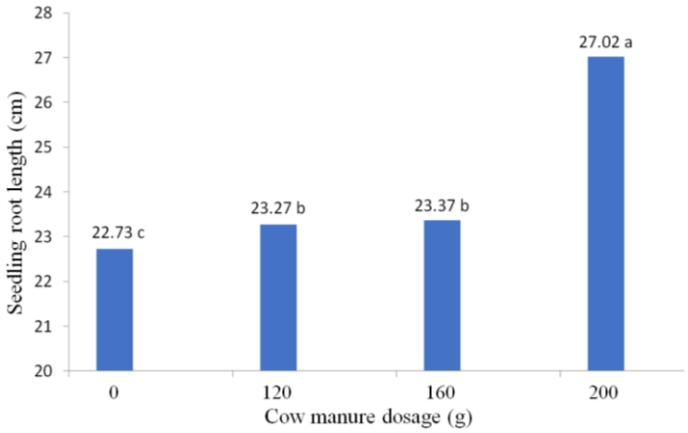

Figure 4. The effect of the dose of cow manure on the seedling root length of 3 month old cork tree seedlings in a growing medium consisting of beach sand.

Remark: $DMRT_{0.05}$= 0.241. 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.

Sand media has a very low nutrient content. Cow manure provides macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), as well as micronutrients that can support root growth, thus optimizing nutrient absorption (Wasis & Prihanto, 2023). The availability of phosphorus from cow manure plays a crucial role in stimulating the formation and elongation of plant roots (Rahayu et al., 2025).

The addition of cow manure to sand significantly affected the root length of cork tree seedlings. This is because cow manure is an important organic material that improves the fertility of the growing medium through various mechanisms. Cow manure provides essential nutrients, including nitrogen, phosphorus, potassium, calcium, and magnesium, while also increasing soil organic matter. The addition of organic matter increases water-holding capacity, improves soil aggregation and porosity (Rayne & Aula, 2020), enhances microbial diversity, increases microbial activity, and increases nutrient availability for plant growth (Das et al., 2017). This combination of factors creates a more supportive environment for root growth and elongation compared to sand media without the addition of manure (Rahayu et al., 2025).

Phosphorus (P) is a nutrient that significantly impacts plant root growth. Phosphorus plays a crucial role in plant energy metabolism, primarily through the production of ATP (Péret et al., 2011)**.** This energy is essential for various growth processes and tissue formation. This is crucial because a strong root system during

the seedling stage will determine the seedlings' ability to absorb water and nutrients during subsequent growth stages (Liu, 2021). Phosphorus deficiency can stunt plant growth and lead to suboptimal root development (Choi et al., 2026; Liu, 2021; Péret et al., 2011).

IV. CONCLUDING REMARK

Conclusion

The application of cow manure to the growing medium of beach sand significantly affected the growth of cork tree seedlings. The higher the dose of cow manure applied to the beach sand, the better the growth of cork tree seedlings. A dose of 200 g of cow manure had the best effect on seedling height, number of seedling leaves, and root length of 3-month-old cork tree seedlings. Doses of 200 g and 160 g of cow manure had the same effect on stem diameter of 3-month-old cork tree seedlings, but were better than doses of 120 g and 0 g of cow manure (without cow manure). Thus, cow manure is a solid organic fertilizer that can be used as an alternative effort to improve critical land, sandy land, and to improve the quality of the growing medium for forest tree seedlings.

Recommedation

Research is needed on the application of cow manure with a dose of more than 200 g to beach sand to determine the optimum dose for the growth of cork tree seedlings. Research is also needed on the dosage of other organic materials such as chicken manure, goat manure, or rice husk charcoal in beach sand on the growth of cork tree seedlings and the growth of other tree seedlings such as beach she-oak (*Casuarina equisetifolia*) and tropical almond (*Terminalia catappa*).

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