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The Effect of Liquid Organic Fertilizer Dosage from Banana Pseudo-Stems on the Growth and Production of Bok Choy (*Brassica rapa* L.) Plants

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Abstract

Background: Bok choy (*Brassica rapa* L.) is a widely cultivated horticultural crop with high economic value. Increasing its production can be achieved through appropriate fertilization strategies. One alternative to chemical fertilizers is the use of liquid organic fertilizer (LOF) derived from banana pseudostems, which is expected to supply nutrients and improve plant growth in an environmentally friendly manner.
Aims: This study aimed to evaluate the effect of liquid organic fertilizer (LOF) derived from banana pseudostems on the growth and yield of bok choy.
Methods: The study was conducted from September to October 2024 at the Experimental Field of the Faculty of Agriculture, Muhammadiyah University of Jakarta. The experiment employed a Randomized Complete Block Design (RCBD) consisting of six treatments, namely P0 (NPK fertilizer at 1 g per plant) as the control, and P1, P2, P3, P4, and P5 which involved the application of liquid organic fertilizer (LOF) derived from banana pseudostems at doses of 100, 150, 200, 250, and 300 mL per plant, respectively. Each treatment was replicated four times, with each experimental unit comprising three plants, resulting in a total of 72 plants. Data was collected on plant height, number of leaves, leaf length, leaf width, root length, root weight, total fresh weight, and consumable fresh weight. The collected data were analyzed using analysis of variance (ANOVA), and when significant differences were detected, Duncan's Multiple Range Test (DMRT) at the 5% significance level was applied to compare treatment means.
Result: The results indicated that the application of NPK fertilizer at 1 g/plant (control treatment) produced the best growth and yield performance across all observed variables compared to the liquid organic fertilizer treatments derived from banana pseudostems.

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1. Introduction

Vegetables are staple food commodities essential for daily consumption, possessing economic value and relatively short harvesting periods. One type of vegetable widely consumed by the public

is mustard greens. Samadi (2017) stated that mustard greens cultivation is highly profitable due to its strong market demand. Mustard greens consist of several varieties, including caisim, Bok Choy, and bitter mustard greens. Bok Choy is one of the most widely cultivated leafy vegetables in Southeast Asia, including the Philippines, Malaysia, Thailand, and Indonesia. It is estimated that this plant was introduced to Indonesia in the 14th century.

Bok Choy or Chinese cabbage belongs to the Brassicaceae family and contains various essential nutrients such as vitamins (A, B, B2, B6, and C), phosphorus, potassium, copper, magnesium, iron, and protein, which are beneficial for preventing high blood pressure and heart disease (Rakhmani *et al.,* 2021; Setiawan & Shiddieq, 2013). Bok Choy is generally cultivated in open fields with a harvest period of 30–45 days after planting (DAP), with potential yields of 10–20 tons ha^{-1} for small Bok Choy and 20–30 tons ha^{-1} for large Bok Choy (Dinas Pertanian Buleleng, 2020).

Increasing vegetable production requires various supporting efforts, one of which is fertilizer application. Currently, farmers still rely heavily on inorganic fertilizers for Bok Choy cultivation due to their availability on the market, despite their relatively high prices and negative environmental impacts (Dewanto, 2013). Long-term use of chemical fertilizers has been reported to cause serious problems, including soil degradation as well as economic and social dependency among farmers (Sedayu *et al.,* 2014). Organic fertilizers represent an alternative to inorganic fertilizers that can reduce production costs and minimize environmental pollution. Organic fertilizers are derived from plant or animal residues, one of which is banana pseudostems, a potential raw material for liquid organic fertilizer production. The application of banana pseudostem-based liquid organic fertilizer (LOF) was previously studied by Wahyudi (2021), who reported that the addition of young coconut water to banana pseudostem LOF did not significantly increase the contents of N, P, K, and organic C. Furthermore, based on Amri (2020) found that the application of banana pseudostem LOF did not affect the growth and yield of mung bean plants across all observed parameters. In contrast, Nurjannah & Lasmini (2022) reported that the application of banana pseudostem LOF at various concentrations significantly affected the number of leaves, leaf area, number of fruits, and fruit fresh weight of tomato plants. A concentration range of 350–600 mL LOF per liter of water was found to promote more optimal growth and yield in tomato plants

Baihaqi (2023) reported that the application of banana pseudostem liquid organic fertilizer (LOF) at a concentration of 20% was the most effective and efficient treatment in increasing kale yield. Similarly, Sinaga *et al.* (2020) stated that banana pseudostem LOF significantly affected several growth and yield parameters of white eggplant (*Solanum melongena* L.), including plant height, stem diameter, flowering time, number of fruits per plot, and fruit weight per plot. Furthermore, Ropiqoh (2019) found that the application of banana pseudostem LOF influenced leaf length at 3 weeks after planting (WAP) and fresh weight per plot in Bok Choy plants. Dewi (2020) also reported that the application of banana pseudostem LOF on the growth of green spinach and red spinach in a hydroponic system resulted in varying effects. The best treatments were P0 (100% AB Mix) and P1 (15% LOF + 85% AB Mix), while the least effective treatment was P3 (65% LOF + 35% AB Mix).

Banana pseudostems contain nutrients with potential use in organic fertilizer production, including nitrogen (N), calcium (Ca), potassium (K), and phosphorus (P). In addition, banana pseudostems are rich in cellulose, with relatively high water and fiber content, and contain essential minerals such as potassium, calcium, phosphorus, and iron. These characteristics indicate that banana pseudostems have considerable potential as a raw material for the production of liquid organic fertilizer (LOF) (Gultom *et al.,* 2021). If left and unprocessed, banana pseudostem waste tends to accumulate and produce unpleasant odors. Nevertheless, despite their nutrient content and important role in organic fertilization, banana pseudostems are still underutilized as a raw material for liquid organic fertilizer production. Banana plants do not possess a true stem; instead, their trunks are formed from tightly packed leaf sheaths (fronds) that develop into a long and soft pseudostem. Banana pseudostems contain considerable amounts of essential nutrients, including calcium (16%), potassium (23%), and phosphorus (32%) (Gultom *et al.,* 2021). These characteristics indicate that banana pseudostems have potential as a raw material for organic fertilizer production.

The liquid organic fertilizer (LOF) used in this study was produced through the fermentation of banana pseudostem waste. When left unprocessed, banana pseudostem waste tends to accumulate and emit unpleasant odors. However, despite their nutrient content and role in improving soil fertility, banana pseudostems are still underutilized as a base material for liquid organic fertilizers.

Banana agricultural waste generally consists of rotten fruits, peels, rachis, leaves, pseudostems, and rhizomes. It has been reported that for every ton of bananas harvested, approximately four tons of waste are generated, including 100 kg of rejected fruit, 480 kg of leaves, 440 kg of peels, and about three tons of pseudostems (Taib *et al.,* 2021). In many agricultural practices, banana pseudostems are considered useless and are discarded after harvest, as banana plants produce fruit only once in their life cycle. Consequently, banana pseudostem waste is abundant but rarely utilized as a value-added product (Suharyani *et al.,* 2014). Recent advancements in agricultural knowledge have encouraged the utilization of banana pseudostems as liquid organic fertilizer. Research by Sari & Alfanita (2018) showed that six days of fermentation of banana pseudostem LOF resulted in nitrogen (N) and potassium (K) contents of 0.04% and 0.017%, respectively, while twelve days of fermentation produced the highest phosphorus (P) content of 0.004%. These findings further support the potential of banana pseudostems as a raw material for organic fertilizer production.

Based on the above considerations, this study aimed to evaluate the effect of different dosages of liquid organic fertilizer derived from banana pseudostems on the growth and yield of Bok Choy. *This study is novel in systematically evaluating a wide range of plant-based dosage levels of banana pseudostem–derived liquid organic fertilizer under field conditions and directly benchmarking its agronomic effectiveness against standard NPK fertilization on bok choy growth and yield.*

2. Method

The study was conducted from September to October 2024 at the Experimental Field of the Faculty of Agriculture, Muhammadiyah University of Jakarta, located at an altitude of approximately 25 m above sea level. The tools used in this study included hoes, knives, buckets, plastic bags, calculators, raffia ropes, label papers, plastic bottles, cameras, rulers, seedling trays, weighing scales, stationery, and other supporting equipment. The materials used consisted of Nauli F1 Bok Choy seeds, rice husks, 30 cm × 30 cm polybags, young banana pseudostems, granulated sugar, EM-4, and goat manure.

Table 1. Treatment Code Mean

Treatment code	
P0	NPK fertilizer 1 g/plant (control)
P1	Banana pseudostem fertilizer dose 100 mL/plant
P2	Banana pseudostem fertilizer dose 150 mL/plant
P3	Banana pseudostem fertilizer dose 200 mL/plant
P4	Banana pseudostem fertilizer dose 250 mL/plant
P5	Banana pseudostem fertilizer dose 300 mL/plant

The experiment employed a Complete Randomized Block Design (CRBD) with a single treatment factor, namely the dosage of banana pseudostem liquid organic fertilizer (LOF), consisting of six treatment levels as presented in Table 1. Each treatment was replicated four times, resulting in 24 experimental units. Each experimental unit consisted of three plants, giving a total of 72 plants. The linear mathematical model for data analysis for CRBD is as follows:

$$Yij = \mu + \alpha i + ßj + \varepsilon ij$$

Yij is the observed value of the effect of the i-th banana pseudostem LOF dose and the j-th group, μ is the general mean, αi is the effect of the i-th banana pseudostem LOF dose, ßj is the effect of the j-th group, εij is the experimental error of the i-th banana pseudostem LOF dose treatment in the j-th group, i is the treatment (0, 1, 2, 3, 4), and j is the group (1, 2, 3, 4, 5). Observations of plant height, number of leaves, leaf length, and leaf width were conducted at 2–5 weeks after planting (WAP). Root length, root weight, total fresh weight, and consumable fresh weight were measured at harvest (5 WAP). The collected data were analyzed using analysis of variance (ANOVA), and when significant differences were detected, further analysis was performed using Duncan's Multiple Range Test (DMRT) at a 5% significance level.

2.1 Banana Pseudostem LOF Making

The materials used include 10 kg of banana pseudostems cut into 3-4 cm pieces, 2 kg of granulated sugar, 750 mL of EM4, and water. All ingredients are placed in a bucket, then 750 mL of EM4 and 2 kg of granulated sugar are added. The mixture is then dissolved in 15 L of water and stirred thoroughly before being tightly sealed. Fermentation is carried out for 14 days and is considered complete when signs such as gas bubbles appear on the surface of the container, water droplets appear on the lid, a fermented cassava-like aroma, a cloudy color, and a white layer on the surface of the solution and the walls of the container appear. The fertilizer can then be used after going through a filtration process (Gultom et al., 2021).

2.2 Plant Cultivation

Land preparation began with clearing the planting area of weeds, followed by soil tillage using a hoe. Weed removal prior to planting was conducted to reduce competition for nutrients, water, and light between the main crop and weeds, as well as to minimize the risk of plant diseases, since certain weeds may act as disease hosts. Bok Choy seeds intended for polybag cultivation were initially sown in seedling trays for 10 days using rice husks as the growing medium. After the seedlings were established, they were transplanted into planting holes in the polybags at a depth of 2–3 cm. Transplanting was carried out in the morning or late afternoon to reduce transplanting stress.

Banana pseudostem liquid organic fertilizer (LOF) was applied once a week at 1, 2, 3, and 4 weeks after planting (WAP). The LOF was applied directly to the Bok Choy plants according to the designated dosage, either in the morning or evening. In addition, NPK fertilizer was applied at 1 WAP at a rate of 1 g per plant. Fertilization was performed by evenly sprinkling the fertilizer onto the growing medium near the plant roots during the morning or evening hours.

Harvesting was conducted 35 days after planting by removing the Bok Choy plants from the polybags. Bok Choy plants ready for harvest were characterized by large and broad leaves. Harvesting was carried out in the afternoon by tearing the polybag, separating the plants from the growing medium, and gently washing the roots with clean water.

3. Results and Discussion

3.1 Plant Height

The results of the analysis of variance indicated that the dosage of banana pseudostem liquid organic fertilizer (LOF) had no significant effect on Bok Choy canopy height at 2–3 weeks after planting (WAP), but showed a significant effect at 4–5 WAP. During the early growth stage (2–3 WAP), the NPK fertilizer treatment (control) produced the highest canopy heights, measuring 13.93 cm and 17.44 cm, respectively.

Further analysis using Duncan's Multiple Range Test (DMRT) at the 5% significance level revealed that at 4–5 WAP, the NPK treatment (control) continued to produce the highest canopy heights, namely 18.36 cm and 20.12 cm, respectively. However, these values were not significantly different from those obtained with the 100 mL/plant LOF treatment but were significantly higher than those of the other LOF dosage treatments (Table 2).

Table 2. The effect of LOF dose of banana pseudo-stem on the Plant Height of Bok Choy plants at 2-5 WAP

Treatment	Crop Height (cm)			
	2 WAP	3 WAP	4 WAP	5 WAP
NPK Dose 1 g/Plant	13.93	17.44	18.36 c	20.12 b
LOF Dose 100 mL/Plant	12.58	15.88	16.65 bc	17.72 ab
LOF Dose 150 mL/Plant	10.86	14.00	14.63 ab	16.25 a
LOF Dose 200 mL/Plant	9.98	12.18	14.66 ab	17.54 a
LOF Dose 250 mL/Plant	10.93	14.38	15.11 ab	16.78 a
LOF Dose 300 mL/Plant	11.30	13.05	14.15 a	17.00 a

Note: Numbers followed by the same letter in the same column show no significant difference based on the DMRT test at the 5%

Overall, the results demonstrated that the NPK treatment consistently produced the greatest canopy height. This finding suggests that nutrient requirements for Bok Choy growth were optimally fulfilled when fertilizers were applied according to recommended rates. Ayal *et al.* (2018) reported that the application of NPK compound fertilizer at a dose of 1 g/plant was the most effective in enhancing plant height and leaf number in Bok Choy. Furthermore, Duaja *et al.* (2012) explained that plants tend to utilize nitrogen preferentially to support shoot growth rather than root development, thereby contributing to increased plant height. Supporting this explanation, Dewi (2020) reported that the application of high concentrations of liquid organic fertilizer (65% LOF) resulted in reduced plant height, indicating that the nutrient content of LOF at such levels was insufficient to fully substitute inorganic fertilizers.

3.2 Total Leaf

The results of the analysis of variance indicated that the dosage of banana pseudostem liquid organic fertilizer (LOF) did not have a significant effect on the number of leaves of Bok Choy plants at 2–5 weeks after planting (WAP). During this observation period, the NPK fertilizer treatment (control) consistently produced the highest number of leaves, with values of 8.17, 12.33, 14.67, and 17.25 leaves at 2, 3, 4, and 5 WAP, respectively; however, these values were not significantly different from those obtained under the LOF treatments (Table 3).

Table 3. The effect of LOF dose of banana pseudo-stem on the number of leaves of Bok Choy plants at 2-5 WAP

Treatment	Total Leaf (Leaf)			
	2 WAP	3 WAP	4 WAP	5 WAP
NPK Dose 1 g/Plant	8.17	12.33	14.67	17.25
LOF Dose 100 mL/Plant	7.46	11.75	13.96	17.17
LOF Dose 150 mL/Plant	7.17	10.42	13.21	15.04
LOF Dose 200 mL/Plant	6.58	9.08	12.33	15.42
LOF Dose 250 mL/Plant	6.63	10.83	12.99	14.01
LOF Dose 300 mL/Plant	6.92	9.00	11.2a	13.75

Note: Numbers followed by the same letter in the same column show no significant difference based on the DMRT test at the 5% level.

The number of leaves is strongly influenced by genetic factors; therefore, the applied treatments were insufficient to induce significant differences in leaf number among bokchoy plants. Gardner *et al.* (1991) stated that certain growth components, such as stem elongation rate and leaf number, are controlled by the interaction between genotype and environmental conditions, with genetic factors exerting a more dominant influence on leaf number.

Leaves play a crucial role as the primary organs for photosynthesis. Hasanah (2017) reported that leaf number is closely associated with photosynthetic capacity, as an increased number of leaves enhances light interception, thereby supporting the photosynthesis process and overall plant growth.

3.3 Leaf Lenght

The results of the analysis of variance showed that the dosage of banana pseudostem liquid organic fertilizer (LOF) had no significant effect on leaf length of Bok Choy plants at 2–3 weeks after planting (WAP), but showed a significant effect at 4–5 WAP. At 2–3 WAP, the NPK fertilizer treatment (control) produced the longest leaf lengths, measuring 9.00 cm and 11.09 cm, respectively. Further analysis using Duncan's Multiple Range Test (DMRT) at the 5% significance level indicated that at 4–5 WAP, the NPK treatment (control) resulted in the longest leaf lengths, namely 11.75 cm and 12.87 cm, respectively. These values were not significantly different from those obtained with the 100 mL/plant LOF treatment, but were significantly different from the other treatments (Table 4).

Table 4. The Effect of LOF Dose of Banana Pseudo-Stem on Leaf Length of Bok Choy Plant at 2-5 WAP

Treatment	Leaf Lenght (cm)					
	2 WAP	3 WAP	4 WAP		5 WAP	
NPK Dose 1 g/Plant	9.00	11.09	11.75	b	12.87	c
LOF Dose 100 mL/Plant	7.99	9.90	10.23	ab	11.29	bc
LOF Dose 150 mL/Plant	6.88	8.51	9.11	a	9.97	ab
LOF Dose 200 mL/Plant	6.28	7.41	8.87	a	10.35	ab
LOF Dose 250 mL/Plant	6.83	7.94	8.93	a	10.22	a
LOF Dose 300 mL/Plant	6.94	8.31	9.21	a	9.80	a

Note: Numbers followed by the same letter in the same column show no significant difference based on the DMRT test at the 5% level.

The greater leaf length observed in the NPK treatment indicates that the nutrients supplied by NPK fertilizer, particularly nitrogen, were sufficient to support leaf growth in Bok Choy plants. Wijaya (2010) reported that plants with adequate nitrogen availability tend to develop longer and wider leaves with higher chlorophyll content, thereby increasing assimilate production to support vegetative growth.

These findings also suggest that the concentration and quality of liquid organic fertilizer (LOF) play an important role in influencing plant growth. It is suspected that the applied LOF dosage may have been excessively concentrated, as it was administered without prior dilution. Such conditions may cause plants to receive nutrient levels beyond their physiological requirements. Both nutrient deficiencies and excesses can adversely affect plant growth and development; excessive nutrient availability can inhibit plant growth and lead to suboptimal development (Agustina, 2004).

3.4 Leaf Width

The results of the analysis of variance showed that the dosage of banana pseudostem liquid organic fertilizer (LOF) did not significantly affect the leaf width of Bok Choy plants at 2–4 weeks after planting (WAP), but had a significant effect at 5 WAP. At 2–4 WAP, the NPK fertilizer treatment (control) produced the widest leaf widths, measuring 5.30 cm, 7.25 cm, and 7.40 cm, respectively. Further analysis using Duncan's Multiple Range Test (DMRT) at the 5% significance level indicated that at 5 WAP, the control treatment resulted in the widest leaf width of 8.42 cm. This value was not significantly different from that obtained with the 100 mL/plant LOF treatment, but was significantly different from the other treatments (Table 5).

Table 5. The Effect of LOF Dose of Banana Pseudo-Stem on leaf width of Bok Choy plant at 2-5 WAP

Treatment	Leaf Width (cm)				
	2 WAP	3 WAP	4 WAP	5 WAP	
NPK Dose 1 g/Plant	5.30	7.25	7.40	8.42	b
LOF Dose 100 mL/Plant	4.69	6.48	6.80	7.68	ab
LOF Dose 150 mL/Plant	4.13	5.31	5.62	6.35	a
LOF Dose 200 mL/Plant	3.54	4.69	5.61	6.76	a
LOF Dose 250 mL/Plant	3.83	5.31	6.07	7.06	a
LOF Dose 300 mL/Plant	4.17	5.25	5.79	7.41	a

Note: Numbers followed by the same letter in the same column show no significant difference based on the DMRT test at the 5% level.

The significant effect observed in the NPK control treatment on leaf width is presumed to be associated with the availability of sufficient nutrients to support optimal plant growth. Leaf width development is strongly influenced by light availability and nutrient supply, which function as essential components in leaf formation. Efficient utilization of light enables plants to develop a broader canopy and wider leaves, thereby enhancing vegetative growth in Bok Choy plants (Ropiqoh, 2019). Similar to the variables of canopy height and leaf length, the effect of banana pseudostem LOF

dosage on leaf width exhibited a comparable trend, in which higher LOF doses tended to result in lower growth responses.

Excessive fertilizer application is suspected to disrupt nutrient balance in the growing medium, thereby limiting the availability and uptake of other essential nutrients required for plant growth. Kusmanto (2010) stated that optimal fertilization efficiency is achieved when fertilizers are applied in appropriate amounts that meet plant nutrient requirements without excess or deficiency. Over-fertilization can increase the concentration of soil solution to harmful levels, potentially causing toxicity to plants, whereas insufficient fertilization may fail to produce a meaningful growth response.

3.5 Root Length

The results of the analysis of variance indicated that the application of banana pseudostem liquid organic fertilizer (LOF) had no significant effect on the root length of Bok Choy plants at 5 weeks after planting (WAP). Among the treatments, the application of LOF at a dose of 100 mL/plant resulted in the longest root length, measuring 29.75 cm.

Table 6. The Effect of LOF Dose of Banana Pseudo-Stem on terhadap Root Length of Bok Choy plant at 2-5 WAP

Treatment	Root Lenght (cm)
NPK Dose 1 g/Plant	26.50
LOF Dose 100 mL/Plant	29.75
LOF Dose 150 mL/Plant	21.71
LOF Dose 200 mL/Plant	29.00
LOF Dose 250 mL/Plant	27.98
LOF Dose 300 mL/Plant	28.19

Note: Numbers followed by the same letter in the same column show no significant difference based on the DMRT test at the 5% level.

The application of banana pseudostem LOF at various dosages did not result in root lengths that differed significantly from the control treatment. Furthermore, higher LOF dosages did not adversely affect root development, indicating that the applied fertilizer levels were still within a tolerable range for root growth.

The similarity in root length across treatments suggests that nutrient availability in the growing media was sufficient to support normal root development. Siregar (2015) reported that adequate phosphorus application can enhance root number and length, thereby increasing the efficiency of nutrient uptake. In line with this, Subandi *et al.* (2015) stated that phosphorus (P) deficiency can inhibit root growth; insufficient nutrient availability may limit root development and disrupt nutrient translocation throughout the plant.

3.6 Root Weight

Based on the analysis of variance, the application of banana pseudostem liquid organic fertilizer (LOF) had a significant effect on the root weight of Bok Choy plants at 5 weeks after planting (WAP). Further DMRT analysis at the 5% significance level indicated that the NPK treatment (control) produced a root weight of 15.00 g, which was not significantly different from the LOF treatment at a dose of 100 mL/plant, but was significantly different from the other LOF dosage treatments (Table 7).

Table 7. The Effect of LOF Dose of Banana Pseudo-Stem on Root weight of Bok Choy plant at 2-5 WAP

Treatment	Root Weight (g)	
NPK Dose 1 g/Plant	15,00	b
LOF Dose 100 mL/Plant	13,04	b
LOF Dose 150 mL/Plant	5,75	a
LOF Dose 150 mL/Plant	6,29	a
LOF Dose 250 mL/Plant	5,04	a
LOF Dose 300 mL/Plant	5,00	a

These results indicate that although root length did not differ significantly among treatments, the application of banana pseudostem LOF at higher dosages resulted in significantly lower root weight compared to the control. This suggests that excessive LOF applications may negatively affect root biomass accumulation. Suriadikarta (2006) emphasized that the application of liquid organic fertilizer must be conducted at an appropriate dosage to achieve optimal plant growth. Furthermore, the findings demonstrate that Bok Choy plants receiving higher LOF dosages tended to exhibit poorer root development, whereas plants treated with lower LOF dosages produced significantly better results. This observation is consistent with the findings of Rusnia (2023), who reported that the application of LOF at a dose of 100 mL/plant resulted in improved growth and yield of Bok Choy plants.

Roots constitute a vital plant organ that plays a crucial role in supporting physiological processes, particularly in nutrient and water uptake. Fariudin *et al.* (2013) stated that roots function as the primary organs for absorbing essential substances, including nutrients and mineral salts, which are fundamental for sustaining plant growth and development.

3.7 Gross Weight

The results of the analysis of variance showed that the application of banana pseudostem liquid organic fertilizer (LOF) had a significant effect on the gross weight of Bok Choy plants at 5 weeks after planting (WAP). Further DMRT analysis at the 5% significance level indicated that the NPK treatment (control) produced the highest gross weight of 90.75 g, which was not significantly different from the LOF treatment at a dose of 100 mL/plant, but was significantly different from the other LOF dosage treatments.

Table 8. The Effect of LOF Dose of Banana Pseudo-Stem on Gross Weight of Bok Choy at 2-5 WAP

Treatment	Gross Weight (g)	
NPK Dose 1 g/Plant	90.75	b
LOF Dose 100 mL/Plant	71.75	ab
LOF Dose 150 mL/Plant	41.50	a
LOF Dose 200 mL/Plant	50.00	a
LOF Dose 250 mL/Plant	45.28	a
LOF Dose 300 mL/Plant	43.75	a

Note: Numbers followed by the same letter in the same column show no significant difference based on the DMRT test at the 5% level.

The optimal gross weight observed in the NPK control treatment indicates that the nutrient requirements of Bok Choy plants were adequately fulfilled. Appropriate fertilizer dosage plays a crucial role in determining fresh weight and consumption weight per plant (Pramitasari *et al.,* 2016). Optimal nutrient availability in the control treatment also supported favorable vegetative growth, resulting in increased plant biomass. According to Prasetya *et al.* (2009), plant weight is closely related to plant height and leaf area, where greater height and wider leaf area contribute to higher plant weight. Among the LOF treatments, the application of 100 mL/plant resulted in the highest gross weight compared to other LOF dosages. These findings indicate that excessive application of LOF tends to reduce plant productivity, likely due to nutrient imbalance or reduced nutrient absorption efficiency caused by over-fertilization. Kusmanto *et al.* (2010) reported that excessive fertilizer application can disrupt nutrient uptake, ultimately leading to suboptimal plant growth and yield.

These results are consistent with the findings of Gunawan (2024), who reported that the optimal application of oil palm empty fruit bunch (OPEFB/TKKS) compost for lettuce plants was 100 g/polybag, while higher fertilizer doses resulted in decreased growth and production. This suggests that both organic solid and liquid fertilizers derived from agricultural waste materials require precise dosage management to achieve optimal plant performance.

3.8 Consumption Weight

The analysis of variance (ANOVA) results showed that the LOF from banana's pseudostems significantly affected the weight of bok choy plants consumed at 5 WAP. The DMRT test results at the 5% level showed that the NPK treatment (control) had the highest consumption weight of 74.67 g, which was not significantly different from the LOF dose of 100 mL/plant, but significantly different from the other treatments.

The NPK treatment had the greatest impact because it met the plant's nutritional needs, which in turn affected plant weight. Plant fresh weight is related to the increase in cells within the plant. According to Arinong & Lasiwua (2011), growth in plant fresh weight occurs because the plant receives the necessary nutrients, allowing cell growth and maximizing water content.

Table 8. The Effect of LOF Dose of Banana Pseudo-Stem on Consumption Weigh of Bok Choy at 2-5 WAP

Treatment	Consumption Weight (g)	
NPK Dose 1 g/Plant	74,67	b
LOF Dose 100 mL/Plant	54,83	ab
LOF Dose 150 mL/Plant	35,29	a
LOF Dose 200 mL/Plant	44,67	a
LOF Dose 250 mL/Plant	38,58	a
LOF Dose 300 mL/Plant	37,13	a

Note: Numbers followed by the same letter in the same column show no significant difference based on the DMRT test at the 5% level.

The superior performance of the NPK treatment is attributed to its ability to adequately meet the nutritional requirements of Bok Choy plants, thereby supporting optimal biomass accumulation. Fresh weight accumulation is closely associated with cell enlargement and cell division processes. According to Arinong & Lasiwua (2011), increases in fresh weight occur when plants receive sufficient nutrients, enabling optimal cell development and maximizing water content within plant tissues.

Among the LOF treatments, the application of 100 mL/plant also resulted in the highest consumption weight compared to other LOF dosages. These findings suggest that higher LOF application rates tend to produce lower yields than lower application rates. Anggraeni (2014) reported that although fertilizer dosage influences nutrient availability, increasing the dosage does not necessarily lead to increased yields, as plants have a limited capacity for nutrient absorption. Furthermore, Djiwosaputro (1990) emphasized that optimal plant growth is achieved when nutrients are supplied in balanced proportions that meet plant physiological requirements.

Based on seed *Note* information, the optimal consumption weight of Bok Choy plants ranges from 350–450 g per plant. However, the consumption weights obtained in this study across all treatments did not reach the potential yield described. This discrepancy is presumed to be influenced by suboptimal environmental conditions at the research location, which may not have fully supported the growth requirements of Bok Choy plants of the Nauli F1 variety.

4. Conclusions

Based on the results of the study, it can be concluded that the application of NPK fertilizer at a dose of 1 g/plant (control) produced the best performance across all observed growth and yield variables. The application of banana pseudostem liquid organic fertilizer (LOF) at a dose of 100 mL/plant resulted in plant growth that was not significantly different from the NPK control. However, increasing the LOF dosage beyond 100 mL/plant led to significantly lower growth and yield compared to the control treatment.

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