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MORALITY BEFORE KNOWLEDGE

Effect of coconut waste and chicken manure on the growth and yield of caisim (*Brassica juncea* L)

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ABSTRACT
Background: Coconut waste and chicken manure present innovative solutions for enhancing the growth and yield of caisim crops. Cocopeat is one of the organic growing media that is increasingly popular in modern horticultural cultivation. Utilizing coconut waste as a planting medium improves aeration and water retention, both of which are crucial for the development of caisim roots. **Methods:** This study used a randomized group design with five soil treatments to evaluate caisim growth. Parameters included plant height, leaf number, biomass, and soil nutrient content, analyzed using ANOVA and DMRT. **Findings:** The study revealed that the P3 treatment (soil:cocopeat:chicken manure = 1:1:1) produced the tallest caisim plants, highest leaf number, and greatest fresh weight. Nutrient balance and organic matter improved plant growth, transpiration, and stomatal conductance, while excessive nitrates and pH deviations reduced leaf formation. Total dissolved solids and electrical conductivity positively correlated with growth, highlighting the importance of balanced planting media for optimal vegetative development and biomass accumulation. **Conclusion:** The results revealed that the composition of the planting medium significantly influenced morphological growth, nutrient content, and the correlation between various growth parameters of caisim plants. **Novelty/Originality of this article:** The treatments P3 (soil: cocopeat: chicken manure in a ratio of 1:1:1) and P4 (1:2:1) yielded the best outcomes, resulting in increased plant height, fresh weight, and nutrient content, including nitrogen, phosphorus, and potassium. Additionally, these treatments produced optimal Total Dissolved Solids (TDS) and Electrical Conductivity (EC) values, which are essential for effective nutrient absorption.

KEYWORDS: caisim; coconut waste; chicken manure; growth; yield.

1. Introduction

The use of coconut waste and chicken manure is an innovative and convincing solution to increase the growth and yield of caisim (*Brassica juncea* L) plants. Coconut waste, such as fibers and shells, is often overlooked, even though it is used as a planting medium with physical and chemical properties supporting plant growth. Using coconut waste as a planting medium can improve aeration and water retention, which is important for the growth of caisim roots (Vieira et al., 2024). Coconut waste is used as cocopeat. As a planting medium, cocopeat has the advantage of storing and binding water strongly; it also contains essential nutrients plants need (Soerya et al., 2020).

Cocopeat is one of the organic growing media that is increasingly popular in modern horticultural cultivation. Cocopeat is a fine powder by-product of coconut fiber processing that has high water absorption ability, good aeration, and is environmentally friendly

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because it comes from abundant agricultural waste (Putra, 2025). According to Ruli et al. (2023), cocopeat is produced through the process of destroying coconut coir so that it produces a fine powder that is excellent for use as a planting medium because it is able to store large amounts of water, maintain moisture, and provide essential nutrients such as calcium, magnesium, potassium, sodium, and phosphorus. The use of cocopeat as a planting medium not only helps reduce coconut waste but also provides an efficient and sustainable alternative to planting media. The advantage of cocopeat also lies in its ability to maintain aeration and soil structure, so that plant roots can grow optimally and not dry out easily (Ruli et al., 2023). Recent research has shown that cocopeat is highly effective as the primary growing medium for a variety of vegetable crops, including caisim *(Brassica juncea* L.). Cocopeat enhances plant growth and yield due to its physical properties that support root development, maintain moisture, and facilitate nutrient absorption (Lestari et al., 2024; Putra, 2025). According to Singh et al. (2025), cocopeat as a soil amendment is able to improve the physical, chemical, and biological properties of the soil, increase the availability of nutrients, and stimulate plant growth. Research conducted by Gonzaga et al. (2021) proves that biochar from coconut husk biochar can increase the water use efficiency and biomass of the *Brassica juncea* L. plant, as well as reduce the concentration of heavy metals such as copper in plant tissues. This shows that coconut waste is not only useful as a planting medium, but can also be used for the remediation of polluted soils.

The use of organic fertilizers, such as chicken manure has been shown to increase the growth and yield of caisim plants because manure contains nutrients necessary for plant growth (Marasini et al., 2024). Chicken manure contains nutrients necessary for plant growth. This fertilizer can increase soil fertility and provide the nutrients needed by caisim, thus increasing crop yields. Chicken manure contains macronutrients such as nitrogen, phosphorus, and potassium, as well as microelements needed by plants (Anandyawati et al., 2023). The use of chicken manure can increase soil enzyme activity and plant growth (Asghar & Kataoka, 2022a). Chicken manure still provides benefits to soil health and its biological activity (Asghar & Kataoka, 2022b). The combination of coconut waste and chicken manure can create an optimal planting medium, provide balanced nutrition and support healthy growth. The combination of coconut waste and chicken manure can create a more effective and sustainable planting medium, which is in line with sustainable agricultural goals. According to Chen et al. (2024) the application of chicken manure composted with biochar can improve plant growth and quality, as well as improve the chemical and biological properties of the soil. The combination of chicken manure and biochar has also been shown to increase the activity of soil enzymes and beneficial microbial populations, thereby supporting optimal plant growth. The use of chicken manure and coconut waste as organic fertilizers can also reduce dependence on chemical fertilizers, support sustainable agriculture, and reduce negative impacts on the environment (Charloq et al., 2025). According to Xu et al. (2023) said that the application of chicken manure to *Brassica juncea* can increase the nutrient content of the soil, but it is also necessary to pay attention to the potential for antibiotic residues from chicken manure which can affect the soil microbiome and residue accumulation in plants.

Caisim is a popular green vegetable in Indonesia, known for its nutritional value and health benefits. Caisim (*Brassica juncea* L.) is one of the leafy vegetables that is widely cultivated in Indonesia because of its economic value and high nutritional content. Public demand for healthy and chemical-residue-free vegetable products is increasing, so the use of organic fertilizers is an important alternative in the cultivation of this plant (Pratama et al., 2022). For optimal growth, caisim requires a planting medium that is rich in nutrients and capable of maintaining soil moisture. Coconut waste presents an environmentally friendly and economical alternative as a planting medium. Research has shown that coconut fiber can enhance soil aeration, improve water retention, and provide essential nutrients for plants. Additionally, utilizing coconut waste as a planting medium can reduce the burden of waste and promote sustainable agricultural practices. By incorporating coconut waste into gardening, we contribute to lowering pollution levels and increasing agricultural productivity. In addition, coconut waste is organic waste, according to Jamison et al. (2021)

organic waste can reduce dependence on inorganic fertilizers, improve soil fertility, and reduce environmental pollution.

This research aims to offer new insights into agricultural waste management and encourage the adoption of more environmentally friendly and sustainable farming practices. We hope that our findings will benefit farmers by enhancing productivity while minimizing negative environmental impacts.

2. Methods

2.1 Research site, materials, and experimental design

Our research, conducted from April to June 2025 in South Jakarta and the Laboratory of Ecotoxicology, Waste, and Biological Agents, Faculty of Agriculture, Bogor Agricultural University, Dramaga, Bogor, West Java, aimed to investigate the effects of different soil compositions on the growth of caisim seeds. The materials used in this study are water, caisim seeds, coconut waste (coir), and chicken drum fertilizer. The tools used in this study were office stationery, blenders, basins, hoes, cork, label paper, knife meters, polybags, measuring cups, filters, microscales, ion meters (including Ca^{2+}, Na^{+}, chlorophyll meters, pH meters), cameras, RGB *colour analyzer*, measuring cup, oven, NPK meter, Horiba Laquatwin Na-11 sodium ion meter pocket tester, Horiba Laquatwin K-11 potassium ion meter pocket tester, Horiba laquatwin NO_3^-11C/NO_3^-11S/NO_3^-11, Horiba Laquatwin Ca-11 calcium ion meter pocket tester, TDS/EC/pH/salinity tester, and ruler.

The design used in this study was a Group Random Design (GBD) consisting of five treatments and four replicates. Each treatment consisted of two polybag so we obtained 40 experimental units. The following is the treatment in this study: P1 100% soil, P2 soil: cocopeat: 1:1, P3 soil: cocopeat: chicken manure: 1:1:1, P4 soil: cocopeat: chicken manure: 1:2:1, P5 soil: cocopeat: chicken manure: 1:2:2.

2.2 Media preparation, cultivation, measurements, and data analysis

Cocopeat, a key component in our study, is made from coconut coir that is cut into small pieces, dried, mashed, and filtered until it becomes a ready-to-use planting medium. The soil medium comes from Latosol soil, which is taken at a depth of 20 cm, then dried, sifted, and put into a 5 kg polybag. Caisim seeds are sown for 12 days in trays containing a mixture of soil and compost fertilizer (1:1), then transferred to a polybag with two seedlings per pot after having 2–4 true leaves. Maintenance is carried out by daily watering to field capacity, and weeding is carried out from 17 Days After Planting (DAP) to harvest at 28 DAP. The parameters observed included plant height, number of leaves, fresh weight of plants and roots, and soil N, P, and K content using the NPK meter. A digital tool measured the TDS, EC, salinity, and pH content from the soil solution. The observation data was analyzed using ANOVA, and if there was a real difference, it was followed by a DMRT test at the level of 5%.

3. Results and Discussion

The results revealed that the plant height variables did not show significant differences in the first, second, and fourth weeks after planting. However, the P3 treatment had the highest results, measuring 8.12 cm, 12.62 cm, and 35.20 cm. The P3 treatment notably differed from the other treatments in the third week. The number of leaves in the first week after planting showed no noticeable difference. In the second week after planting, the P3 treatment showed the highest results, and in the fourth week after planting, the P3 treatment demonstrated a significant difference.

The results showed that the height of the plant and the number of leaves in the P3 Treatment (soil: cocopeat: chicken manure = 1:1:1) affected the plant's vegetative growth. A greater number of leaves reflects higher photosynthetic activity, which contributes to the accumulation of plant biomass. The increase in the number of leaves is closely related to the availability of sufficient nitrogen, as nitrogen plays an important role in the formation of chlorophyll. The P3 treatment consistently demonstrated the best results, with plant heights reaching 28.50 cm at 3 WAP and 35.20 cm at 4 WAP, and the highest number of leaves at 17.5 at 3 WAP and 18.5 leaves at 4 WAP. These results underscore the effectiveness of a balanced combination of planting medium, including mineral soil, chicken manure, and cocopeat in enhancing plant growth. This information equips the audience with effective cultivation practices.

Table 1. Effect of treatment on plant height and number of caisim leaves

Treatment	Plant height (cm)				Number of leaves			
	1 WAP	2 WAP	3 WAP	4 WAP	1 WAP	2 WAP	3 WAP	4 WAP
P1	6.37	10.25	19.12b	26.50	3.6	5.8a	9.1b	11.0bc
P2	5.50	9.25	16.87b	18.12	3.5	5.4a	7.6b	9.7c
P3	8.12	12.62	28.50a	35.20	3.7	5.8a	17.5a	18.5a
P4	5.12	8.50	23.62ab	28.25	3.5	5.3a	12.2ab	15.2ab
P5	5.50	8.12	22.62ab	21.75	2.6	3.9b	13.1ab	16.5a
Total average	6.12	9.75	22.15	25.97	3.4	5.2	11.9	14.2
Pr > F	Mean	Mean	*	Mean	Mean	*	*	**

Note: Data followed by the same letter in the same column does not differ significantly based on DMRT level α = 5%. ns) There is no significant difference in the F-test results of the α=0.05 level; *) There is a real difference in the F-level test results of α=0.05: **) There is a significant difference in F-level test results α=0.01; WAP) Sunday after planting

The combination of cocopeat and chicken manure is known to have an important role in improving the quality of planting media. Cocopeat functions to maintain moisture and improve the porosity of the planting medium, while chicken manure supplies macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), which are essential for leaf and stem growth. These findings are following the findings of Yusriani & Tammin (2022), which show that the combination of coconut coir media (cocopeat) and chicken manure significantly increases plant height and leaf count in cayenne pepper plants compared to media without organic fertilizer. The P3 treatment is optimal performance, proved by the results of research by Wasis & Fitriani (2022), which show that planting media made from soil, cocopeat, and manure can increase plant height, stem diameter, and number of leaves in sengon seedlings. They concluded that a balanced proportion of the mixture could improve the physical and chemical properties of the soil and increase the activity of soil microbes that support plant growth.

Despite the P5 treatment (soil: cocopeat: chicken manure= 1:2:2) producing many leaves, namely 13.1 leaves at 3 WAP and 16.5 leaves at 4 WAP, it could not surpass the P3 treatment. The likely cause of this is the excess nutrient accumulation, possibly due to the high content of chicken manure, which can lead to physiological stress, such as high salinity or nutrient imbalances. A similar study by Lamdo et al. (2023) found that excessive chicken manure doses can reduce nutrient absorption efficiency and inhibit green lettuce plants growth. P1 (100% soil) and P2 (soil: cocopeat = 1:1) treatments showed the lowest growth. Planting media in pure soil tends to be dense, less aerated, and has a lower organic content, which does not support root development and optimal nutrient absorption. Research by Sitorus et al. (2024) also showed that using chicken manure on ultisol soil significantly increased the height and number of leaves of sweet corn plants compared to soils without manure, confirming organic matter's importance in supporting plant growth.

Based on the data in table 2, the composition of plant media is proven to have a real influence on the morphological character of caisim plants, especially plant height, number of leaves and fresh weight of plants. The results of statistical tests showed that the treatment had a real effect on the height of the plant and very noticeable on the number of leaves and the fresh weight of the plant. This shows that the caisim growth response is greatly influenced by the availability and balance of nutrients as well as the physical properties of the planting medium.

Table 2. Effect of treatment on the morphological character of caisim

Treatment	Height of the ton (cm)	Number of leaves	Fresh weight of land (g)	Fresh weight of roots (g)
P1	26.50ab	35.5a	46.88bc	4.37
P2	19.75b	9.8c	26.38c	5.75
P3	36.12a	18.5b	132.50a	8.38
P4	32.50a	15.3b	118.25a	9.63
P5	29.50ab	16.5b	102.63ab	4.75
Total average	28.87	19.1	85.32	6.57
Pr > F	*	**	**	Mean

Note: Data followed by the same letter in the same column does not differ significantly based on DMRT level α = 5%. ns) There is no significant difference in the F-test results of the α=0.05 level; *) There is a real difference in the results of the F-level test α=0.05: **) There is a real difference in the results of the F-level test α=0.01

The results of the study revealed that the P3 treatment, a blend of soil, cocopeat, and chicken manure in a 1:1:1 ratio, produced the tallest plants (36.12 cm), followed by the P4 treatment (1:2:1) with a height of 32.50 cm. These two treatments, which significantly outperformed the others, highlight the potential of a planting media mix enriched with organic nutrients to increase plant biomass accumulation substantially. The combination of cocopeat and chicken manure in the P3 treatment is the best combination to increase the fresh weight of the plant. This is in line with the results of research conducted by Kesti et al. (2020) showing that the combination of cocopeat and husk charcoal can increase the fresh weight and chlorophyll content of mustard greens, due to the improvement of the structure of the planting medium and the increase in photosynthesis efficiency. Another study conducted by Marbun et al. (2024) also stated that planting media other than soil, such as cocopeat, is more optimal in supporting the growth of microgreen caisim, especially when combined with organic nutrient sources. Cocopeat plays a role in maintaining the moisture and porosity of the medium, while chicken manure provides the nitrogen necessary for the formation of vegetative tissue and an increase in leaf area.

The advantages of P3 and P4 treatment show the importance of a balance between the chicken manure's nutrients and the cocopeat's water retention ability. The study of Suruban et al. (2022) has strengths; these results, which reported that the use of chicken manure in combination with organic-based planting media can increase nitrogen availability and improve soil structure, have a positive impact on the growth and fresh weight of pakcoy mustard plants. According to Sharma et al. (2025) also confirms that the application of chicken manure and vermicompost can increase the growth and yield of *Brassica juncea*. Chicken manure is known to be a readily available source of nitrogen that is urgently needed by broadleaf plants such as caisim. The P1 treatment (100% soil) yielded the highest number of leaves, 35.5 leaves, but the fresh weight of the plant in this treatment was only 46.88 g. This finding suggests that the number of leaves is not always directly proportional to the plant's total weight. Research by Indriyati (2014) shows that although leaf count growth can occur in the medium without the addition of organic fertilizers, biomass accumulation remains lower if sufficient amounts of nitrogen are not available. The P2 treatment (soil:cocopeat = 1:1) showed the lowest results on almost all parameters, including plant height (19.75 cm), number of leaves (9.8 leaves), and fresh plant weight (26.38 g). This reveals that the use of cocopeat without additional organic nutrients causes the planting medium to be relatively poor in macroelements, especially nitrogen and phosphorus, which are essential for the formation of plant vegetative tissues. Another study conducted by De Side et al. (2022) showed that cocopeate media does not contain enough nutrients for optimal plant growth so it needs the addition of fertilizer to achieve the expected growth, nitrogen and phosphorus levels in cocopeat are significantly lower than fertilizer-enriched media, So it is necessary to mix nutrient sources to meet the nutritional needs of plants.

Table 3. Correlation between nutrient content component variables and caisim morphological character

Nutritional content	Morphological characters			
	Plant height (cm)	Number of leaves	Plant weight (g)	Weight of roots (g)
TDS	0.53*	-0.52*	0.60*	0.55*
EC	0.60*	-0.32tn	0.70**	0.58*
PH	0.13tn	-0.73**	0.30tn	0.23tn
N	0.40tn	0.00tn	0.33tn	0.27tn
P	0.40tn	-0.05tn	0.34tn	0.25tn
K	0.42tn	-0.01tn	0.33tn	0.30tn
NO_3	-0.69**	-0.53*	-0.53*	-0.38tn
Ca	-0.24tn	-0.69**	-0.14tn	-0.05tn
Na	0.48tn	-0.28tn	0.59*	0.44tn
PAR	0.24tn	-0.11tn	0.45tn	0.54*
PN	-0.13tn	-0.26tn	-0.24tn	-0.20tn
E	0.07tn	-0.19tn	0.33tn	0.24tn
C	-0.10tn	-0.42tn	-0.00tn	-0.17tn
CI	-0.01tn	0.24tn	0.05tn	0.07tn

Note: ns No real effect based on Pearson correlation analysis of α=0.05; *,**) A real effect based on Pearson correlation analysis of α=0.05 and α=0.01, respectively

Based on Table 3, it can be seen that not all nutrient components have a significant linear relationship with the morphological character of the caisim plant. The Total Dissolved Solids (TDS) and Electrical Conductivity (EC) parameters showed a significant positive correlation with plant height, plant fresh weight, and root fresh weight, while NO_3^- showed a significant negative correlation with several growth parameters. This suggests that caisim growth is more influenced by the balance and availability of nutrient ions as a whole than by individual concentrations of certain nutrients. A significant positive correlation between TDS and plant height (r = 0.53), plant fresh weight (r = 0.60), and root fresh weight (r = 0.55) suggests that an increase in the total amount of solutes in the nutrient solution, within optimal limits, is able to support the vegetative growth of caisim. pH values showed only a significant negative correlation to number of leaves, while macronutrients such as N, P, and K showed no significant correlation to morphological character. A positive correlation between TDS and EC with caisim growth was also found by Dewi et al. (2019), who reported that variations in the nutrient concentration of AB Mix and liquid organic fertilizer can significantly increase plant height, number of leaves, and fresh weight of caisim in a hydroponic system. They assert that the increase in EC and TDS within the optimal limit is directly proportional to the morphological growth of the plant. According to Agustina et al. (2024) also showed that nutrient concentration and proper EC regulation in hydroponic NFT systems have a noticeable effect on plant height, number of leaves, and fresh weight of caisim, supporting the finding that EC and TDS are important indicators in hydroponic nutrient management.

The results of the Electrical Conductivity (EC) study showed a significant positive correlation between plant height (r = 0.60), plant fresh weight (r = 0.70), and root fresh weight (r = 0.58). This indicates that electrical conductivity, a measure of nutrient ion availability, significantly affects plant productivity. Nutrient ion availability refers to the concentration of essential nutrients in the soil solution that are readily available for plant uptake. A study by Ding et al. (2018) proved that an increase in EC of up to 4.8 dS/m can significantly increase the fresh weight and area of pakcoy leaves, but growth decreases drastically at EC > 9.6 dS/m due to salt stress. The pH parmeter showed a very significant negative correlation with the number of leaves (r = –0.73), indicating that pH deviations from the optimum range had a direct impact on leaf formation. Tarigan et al. (2021) explained that the pH of the planting medium that is too acidic or alkaline reduces the availability and efficiency of the absorption of macroelements such as nitrogen and potassium which are essential for the division and enlargement of leaf cells in Brassicaceae plants. This is also supported by Marschner (2012), who asserts that pH affects the chemical form and solubility of nutrients in soil and hydroponic solutions.

The NO_3^- (nitrate) content showed a significant negative correlation with plant height (r = –0.69), number of leaves (r = –0.53), and fresh weight of the plant (r = –0.53). The accumulation of nitrates causes this correlation, indicating that plants do not absorb, which can indicate excess nitrogen that causes metabolic imbalances. Zhu et al. (2021) stated that an unbalanced NO_3^-/NH_4^+ ratio can decrease the efficiency of nitrogen use by plants and trigger an excess of ions that can inhibit growth. Research conducted by Novianto et al. (2023), which found that excess nitrogen, particularly in the form of nitrates, can inhibit the vegetative growth of caisim due to an imbalance in the absorption of other nutrients such as phosphorus and potassium. The macro elements N, P, and K individually do not show a significant correlation with the morphological character of the caisim. This shows that plant growth is not only determined by the concentration of one element, but by the interaction and balance between nutrients. Marschner (2012) emphasized that the plant growth response is often more influenced by nutrient balance than absolute levels of certain nutrients, especially in leafy vegetable plants that have a high rate of nutrient absorption.

The element Na^+ ion showed a significant positive correlation with the fresh weight of the plant (r = 0.59), although it was not significant to other parameters. According to Munns and Tester (2008), sodium in low concentrations can act as a partial substituent of potassium in maintaining the osmotic pressure of cells, but in high concentrations it can be toxic. In contrast, Ca^{2+} showed a significant negative correlation with leaf count (r = –0.69), indicating that excess calcium may disrupt the balance of other cations such as Mg^{2+} and K^+ that play an important role in leaf expansion, as described by White & Broadley (2003). The results of this study emphasize that the growth of caisim morphology is not only about the quantity of nutrients, but also about the chemical balance of the planting media solution. Even essential nutrients, if present in excess, can have side effects. These findings underscore the important role of audiences in careful nutrition management and the formulation of planting media that prioritizes the balance of elements over their concentration.

Table 4. Effect of treatment on the nutritional content of caisim

Treatment	TDS	EC	PH	N	P	K	NO_3	Ca	Na
P1	8.33th	18.67d	4.73d	30.67c	113.67c	107.67c	16.67c	213.33c	90.33d
P2	23.33d	43.00c	5.97c	18.00d	87.67p	82.00th	25.00a	256.67a	97.00cd
P3	40.00b	162.67a	5.97c	20.00d	93.33cd	88.33d	16.33c	230.00bc	153.33a
P4	54.67a	117.00b	6.37b	66.00a	199.00a	194.67a	16.33c	233.33b	116.67b
P5	29.00c	53.33c	6.70a	45.00b	160.67b	137.67b	21.33b	260.00a	103.33c
Total average	31.06	78.93	5.94	35.93	130.86	122.07	19.13	238.67	122.13
Pr > F	**	**	**	**	**	**	**	*	**

Note: Data followed by the same letter in the same column does not differ significantly based on DMRT level α = 5%. ns) There is no significant difference in the F-test results of the α=0.05 level; *) There is a real difference in the results of the F-level test α=0.05: **) There is a real difference in the results of the F-level test α=0.01

Based on Table 4, the treatment of planting media had a very significant effect (α = 0.01) on all observed nutritional parameters, including TDS, EC, pH, N, P, K, and NO_3^-, Ca^{2+}, and Na^+ ions. This confirms that the composition of the planting medium plays an important role in determining the chemical dynamics of the media solution and the availability of nutrients for caisim plants. The P4 treatment (soil : coconut powder : chicken manure = 1:2:1) showed the highest values for TDS (54.67 ppm), EC (117 dS/m), as well as N, P, and K content compared to other treatments. According to Tarigan et al. (2021), the Total Dissolved Solids (TDS) and Electrical Conductivity (EC) values reflect the amount of dissolved ions available for root absorption, so they are often used as an indicator of nutrient solution fertility.

The increase in EC in high-organic media reflects the mineralization process of organic matter that results in available ions such as NH_4^+, NO_3^-, $H_2PO_4^-$, and K^+. These findings are in line with the research of Agegnehu et al. (2016) who reported that the application of poultry manure significantly increases the N, P, and K content of the soil due to the low C/N ratio and rapid decomposition rate. The high nutrient content of P4 treatment indicates that chicken manure acts as an effective source of macronutrients, especially nitrogen and phosphorus which are urgently needed in the vegetative growth phase of Brassica plants. Research conducted by Clemente et al. (2005) also showed that the addition of manure and compost was able to increase the availability of nutrients and biomass of *Brassica juncea*, especially in soils with low organic matter content. In the context of this study, the presence of coconut powder and chicken manure in P4 not only increases the cation exchange capacity (KTK), but also improves water retention and nutrient ion stability in the planting medium.

The P4 treatment also produced the highest values for nitrogen (66.00 mg/L), phosphorus (199.00 mg/L), and potassium (194.67 mg/L) content. This rich macronutrient content, as described by Zhu et al. (2021), is closely related to the vegetative growth of plants. Nitrogen and phosphorus, in particular, play an important role in the formation of proteins and ATP, while potassium regulates osmotic pressure and the opening of stomata, thus favoring photosynthesis and biomass formation. This implication arouses the curiosity of researchers and plant scientists. The P2 treatment showed the highest NO_3^- content (25.00 mg/L), but was not followed by high total nitrogen. This indicates the accumulation of nitrates that are not optimally utilized by plants. According to Zhang et al. (2021), an imbalance in the NO_3^-/NH_4^+ ratio as well as the limitation of supporting elements such as Mg^{2+} and S can decrease the efficiency of nitrogen use and lead to the accumulation of nitrates in plant media or tissues. This condition also often occurs in planting media with low organic matter content and limited microbial activity.

The elements calcium (Ca^{2+}) and sodium (Na^+) show an increase as the proportion of organic matter in the planting medium increases, especially in P3, P4, and P5. Ding et al. (2018) stated that increased Ca^{2+} can improve cell wall stability and membrane function, but excess Ca^{2+} has the potential to inhibit the absorption of other cations such as Mg^{2+} and K^+. Meanwhile, Na^+ ions in moderate concentrations are still tolerable to plants, but at high levels they can compete with K^+ and disrupt the ionic balance in the root zone. The results of this study confirm that the nutritional quality of the planting medium is not only determined by the amount of nutrients, but also by the ionic balance and chemical properties of the medium. The combination of soil-based planting media, organic matter, and chicken manure has been proven to be able to create optimal chemical conditions for the growth and absorption of caisim nutrients. These findings reinforce the importance of a balance-based nutrient management approach in leafy vegetable cultivation systems.

Table 5. Effect of treatment on photosynthetic active radiation variables, photosynthesis rate, transpiration rate, stomatal conductance, internal CO^2

Treatment	Photosynthetic active radiation	Rate of photosynthesis	Transpiration rate	Stomatal conductance	Internal CO^2
P1	0.23	-11.16	0.76bc	178.67c	855.2
P2	0.33	6.69	1.03b	300.75b	726.7
P3	0.37	-6.50	1.38a	309.18ab	706.5
P4	0.37	-21.19	0.65c	196.07c	890.4
P5	0.23	7.92	1.05b	387.05a	738.4
Total average	0.31	-4.84	0.98	271.85	788.95
Pr > F	Mean	Mean	**	**	Mean

Note: Data followed by the same letter in the same column does not differ significantly based on DMRT level α = 5%. ns) There is no significant difference in the F-test results of the α=0.05 level; *) There is a real difference in the results of the F-level test α=0.05: **) There is a real difference in the results of the F-level test α=0.01

The results showed that different treatments on the planting medium did not have a significant effect on Photosynthetic Active Radiation (PAR) and Photosynthesis Rate (Pn) (Pr > F tn). However, the Transpiration Rate (E) and Stomatal Conductance (gs) showed significant differences: the highest averages were found in the P3 (E = 1.38) and P5 (E =

1.05) treatments for transpiration rates, and P5 (gs = 387.05 mmol m^{-2} s^{-1}) for stomatal conductance. The result shows that a medium with balanced organic matter and cocopeat improves the efficiency of plants in opening the stomata to CO_2 absorption and the release of water vapor. However, the rate of photosynthesis does not increase significantly. According to Ding et al. (2018), the increase in EC values, which is in line with the increase in the transpiration rate and conductance of the stomata, in pakcoy can increase the efficiency of photosynthesis and stomata activity to the optimum point of EC of around 1.8–2.4 dS/m. Yamori et al. (2020) explain that the interaction between stomatal conductance and photosynthesis rate, which increases stomatal conductance, allows an increase in the rate of photosynthesis under adequate light conditions, even if it does not increase the rate of photosynthesis directly in the short term. According to Zangani et al. (2021), the addition of nitrogen and phosphorus can improve the stomatal conductance and photosynthetic sensitivity of rapeseed plants, supporting the finding that P5, which has a high nutrient content, exhibits the highest stomatal conductance. Although Internal CO_2 showed variation but not significant between treatments, increased E and gs in P3 and P5 improved the plant's ability to exchange gases overall, which is important in stress growing conditions or media with excess water resistance.

The Transpiration rate and stomatal conductance in the P3 treatment resulted in the highest transpiration rate (1.38 mmol m^{-2} s^{-1}), while the highest stomatal conductance was achieved by P5 (387.05 mmol m^{-2} s^{-1}). The increase in these two parameters is generally related to the availability of nutrients, specifically nitrogen and phosphorus. Zangani et al. (2021) asserted that the addition of nitrogen and phosphorus can improve stomatal conductance and photosynthetic response in *Brassica napus*, thus supporting the finding that treatments with high nutrient content (such as P5) are able to improve the efficiency of gas exchange and photosynthesis. Research conducted by Sami & Hayat (2019) also reported that the application of exogenous glucose in *Brassica juncea* increased the rate of photosynthesis, conductance of the stomata, the rate of transpiration, and the concentration of internal CO_2, which contributed to the improvement of the water status of the leaves and the activity of photosynthetic enzymes. In addition, Siddiqui et al. (2022) showed that brassinosteroid applications can improve the efficiency of photosynthesis and conductance of stomata through increased enzyme activity and leaf mineral status.

The rate of photosynthesis and internal CO_2 from the results obtained by the P5 treatment was the highest value and P2 (6.69), while the lowest value was P4 (-21.19). Internal CO_2 tends to be high in treatments with low photosynthesis rates, indicating limitations in the utilization of CO_2 by photosynthetic machines. Taylor et al. (2020) highlight that biochemical and stomatal limitations can limit the rate of CO_2 assimilation, especially when there is a change in light intensity. Shang & Shen (2018) also confirmed that the ammonium or nitrate ratio, light intensity, and water availability greatly influence the rate of photosynthesis, transpiration, stomatal conductance, and internal CO_2 in *Brassica chinensis*.

4. Conclusions

The study results underscore the significant impact of the planting medium's composition on morphological growth, nutrient content, and the correlation between caisim plant growth parameters. Treatments P3 (soil: cocopeat: chicken manure = 1:1:1) and P4 (1:2:1) demonstrate the most promising outcomes in enhancing plant height, fresh weight, and nutrient content, including nitrogen, phosphorus, and potassium. These treatments also maintain optimal Total Dissolved Solids (TDS) and Electrical Conductivity (EC) values, which are crucial for supporting nutrient absorption.

The study identifies the ideal planting medium for caisim growth as the soil composition: cocopeat: chicken manure 1:1:1 found in treatment (P3). This medium plays a crucial role in providing a balanced supply of macronutrients, maintaining a pH close to neutral, and enhancing nutrient absorption efficiency. These factors collectively support vegetative growth and optimal biomass accumulation in caisim plants.

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Author Contribution

Conceptualization, B.S.; Methodology, B.S.; Software, B.S.; Validation, B.S., H.A.; Formal Analysis, B.S., H.A.; Investigation, B.S.; Resources, B.S., H.A.; Data Curation, B.S.; Writing–Original Draft Preparation, B.S.; Writing–Review & Editing, B.S., H.A.; Visualization, B.S.; Supervision, B.S.; Project Administration, B.S., H.A.; and Funding Acquisition, H.A.

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The authors declare noconflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the author(s) used a generative AI tool to assist in paraphrasing certain sections for clarity and Grammarly to assist in improving the grammar and academic tone of the manuscript. After using these tools, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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