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Response of Plant Height and Number of Seedling Leaves Clove Variety Zanzibar on Cambisols Soil After Application of Manure and Biochar

Charles Silahooy
Soil Science Study Program, Department of Agricultural Cultivation, Faculty of Agriculture, Pattimura University
Corresponding Author: Charles Silahooy charlessilahooy@gmail.com

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A B S T R A C T

The combination of soil, manure, and biochar serves as an alternative growing medium to enhance soil nutrients, quality, and structure. Biochar improves soil chemistry and physical properties, while manure acts as a conditioner, increasing cation exchange capacity and supporting microbial activity. This study examines the impact of manure and biochar on the height and leaf count of Zanzibar clove seedlings in cambisol soil. Conducted in Seith Village, Central Maluku, from October 2024 to February 2025, the research used a randomized block design with seven treatments. The best growth was observed in the 1:1:1 soil, manure, and biochar ratio (P3), yielding a plant height of 19.93 cm and 8.48 leaves.

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INTRODUCTION

Cloves (Syzygium aromaticum), in English called cloves, are aromatic dried flower stalks from the Myrtaceae tree family which are native to Indonesia, and one of Indonesia's main spice commodities originating from Maluku, have high economic value, both as raw materials for the kretek cigarette industry (Soenarsih et al., 2021), and are also one of the producers of essential oils, widely used as raw materials in the culinary and medicinal fields (Asriani et al., 2023 and Fatmah et al., 2024). One of the superior varieties of cloves is the Zanzibar variety, which is known to have high productivity and good quality essential oils. This variety is known for its high productivity and good flower quality. Zanzibar cloves begin to flower at the age of 4.5 to 6.5 years, with plump, long-stemmed, and green flowers when young which turn yellow when ripe. Each flower stalk has hundreds of seeds, indicating high production potential. Cloves are annual plants that can grow to a height of 10 – 20 m, have oval-shaped leaves that bear flowers on the tops. The fruit stalk is initially green, and red when it has bloomed (Soenarsih et al., 2021).

Maluku has a tropical climate that supports the growth of Zanzibar cloves. High rainfall, fertile volcanic soil, and an altitude of 300-600 meters above sea level are ideal factors for the growth of this plant. Optimal growth of clove seedlings is highly dependent on soil conditions and the availability of nutrients. Planting media plays an important role in providing nutrients and improving soil structure. Healthy clove seedling growth requires optimal growing environmental conditions, so that the resulting seedlings are healthy, the availability and balance of nutrients in sufficient quantities is an important factor in plant growth, in addition sufficient organic matter also plays an important role in plant growth (Launuru et al., 2019).

One type of soil that grows cloves of the Zanzibar variety is cambisol. Cambisol soil is generally formed in volcanic areas, often has low fertility due to limited organic matter content and low cation exchange capacity (CEC). This condition can limit plant growth, including clove seedlings. According to Leszczynska & Malina, (2011) in Launuru et al., (2019), the provision of organic fertilizer can increase soil pH, water capacity, cation exchange capacity (CEC), porosity, and stimulate the growth of microorganisms in the soil.

The use of manure and biochar has been widely reported to improve the physical, chemical, and biological properties of the soil. Manure is a source of organic material rich in macronutrients (N, P, K) and micronutrients, and contributes to increasing the organic matter content of the soil. Meanwhile, Biochar is a carbon-rich material produced from the biomass pyrolysis process. The provision of biochar can increase water retention capacity, CEC, and stabilize soil pH (Lehmann & Joseph, 2015). In addition, biochar can also increase the activity of soil microorganisms that play an important role in the nutrient cycle. The combination of manure and biochar has been shown to provide a synergistic effect in improving soil fertility and supporting plant growth (Zhang et al., 2019).

The combination of soil, manure and biochar as growing media is an alternative. to provide nutrients in the soil. biochar is also able to influence

availability element Harmony to fix quality land, characteristic chemistry, and physical properties of the soil. While manure acts as a soil conditioner that is useful for improving soil structure, increasing cation capacity, stimulating the activity of nutrient-cycling microbes and decomposing organic matter in the soil. Based on this, it is necessary to conduct research on the response of plant height and number of seedling leaves clove variety Zanzibar on cambisol soil after application of manure and biochar.

THEORETICAL REVIEW

Clove (Syzygium aromaticum L.) is a significant agricultural commodity with economic value, primarily cultivated for its dried flower buds used in various industries (Asriani et al., 2023). The nursery stage is crucial for ensuring optimal clove seedling growth, which is influenced by soil conditions and nutrient availability (Fatmah et al., 2024). The combination of manure and biochar as a planting medium is one approach to enhancing soil quality and supporting seedling development (Harsono et al., 2020).

Manure serves as an organic soil amendment that improves soil structure, increases microbial activity, and enhances nutrient availability for plant growth (Johan et al., 2022). Its role in promoting clove seedling growth has been widely studied, with findings showing that manure application positively impacts root development and seedling vigor (Syafri et al., 2020). Similarly, biochar has gained attention due to its ability to enhance soil fertility by improving water retention, cation exchange capacity, and microbial habitat (Lehmann & Joseph, 2015). Studies have shown that biochar can significantly contribute to plant growth, especially in marginal soils, by increasing nutrient retention and reducing leaching losses (Utami & Widiastuti, 2021).

The synergistic effect of combining manure and biochar in the planting medium has been explored in various studies, showing improvements in both soil physical properties and plant growth (Yulianti et al., 2021). The application of biochar and organic fertilizers enhances nutrient cycling and microbial activity, leading to better seedling performance (Zhang et al., 2019). Research on clove seedlings has demonstrated that an optimal combination of manure and biochar can significantly increase plant height and leaf number, contributing to improved seedling establishment (Salawati et al., 2019). Furthermore, biochar's ability to improve nutrient-use efficiency in various crops highlights its potential role in sustainable agricultural practices (Manzoor et al., 2021).

In the context of cambisol soil, which often requires enhancement in organic matter and nutrient availability, the application of manure and biochar offers a promising solution. Cambisol, characterized by its relatively young development and moderate fertility, benefits from organic amendments that improve its physical and chemical properties (Sinaga et al., 2017). Studies indicate that integrating biochar and organic manure into such soils enhances seedling growth by optimizing soil aeration, moisture retention, and nutrient supply (Yadav et al., 2019). Additionally, the application of organic-inorganic fertilizers, combined with growth-promoting substances like triacontanol, has

been reported to positively affect clove plant development (Launuru et al., 2019).

Overall, the integration of manure and biochar in cambisol soil presents a viable strategy for improving the growth response of Zanzibar clove seedlings. By enhancing soil structure, increasing nutrient availability, and promoting beneficial microbial activity, this combination supports the early-stage development of clove plants, which is essential for achieving high-yielding and healthy plantations.

METHODOLOGY

This research was conducted at a nursery location in Seith Village, Leihitu District, Central Maluku Regency from October 2024 to February 2025 at an altitude of 100 meters above sea level (masl).

The tools used in this study were hoes, shovels, machetes, paranets, blocks, analytical scales, vernier calipers, rulers, hammers, hoses, ovens, label paper, stationery and cameras. The materials materials used are: Zanzibar clove seeds, 15 x 30 cm polybags, cow manure, cambisol soil, biochar, boards, nets.

Study This uses the Design Random Group (RACK) Which consists of 7 levels of treatment, namely:

P_0 = Soil Media (without cow manure and biochar),
P_1 = 1 Land : 1 cow manure (1 : 1),
P_2 = 1 Land : 1 Biochar (1 : 1),
P_3 = 1 Land : 1 Cow manure : 1 Biochar (1 : 1 : 1),
P_4 = 1 Land : 2 Cow manure : 1 Biochar (1 : 2 : 1),
P_5 = 1 Land : 1 Cow manure : 2 Biochar (1 : 1 : 2),
P_6 = 1 Land : 2 Cow manure : 2 Biochar (1 : 2 : 2).

Each was repeated 3 times, so there were 21 experimental units. Each experimental unit consisted of 5 plants can be obtained 105 populations and the number of samples taken for each treatment is 3 so that the total number of samples is 63 samples. The data obtained were analyzed in the analysis of variance. If there is a real effect, or very real on the combination of planting media treatments, then further testing is carried out using the 5% BNJ test.

Implementation Study

Biochar preparation

Biochar production using gasification methods or heat sources directly. The stages start from preparing the rice husks, then dried in the sun so that they dry evenly, then made into a pile, the middle of which is made a hole and 3 sheets of white paper are placed as a lighter, then burned for up to 2 hours, after the husks are black, sprinkled with water so that ashing does not occur.

Preparation Seeds

The source of seeds to be used as seedlings was obtained from Seith Village, Leihitu District, Central Maluku Regency, with the characteristic of shiny blackish purple. The seeds obtained were weighed to determine the

uniformity of weight, then peeled. and soaked, then sown in polybags and cared for until 3 months old, to then be transferred to the nursery media. The nursery is made by erecting a roofed shelter paranet with size tall 2 meters, long 4 meters and width 3 meters and division is done track polybag in a way elongated as much as 3 test. Each The path has a width of 100 cm and a distance between treatments of 30 cm and a distance between replications of 30 cm. cm. The nursery location is a place that is clean from grass and close to a water source.

Making Planting Media

Soil sampling was carried out in Seith Village, Leihitu District, Central Maluku Regency, cambisol soil was taken at a depth of 0-30 cm from the surface of the soil, then the soil was air-dried and sieved with a 2mm sieve. Next, the soil was mixed with biochar and cow manure according to the combination evenly (v/v) according to the treatment. Then weighed as much as 3 kg and put into a polybag measuring 15x30 cm. After that, labeled according to treatment.

Planting

Zanzibar clove seedlings that are ready for transplanting (3 months old) are planted in polybags that have been filled with media according to the treatment. The polybags used are 15x30 cm in size and each contains one clove seedling that is labeled according to the treatment code.

Maintenance

Plant maintenance includes watering using a handsprayer twice a day, in the morning and evening or adjusted to weather conditions. Watering is done carefully so that the young parts of the seedlings are not damaged by water pressure. Watering is done evenly and stopped if some of the water has come out of the bottom hole of the polybag. Weeding or weed control is done every time weeds grow by pulling them out. Pest and disease control carried out if there is an attack on the plant.

Observation Parameters

The research parameters observed in this experiment were plant height and number of leaves. Plant height was measured every 3 weeks, at the age of 3, 6, 9 to 12 weeks after planting (MST) measurement. Carried out from the base of the stem to the highest growing point using a ruler. While the number of leaves was calculated every 3 weeks until the end of the study (12 MST), where the data used to be processed and discussed were the height of the plant and the number of leaves of Zanzibar cloves at the age of 12 MST.

RESULTS

Tall Plant

The results of the study showed that the combination of soil, manure, and biochar planting media affected the height of clove seedlings at the age of 12 MST. The average increase in the height of Zanzibar clove seedlings in soil

planting media combined with biochar and cow dung manure was higher when compared to Zanzibar clove seedlings in planting media without both. However, the increase in the height of Zanzibar clove seedlings had a very significant effect on the use of a combination of soil, manure, biochar 1:1:1 (P3) planting media, as presented in Table 1.

Table 1. Average height (cm) of clove plants aged 12 MST due to the influence of planting media combinations.

Treatment	Tall Plants (cm)
P0= Land Media (Control)	16.20 a
P1= Land : Cow dung fertilizer (1:1)	17.18 b
P2= Land : Biochar (1:1)	16.57 a b
P3= Land : Cow manure : Biochar (1:1:1)	19.93 d
P4= Land : Cow manure : Biochar (1:2:1)	16.84 ab
P5= Land : Cow manure : Biochar (1:1:2)	16.81 ab
P6= Land : Cow manure : Biochar (1:2:2)	18.67 c

Description: Numbers marked by the same letter in the column and line the same means not significantly different at the 5% BNJ test level.

Some of the benefits of biochar for clove seedling growth are increasing water retention and soil aeration so that it supports nutrient absorption, improving nutrient availability by increasing cation exchange capacity (CEC), and reducing soil toxicity, especially in soil contaminated with heavy metals. The results of research by Yadav et al., (2019) showed that the administration of biochar increased soil CEC from 18 meq/100 g to 30 meq/100 g. This is in line with research by Yulianti et al., (2021) which found that the administration of biochar to Kambisol soil caused an increase in the physical and chemical properties of the soil so that there was an increase in nutrient absorption which had an effect on increasing the height of clove seedlings.

The application of manure to cambisol soil as a planting medium for Zanzibar cloves causes an increase in nutrients such as nitrogen (N), phosphorus (P), and potassium (K) so that nutrients can be easily available to Zanzibar clove plants. In addition, manure also stimulates the activity of soil microorganisms that support the mineralization of organic matter, and improves soil structure, making it looser and easier to process. The results of research by Syafri et al., (2020) showed that the application of cow manure with a dose of 2 kg/plant can increase the height of clove seedlings by up to 30% higher than without manure within 12 weeks after planting.

The combination of Biochar and manure is often used as a natural soil conditioner because of its benefits in improving the physical, chemical, and biological properties of the soil. The combination of these two materials can provide synergistic results on plant growth, including the height of clove seedlings. Biochar is carbon from the pyrolysis of organic materials such as agricultural waste. Biochar and manure can provide synergistic effects,

including: increasing the efficiency of fertilizer use Biochar helps retain nutrients from being washed away, while manure provides the nutrients needed.

Optimal nutrition and better soil conditions allow plants to grow faster. In addition, biochar can slow down the release of nutrients from manure, so that nutrient availability lasts longer. According to Sinaga et al., (2017), a balanced combination of soil, biochar and manure can increase permeability and percolation, so that soil fertility increases due to the presence of nutrients. Plant roots then absorb nutrients and increase water binding capacity (Salawati et al., 2019), thus increasing the growth of clove seedlings significantly (Harsono et al., 2020). This is in line with research by Yulianti et al., (2021) which shows that the combination of manure with biochar increases the soil's capacity to store water and nutrients, thus providing increased growth of clove seedlings.

Amount Leaf

The results of the study showed that the combination of soil, manure, and biochar planting media affected the number of clove seedling leaves at the age of 12 MST. The increase in the number of leaves in Zanzibar clove seedlings aged 12 MST was obtained in a combination of soil, manure, biochar with a ratio of 1:1:1 (P3). The average number of leaves of Zanzibar clove seedlings after the administration of biochar and manure showed a very significant effect at the age of 12 MST which is presented in Table 2.

Table 2. Average number of leaves (strands) of clove plants aged 12 MST due to the influence of planting media combinations.

Treatment	**Amount Leaf (Sheet)**
P0= Land Media (Control)	6.12 a
P1= Land : Cow dung fertilizer (1:1)	6.23 a
P2= Land : Biochar (1:1)	6.68 ab
P3= Land : Cow manure : Biochar (1:1:1)	8.48 c
P4= Land : Cow manure : Biochar (1:2:1)	6.21 a
P5= Land : Cow manure : Biochar (1:1:2)	7.26 b
P6= Land : Cow manure : Biochar (1:2:2)	7.28 b

Description: Numbers marked by the same letter in the column and line the same means not significantly different at the 5% BNJ test level.

Formation shoots on seed clove very influenced by condition environment which supports the formation of leaf shoots more quickly, such as shade temperatures, and availability of nutrients. The addition of biochar and manure to the clove seedling growth media that was tested was able to supply nutrients and provide optimum growing space for plant growth. Biochar is carbon produced from the pyrolysis of organic materials. The

benefits of biochar for clover leaf growth are increasing water retention where biochar is able to retain moisture so that the leaves can continue to get sufficient water supply for the metabolic process, biochar increases the availability of nutrients such as nitrogen and potassium which play a role in leaf formation, more readily available due to the high cation exchange capacity (CEC) of biochar. In addition, biochar supports soil microbial activity, namely biochar provides a habitat for microorganisms that help release nutrients from organic matter and extend nitrogen retention from SRN in the plant root zone, ensuring continuous nutrient availability (Manzoor et al., 2021). The effect of biochar on the activity of these microorganisms causes an increase in nutrients in cambisol soil so that plant growth increases as indicated by an increase in the number of leaves (Utami & Widiastuti, 2021).

The effect of manure is as a source of organic material rich in macro and micro nutrients, such as nitrogen, phosphorus, and potassium, thus affecting the increase in the number of clove leaves. The increase in nutrients directly absorbed by plants, such as nitrogen, greatly supports the division and elongation of leaf cells. Manure also increases the activity of soil microorganisms, which helps the decomposition of organic matter and the provision of nutrients. In addition, it improves soil structure so that roots can absorb water and nutrients more effectively to support leaf growth. This is in line with research by Johan et al., (2022), which found that the provision of manure can increase leaf growth so that the number of clove seedling leaves increases.

The combined effect of biochar and manure creates a synergy that supports leaf growth by increasing leaf nutrient absorption, namely manure provides the required nutrients, while biochar helps keep the nutrients from being easily washed out. The combination of biochar and manure improves soil quality sustainably, namely biochar increases nutrient retention capacity, while manure provides organic matter to support plant growth. In addition, the nitrogen content of manure and biochar helps the process of chlorophyll formation, thus supporting an increase in the number of leaves. This is in line with Salawati's research et al., (2019) shows that nitrogen from biochar and manure added to the planting medium can improve soil quality and encourage increased growth of the number of clove seedling leaves. This is in line with Salawati's research et al., (2019), which showed that the combination of manure and biochar can increase the number of leaves of Zanzibar clove seedlings.

CONCLUSIONS AND RECOMMENDATIONS

Based on results study can concluded that on treatment the combination of planting media suitable for the growth of Zanzibar clove plants was obtained in treatment of soil media type, manure and biochar with a ratio of 1:1:1 (P3). In this combination of planting media, a plant height of 19.93 cm and a number of leaves of 8.48 (strands) were obtained.

FURTHER STUDY

Future research should explore the long-term effects of manure and biochar application on Zanzibar clove plants beyond the seedling stage, including their impact on flowering, yield, and overall plant health. Additionally, studies comparing different biochar sources and manure types could provide insights into the most effective combinations for optimizing growth. Investigating the microbial community dynamics in the soil under different planting media compositions would also be beneficial in understanding the mechanisms that enhance plant development. Furthermore, trials in different agroecological zones could determine the adaptability of this planting media combination across various environmental conditions.

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