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Growth And Yield Response of Two Pakchoi (*Brassica Rapa* L.) Varieties for Biofertilizer Application

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Abstract

Pakchoy is one of the vegetables that is highly favored by the public. Consumer demand for pakchoy has increased in line with growing awareness of healthy living. The increase in pakchoy production needs to be supported by fertilization to maintain soil fertility. One effort to improve soil fertility is through the use of biofertilizers, which are a type of organic fertilizer containing microorganisms that can enhance or restore soil fertility. This study aims to determine the growth response and yield of two pakchoy varieties to the application of biofertilizer. The research was conducted from November 2024 to January 2025, located in the home yard at Warung Mangga Village, Pinang District, Tangerang City, Banten Province. The study used a Factorial Randomized Complete Block Design (RCBD) with two factors. The first factor had two levels: V1 = Nauli F1 variety and V2 = Flamingo variety. The second factor had five levels: H0 = no fertilizer, H1 = biofertilizer at 100 kg/ha, H2 = biofertilizer at 150 kg/ha, H3 = biofertilizer at 200 kg/ha, and H4 = NPK at 150 kg/ha (control). The observed variables included plant height, number of leaves, shoot fresh weight, root fresh weight, and root length. The results showed that the Nauli F1 pakchoy variety treated with a biofertilizer dose of 200 kg/ha exhibited the best response across all parameters: plant height, number of leaves, shoot fresh weight, root fresh weight, and root length.

Keywords: *Biofertilizer, Flamingo, Nauli F1, Varieties*

INTRODUCTION

Indonesia, as an agrarian country, holds great potential in the agricultural sector. One of the high-value horticultural commodities is pakchoy (*Brassica rapa* L.), which is favored by the public due to its high nutritional content and ease of preparation. Although market demand continues to increase, national pakchoy production has declined in recent years (BPS, 2023). One of the contributing factors is the limited application of modern cultivation technologies, particularly in fertilization and the use of superior varieties (Oktafia & Maghfoer, 2018).

According to Siregar (2015), different varieties have distinct genetic compositions, resulting in diverse plant traits, morphologies, and growth characteristics. Research by Dwi (2019) showed that the Nauli F1 pakchoy variety had a significant response in plant height, number of leaves, fresh weight per plant, dry weight per plant, and chlorophyll content. Varieties such as Nauli F1 and Flamingo have been proven to respond well to cultivation treatments (Utami & Setiawati, 2018).

Decreasing soil fertility due to prolonged chemical fertilizer use presents another major challenge. To address this issue, biofertilizers offer an environmentally friendly solution, as they contain microorganisms that enhance nutrient availability, improve soil structure, and increase nutrient absorption efficiency in plants (Sholihah & Sugianto, 2014; Samsudin et al., 2022). Biofertilizers contain functional microorganisms such as *Azospirillum* and *Pantoea* sp., which assist in nitrogen fixation and phosphate solubilization. They can also improve soil structure and biology, thereby accelerating the decomposition of soil organic matter. Research by Samsudin et al. (2022) found that applying 150 kg/ha of biofertilizer in a planting medium consisting of soil, manure, and rice husk charcoal significantly affected plant height (20.53 cm), number of leaves (10.86), fresh weight (59.89 g), and dry weight (15.93 g) of the Nauli F1 pakchoy variety. Regression analysis indicated an

optimal biofertilizer dose of 150 kg/ha, yielding an economic plant weight of 136.882 grams per plant. Based on these results, it is recommended that biofertilizer application can improve the growth and yield of pakchoy plants.

This study contributes to the development of environmentally friendly pakchoy cultivation techniques through the use of biofertilizers and the selection of adaptive superior varieties. The findings are expected to serve as a reference for sustainable agricultural practices and to reduce dependence on chemical fertilizers.

RESEARCH METHODOLOGY

This research was conducted from November 2024 to January 2025. The study took place in Warung Mangga Village, Pinang Subdistrict, Tangerang City, Banten Province. The tools used in this research included a shovel, measuring tape, sprayer, seedling tray, 20×20 cm polybags, ruler, camera, stationery, and a digital scale. The materials used were pakcoy seeds of Nauli F1 and Flamingo varieties, soil, goat manure, Petrobio biofertilizer, NPK compound fertilizer (16:16:16), water, rice husk charcoal, and botanical fungicide.

This study employed an experimental method using a factorial Randomized Complete Block Design (RCBD) consisting of two factors. The first factor comprised two levels: V1 = Nauli F1 variety and V2 = Flamingo variety. The second factor consisted of five levels: H0 = no fertilizer, H1 = biofertilizer at 100 kg/ha, H2 = biofertilizer at 150 kg/ha, H3 = biofertilizer at 200 kg/ha, and H4 = NPK fertilizer at 150 kg/ha (control). Based on this design, the study consisted of 10 treatment combinations, each replicated three times, resulting in 30 experimental units. Each unit contained two plants, yielding a total of 60 plants in the study.

The seedling medium used was a mixture of soil and rice husk charcoal in a 1:1 ratio. Each seedling tray hole was filled with one pakcoy seed that had been soaked in warm water for 30 minutes. The seedling process was carried out for two weeks. The observed variables in this research were plant height, number of leaves, shoot fresh weight, root fresh weight, and root length. The collected data were analyzed using Analysis of Variance (ANOVA) and followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level.

RESULTS AND DISCUSSION

Plant Height

In crop cultivation research, plant height is one of the primary parameters for evaluating growth due to its ease of observation. According to Darmawan (2019), this parameter can be used to determine the effect of treatments on the conducted experiment. Based on Table 1, which shows the average plant height of pakcoy at each week after planting (WAP), there were differences in response between the two varieties (Nauli F1 and Flamingo) to the application of biofertilizer. In the treatment without fertilizer (H0), plant height tended to be lower compared to treatments that received biofertilizer. Higher doses of biofertilizer (H3 and H4) resulted in greater plant height than the lower doses (H1 and H2).

This result shows that the application of biofertilizer influences the increase in plant height. The biofertilizer used in this study contains microorganisms such as *Azospirillum* sp. and *Pantoea dispersa*. These microbes act as nitrogen-fixing bacteria and plant growth-promoting rhizobacteria (PGPR). The presence of these microbes can enhance the availability of nutrients in the soil, especially nitrogen, and stimulate the production of growth hormones that accelerate the plant growth process, including the increase in plant height. According to Handayani and Elfarisna (2021), plants require large amounts of the macronutrients nitrogen (N), phosphorus (P), and potassium (K).

Nitrogen plays a role in cell elongation and division as it is a component of the protoplasm in the growing point tissues. When nitrogen availability is sufficient, it plays an important role in increasing plant height. The application of nitrogen at the appropriate dose results in optimal nutrient uptake, thus affecting plant height (Fathin et al., 2019).

Table 1. Average Plant Height of Pakcoy (*Brassica rapa* L.)

MST	Biofertilizer	Plant Height (cm)	
		V1 (Nauli F1)	V2 (Flamingo)
1	H0	4,98 a	4,53 a
	H1	5,26 ab	4,57 a
	H2	5,21 ab	4,63 a
	H3	6,19 b	5,09 a
	H4	5,87 b	4,98 a
2	H0	8,43 ab	7,53 a
	H1	8,57 ab	7,81 a
	H2	8,66 ab	8,09 ab
	H3	9,48 b	8,58 ab
	H4	9,24 b	8,64 ab
3	H0	14,03 b	12,52 a
	H1	14,14 b	12,58 a
	H2	14,26 b	12,69 a
	H3	15,40 b	14,52 b
	H4	15,30 c	14,41 b
4	H0	19,62 b	18,43 a
	H1	19,73 b	18,49 a
	H2	19,84 b	18,61 a
	H3	20,65 c	19,53 b
	H4	20,50 c	19,33 b

Note**:** The same letters in the same row or column indicate no significant difference based on the DMRT test at the 5% significance level.

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At the end of the study, the Nauli F1 variety (V1) produced the tallest plants, recorded in treatments H3 and H4, measuring 20.65 cm and 20.50 cm, respectively. Meanwhile, treatments H0 through H2 resulted in shorter pakcoy plants with heights of 19.62 cm, 19.73 cm, and 19.84 cm. The average plant height for the Nauli F1 variety was 20.07 cm, indicating that the application of

biofertilizer tends to increase plant growth. In the Flamingo variety (V2), the tallest plants were obtained from treatments H3 and H4, with heights of 19.53 cm and 19.33 cm, compared to treatments H0 through H2 which had plant heights ranging from 18.43 cm to 18.61 cm. The average plant height of the Flamingo variety was 18.88 cm, which is lower than that of the Nauli F1 variety. These results demonstrate that the Nauli F1 variety shows a better growth response to biofertilizer application compared to the Flamingo variety. This indicates an interaction between the variety type and biofertilizer application, which can affect the effectiveness of plant growth. According to Zakaria and Wicaksono (2023), each variety has different responses to treatments and the environment where it grows.

Number of Leaves

Leaves on plants can be used as a criterion to determine the level of plant growth and development because leaves are the site of photosynthesis reactions (Rismayanti et al., 2024). Based on Table 2 regarding the number of pakcoy leaves at 4 weeks after planting (WAP), there is a difference in response between the two varieties (Nauli F1 and Flamingo) to biofertilizer treatments. In the treatment without fertilizer (H0), the number of leaves tends to be lower compared to treatments receiving biofertilizer. The application of biofertilizer significantly increased the number of leaves, especially in higher doses (H3 and H4), which showed better results compared to lower doses (H1 and H2).

The application of biofertilizer had a significant effect on the number of pakcoy leaves, with the best result at the biofertilizer dose of 200 kg/ha (H3), producing 12.22 leaves (Figures 1 and 2). The biofertilizer used contains *Azospirillum* sp. microorganisms that function to fix nitrogen from the air, produce auxin, cytokinin, and gibberellin hormones, which help in chlorophyll formation. These hormones can stimulate leaf growth and accelerate the photosynthesis process in plants. Wenno and Sinay (2019) stated that nitrogen can increase the rate of photosynthesis, and the resulting products can be accumulated in all parts of the plant for growth, including leaf formation. The more nitrogen available in the growing medium, the more chlorophyll is produced for photosynthesis, thereby increasing the availability of nutrients for plant growth..

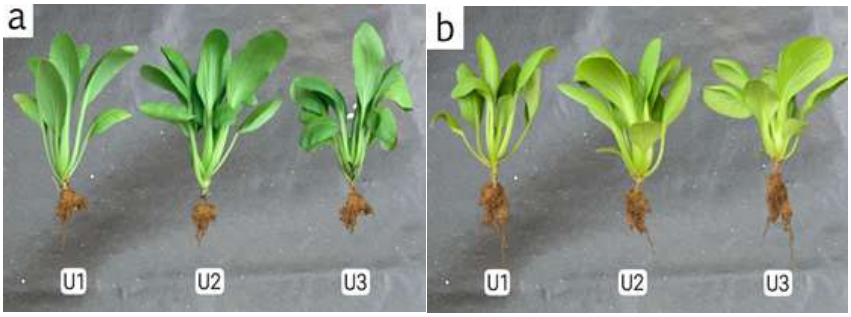

Figure 1. Difference in the Number of Leaves at 4 MST
(a). Nauli F1 Variety, (b). Flamingo Variety

In the Nauli F1 variety (V1), biofertilizer treatment had a significant effect on increasing the number of leaves. At the end of the study, treatment H3 produced the highest number of leaves at 12.22 leaves, followed by H4 with 12 leaves. The treatment without fertilizer (H0) showed the lowest number of leaves at 10.17 leaves, while treatments H1 and H2 produced 10.33 leaves and 10.88 leaves, respectively. Overall, the average number of leaves for the Nauli F1 variety was 11.12 leaves. For the Flamingo variety (V2), the leaf number growth pattern also showed a

positive response to biofertilizer treatment, although the overall leaf count was slightly lower compared to Nauli F1. Treatment H3 gave the best result with 11.33 leaves, followed by H4 with 11 leaves. The treatment without fertilizer (H0) showed the lowest number of leaves at 9.8 leaves, while H1 and H2 produced 10 leaves and 10.5 leaves, respectively. The average number of leaves for the Flamingo variety was 10.47 leaves (Table 2). The best-performing variety was Nauli F1, as it exhibited faster leaf growth. These results indicate that the Nauli F1 variety responds better to biofertilizer application compared to the Flamingo variety. This allows the plants to produce leaves in a shorter time, significantly increasing the number of leaves. Additionally, the leaves have a non-bitter taste and a bright green color, indicating a high chlorophyll content. Pakcoy varieties with better genetics show improved physiological responses at younger ages, enabling them to produce more leaves.

According to Valupi (2022), each variety has genetic factors and varietal traits that shape the characteristics of the plant, including growth and productivity. Therefore, using different varieties results in different yields and plant characteristics.

Tabel 3. Pengaruh konsentrasi BAP terhadap tinggi tunas ubi jalar aksesi Katulampa (cm)

MST	Biofertilizer	Number of Leaves (leaves)	
		V1 (Nauli F1)	V2 (Flamingo)
1	H0	5,17 a	4,83 a
	H1	5,24 b	4,83 a
	H2	5,33 b	5,00 a
	H3	7,33 d	6,17 c
	H4	6,83 d	6,00 c
2	H0	6,33 a	6,00 a
	H1	6,33 a	6,33 a
	H2	6,67 a	6,33 a
	H3	9,17 c	7,33 b
	H4	9,83 c	7,17 b
3	H0	7,83 a	7,67 a
	H1	8,17 a	8,17 a
	H2	8,33 a	8,33 a
	H3	11,00 b	9,67 b
	H4	10,67 b	9,33 b
4	H0	10,17 a	9,5 a
	H1	10,33 a	10 a
	H2	10,83 a	10,5 a
	H3	12,33 b	11,33 b
	H4	12,00 b	11,00 b

Note: The same letters in the same row or column indicate no significant difference based on the DMRT test at the 5% significance level.

Fresh Shoot Weight

Fresh shoot weight is the weight of the plant without roots after harvest and before the plant experiences wilting and water loss. Based on Table 3 regarding the fresh shoot weight of pakcoy plants, there is a difference in response between the two varieties (Nauli F1 and Flamingo) to biofertilizer treatment. In the treatment without fertilizer (H0), the fresh shoot weight tended to be lower in both varieties. An increase in fresh shoot weight was observed starting from higher biofertilizer doses (H3 and H4), where the Nauli F1 variety (V1) reached its highest weight at the 200 kg/ha dose (H3), similarly to the

Flamingo variety (V2), which also showed the highest weight under treatment H3 with a 200 kg/ha dose. This indicates that higher doses of biofertilizer can significantly improve shoot growth, although the response exhibited by the two varieties differs. This is because the biofertilizer used in this study contains several microbes such as *Aspergillus niger*, *Penicillium oxalium*, and *Streptomyces* sp., which aid in composting organic materials by producing cellulase and ligninase enzymes as decomposers, increasing nutrient availability, and improving soil structure. The application of biofertilizer can provide a sufficient nutrient supply for pakcoy plants. According to Balompapung (2021), biofertilizers contain N, P, and K elements, each functioning for plant growth and development, impacting plant productivity. Therefore, they can improve soil quality and enhance the soil's ability to absorb water and nutrients, allowing pakcoy plants to grow better and positively affect fresh shoot weight. This aligns with Suryawati et al. (2022), who stated that nutrients in biofertilizers are easily absorbed by plants, contain microorganisms, overcome nutrient deficiencies, are not problematic in nutrient leaching, and can supply nutrients quickly.

In the Nauli F1 variety, treatment H3 produced the heaviest fresh shoot weight at 76.79 grams, followed by H4 with 65.44 grams. The treatment without fertilizer (H0) produced the lowest weight at 43.60 grams, while treatments H1 and H2 resulted in weights of 51.93 grams and 46.52 grams, respectively. The average fresh shoot weight for the Nauli F1 variety was 56.85 grams. In the Flamingo variety, treatment H3 again provided the highest fresh shoot weight at 76.79 grams, followed by H4 with 65.44 grams. Treatments H0, H1, and H2 showed weights of 40.51 grams, 43.36 grams, and 50.44 grams, respectively. The average fresh shoot weight for the Flamingo variety was 47.44 grams. Both varieties showed a positive response to biofertilizer application, especially in treatments H3 and H4, which yielded the highest fresh shoot weights.

Nauli F1 is one of the pakcoy varieties with genetic potential to produce high fresh shoot weight. This variety has been developed through genetic selection for optimal growth characteristics, including the development of large and thick leaves. This is consistent with Permatarasari et al. (2023), who stated that using superior varieties can increase crop production by up to 56%, while the interaction between superior varieties and fertilization can increase harvest yields by up to 75% and reduce the use of chemical pesticides during cultivation. Therefore, the Nauli F1 variety produces higher fresh shoot weight compared to other pakcoy varieties because it is better at absorbing and utilizing nutrients available in the soil. Other factors such as crop management, soil quality, and environmental conditions can also influence the overall fresh shoot weight.

Table 3. Average Fresh Shoot Weight of Pakcoy (*Brassica rapa* L.)

Biofertilizer	Fresh Shoot Weight (g)	
	V1 (Nauli F1)	V2 (Flamingo)
H0	43,60 a	40,51 a
H1	51,93 a	43,36 a
H2	46,52 a	50,44 a
H3	76,79 b	55,29 a
H4	65,44 b	47,58 a

Note**:** The same letters in the same row or column indicate no significant difference based on the DMRT test at the 5% significance level

Fresh Root Weight

Fresh root weight is one of the parameters used to study plant growth by measuring the fresh weight of roots after harvest without drying. Based on Table 4 regarding the average fresh root weight of pakcoy plants, there is a difference in response between the two varieties (Nauli F1 and Flamingo) to biofertilizer treatments. In the treatment without fertilizer (H0), the fresh root weight for both varieties ranged between 3.16 and 3.26 grams. A significant increase in fresh root weight was observed in treatments H3 and H4, where the Nauli F1 variety achieved the highest weight in treatment H3, similarly to the Flamingo variety, which also reached its highest weight in treatment H3. This is suspected to be because the application of biofertilizer at the appropriate dose can meet the nutritional needs of the plants, which promotes root growth and development, resulting in greater fresh root weight. Additionally, it can increase organic matter content in the soil, improve soil structure, enhance water retention capacity, and increase nutrient availability in the soil. Thus, biofertilizer has a very significant effect on the fresh root weight parameter of pakcoy plants. According to Fathin et al. (2019), the use of biofertilizers can improve soil productivity both physically and chemically, aiming to increase soil fertility and nutrient availability.

In the Nauli F1 variety, treatment H3 produced the highest fresh root weight at 5.97 grams, followed by treatment H4 with 5.82 grams. The treatment without fertilizer (H0) resulted in the lowest root weight of 3.26 grams, while treatments H1 and H2 recorded weights of 3.28 grams and 3.71 grams, respectively. The average fresh root weight for this variety was 4.41 grams. Similarly, the Flamingo variety showed comparable results. Treatment H3 yielded the highest fresh root weight of 4.78 grams, followed by H4 with 4.63 grams. Treatments H0, H1, and H2 produced fresh root weights of 3.16 grams, 3.22 grams, and 3.38 grams, respectively. The average fresh root weight for the Flamingo variety was 3.85 grams. From these data, it can be concluded that biofertilizer application, especially in treatments H3 and H4, consistently increases fresh root weight in both pakcoy varieties. This indicates that biofertilizer application can improve root system growth, which contributes to enhanced water and nutrient uptake efficiency. The Nauli F1 variety showed a higher average fresh root weight compared to the Flamingo variety, indicating better root growth potential under the same treatment conditions. The use of different varieties has a significant influence on the fresh root weight parameter, due to the genetic differences between varieties, particularly in root system growth. These differences include water and nutrient absorption capacity, root growth rate, and nutrient use efficiency in the soil. According to Dewi (2019), varieties with stronger and more extensive root systems tend to have higher fresh root weights because they can accumulate more root biomass. Therefore, genetic variation among varieties is a primary factor causing significant differences in the fresh root weight of plants.

Root Length

Root length is an important parameter used to evaluate the growth of the plant's root system, particularly in absorbing water and nutrients from the soil. Root length measurement is conducted after harvest using a ruler, starting from the base of the root to the tip of the longest root. Based on Table 5 regarding the root length of pakcoy plants, there are differences in response between the two varieties (Nauli F1 and Flamingo) to biofertilizer treatments. In the treatment without fertilizer (H0), root lengths for both varieties ranged from 10.09 cm to 10.36 cm. Root length increased along with higher doses of biofertilizer, especially in treatments H3 and H4. The

Nauli F1 variety reached its highest root length in treatment H3 (15.14 cm), while the Flamingo variety achieved its longest root in treatment H3 as well (14.12 cm). This indicates that the application of biofertilizer can influence the development of the pakcoy root system. The active microorganisms in the biofertilizer enhance the availability of essential nutrients, especially nitrogen and phosphorus, which are highly needed during the early root growth phase. Microorganisms such as *Azospirillum* sp. and *Streptomyces* sp. in the biofertilizer not only assist in nitrogen fixation and phosphate solubilization but also produce growth regulators like auxin that directly stimulate root cell division and elongation. According to Purba et al. (2020), microbial activity improves soil structure and the microenvironment around the roots, making it easier for roots to penetrate the growing medium and develop further. Consequently, roots can grow longer to seek water and nutrients, resulting in a significant increase in root length in plants treated with biofertilizer.

Table 4. Average Fresh Root Weight of Pakcoy (*Brassica rapa* L.)

Biofertilizer	Fresh Root Weight (g)	
	V1 (Nauli F1)	V2 (Flamingo)
H0	3,26 a	3,16 a
H1	3,28 a	3,22 a
H2	3,71 a	3,38 a
H3	5,97 b	4,78 b
H4	5,82 b	4,63 b

Note**:** The same letters in the same row or column indicate no significant difference based on the DMRT test at the 5% significance level.

Table 5. Average Root Length of Pakcoy (*Brassica rapa* L.)

Biofertilizer	Root Length (cm)	
	V1 (Nauli F1)	V2 (Flamingo)
H0	10,36 b	10,09 a
H1	10,41 b	10,10 a
H2	10,49 b	10,23 a
H3	15,14 d	14,12 c
H4	14,83 c	13,93 c

Note**:** The same letters in the same row or column indicate no significant difference based on the DMRT test at the 5% significance level.

For the Nauli F1 variety, the treatment without fertilizer (H0) produced the shortest root length of 10.36 cm. Root length started to increase in treatments H1 and H2, measuring 10.41 cm and 10.49 cm, respectively. Treatment H3 gave the highest root length at 15.14 cm, followed by H4 at 14.83 cm, with an overall average of 12.42 cm. Similarly, in the Flamingo variety, treatments H0, H1, and H2 produced relatively shorter roots, measuring 10.09 cm, 10.10 cm, and 10.23 cm, respectively. Significant increases were recorded in treatments H3 and H4, with root lengths of 14.12 cm and 13.93 cm, respectively. The average root length for this variety was 11.70 cm. The application of biofertilizer, especially in treatments H3 and H4, consistently increased the root length of pakcoy plants. This shows that the use of biofertilizer can optimally stimulate the growth of the plant's root system. Moreover, the Nauli F1 variety tends to have longer roots compared to the Flamingo variety, indicating different varietal responses to biofertilizer treatment.

CONCLUSION AND SUGGESTION

In this study, pakcoy plants of the Nauli F1 variety treated with a biofertilizer dose of 200 kg/ha showed the best response in terms of plant height, number of leaves, fresh shoot weight, fresh root weight, and root length. Optimal pakcoy cultivation can be achieved by using the appropriate variety along with the right type and dosage of biofertilizer.

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