DEMETER: Journal of Farming and Agriculture
Vol 3, Issue 1, March 2025, Page 237-247
ISSN: 2987-5889 (Media Online)
DOI: https://doi.org/10.58905/demeter.v3i1.692

Improvement of Growth and Yield of Romaine Lettuce (*Lactuca sativa* L.*)* with the Application of Liquid Organic Fertilizer from Goat Manure and a Combination of Biochar Charcoal as Planting Media

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Abstract. This study aims to re-examine the optimization of Romaine lettuce yield under the application of a combination of biochar charcoal husk growing media and goat manure liquid organic fertilizer. This study was conducted from July to September 2024 at an experimental site located in Tebel Barat Village, Gedangan Subdistrict, Sidoarjo Regency, at an altitude of approximately 25 meters above sea level. This area has a temperature range of 21-34°C and an average rainfall of 1,300-1,700 mm per year. This study used a randomized block design with two treatment factors. The first factor involved the application of planting media consisting of three levels, namely 0g of biochar from rice husk charcoal, 29g of biochar from rice husk charcoal. Biochar Rice Husk Charcoal 147g. The second factor is the concentration of goat manure POC with 3 levels, namely: Liquid Organic Fertilizer from Goat Manure 1ml/5lt Water, Liquid Organic Fertilizer from Goat Manure 3ml/5lt Water, Liquid Organic Fertilizer from Goat Manure 5ml/5lt Water. The treatment was repeated three times, resulting in 27 experimental units. Data analysis was performed using analysis of variance, followed by a 5% BNJ test with observation variables including plant height, number of leaves, root length, wet weight, dry weight, and harvest index. The biochar husk charcoal growing medium treatment showed significantly different results in observation variables such as plant height and root length. In the plant height observation, the highest result was found in the observation without biochar charcoal husks. And in the root length observation variable, the highest value was found in the concentration without biochar charcoal husks. Meanwhile, the goat manure POC fertilizer observation results showed significant differences in several observation variables, such as plant height and number of leaves. Plant height showed significant results at 7, 14, and 35 days after planting, with the highest results for goat manure POC at 5 ml/5 L of water at 7 days after planting, goat manure POC at 5 ml/5 L of water at 14 days after planting, and goat manure POC at 1 ml/5 L of water at 35 days after planting. In the leaf number observation variable, the highest value was obtained in the treatment with 5 ml/5 L of goat manure POC. The biochar charcoal husk growing medium, observed without biochar charcoal husk and goat manure POC fertilizer at a dose of 5ml goat POC and 5L water, was able to produce the best vegetative growth on lowland plantations with good soil conditions, showing potential for further application in the future.

Keywords: Romaine lettuce, Goat manure POC, Rice husk biochar

1 Introduction

Lettuce is a vegetable that is widely loved by Indonesians. In addition to its affordable price, this plant also has many benefits. Among other things, lettuce can be consumed raw or cooked and can also be used as an ingredient in various dishes. From this, we can conclude that lettuce is well accepted and utilized by the people of Indonesia.

Lettuce is also a type of vegetable whose leaves are consumed. Lettuce also has many minerals and vitamins that are beneficial to health. The growth and yield of lettuce plants are greatly influenced by environmental conditions, with sunlight being one of the important factors that is constant and cannot be changed. Sunlight plays a crucial role in various physiological processes of plants such as photosynthesis, respiration, and transpiration, so its availability is very decisive. Lettuce plants are generally grown in highland areas with an optimal temperature between 15-25°C[1]. Lettuce plants also have benefits as vegetables with good nutritional content.

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Vol 3, Issue 1, March 2025, Page 237-247
ISSN: 2987-5889 (Media Online)
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Lettuce plants also have benefits for the therapeutic treatment of various types of diseases because they contain anthocyanin pigments that are useful as antioxidants that can damage cells in the body[2]. As people become more aware of this, they are beginning to carefully choose organic agricultural products over inorganic ones. Organic vegetables contain more antioxidants, 10 to 50% more than inorganic vegetables. This includes . The nitrate content in organic vegetables and fruits is known to be 25% lower than in similar commodities cultivated inorganic[3].

The use of organic goat manure fertilizer has a high nitrogen content, and organic fertilizer derived from goat manure has a sufficiently high nitrogen (N) and potassium (K) content. The nutrient composition of this fertilizer includes 2.10% nitrogen, 0.66% phosphorus (P_2O_5), 1.97% potassium (K_2O), 1.64% calcium (Ca), 0.60% magnesium (Mg), 233 ppm manganese (Mn), and zinc (Zn) 90.8 ppm[4]. However, goat manure has a fairly high potassium content, which can reach 519.07 ppm. This high potassium content can help stimulate the growth of vegetables, flowers and fruits. In addition to playing an important role in the formation of proteins and carbohydrates, potassium also contributes to the formation of antibodies, making plants more resistant to disease[5]. Goat manure can also be used as manure to help fertilize the soil. In addition, processing this manure into fertilizer can also reduce air pollution caused by pungent odors that have the potential to damage the surrounding environment. On the other hand, goat manure itself contains nutrients such as nitrogen (N), phosphorus (P), and potassium (K). Nitrogen stimulates overall plant growth, phosphorus aids root development, while potassium strengthens the plant structure so that leaves, flowers, and fruits are more resistant to falling off[6].

The community generally uses solid goat manure as environmentally friendly organic fertilizer for plant growth. It should be noted that liquid organic fertilizer can generally be defined as fertilizer obtained through the fermentation of organic materials. Experts consider organic fertilizer to be fertilizer derived from animals or plants that have undergone fermentation. Several studies also explain that liquid organic fertilizer is a solution-based fertilizer containing various nutrients as a result of the decomposition of organic materials. According to Hadisuwito (2012), liquid organic fertilizer has several advantages over solid fertilizer, namely that it can immediately address nutrient deficiencies, does not experience nutrient leaching, is able to quickly provide nutrients to plants, contains binding agents that allow for direct absorption by plants, and contains certain substances such as microorganisms that are rarely found in dry solid organic fertilizer[7]. Applying a concentration of 5 ml of POC per 5 liters of water per polybag provides the best chlorophyll content at 15 days after planting[8]. Goat manure liquid fertilizer itself contains one or more components that can provide nutrients needed for plant growth. Additionally, its ease of dissolution is a distinct advantage for its use. The use of liquid fertilizer can also help minimize nutrients quickly, compared to solid fertilizers[9]. Goat manure also contains protein in the range of 36-57%. Protein is an important nutrient for plant growth and development. The crude fiber content in goat manure is usually low, ranging from 0.05-2.38%. Crude fiber helps improve soil structure and increase water retention. The water content in goat manure varies, ranging from 24-63%. High water content allows goat manure to easily decompose and be absorbed by the soil. The potassium content in goat manure ranges from 0.9-5%. Potassium content itself is very important for increasing soil fertility and can help maintain stable soil pH. The phosphorus content in goat manure ranges from 1-1.9%. Phosphorus is an important nutrient for root growth, flowering, and fruit formation in plants. In addition, goat manure also contains other nutrients such as nitrogen (N), potassium (K), and other nutrients necessary for optimal plant growth and development. Thus, the use of goat manure as organic fertilizer can provide the nutrients needed by plants and improve soil fertility[10]. Manure itself also has various benefits depending on the type. One of the benefits is that goat manure POC can be used to minimize the use of chemical fertilizers, which are currently widely used. The quality of goat manure POC is also no less good than that of chemical fertilizers, both of which produce crops of equally good quality. Goat manure POC also has a lower C/N ratio (below 20), and it is indeed better if it is composted first before use to avoid too rapid decomposition and loss of nutrients that are beneficial to plants[11].

In addition to using liquid organic fertilizer, this study will also use charcoal biochar. Biochar is an organic fertilizer material that can be utilized as biomass from farmers that has not been properly utilized, one of which is rice husks. Rice husks can be used as a material for making biochar. Biochar is a material rich in carbon with a very stable structure that is resistant to degradation. Its organic part contains high amounts of carbon, while its inorganic part consists of various minerals such as calcium (Ca), magnesium (Mg), potassium (K), and inorganic carbonates (carbonate ions)[12]. It is hoped that the addition of solid organic fertilizer biochar and liquid organic fertilizer animal manure ( ) will improve growth and yield, and that the optimal concentration combination of biochar and animal manure liquid fertilizer for romaine lettuce can be found. Rice husks, which are waste from the rice milling process, account for about 20-23% of the total rice. This waste has great potential to be processed into husk charcoal biochar to increase the nutrient content in plants. Husk charcoal biochar is known to improve soil quality and function as a soil conditioner. The application of biochar to agricultural land can increase soil carbon content, water retention capacity, and nutrient availability. According to Gani (2009), another advantage of rice husk biochar is its stable carbon content, which can be stored in the soil for thousands of years. Rice husk biochar also provides 0.13% nitrogen, approximately 34.81 ppm of available phosphorus, and a maximum

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potassium content of 0.90%. In addition, rice husk biochar also provides the highest cation exchange capacity (CEC), which is 29.27 me/100 g[13]. The application of rice husk biochar can increase the availability of P, K, Ca, and Mg in the soil. Rice husk charcoal biochar also contains nutrients such as organic C (20.93%), N (0.71%), P (0.06%), and K (0.14%). Thus, when applied to the soil, it will provide optimal plant growth[14]. The application of 40 t/ha of biochar is the best dose[15]. Some of the benefits of rice husk charcoal biochar for the soil include helping to make the soil looser, so that plant roots can absorb nutrients more efficiently. In addition, the soil can better retain moisture and provide sufficient air and nutrients around the root zone.The presence of fine pores in rice husk biochar is also very effective in absorbing and binding nutrients, so that nutrients are not easily dissolved and lost during the watering process. In addition, burnt husks also have a fairly high pH, between 8.5 and 9, so they can help neutralize overly acidic soil and improve soil pH conditions. Biochar from husks is also capable of absorbing toxins and inhibiting the spread of disease around plant roots, making plants more resistant to pests and diseases. Rice husk biochar can also be used to improve soil conditions that have been degraded by excessive use of chemicals and can help restore soil fertility gradually[16].

Rice husk waste has great potential as an effective planting medium. One of the main advantages of using rice husks is their ability to improve soil structure, as husks can improve soil aeration and porosity. This helps plant roots grow healthier and develop better because they can easily find the oxygen and water they need. In addition, rice husks also have the ability to retain water well without becoming too saturated, which is very important for maintaining soil moisture balance. Thus, rice husks can provide optimal conditions for plants, as they support stable water and nutrient availability for plants[17].

In this study, there are two problems to be solved: how does the combination of rice husk biochar and goat manure affect the growth and yield of romaine lettuce? This study aims to determine the effect of the combination of rice husk biochar and goat manure on the growth and yield of romaine lettuce. Based on the above description.

2 Methods

This study was conducted on experimental land located in Tebel Barat village, Gedangan sub-district, Sidoarjo district, at an altitude of about 25 meters above sea level. This area has a temperature range of 21-34°C and an average rainfall of 1,300-1,700 mm per year. In addition, the agrotechnology laboratory of Muhammadiyah University Sidoarjo was also used in this study. The study was conducted from July to September 2024. The materials used in this study were romaine lettuce seeds, goat manure, husk charcoal, EM4, molasses, soil, and water. The tools used were black polybags measuring 15 cm x 30 cm, containers/barrels, measuring cups, scales, rulers, writing instruments, label paper, mobile phones, sacks, and trowels. This study used a randomized block design with two treatment factors. The first factor involved the application of charcoal husk planting media consisting of 3 levels, namely Biochar Charcoal Husk 0g (M0), Biochar Charcoal Husk 29g (M1), Biochar Charcoal Husk 147g (M2). The second factor was the concentration of goat manure liquid organic fertilizer with 3 levels, namely: Liquid Organic Fertilizer from Goat Manure 1ml/5lt Water (K1), Liquid Organic Fertilizer from Goat Manure 3ml/5lt Water (K2), Liquid Organic Fertilizer from Goat Manure 5ml/5lt Water (K3). The treatment was repeated 3 times, resulting in 27 experimental units.

The research began with the production of rice husk biochar. The process started with making a chimney and lighting a fire with fuel such as paper, firewood, or dry leaves. Next, rice husks were piled around the fire and gradually raised. This process lasted for 20-30 minutes or until all the rice husks turned black. When the husks turn black, the burning process is stopped and water is sprinkled evenly over them. This prevents the rice husks from turning to ash. After that, the charcoal pile is dried and put into sacks for storage in a dry place. By following these steps, rice husk burning can be carried out efficiently and safely[18]. According to Kusuma (2013), husk charcoal contains minerals that are very useful in improving the quality of the planting medium, especially in terms of improving drainage. Some of the special characteristics of husk charcoal that make it suitable as a planting medium mixture include good drainage, which allows husk charcoal to have a large pore structure, enabling water to seep through well. This helps prevent waterlogging, which can cause excess water accumulation in the growing medium. Although rice husk charcoal itself does not contain many nutrients, it can act as a reservoir for additional nutrients added to the growing medium. This helps in providing the right nutrients for plants. Rice husk charcoal also has the ability to balance soil pH, making it more neutral. This is important because optimal soil pH allows plants to absorb nutrients more efficiently. By adding charcoal to growing media with poor drainage, you can help improve the quality of the growing media, allowing plants to grow healthier and more optimally[19]. After that, before being transferred to polybags, romaine lettuce seeds must first be sown in a seedling tray. Seed sowing is carried out using a seedling tray for three weeks. The planting medium used for the sowing and planting stages consists of a mixture of soil and charcoal in a 1:1 ratio[20]. Then, the mixture is stirred until evenly mixed, then put into 15 cm x 30 cm polybags. This planting medium is prepared one week before planting. Planting is done after the lettuce plants are three weeks old after sowing (MSS), by transferring the seedlings from the seedling tray to the polybags. The seedlings are transplanted carefully along with the growing medium so that the root system is not damaged[21]. Planting is then carried out when the romaine lettuce seedlings are 3 weeks old or

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have 4-6 leaves and is done in the morning or afternoon. Before the seedlings are removed, the sowing medium is watered first to make it easier to remove the seedlings without damaging the roots. The seedlings are then transplanted into 15 cm x 30 cm polybags. Make sure the polybags are labeled to facilitate identification of the plants that will be planted in them. Ensure that the planting medium is evenly distributed throughout the polybag. Once the planting medium is fully filled, the polybag is ready to be used for planting the desired seedlings. By carefully preparing the planting medium, you can ensure that the plants will have an optimal environment to grow and develop well. Each polybag should contain one romaine lettuce seedling. After that, watering and maintenance are carried out. In addition to watering and caring for the romaine lettuce seedlings, maintenance is also necessary to ensure that the seedlings grow well, by fertilizing, weeding, and cleaning weeds[22].

After the biochar husk charcoal production process is complete, the following steps must be taken to prepare the planting medium: Prepare all the necessary planting medium ingredients, such as soil and biochar husk charcoal, according to the needs of the plants to be grown. Mix all the planting medium ingredients evenly in proportions appropriate to the needs of the plants. Once all the ingredients are well mixed, put the planting medium mixture into prepared 15cm x 30cm polybags. Continue with the production of goat POC (liquid organic fertilizer). Goat POC is a type of organic fertilizer made from natural ingredients, including animal manure. The following are the steps for making goat manure POC based on the ingredients mentioned, including 5 kg of goat manure, 10 liters of water, 100 cc of EM4 (Effective Microorganism), 250 g of granulated sugar, a plastic drum/container, a scale, and a bucket. The steps for making it are to weigh 5 kg of goat manure using a scale. Put the goat manure into the plastic drum. Then pour 10 liters of water into the plastic drum/container containing the goat manure. Add 100 cc of EM4 to the mixture of goat manure and water. Then mix the goat manure, water, and EM4 evenly using a mixer or by mixing manually. Then add 250 g of granulated sugar to the mixture. Stir the mixture again evenly until the sugar dissolves in the mixture. Close the plastic drum tightly and let the mixture ferment for several weeks (usually about 2-3 weeks). After the fermentation process is complete, POC can be used as liquid organic fertilizer for plants. It is important to remember that one of the commonly used activators is Effective Microorganism 4 (EM4), which is a mixture of microorganism cultures that are beneficial for plant growth. EM4 can also be used as an inoculant to increase the diversity and population of microorganisms in the soil[23]. The next process is planting. Planting is carried out when the romaine lettuce seedlings are 3 weeks old or have 4-6 leaves and is done in the afternoon. Before the seedlings are pulled out or removed, they are first selected to obtain uniform seedlings that are free from pests and diseases. Then, the seedling medium is watered first to make it easier to remove the seedlings without damaging the roots. The seedlings are then transplanted into 15 cm x 30 cm polybags. Make sure the polybags are labeled to facilitate identification of the plants that will be planted in them. Gently press the planting medium mixture so that it is not too loose in the polybag. Ensure that the planting medium is evenly distributed throughout the polybag. Once the planting medium is fully filled, the polybag is ready to be used for planting the desired seedlings. By carefully preparing the planting medium, you can ensure that the plants will have an optimal environment to grow and develop well. Each polybag should contain one romaine lettuce seedling. After that, continue with watering and care after the planting process. There are four main factors in care, namely watering, weeding, fertilizing, and pest control. Watering is done twice a day, in the morning and afternoon, regularly and in sufficient amounts depending on the moisture content of the medium in the polybag. Thinning is done if there are plants that die or grow abnormally after one week of transplanting, after the plants have been prepared in advance. Fertilization is carried out by sprinkling/watering, with the concentration adjusted according to the treatment, namely 1 ml/5 liters of water, 3 ml/5 liters of water, and 5 ml/5 liters of water. Liquid organic fertilizer from goat manure is applied when the plants are 14 days old, 21 days old, and 28 days old[25]. Pest control is carried out manually, using natural pesticides, or mechanically. Weeding is done mechanically at all times.

The final process is harvesting, which involves pulling up the entire romaine lettuce plant. Harvesting of romaine lettuce is done at the right time to maximize results, namely at 35 days after planting (DAP), because at that time the romaine lettuce plants have reached the optimal condition for harvesting, with certain physical characteristics such as mature leaves that are dark green in color and wavy leaves with a stiffer and firmer texture. Harvesting is done by tearing the polybag, then cleaning the plant from the growing medium[26]. After that, the plants can be prepared for the next process. The variables observed include plant height (cm), number of leaves (pieces), root length (cm), wet weight (g), and dry weight (g). All data from the observations are processed using analysis of variance. If there are significant or very significant differences in the results, they are followed up with a Honest Significant Difference (HSD) test.

3 Results and Discussion

3.1 Plant Height

Based on the results of the analysis of variance, there was no interaction between the effects of biochar charcoal husk growing medium and goat manure POC on the plant height observation variable.

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Vol 3, Issue 1, March 2025, Page 237-247
ISSN: 2987-5889 (Media Online)
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Table 1. Average Effect of Biochar Charcoal Husk Growing Medium and Goat Manure POC on Lettuce Plant Height Romaine

Treatment	Plant Height (cm^2)				
	7 days after sowing	14 days after sowing	21 days after sowing	28 days	35 days
Biochar 0g (M0)	15.47 c	20.77 c	30.40	51.80	66.43
Biochar 29g (M1)	14.07 b	18.60 b	28.00	51.23	60.20
Biochar 147g (M2)	11.67a	15.10a	25.67	44.00	56.93
BNJ 5%	1.59	1.43	tn	tn	tn
POC Goat 1 ml/5 L water (K1)	11.33a	16.50a	33.33	54.17	67.30 c
POC Goat 3ml/5L water (K2)	11.00a	16.40a	25.07	48.47	61.13 b
Goat POC 5ml/5L water (K3)	15.00 b	21.57 b	25.67	44.40	55.13a
BNJ 5%	1.14	1.43	tn	tn	2.97

Note: Numbers accompanied by the same letter in the same column indicate a significant difference (SD 5%).
ns = not significant

The analysis of variance in Table 1 shows that the increase in plant growth in the height of romaine lettuce plants using goat manure POC and a mixture of biochar and rice husk charcoal as planting media experienced significant changes, from an average age of 7 days after sowing (DAS) and 14 DAS, while plant height in the goat manure POC and rice husk charcoal biochar mixture treatments at 21, 28, and 35 days after sowing showed no significant change. Then, at 35 days after sowing, plant height using goat manure POC showed a significant change. Table 1 also shows data as displayed in the table that biochar charcoal husk with a dose of 0g produced the best plant growth, namely 66.43 cm, while the application of biochar charcoal husk with a dose of 147g showed the lowest plant growth, namely 11.67 cm. Meanwhile, the goat manure POC treatment at 1 ml/5 produced the best plant growth at 67.30 cm, while the goat manure POC treatment at 3 ml/5 produced the lowest plant growth at 11.00 cm.

3.2 Number of Leaves

Based on the results of the analysis of variance, there was no interaction between the effects of biochar charcoal husk and goat manure POC on the variable of total number of leaves.

Table 2. Average Effect of Biochar Charcoal Husk and Goat Manure POC on the Number of Leaves of Romaine Lettuce Plants

Treatment	**Number of Leaves**				
	7 days after sowing	**14 days after sowing**	**21 days after sowing**	**28 days after sowing**	**s 35 days after sowing**
Biochar 0g (M0)	12.00	28.50	27.00	36.00	50.70
Biochar 29g (M1)	11.00	31.00	21.70	38.30	51.00
Biochar 147g (M2)	10.30	25.50	28.70	39.00	57.00
	tn	**tn**	**tn**	**tn**	**tn**
POC Goat 1ml/5L water (K1)	11.30	17.00a	27.00	39.00 c	56.00
Goat POC 3ml/5L water (K2)	11.00	18.70 b	24.30	40.30	53.30a
Goat POC 5ml/5L water (K3)	11.00	21.00 c	26.00	34.00	49.30 b
BNJ 5%	**tn**	**0.97**	**tn**	**11.62**	

Note: Numbers accompanied by the same letter in the same column indicate a significant difference (BNJ 5%). tn = not significant

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From the data in Table 2, the number of leaves was counted when the plants were 7 hst to 35 hst old. As shown in Table 2, the biochar charcoal husk growing medium treatment at all observation ages showed insignificant results. Table 2 also shows that the treatment without biochar charcoal husk obtained the lowest results in each observation. Meanwhile, at 21, 28, and 35 days after planting, the biochar charcoal husk 147g growing medium treatment obtained the highest results, namely 28.70, 39.00, and 57.00, respectively. The effect of goat POC at 7, 21, and 28 days after planting showed no significant effect, while at 14 and 35 days after planting, there were significant results, and at 35 days after planting, the highest results were observed in the goat POC treatment at a dose of 1 ml/5 L of water, with an average number of leaves of 56.00. The lowest result was observed in the goat POC treatment at a dose of 3 ml/5 L water, with an average number of leaves of 11.00.

3.3 Root Length

Based on the results of the analysis of variance, there was no interaction in all observations of the root length variable with the effect of the mixture of biochar charcoal husk and goat manure POC growing media.

Table 3. Average Effect of Growing Medium and Goat Manure POC on the Root Length of Romaine Lettuce Plants

Treatment	Root Length (cm)
Biochar 0g (M0)	30.37
Biochar 29g (M1)	32.80
Biochar 147g (M2)	37.67
	tn
Goat manure 1ml/1L water (K1)	32.13
Goat POC 3ml/1L water (K2)	33.47
Goat POC 5ml/1L water (K3)	35.23
	tn

Note: tn = not significant

The data in Table 3 shows that the root length in the biochar charcoal husk growing medium treatment was relatively similar, ranging from 30.37 cm to 32.80 cm, but the root length was influenced by the appropriate treatment, as seen in the biochar charcoal husk growing medium M0/0g, which obtained the highest result of 37.67 cm. Root length showed no significant effect on goat POC application, which produced the highest root length in the K3/goat POC 5ml/5L treatment with an average result of 35.23 cm and the lowest result in the K1/goat POC 1ml/5L treatment with an average of only 32.13 cm.

3.4 Fresh Weight and Dry Weight

Based on the results of the analysis of variance, there was no interaction in all observations of the wet weight and dry weight variables with the influence of biochar charcoal and goat POC planting media.

Table 4. Average Effect of Biochar Charcoal Husk and Goat Manure POC Growing Media on the Wet Weight and Dry Weight of Romaine Lettuce Plants

Treatment	Wet Weight (g)	Dry Weight (g)
Biochar 0g (M0)	34.6	11.17
Biochar 29g (M1)	32.07	7.80
Biochar 147g (M2)	38.87	10.07
	tn	tn
POC Goat 1ml/5L water (K1)	32.37	10.10
Goat POC 3ml/5L water (K2)	39.40	10.53
Goat POC 5ml/5L water (K3)	33.77	8.40
	tn	tn

Note: n.s. = not significant

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The data in Table 4 shows that the effect of biochar charcoal husk growing media on wet weight is insignificant, as is the effect on dry weight. The dry weight of biochar charcoal husk growing media treatment is also insignificant. In terms of wet weight, the biochar charcoal husk growing medium treatment with a concentration of 147g had the highest average of 38.87g, while the lowest result was obtained from the biochar charcoal husk growing medium treatment with a concentration of 29g, which yielded 32.07g. Meanwhile, the dry weight data showed relatively similar average results, ranging from 7.8g to 11.17g. In the goat POC treatment, both wet and dry weights had no significant effect, with wet weights ranging from 32.37g to 39.40g and dry weights ranging from 8.4 to 10.53g.

3.5 Harvest Index

Based on the results of the analysis of variance, there was no interaction between all observations of the harvest index variable and the effects of biochar charcoal husk and goat manure POC growing media.

Table 5. Average Results of the Effect of Biochar Charcoal Husk and Goat Manure POC Growing Media on the Harvest Index of Romaine Lettuce.

Treatment	Harvest index
Biochar 0g (M0)	0.72
Biochar 29g (M1)	0.66
Biochar 147g (M2)	0.76
	tn
Goat manure 1 ml/5 L water (K1)	0.74
Goat POC 3ml/5L water (K2)	0.72
POC Goat 5ml/5L water (K3)	0.68
	tn

Note: tn = not significant

The data in Table 5 shows that the results of applying biochar charcoal planting media at a dose of 147g showed the best results, namely 0.76. Meanwhile, in the treatment of 1ml/5L water, the application of goat manure POC concentration showed the highest results, namely 0.74, while in the treatment of 29g biochar charcoal showed the lowest results, namely 0.66. Meanwhile, the lowest result for goat manure POC was found in the 5ml/5L water treatment, which produced a result of 0.68.

3.6 Discussion

The data on plant height shows that plant height growth was obtained from the observation phase of measurements every week. in this case, it can be concluded that biochar husk charcoal combined with goat POC has a significant effect on the growth of romaine lettuce in the early growth phase or at 7 and 14 days after planting. This is because biochar husk charcoal and goat POC planting media can increase the availability of nutrients in the soil, thereby supporting the metabolic process of growth and development of romaine lettuce. According to Tapubolon (2012), plants require nutrients during their growth and development in order to grow and reproduce well[27] . Meanwhile, the results of observations of plants at 21 and 28 days after planting showed no significant effect because the interaction between the two treatments did not work well due to their different mechanisms of action. Each factor was more prominent on its own in significantly influencing plant physiological activity. As stated by Kartasapoetra and Sutejo (2000), if one factor is stronger, the other factor will be overshadowed[28] . Significant differences occurred at 35 days after planting in the goat POC treatment. According to Aziz (2006) in the study[29] , one of the causes of plant height growth is the division and elongation of cells in plants, which is dominated at the tips of the shoots. This process is a protein synthesis process obtained by plants from the organic soil environment and the addition of organic materials containing N nutrients, which can affect the total N content that can help activate plant cells to maintain the photosynthesis process that can have a significant effect on the rate of plant height growth.

In the observation results, the early growth phase of the plants experienced slow growth at the beginning. According to Sukarman (2012), this was due to the use of a planting medium composition with animal manure fertilizer doses that did not interact with the growth and yield of lettuce plants. The treatment of the planting medium composition with animal manure fertilizer doses had no significant effect on the number of plant leaves.

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ISSN: 2987-5889 (Media Online)
DOI: https://doi.org/10.58905/demeter.v3i1.692

The interaction did not occur, presumably because the two treatments did not support the improvement of plant growth and yield. This could also be due to the slow rate of photosynthesis and nutrient absorption by the plants[30] . An increase in the number of leaves using a combination of soil, charcoal husk, and goat manure as the planting medium provides sufficient nutrients to meet the needs of the plants, thereby stimulating growth and physiology in the plants when the leaves have matured, and increasing the transfer of mineral nutrients and amino acids. An increase in the amount of nitrogen in the soil produces large amounts of nitrogen nutrients in plants, thereby increasing plant tissue growth. The addition of goat manure and charcoal to lettuce plants can increase the required nitrogen content, thereby increasing the number of leaves. This may also be due to the fact that each lettuce variety has a different response to the components of and lettuce growth. In addition, romaine lettuce plants themselves also have differences in terms of leaf growth. Romaine lettuce tends to have more leaf growth than other types of lettuce plants. This is because each lettuce plant has different genetics. This is also supported by the opinion of Nur and Thohari (2005), who stated that the variation in romaine lettuce is caused by genetic and environmental factors[31] .

This also occurred in the results of the analysis of variance, which showed that the addition of husk charcoal media had a significant effect on the root length (cm) of the plants. This is because the roots of plants with fibrous roots spread into the media and partly down into the media, as well as environmental factors such as media atmosphere, media pH, media temperature, media physical condition, and media humidity. Charcoal husks themselves have many pores that can increase aeration, as well as high porosity, so that charcoal husk planting media are more crumbly. This property is thought to make it easier for roots to penetrate the media and increase the area of root elongation, as well as accelerate root development. According to Hanafiah (2007), the particles found in organic matter are the components of pore space that function as a source of water and air, and can also be used as space for roots to penetrate, because the more pore space there is, the more the root system can expand so that the root system can more easily absorb nutrients and water in the soil. However, the less pore space there is, the less the plant's root system will develop. According to Islami and Utomo (1995) in their study "[32] ," the results of the analysis of variance showed that the application of goat POC had no significant effect due to the soil mixture not being too loose. It was also explained that the growth of plant root length is influenced by nutrients, water, and soil. The more nutrients that can be absorbed by plants, the longer the growth will be. The application of goat POC not only adds nutrients to the soil but also plays a role in improving the physical, chemical, and biological properties of the soil. Loose soil with good aeration can stimulate plant root growth. According to AAK (2007), loose soil makes it easier for roots to penetrate the soil, allowing them to grow rapidly[33] .

Biochar charcoal husk planting media is known to have good porosity, making it easy to absorb water. However, this media also loses water easily, so the nutrients provided cannot be stored longer in the media. Therefore, watering is a key component in helping plant tissue formation and greatly influences plant growth and development. Thus, lower water availability will inhibit plant growth and reduce water content in plant tissue[34] . According to Aji Saputra (2017), water availability in white beans given rice husk charcoal was higher than in the control treatment (without charcoal). This is because rice husk charcoal can reduce evaporation, while evaporation occurs in all treatments under the same temperature conditions[35] . According to the research by Arlen & Fauzana (2019), plant dry weight is an indicator of plant nutritional status because plant dry weight depends on the number of cells, the size of the cells that make up the plant, which generally consist of 70% water, and with water drying, dry matter in the form of organic substances is obtained[36] .

According to Saepuloh et al. (2020), to achieve optimal wet weight, plants still require a lot of energy and nutrients so that the increase in cell number and size can be achieved optimally and allow for an optimal increase in water content in plants. This is also supported by the statement of Pamuji et al. (2018) in Siti Aisyah's (2024) research that the availability of nutrients that can be absorbed by plants is one of the factors that can affect the increase in plant productivity. According to Evanita et al. (2014), goat manure contains complete macro and micro nutrients. The pores in manure can retain more water and nutrients, thereby improving the physical properties of the growing medium. According to Hertos (2015), soil pH can have a positive effect on plant height, dry weight, and number of leaves. The application of goat manure can be supplemented with rice husk charcoal[37] .

This is also due to the influence of different fertilizer doses, which cause increased growth in crop yields. The effects of goat manure POC fertilizer and biochar husk mixture show equally good results and no significant differences, as both have sufficient nitrogen and phosphorus nutrient content. This is in line with the opinion of Puspadewi et al. (2016) that nitrogen and phosphorus nutrients play a very important role in determining the harvest index produced by the plant. He also states that nitrogen nutrients can increase the number of leaves, widen the leaves, enlarge the stem diameter, and lengthen the stem so that it will increase the weight of the plant. The harvest index itself depends on the growth period of a plant. The harvest index can also affect the slow and rapid growth of plants. This is in line with the opinion of Wahyudin et al. (2015) that the value of a harvest index is highly dependent on the duration and relative growth rate before and after the fruiting period, which is influenced by genetic and environmental factors[38] .

4 Conclusion

Based on the results obtained from this study, it can be concluded that the type and concentration of treatment of the mixture of biochar charcoal husk and goat manure POC did not interact with all plant yield variables. Significant differences were observed in the variables of plant height at 7, 14, and 35 days after sowing and in the number of leaves at 14 and 35 days after sowing. The treatment with biochar charcoal ash at a concentration of 0g showed the best results, while the treatment with 1ml/5L of goat manure POC produced the best plants.

Acknowledgments

Praise and thanks be to Allah SWT for His mercy, guidance, and grace, enabling the researcher to complete this final project successfully. On this occasion, the researcher would like to express gratitude to:

a. Iswanto, ST., M.MT., Dean of the Faculty of Science and Technology, Muhammadiyah University of Sidoarjo.
b. The Head of the Agrotechnology Study Program at Muhammadiyah University Sidoarjo.
c. Friends and fellow colleagues.

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