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The Effect of Planting Media on Several Chemical Properties of Soil and Growth of Moringa Stem Cuttings (*Moringa oleifera* Lam.)

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ABSTRACT

This research was conducted to determine the effect of planting media on the growth of Moringa stem cuttings and determine the best planting media for growing Moringa stem cuttings. The research was carried out in July-October 2023. Located on the Wasaka III Student Dormitory grounds, Lambung Mangkurat University, Banjarbaru, South Kalimantan. The research was carried out using a one-factor Completely Randomized Design (CRD) method with four treatments and five replications to obtain 20 experimental units. The treatments given: m0: 6 kg peat soil, m1: 5 kg peat soil + 1 kg husk charcoal, m2: 5 kg peat soil + 1 kg laying chicken manure, m3: 5 kg peat soil + 0.5 kg husk charcoal + 0.5 kg laying chicken manure. The results showed that the planting had a significant effect on soil pH, shoot length, number of leaf stalks, root length and root volume of Moringa stem cuttings. However, it had no real effect on the number of shoots on Moringa stem cuttings. Based on research that has been carried out, it shows that planting media given husk charcoal and manure increases the available P content by 241.34 ppm, N-dd 1.70 me/100 g, and K-dd 1.65 me/100 g in the soil. Peat can increase the pH of peat soil from acid to neutral. The treatment also had a very significant effect to all parameters.

Keywords: Ammonium, available P, organic carbon, organic matter, soil fertility

INTRODUCTION

Moringa is a plant in the Moringaceae family, native to India. Moringa is a magical plant that is not only used as a source of food, medicine, and animal feed. However, it can also serve as an alternative energy source for environmentally friendly biodiesel (Nurcahyani, 2014). Dried moringa leaves contain 3.65% Ca, 0.30% P, 0.50% Mg, 1.5% K, 0.164% Na, 0.63% S, 31 mg kg^{-1} Zn, 86.5 mg kg^{-1} Mn, and 363 mg kg^{-1} Fe (Moyo et al., 2011). In Indonesia, moringa is still not widely used and is generally only used as a fresh vegetable. In fact, moringa can also be processed into flour which can be used as an ingredient to meet the nutritional needs of various food products (Aminah et al., 2015). As a functional food, the leaves, bark, seeds, and roots of the moringa plant are not only a source of nutrition but also function as a very efficacious herb for health (Simbolan et al., 2007). Therefore, the development of this plant is essential. The opportunity to develop moringa plants that remain large will undoubtedly increase demand for high-quality, large-quantity seeds. One alternative to get a lot of uniform seeds is by stem cuttings. In addition to the relatively short time required, propagation by stem cuttings will also produce offspring identical to their parents, allowing superior characteristics to be maintained.

In order to support the development of moringa plants, Wahdah and Makalew (2022) conducted research on the suitability of moringa plant land on acid sulfate soil. The results of the study showed that the suitability of acid sulfate soil for moringa plants is limited by soil pH, particularly in very acidic conditions (<4), and by very clayey soil texture. Efforts were made to improve the land suitability class. Wahdah et al. (2022) continued the research on the growth of moringa plants in acidic sulfate soil with the addition of ameliorant materials of EOPB (Empty Oil Palm Bunches) compost and rice husk ash. The study found that the ameliorant treatment affected only the number of shoots on the moringa plant. It is thought to be due to the ameliorant material not raising the soil pH, and the soil texture remaining clayey, resulting in suboptimal growth of the moringa plant. Based on these problems, this study was conducted on peat soil with the addition of rice husk charcoal and chicken manure. It is hoped that, with the addition of rice husk charcoal and chicken manure, peat soil can serve as an ideal planting medium for moringa plants. Indonesia has 37.8 million hectares of wetlands, of which around 22.5 million hectares are peatlands and 4.8 million hectares are on the island of Kalimantan (Anggara, 2020). The vast peatlands in Kalimantan have great potential for agricultural land. The use of peat soil as a nursery medium is carried out because of the vast peatlands in Kalimantan, and also the absence of special moringa cultivation on peat soil. It is expected that peat soil can be well managed for agricultural land, especially for moringa cultivation, provided that peat ecosystems are protected and managed, so that they can support the sustainability and continuity of the ecosystem and its benefits for people's lives in the future.

According to Krisnadi (2015), the growing requirements for moringa include a medium of sandy soil or sandy loam with a pH of 5-9. Based on the research by Nugroho and Widodo (2001), the peat soil porosity ranges from 83.62% to 95.1%, and the soil texture is relatively crumbly or loose, making it suitable for plant root development. However, acidic peat soil conditions will prevent moringa plants from growing well, as they require a pH of 5-9. Efforts to improve the chemical properties and increase the fertility of peat soil include adding other planting media, such as rice husk charcoal, and applying laying hen manure.

Rice husk charcoal consists of lightweight, microporous materials with an average BD of around 0.150 g cm^{-3}. Rice husk charcoal has a pH of 7.92, N (1.45%), and C (28.6%) (Soil Research Institute, 2012). The provision of rice husk charcoal will improve the pH of peat soil, thereby releasing nutrients such as P and K initially bound by organic acids into forms that plants can utilize. Rice husk charcoal also contains SiO_2 (52%), K (0.3%), P (0.08%), and Ca (0.14%) (Kusmarwiyah & Erni, 2011).

Chicken manure contains macronutrients, with exceptionally high levels of N compared to other manures. Nitrogen can stimulate vegetative plant growth, a component of chlorophyll, protein, and fat, increase the development of living tissue, and encourage leaf and stem growth in the early and middle phases of growth (Hariyono, 2016). Manure from laying hen manure has a total N nutrient content of 1.95%, P_2O_5 4.88%, K_2O 2.29%, organic-C 6.94% and pH (H_2O) of 8.68 (Santoso, 2022). Based on this background, this study was conducted to determine the effects of adding rice husk charcoal and laying hen manure to planting media on the propagation of moringa stem cuttings and to assess changes in several chemical properties of the peat soil. It is hoped that this study will determine the optimal planting media for the propagation of moringa stem cuttings while improving the fertility of peat soil.

MATERIALS AND METHODS

Research Location and Time

The research was carried out in July-October 2023. Located on the Wasaka III Student Dormitory grounds, Lambung Mangkurat University, Banjarbaru, South Kalimantan.

Research Method

This study used a one-factor Completely Randomized Design (CRD) with 4 treatments and 5 replications to obtain 20 experimental units. The treatments used were the addition of rice husk charcoal and laying hen manure to peat soil as follows: m0: 6 kg of peat soil, m1: 5 kg of peat soil + 1 kg of rice husk charcoal, m2: 5 kg of peat soil + 1 kg of laying hen manure, m3: 5 kg of peat soil + 0.5 kg of rice husk charcoal + 0.5 kg of laying hen manure. Preparation of planting media.

Research Procedures

Peat soil was taken from Syamsudin Noor's Street, Landasan Ulin District, Banjarbaru Regency, South Kalimantan Province, as much as 110 kg. Before use, the peat soil was separated from twigs, leaves, and other undecomposed material. Mixing of planting media. Making planting media M0: peat soil without mixing other materials, up to 6 kg per polybag and making planting media M1, peat soil mixed with rice husk charcoal (5 kg peat soil + 1 kg rice husk charcoal) as much as 6 kg per polybag and making planting media M2, peat soil mixed with rice husk charcoal (5 kg peat soil + 1 kg chicken manure) as much as 6 kg per polybag. Making planting media M3, peat soil mixed with rice husk charcoal (5 kg peat soil + 0.5 kg rice husk charcoal + 0.5 kg chicken manure), as much as 6 kg per polybag. Then the polybags are arranged in a prepared place that has been incubated for 2 weeks. Preparation of moringa stem cuttings. Moringa cuttings are taken from the parent tree in the Wasaka III Student Dormitory, Lambung Mangkurat

University, Banjarbaru. Based on the Decree of the Minister of Agriculture of the Republic of Indonesia (2020), the moringa cuttings are taken from 2-year-old parent trees with a minimum diameter of 3 cm and a length of 50 cm (minimum three growing points). The bark is white or white with a small quantity of green. Moringa stems are cut with a saw, up to 30 at a time.

Soaking seeds with Rootone F. Soak seeds in Rootone F by mixing 20 g of Rootone F with 2 L of water in a bucket. Then the base of the moringa stem is soaked in the solution for 15 minutes (Cahyadi & Ardian, 2017). Planting moringa stem cuttings. Moringa stems are planted by immersing the base of the stem in the nursery media to a depth of 10 cm. Maintenance. Nursery maintenance includes watering and weeding. Watering is done once a day, in the morning or evening, to maintain soil moisture. The water used for watering is healthy. Weeding is done if weeds are growing around the plants. The observation parameters in this study were soil pH, number of shoots, shoot length, number of leaf stalks, root length, and root volume.

Data Analysis

Data analysis began with a test of homogeneity of variances (Bartlett's Test). Homogeneous data were then analyzed using a repeated-measures ANOVA to assess the effect of treatment. The data with a significant effect were then followed by Duncan's Multiple Range Test (DMRT) at the 5% significance level. All stages of statistical analysis are performed in Excel.

RESULTS AND DISCUSSION

Chemical properties of soil after incubation

The results of the analysis of variance showed that the treatment of planting media had a very significant effect on pH, Exchangeable-Na, Available-P, and Exchangeable-K of peat soil and did not affect the content of Total-N, Organic-C, and C/N. The results are shown in Table 1.

Referring to Table 1, the treatment of planting media affects the amounts of available P, exchangeable Na, exchangeable K, and pH. However, it does not affect the amount of Total N, Organic C, and C/N. The available P content in peat soil amended with laying hen manure is the highest at 241.34 ppm, compared to other treatments. The amount of Exchangeable-N shows the same thing: treatment with laying hen manure can increase the amount of Exchangeable-N compared to other treatments, as well as the Exchangeable-K content. The soil pH indicates that the rice husk charcoal and chicken manure treatment is not significantly different from the M0 (control) treatment. The increase in soil pH is very significant, from 5.97 to 6.31 to 6.41, which is already within the neutral criteria. Chicken manure has a pH of 6.8, organic C 12.23%, N-total 1.77%, P_2O_5 27.45% and K_2O 3.21%. Providing several doses of chicken manure fertilizer can increase soil N because organic matter from the fertilizer serves as food for soil microorganisms, some of which harbor N-binding microorganisms. The application of chicken manure fertilizer to acidic soil can reduce P fixation by soil acid cations, thereby increasing soil P availability (Tufaila et al., 2014). The results of research by Maya and Adriyani (2005) show that the provision of chicken manure as much as 20 Mg ha^{-1} can provide the highest results in plant height parameters, leaf area index, number of branches, number of internodes, root dry weight, crown dry weight, harvest pod weight/plot, and soybean plant pod weight. Chicken manure fertilizer contains many macro nutrients such as Ca, Mg, S, N, P, and K. According to (Sari et al., 2016) chicken manure has good potential, because in addition to playing a role

Table 1. Soil Chemical Analysis After Incubation.

No	Treatment	Available-P (ppm)	Total-N (%)	Organic-C (%)	C/N	Na-dd (me 100 g^{-1})	K-dd (me 100 g^{-1})	pH (H_2O)
1	M0	7.19a	0.93	16.63	18.44	0.06a	0.07a	5.97a
2	M1	29.36a	0.76	16.35	21.45	0.78a	0.75b	6.31b
3	M2	241.34c	0.94	17.97	19.32	1.70c	1.65d	6.47b
4	M3	161.04b	0.84	15.49	18.77	1.00b	1.12c	6.41b

Description: M0 6 kg peat soil. M1 5 kg peat soil + 1 kg rice husk charcoal. M2 5 kg peat soil + 1 kg laying hen manure. M3 5 kg peat soil + 0.5 kg rice husk charcoal + 0.5 kg laying hen manure. The same letter indicates that the treatment is not significantly different based on DMRT 5%

in improving the physical, chemical, and biological properties of the soil, chicken manure also has a higher N, P, and K content when compared to other manures. The nutritional elements in chicken manure are N 3.21%, P_2O_5 3.21%, K_2O 1.57%, Ca 1.57%, Mg 1.44%, Mn 250 ppm, and Zn 315 ppm; cow manure N 2.33%, P_2O_5 0.61%, K_2O 1.58%, Ca 1.04%, Mg 0.33%, Mn 179 ppm, and Zn 70.5 ppm. And goat manure N 2.10%, P_2O_5 0.66%, K_2O 1.97%, Ca 1.64%, Mg 0.60%, Mn 233 ppm, and Zn 90.8 ppm (Ichsani, 2021).

Chicken manure is one of the wastes produced by both laying hens and broilers that has excellent potential as organic fertilizer. The composition of manure varies greatly depending on the physiological characteristics of the chicken, the rations eaten, and the cage environment, including temperature and humidity. Chicken manure is one of the organic materials that affects the physical, chemical, and growth properties of plants. Chicken manure has high levels of nutrients and organic matter and low water content. Manure is an easily obtained, widely available organic material for farmers. The provision of manure can increase the absorption of nutrients by plants, reduce the use and increase the efficiency of the use of chemical fertilizers (Martin et al., 2006), can improve soil aggregation so that it can increase the number of soil pores so that it finally becomes a suitable medium for plant growth because the root reach is wider so that nutrient absorption is easier. The wider root reach and increased nutrient absorption are expected to improve fertilization efficiency, enabling plants to grow well (Wahyuningsih, 2005). The nutrient composition contained in organic chicken manure fertilizer includes N (1.50%), P (1.30%), K (0.8%), Ca (4.0%), and a C/N ratio of 9-11% (Balittan, 2014).

Zainal et al. (2014) found that soybean plants fertilized with chicken manure at 15 Mg ha^{-1}, combined with various levels of N fertilization, produced the highest growth components (root fresh weight and number of branches) and yield components (number of pods per plant). Plants fertilized with chicken manure at a dose of 15 Mg ha^{-1} produced the highest weight of filled pods per plant, weight of 100 seeds, and seed yield (Mg ha^{-1}), respectively, 36.77 g $plant^{-1}$, 13.94 g, and 2.17 Mg ha^{-1} dry seeds. Research by Sulaiman et al. (2017) also found that treatment with chicken manure or sludge increased plant height and corn plant residue compared with no inorganic fertilizer. The use of chicken manure or sludge at a rate of 5 t ha^{-1} in corn farming on dry, acidic land is technically and economically more recommended because it can reduce inorganic fertilizer costs by 50% and reduce the risk of land degradation and environmental pollution. The study by Purnomo et al. (2013) showed that treatment with 20 Mg ha^{-1} of manure resulted in a larger cucumber stem diameter. Application of chicken manure compost at a rate of 15 Mg ha^{-1} had a very significant effect on total cucumber fruit production (Tufaila, 2014). The 20 Mg ha^{-1} dose of chicken manure produced the best growth of pakchoy plants compared to lower doses (Sari et al., 2016). This is supported by the opinion of Hartatik et al. (2015), who noted that the nutrient composition of organic fertilizer is relatively low and highly variable. Hence, its benefits for plants are indirect and long-lasting. Based on the results of the study (Melati, 2005), the provision of chicken manure of 20 t ha^{-1} can provide the highest results on the variables: plant height, leaf area index (ILD), number of branches, number of internodes, root dry weight, crown dry weight, harvest pod weight per plot, filled pod weight in soybean plants. The provision of several doses of chicken manure can increase N in the soil because organic material from chicken manure is food for soil microorganisms, some of which contain N-binding microorganisms, this is in line with the research conducted that the availability of N in peat soil increases with the provision of rice husk charcoal and manure compared to without the provision of chicken manure and rice husk charcoal. The application of chicken manure to acidic soil can reduce P fixation by soil acid cations, thereby increasing soil P availability (Tufaila et al., 2014). This is clearly seen in Table 1: the increase in available P is much greater in soil without rice husk charcoal than in soil with manure. Table 1 shows that the treatment with the provision of manure increases the amount of available P the most (241.34 ppm) compared to the provision of only rice husk charcoal or rice husk charcoal + manure. The benefits of chicken manure, based on research by Hakim et al. (2006), include, in addition to containing macro nutrients, microelements such as Cu and small amounts of Mn, Co, and B, which are very important for plant growth.

Furthermore, the results of Husin's research. Purnamasari (2009) conducted on Ultisol soil showed that the provision of 15 Mg ha^{-1} of chicken manure can increase soil pH by 0.37, total N by 0.242%, and available P by 5.9 ppm, while soil Al-dd decreased by 1.78 me 100 g^{-1}. Table 1 shows that the provision of manure and rice husk charcoal increases the pH of peat soil.

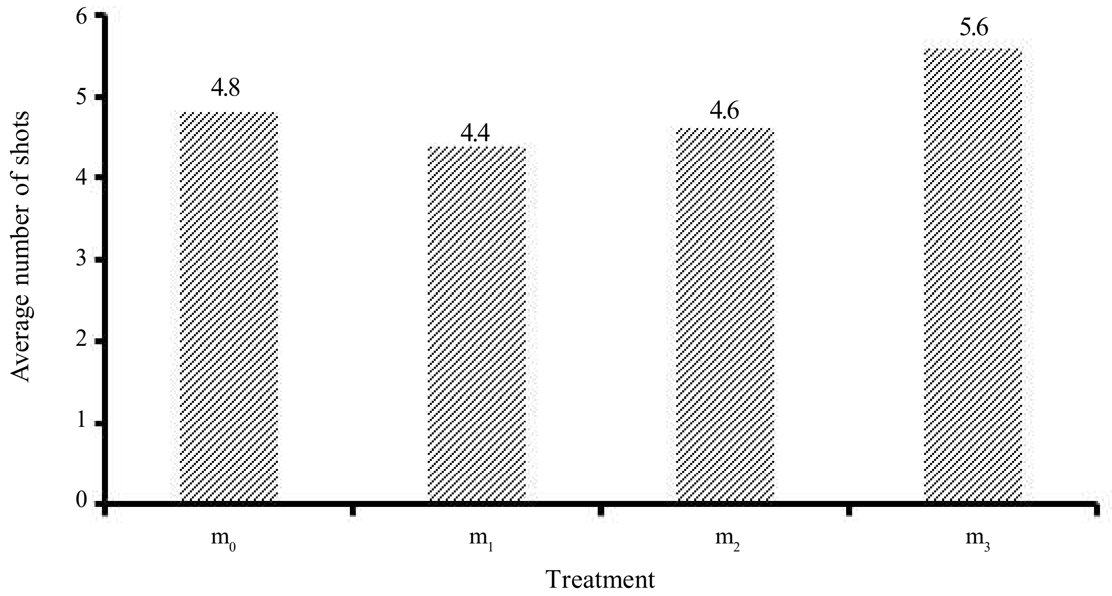

Figure 1. Average number of shoots of moringa cuttings 8 WAP. M0 6 kg peat soil. M1 5 kg peat soil + 1 kg rice husk charcoal. M2 5 kg peat soil + 1 kg laying hen manure. M3 5 kg peat soil + 0.5 kg rice husk charcoal + 0.5 kg laying hen manure. The same letter indicates that the treatment is not significantly different based on DMRT 5%.

Number of Moringa Cutting Shoots

The analysis of variance showed that the planting media treatment had no significant effect on the number of moringa cutting shoots. The results are shown in Figure 1.

Based on the research results, the number of shoots from moringa cuttings with rice husk charcoal and chicken manure added to the planting medium does not differ significantly. The highest number of shoots was obtained with the treatment of 5 kg of peat soil + 0.5 kg of rice husk charcoal + 0.5 kg of laying hen manure (M3), namely 5.6 shoots. It is thought to be because the formation of shoots still uses carbohydrates found in plant cells. Indriyani et al. (1999), as cited in Sawaluddin et al. (2018), reported that high photosynthate accumulation leads to cell enlargement and differentiation, as evidenced by increases in height, shoot number, leaf number, and stem diameter.

Based on the research, the treatment of the planting medium did not have a significant effect. It happened because, at the end of the observation, many shoots had turned yellow and fallen, while some of the moringa cuttings had several new shoots. Yellowing and shoot fall in the treatment are suspected to be due to environmental factors, such as high air temperatures and unpredictable rain and heat, which cause leaves to fall as temperatures rise.

Length of Moringa Cutting Shoots

The analysis of variance showed that the planting media treatment had a significant effect on the length of moringa cutting shoots. The results obtained can be seen in (Figure 2).

Based on the research carried out, it is known that adding rice husk charcoal and laying hen manure to the planting medium significantly affects the length of moringa cuttings' shoots. The highest shoot length was observed in the 5 kg peat soil + 1 kg rice husk charcoal (M3) treatment, at 64.83 cm, which was not significantly different from M1 and M2. Meanwhile, the lowest shoot length was observed in the peat soil treatment (M0; 21.93 cm), which was significantly different from treatments M1, M2, and M3. The increase in the length of the shoots of moringa cuttings in the media mixed with rice husks and laying hen manure was faster than the M0 treatment, allegedly because in treatments M1, M2, and M3 the addition of rice husk charcoal and laying hen manure was able to meet the nutrient needs for plants in the process of increasing the length of the shoots of moringa cuttings. This is in accordance with Komarayati et al. (2003), which states that the provision of rice husk charcoal can improve soil properties, including making fertilization more effective, because, in addition to improving the physical properties of the soil, rice husk charcoal

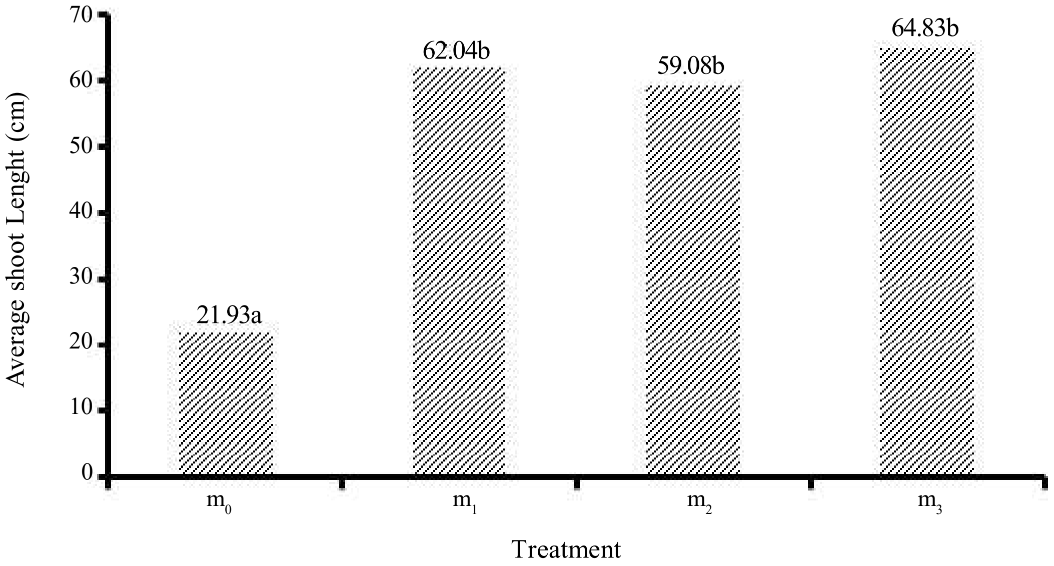

Figure 2. Average length of Moringa cutting shoots 8 Wap. M0 6 kg peat soil. M1 5 kg peat soil + 1 kg rice husk charcoal. M2 5 kg peat soil + 1 kg laying hen manure. M3 5 kg peat soil + 0.5 kg rice husk charcoal + 0.5 kg laying hen manure.The same letter indicates that the treatment is not significantly different based on DMRT 5%.

also functions as a nutrient binder that can be used by plants when there is a lack of nutrients.

Manure from laying hen manure has a total N nutrient content of 1.95%, P_2O_5 4.88%, K_2O 2.29%, organic-C 6.94% and pH (H_2O) of 8.68 (Santoso, 2022). According to Suryati et al. (2015), during plant growth, N is essential and plays a significant role in stimulating overall vegetative growth, particularly stem growth, which can spur plant height.

Based on research by Ekawati and Wati (2019), the planting media of soil, rice husk charcoal, and manure, in a 1:1:1 ratio, yield the longest moringa shoots. The increase in plant height reflects plant growth, as plant segments elongate through cell

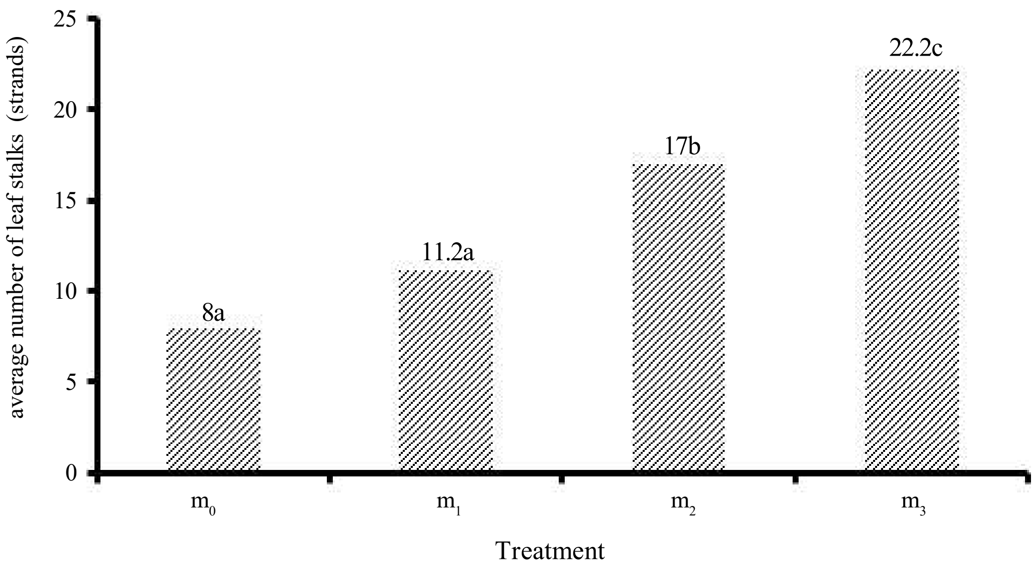

Figure 3. Average number of leaf stalks of moringa cuttings 8 WAP. M0 6 kg of peat soil. M1 5 kg of peat soil + 1 kg of rice husk charcoal. M2 5 kg of peat soil + 1 kg of laying hen manure. M3 5 kg of peat soil + 0.5 kg of rice husk charcoal + 0.5 kg of laying hen manure. The same letter indicates that the treatments are not significantly different at the 5% level based on the DMRT.

enlargement and elongation. As a plant ages, its growth is determined by the availability of nutrients in the planting medium.

Number of Moringa Cutting Leaf Stalks

The analysis of variance showed that the planting media treatment had a highly significant effect on the number of moringa cutting leaf stalks. The results are shown in Figure 3.

Based on the results of the research that has been carried out, it is known that the addition of rice husk charcoal and laying hen manure to the planting medium has a very significant effect on the number of leaf stalks of moringa cuttings. The highest number of leaf stalks was obtained in the treatment of 5 kg peat soil + 0.5 kg rice husk charcoal + 0.5 kg laying hen manure (M3), namely 22.2 strands, which was significantly different from treatments M0, M1, and M2. Meanwhile, the lowest number of leaf stalks was observed in the peat soil treatment (M0), namely 8 cm, which was not significantly different from treatment M1 but significantly different from treatments M2 and M3. The large number of leaf stalks in treatment M3 is thought to be due to the addition of rice husk charcoal and laying hen manure to the medium, which meet the plants' nutrient needs during plant growth, especially leaf production. Chicken manure has a fine-grained texture that decomposes quickly when mixed with rice husk charcoal. Wijiyanti (2019) stated that N is the most influential nutrient for leaf growth. The high N content increases leaf number. According to Pangaribuan et al. (2012), chicken manure has higher levels of N, P, and K than other manures because solid poultry manure is mixed with liquid manure. This condition is well-suited to the plant's needs.

Based on research conducted by Komarayati et al. (2003), it is stated that the provision of rice husk charcoal can improve soil properties, including making fertilization more effective, because, in addition to improving porosity and aeration, rice husk charcoal also functions as a nutrient binder that can be used by plants when there is a lack of nutrients. This is consistent with Dharmasika et al. (2019), who reported that adding rice husk charcoal and manure can increase the number of leaves on corn plants. It is because rice husk charcoal contains silica (Si), which can improve the exchange of photosynthetic products in plant leaf organs, thereby increasing the number of leaves.

Research indicates that the length of the moringa cutting shoots affects the number of leaf stalks produced. The longer the shoots, the more leaf stalks are produced. However, in the M1 and M0 treatments, the number of leaf stalks did not differ significantly. It is because in the M1 treatment at the end of the observation, many leaves had turned yellow and fallen, so that at the time of observation, the number of leaf stalks had decreased. The decrease in the number of leaf stalks in the M1 treatment is thought to be due to changes in air temperature, as at the time of observation, there

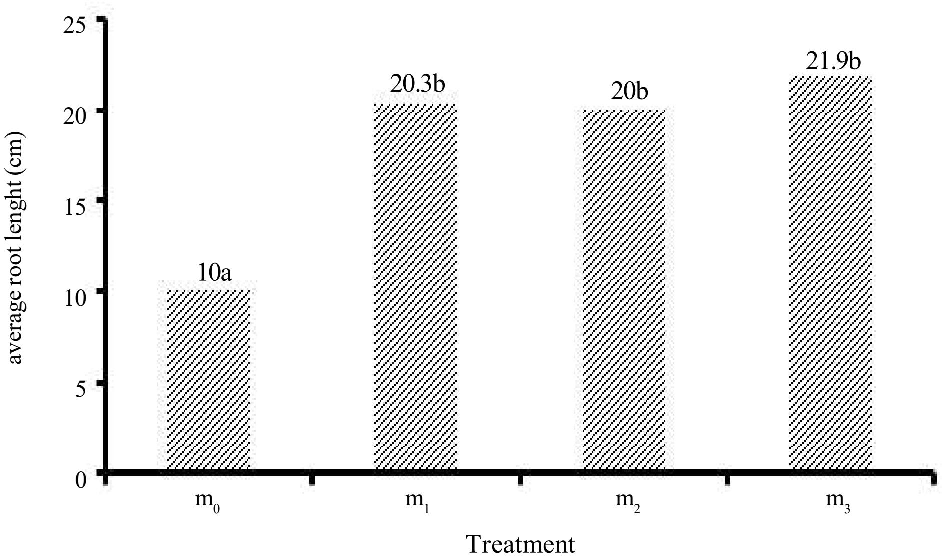

Figure 4. Average root length of moringa cuttings 8 WAP. M0 6 kg peat soil. M1 5 kg peat soil + 1 kg rice husk charcoal. M2 5 kg peat soil + 1 kg laying hen manure. M3 5 kg peat soil + 0.5 kg rice husk charcoal + 0.5 kg laying hen manure. The same letter indicates that the treatment is not significantly different based on DMRT 5%.

was unpredictable rain and heat, which caused leaves to fall as temperatures increased. According to Levitt (1980) and Andriani (2017), one of the plant's efforts to balance water and nutrient levels under salt stress is to reduce leaf number to reduce transpiration.

Length of moringa cutting roots

The analysis of variance showed that the planting media treatment had a highly significant effect on the root length of the moringa cuttings. The results are shown in Figure 4.

Based on the research carried out, it is known that adding rice husk charcoal and laying hen manure to the planting medium has a very significant effect on the root length of moringa cuttings. The highest root length results were observed in the treatment of 5 kg of peat soil + 0.5 kg of rice husk charcoal + 0.5 kg of laying hen manure (M3), with a value of 21.9 cm, not significantly different from the treatments M2 and M3. Meanwhile, the lowest root length was observed in the peat soil treatment (M0), at 10 cm, which was significantly different from the treatments M1, M2, and M3. The planting medium supplemented with laying hen manure and rice husk charcoal can improve its porosity, enabling it to support respiration and root growth while maintaining soil moisture. The increase in root length will, of course, increase the roots' ability to absorb nutrients in the planting medium. It is related to root interception or root infiltration. Root interception occurs as a result of root growth from short to long, from unbranched to branched, and from few branches to many branches. This growth will enable the roots that form to reach parts of the planting medium that have not been reached before. Root interception is influenced by all things that affect root growth, such as soil moisture, soil porosity, soil pH, nutrient content, and soil aeration (Wiraatmaja, 2016). Organic material particles are the components of pore space that function as a source of water and air, as well as a space for roots to penetrate the soil. The more porous the space, the wider the root system will be, and the roots will be able to absorb nutrients and water from the soil more easily. This characteristic is essential for plant roots because it is closely related to their physical, chemical, and biological properties (Putri, 2008). According to Supriyanto and Fiona (2010), rice husk charcoal improves the soil's physical, chemical, and biological properties. Rice husk charcoal can also increase soil porosity, making the soil looser and improving its water-holding capacity. Marlina et al. (2015) also stated that chicken manure can improve soil structure, enhance soil aeration, increase soil's nutrient storage capacity, increase water retention capacity, increase soil resistance, and serve as a source of energy for soil microorganisms (Figure 5).

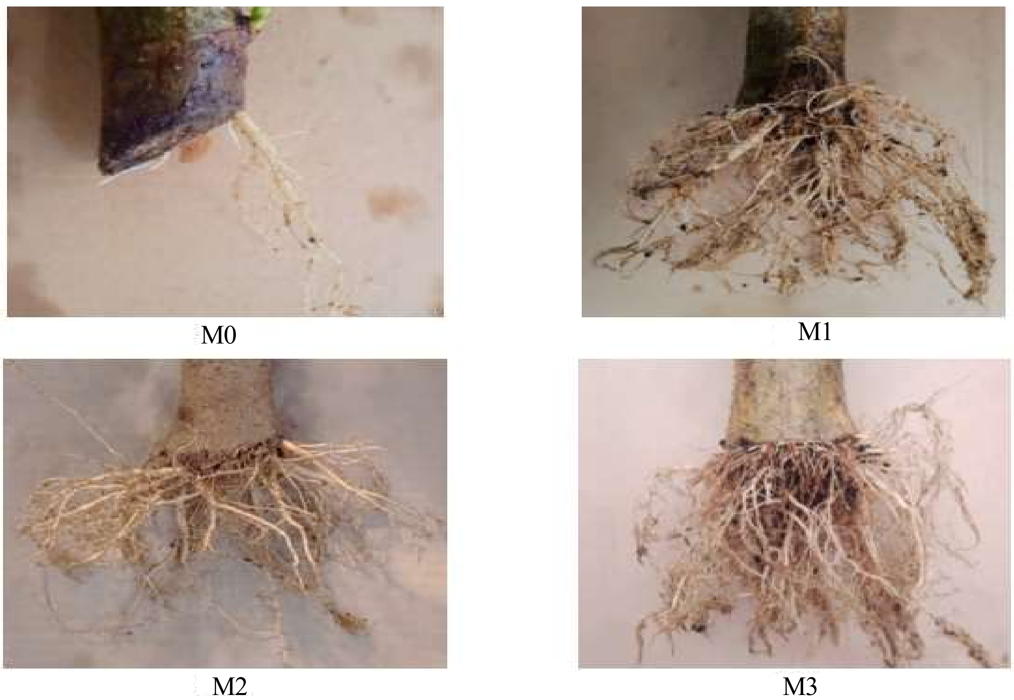

Figure 5. Moringa Root.

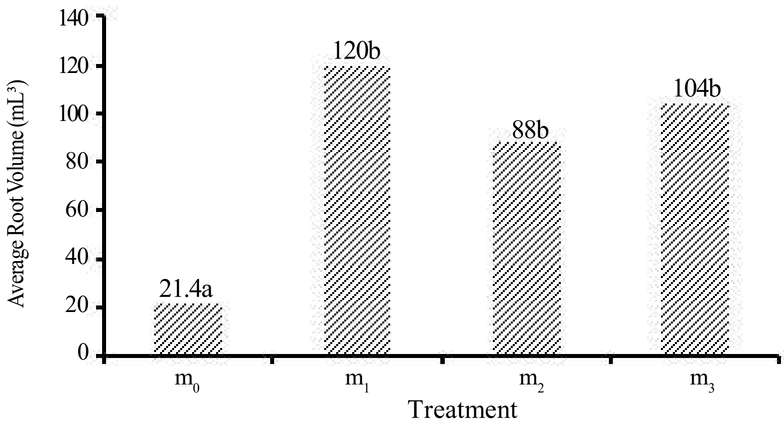

Figure 6. Average root volume of moringa cuttings 8 WAP. M0 6 kg peat soil. M1 5 kg peat soil + 1 kg rice husk charcoal. M2 5 kg peat soil + 1 kg laying hen manure. M3 5 kg peat soil + 0.5 kg rice husk charcoal + 0.5 kg laying hen manure. The same letter indicates that the treatment is not significantly different based on DMRT 5%.

Volume of moringa cutting roots

The analysis of variance showed that the planting media treatment had a highly significant effect on the root volume of moringa cuttings. The results are shown in Figure 6.

Based on the research conducted, it is known that treating the planting media with rice husk charcoal and applying laying hen manure has a very significant effect on the root volume of moringa cuttings. The highest root volume was observed in the M1 treatment (120 mL^3), which was not significantly different from the M2 and M3 treatments. Meanwhile, the lowest root volume was observed in the peat soil treatment (M0; 21.4 mL3) and was significantly lower than in the M1, M2, and M3 treatments. This is thought to be because the planting media, supplemented with rice husk charcoal and laying hen manure, can improve its porosity, facilitating root respiration and development, and maintaining its humidity. According to Prihmantoro and Indriani (2003), rice husk charcoal has porous properties, readily binds water, is light, and does not clump. Sufficient water is needed for metabolic processes in the plant body. Based on their research, Wibowo et al. (2021) stated that rice husk charcoal improves soil physical, chemical, and biological properties and serves as a soil conditioner. Rice husk charcoal can produce higher root dry weight and root volume. Simanungkalit et al. (2013) also stated that the provision of chicken manure significantly affected the root volume of cayenne pepper plants in peat soil. Providing chicken manure fertilizer resulted in a higher average root volume than without it. This is because applying chicken manure fertilizer can improve soil water-holding capacity, thereby facilitating nutrient absorption.

CONCLUSIONS

Based on the research conducted, the planting medium containing rice husk charcoal and manure increases the content of available P (241.34 ppm), Exchangeable-N (1.70 me 100 g-1), and Exchangeable-K (1.65 me 100 g^{-1}) in peat soil. It can increase the pH of peat soil from acidic to neutral. The treatment also significantly affected the growth of shoot length, number of leaf stalks, root length, and root volume of moringa stem cuttings. The best planting medium for growing moringa plants is 0.5 kg of rice husk charcoal and 0.5 kg of laying hen manure mixed with peat soil.

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