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Optimizing the growth of caisim (*Brassica juncea* L.) using rabbit feces fertilizer as an eco-friendly organic alternative

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ABSTRACT

Caisim (*Brassica juncea* L.) is a widely consumed leafy vegetable that requires adequate nutrients for optimal growth. This study aimed to investigate the effect of rabbit manure on the growth of caisim plants, specifically focusing on fresh weight, dry weight, and root length. The experiment was conducted using a Completely Randomized Design (CRD) with five treatments and five replications. Treatments consisted of different soil-to-rabbit manure ratios: P0 (control, no manure), P1 (1:1), P2 (2:1), P3 (3:1), and P4 (4:1). The results showed that the application of rabbit manure significantly affected all three observed growth parameters. The best results were obtained in the P2 treatment (2:1 ratio), which yielded an average fresh weight of 21.902 g, a dry weight of 1.17 g, and a root length of 5.58 cm. These findings suggest that rabbit manure supplies essential nutrients, including nitrogen, phosphorus, and potassium, which contribute to enhanced root development and overall plant growth. The 2:1 ratio was found to offer the most effective nutrient balance for caisim cultivation. The implication of this study is that rabbit manure can serve as an environmentally friendly and effective organic fertilizer alternative to chemical fertilizers, supporting sustainable agricultural practices and offering a practical solution for enhancing the productivity of horticultural crops.

INTRODUCTION

The growth of the culinary industry in Indonesia has had a measurable impact on the agricultural sector. For example, production of caisim has shown an upward trend: from 635,990 tons in 2018 to 727.467 tons in 2021 (BPS, 2021). Over the same period, average consumption of caisim rose from about 666,288 tons/year in 2018 to 729.216 tons/year in 2021. This increase suggests a rising market demand for caisim beyond what domestic production alone can satisfy. In fact, import data indicates that caisim imports reached 45.130.1 tons in 2018, with a value of approximately IDR 267.6 billion, and 17.908 tons in 2019. A key driver behind this is the expansion of modern retail channels and increasing consumer preference for fresh vegetables, particularly for dishes incorporating caisim. As businesses focused on vegetable-intensive cuisine continue to expand, the demand for caisim has intensified. This presents a significant opportunity for farmers to expand cultivation of caisim, since the crop has a quick growth cycle (typically harvested in ~30–35 days) and can provide relatively fast returns. Additionally, caisim of high quality that meets standards of modern markets and supermarkets commands premium acceptance and value (Susilo & Diennazola, 2012).

Indonesia's geographical location, with its tropical climate, makes it highly suitable as a center for vegetable production, including caisim. From climatic, economic, and social perspectives, caisim cultivation in Indonesia is very promising and feasible. Although caisim is not native to Indonesia, the local environment, with its suitable climate, allows caisim to thrive (Surachman et al., 2025). The plant can grow well in both lowland and highland areas, under both hot and cold climates (Fahrurroji, 2013). Therefore, developing caisim cultivation in Indonesia is not only relevant to food security but also provides significant support to the country's agricultural sector.

Vegetables play an essential role in daily food consumption because they are rich in nutrients, particularly vitamins and minerals, which are necessary to maintain human health. Additionally, vegetables are high in fiber, which is beneficial for digestion, especially when consumed fresh. Caisim contains important vitamins such as K, A, C, and E. This plant belonging to the Brassica genus, is primarily utilized for its leaves as a food source, either fresh or processed (Fahrurroji, 2013).

To optimize caisim production, appropriate fertilization is crucial for enhancing both the quality and quantity of the crop yield. Fertilization aims to maintain and improve soil fertility by providing the necessary nutrients that plants absorb (Lingga, 2013). However, excessive use of chemical fertilizers over time has led to negative environmental and soil impacts. These include a decline in soil organic matter which undermines aggregate stability, increased soil acidity due to nitrification of ammonium-based fertilizers, reduction in porosity and aeration resulting in soil compaction, and suppression of beneficial soil microorganisms and enzyme activities that are essential for nutrient cycling (Zhao et al., 2020). These negative effects include the degradation of soil structure, which makes it hard during the dry season and sticky during the rainy season, thereby reducing soil porosity (Mutryarny, 2014). In contrast, chemical fertilizers lack the ability to directly improve the physical and biological properties of the soil, unlike organic fertilizers, which help to enhance these properties and support the microbial life essential for soil fertility (Suwahyono, 2011).

Moreover, organic fertilizers help increase the availability of essential nutrients required by vegetable crops, such as nitrogen (N), phosphorus (P), and potassium (K), which are easily lost due to evaporation or being washed away by irrigation and rain. Another advantage of organic fertilizers is their ability to bind these nutrients, preventing them from being leached and ensuring they remain available to plants (Wijaya, 2008). Due to the growing demand for fertilizers and the increasing difficulty of obtaining organic fertilizers, one alternative that has gained attention is the use of rabbit feces as an organic fertilizer. Although not widely known, rabbit feces has a higher nutrient content compared to feces from other livestock, which is more commonly used by farmers as fertilizer.

Rabbit feces contain various essential nutrients and have been reported to be relatively rich in nitrogen and other macronutrients. Typical analyses of fresh rabbit manure indicate nitrogen (N) about 2.0–2.4%, phosphorus (P) about 0.5–1.5% (commonly ≈ 1%), and potassium (K) about 0.6–1.5%, together with appreciable amounts of Ca and Mg (Li et al., 2022; Adi et al., 2020; Tumimbang et al., 2022). The favorable NPK and micro-nutrient profile of rabbit manure suggests its potential as an effective organic fertilizer to support caisim growth. Moreover, rabbit manure is widely available as a byproduct of small-scale and commercial rabbit husbandry and has been increasingly promoted for on-farm recycling into compost or organic fertilizer in Indonesia (Adi et al., 2020; Mahardika et al., 2024). Therefore, this study explores the effectiveness of using rabbit feces as fertilizer for caisim (*Brassica juncea* L.) growth, contributing to sustainable and environmentally friendly cultivation practices.

METHOD

This research was conducted at the Green House of the Muhammadiyah University Prof. Dr. Hamka, Jl. Tanah Merdeka, Pasar Rebo, East Jakarta. The method used in this study was an experimental method with a Completely Randomized Design (CRD). Each experimental unit (polybag containing caisim plants) was assigned randomly to one of the five treatments using a random number table to avoid positional bias in the greenhouse. The randomization process was carried out by numbering all experimental units and then assigning treatments based on the generated random sequence. The positions of the polybags were also rearranged periodically during the experiment to minimize environmental variation such as light intensity or airflow differences.The study consisted of five treatments and five replications, namely:
P0 = control treatment without the addition of rabbit feces fertilizer
P1 = mixture of soil and rabbit feces fertilizer with a ratio of 1:1 (v:v)
P2 = mixture of soil and rabbit feces fertilizer with a ratio of 2:1 (v:v)
P3 = mixture of soil and rabbit feces fertilizer with a ratio of 3:1 (v:v)
P4 = mixture of soil and rabbit feces fertilizer with a ratio of 4:1 (v:v)
Thus, the total number of samples used in this study was 25 experimental units.

The steps in this research began with the preparation of the planting medium using rabbit feces that had been dried for 10 days and then mixed with soil. A total of 25 polybags, each measuring 20 x 20 cm, were prepared, and each polybag was filled with the planting medium according to the designated treatments.
P0 = soil without rabbit feces fertilizer
P1 = mixture of soil and rabbit feces fertilizer with a ratio of 1:1 (v:v)
P2 = mixture of soil and rabbit feces fertilizer with a ratio of 2:1 (v:v)
P3 = mixture of soil and rabbit feces fertilizer with a ratio of 3:1 (v:v)
P4 = mixture of soil and rabbit feces fertilizer with a ratio of 4:1 (v:v)

Caisim seeds were soaked for 2 hours to accelerate germination. After soaking, the seeds were sown in the nursery beds filled with the appropriate planting medium. After 14 days, uniform caisim seedlings were selected and transferred to the prepared polybags. The soaking process helps soften the seed coat and stimulates enzymatic activity, thereby enhancing germination rate and uniformity (Rahmawati, 2021).

At 14 days after sowing (DAS), 25 uniform plants (with 4 leaves) were selected and transferred to polybags, with one caisim seedling per polybag. Plant care was carried out by watering the plants as needed, twice a day, in the morning and evening. The caisim plants were harvested at 35 DAS. The parameters measured in this study were fresh weight, dry weight, and root length.

RESULTS AND DISCUSSION

The use of rabbit manure with different proportions showed significant differences in fresh weight, dry weight, and root length of caisim plants.

Fresh Weight

The fresh weight of caisim plants showed normally distributed data after normality testing, and homogeneous variance after Bartlett's homogeneity test. ANOVA showed that rabbit manure had a highly significant effect on the fresh weight of caisim plants. The results of the Least Significant Difference (LSD) test indicated that the control treatment (P0) was significantly different from treatments P1, P2, P3, and P4.

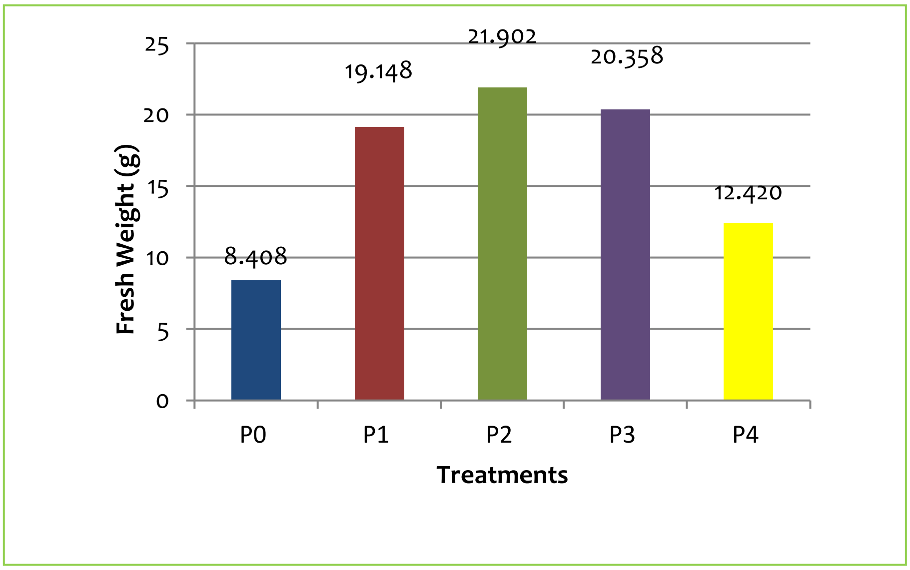

Figure 1. Bar diagram of the average fresh weight of caisim plants in various treatments

Dry Weight

Normality testing on the dry weight of the plants showed a normal distribution of data, and Bartlett's homogeneity test indicated homogeneous variance. ANOVA also showed that rabbit manure had a highly significant effect on the dry weight of caisim plants. The results of the LSD test showed that the control treatment (P0) was significantly different from P1, P2, P3, and P4.

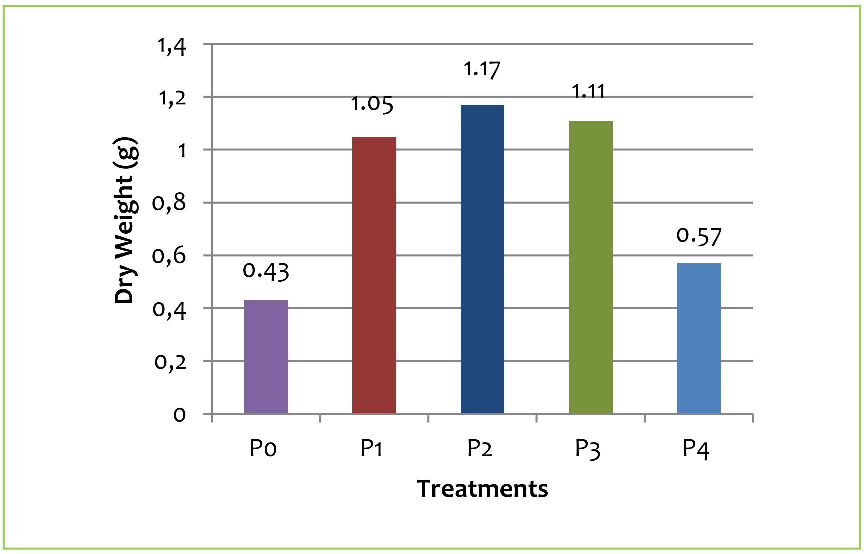

Figure 2. Bar diagram of the average dry weight of caisim plants in various treatments

Root Length

The testing of root length showed that the data were normally distributed, as confirmed by normality testing, and had homogeneous variance, as confirmed by Bartlett's homogeneity test. ANOVA indicated that rabbit manure had a significant effect on the root length of caisim plants. The results of the LSD test showed that the control treatment (P0) was significantly different from P2, P3, and also different from P1 and P4.

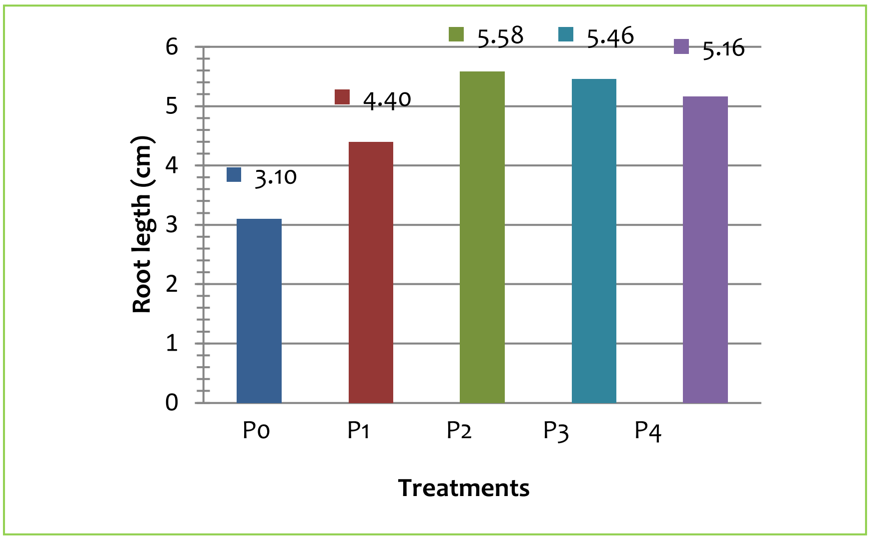

Figure 3. Bar diagram of the average root length of caisim plants in various treatments.

Based on the research results and statistical analysis, rabbit manure application had a significant effect on three key growth parameters of caisim plants (fresh weight, dry weight, and root length). Among the five treatments, the most optimal growth occurred in treatment P2 (a 2:1 soil-to-rabbit manure ratio), which produced an average fresh weight of 21.902 g, dry weight of 1.17 g, and root length of 5.58 cm. These results were greater than those of the other four treatments.

This may be because the 2:1 ratio provided an optimal amount of nutrients needed for caisim plant growth. According to Li et al. (2022), rabbit manure contains balanced macronutrients — approximately N 2.4%, P 1.4%, and K 0.6% — that support vegetative development. The addition of nitrogen, which is an essential component of chlorophyll, greatly affects the quality of leafy vegetables, one of which is determined by the green color intensity of the leaves (Wijaya, 2008).

The higher fresh weight in treatment P2 reflects better water absorption and cell enlargement. Nitrogen plays a central role in the synthesis of proteins and enzymes that regulate photosynthesis, promoting leaf expansion and biomass accumulation (Taiz et al., 2018). Plants that receive sufficient nitrogen can maintain higher turgor pressure and leaf hydration, resulting in increased fresh biomass. Conversely, the dry weight parameter represents the accumulation of organic matter after removing the water content, indicating the actual growth efficiency and the conversion of photosynthetic products. The significantly higher dry weight in P2 suggests that rabbit manure not only enhances water retention but also improves nutrient utilization efficiency in metabolic processes (Quintero-Velez et al., 2024).

In treatment P2, the soil-to-manure ratio enabled the plants to absorb nutrients more efficiently due to the optimal balance between organic matter and mineral nutrients in the growing medium. Adequate nitrogen supply promotes good root growth, which in turn enhances nutrient absorption by the plants (Wijaya, 2008). Phosphorus (P) also plays a crucial role in energy transfer processes such as ATP synthesis, which is vital for cell division and root elongation (Havlin et al., 2022).

Furthermore, the presence of potassium (K) in the manure positively influenced metabolic processes and enzyme activation. Potassium regulates osmotic balance, supports protein synthesis, and enhances photosynthetic efficiency, thereby contributing to the increased fresh and dry weight of the caisim plants (Zörb et al., 2014). It also strengthens cell walls and improves resistance to stress, which may explain the healthier appearance of caisim under treatment P2.

In contrast, the poor growth observed in the control treatment (P0) can be attributed to nutrient deficiency, particularly nitrogen and phosphorus. Nitrogen deficiency reduces chlorophyll synthesis, leading to chlorosis (yellowing of leaves) and slower growth (Lingga, 2013). Plants with inadequate phosphorus also exhibit weak root systems and reduced photosynthetic efficiency (Lakitan, 2011).

The significant improvement in both fresh and dry weight in P2 supports the hypothesis that rabbit manure enhances soil structure and microbial activity, thereby improving nutrient mineralization. Organic matter from rabbit manure enhances soil porosity, water-holding capacity, and microbial biomass, all of which are essential for maintaining sustainable soil fertility (Adi, 2020).

However, this study also has several limitations. Environmental factors such as microbial community composition, soil pH fluctuations, and temperature variations were not controlled during the experiment. Microbial activity plays an important role in decomposing organic matter and releasing nutrients in plant-available forms (Ahemad & Kibret, 2014). Differences in microbial abundance could affect nutrient availability and absorption by the plants. In addition, the study was conducted in a controlled greenhouse environment, so the results may vary under field conditions where rainfall, pests, and soil biodiversity are more complex.

Future research should therefore consider analyzing soil microbiological properties and the decomposition rate of rabbit manure to better understand its long-term effects on soil fertility and caisim productivity.

CONCLUSION

The application of rabbit manure has a significant influence on the growth of caisim plants, particularly in terms of fresh weight, dry weight, and root length. The best performance was observed in the 2:1 soil-to-rabbit manure ratio (P2), which produced the highest growth across all parameters. This optimal combination likely provides a balanced supply of essential nutrients such as nitrogen, phosphorus, and potassium—elements crucial for photosynthesis, chlorophyll formation, and root development. Practically, the use of rabbit manure can increase caisim productivity by an estimated 20%–35% compared to unfertilized plants, as reflected by the substantial improvement in biomass production observed in this study. For small-scale farmers, rabbit manure offers a cost-effective and locally available alternative to chemical fertilizers. Rabbit farms are relatively common in peri-urban and rural areas of Indonesia, and their waste can be directly composted and applied to vegetable crops without requiring expensive processing. This reduces fertilizer costs by up to 40–60%, making it particularly beneficial for farmers with limited capital. In addition to its economic value, the use of rabbit manure also supports sustainable agricultural practices, as it improves soil fertility, enhances microbial activity, and reduces environmental pollution associated with the overuse of synthetic fertilizers. Therefore, rabbit manure is not only an effective organic fertilizer for caisim cultivation but also a promising component of environmentally friendly and circular agricultural systems. Further research should focus on quantifying the long-term yield improvement, soil health effects, and cost-benefit analysis of rabbit manure application under field-scale conditions.

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