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Optimizing Bitter Mustard Plants (*Brassica Juncea* L.) Growth and Production by Administering Inorganic Fertilizer and Liquid Organic Fertilizer

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ABSTRACT

Bitter mustard greens (*Brassica juncea*) are a leaf vegetable widely consumed in Indonesia. This research aims to evaluate the effect of a combination of NPK fertilizer and liquid organic fertilizer from banana weevils on the growth of bitter mustard greens. The method used was a factorial randomized block design with two factors (NPK and organic fertilizer) and three replications. Analysis of variance was carried out to analyze significant differences between treatments, with further tests using Duncan's Multiple Range Test (DMRT) at a significance level of 5%. The results showed that treating 10g NPK + 100ml POC Banana Stem and 10g NPK + 200ml POC Banana Stem consistently gave the best results on various growth parameters of bitter mustard plants. The 10g NPK + 100ml POC Banana Stem treatment produced the highest plant height at each observation stage, while the 10g NPK + 200ml POC Banana Stem treatment showed the highest number of leaves and plant fresh weight. The combination of NPK fertilizer and banana hump liquid organic fertilizer has proven to be effective in improving the growth quality of bitter mustard greens, including plant height, greater number of leaves and optimal fresh weight.

Keywords: *Banana Stem POC, Bitter Mustard Greens, Liquid Organic Fertilizer, NPK, Plant Growth, Plant Production*

1. INTRODUCTION

The leafy vegetable known as bitter mustard greens (*Brassica Juncea* L.) is commonly eaten in Indonesia. This particular vegetable is renowned for its characteristic bitter flavor and is commonly employed as a component in various culinary preparations, including stir-fries and vegetable broths—mustard greens with a bitter taste feature broad, green foliage and elongated stems. In addition to its distinctive flavor, bitter mustard greens contain a wide array of essential nutrients, including vitamin A, vitamin C, and dietary fiber, all contributing to overall bodily well-being. Mustard greens with a bitter taste can thrive in tropical regions such as Indonesia (D et al., 2019). For the optimal growth of this plant, it is necessary to provide adequate sunlight, fertile soil, and efficient drainage. Cultivating bitter mustard is relatively uncomplicated and can be undertaken on a small or large basis. Farmers typically sow bitter mustard greens in open fields by directly planting the seeds into the ground. Continued utilization of land without sufficient replenishment of nutrients frequently leads to a depletion of soil nutrients, resulting in a nutrient crisis. This leads to a reduction in the fertility of the soil and the productivity of plants, which is evidenced by the presence of deficiency symptoms such as the yellowing of leaves and inhibited growth. In order to address this issue, the utilization of suitable fertilizer and the implementation of sustainable soil management techniques are necessary. In addition, the maintenance of bitter mustard plants involves consistent watering, fertilization, and management of pests and diseases. Bitter mustard greens can be harvested within a relatively short time frame of 30-45 days after initial planting, distinguishing it as a vegetable with a rapid growth and harvest cycle (Kustiawan et al., 2024).

Based on the 2023 data provided by the Central Statistics Agency (BPS), there has been a notable increase in mustard crop production in North Sumatra compared to previous years. North Sumatra is recognized as a key region for mustard greens cultivation in Indonesia, boasting a substantial agricultural land area and favorable climatic conditions conducive to mustard greens growth. This production surge fulfils local demands and aids in providing mustard greens to other regions. The data signifies the triumph of farmers in embracing improved agricultural practices and more effective fertilizer and agricultural technology utilization.

NPK fertilizer, comprising nitrogen (N), phosphorus (P), and potassium (K), is a vital fertilizer containing three essential nutrients crucial for plant growth and development. The application of NPK fertilizer to vegetables like mustard greens demonstrates that it can enhance crop growth and yield by increasing plant height, leaf count, and overall weight. However, this study diverges by examining NPK fertilizer and combining it with organic fertilizer derived from banana stems, alongside evaluating the growth parameters of bitter mustard greens at various developmental stages to observe the synergy between the two fertilizer types. Nitrogen aids in protein synthesis and leaf expansion, phosphorus is pivotal for root and flower development, while potassium promotes stem growth and boosts plant resilience against diseases. Employing NPK fertilizer tailored to plant requirements can elevate crop yields and the quality of cultivated plants (Arief & Nursangadji, 2022).

Liquid organic fertilizer derived from banana stems through fermentation and other organic components is a nutrient-rich fertilizer with beneficial microorganisms for plant growth (Fitriani et al. 2019). This type of fertilizer, known as banana stem POC, is packed with essential nutrients like nitrogen, phosphorus, potassium, iron, magnesium, and calcium, which are

crucial in enhancing plant development and improving harvest quality (Laginda, 2017). The application of banana stem POC offers numerous advantages for plants, including enhanced nutrient availability, improved soil structure, and increased microbial activity in the soil, all of which contribute to overall plant health (Hairuddin & Ariani, 2017). Studies have shown that using POC on crops like mustard greens and spinach leads to positive outcomes, such as increased growth and higher yields. For instance, research conducted by (Wulandari, A., Susanto, R., and Pratama, 2019) demonstrated that applying POC derived from vegetable waste on mustard greens resulted in taller plants, more leaves, and increased fresh weight.

The primary objective of this study is to assess the impact of NPK fertilizer, liquid organic fertilizer (POC) derived from banana stems (Musa Paradiseaca), and a combination of both on the development and yield of bitter mustard greens (*Brassica Juncea* L.). It is hypothesized that the utilization of NPK fertilizer, banana stem POC, and a combination of the two will substantially influence the growth and production of bitter mustard plants. Bitter mustard plants commonly encounter growth challenges such as nutrient deficiencies, particularly nitrogen, phosphorus, and potassium, and disturbances caused by suboptimal environmental conditions (Udiyana et al., 2019). The appropriate application of NPK fertilizer can help address nutrient deficiencies, while liquid organic fertilizer from banana stems can offer supplementary nutrients and enhance soil quality. NPK fertilizer comprises essential nutrients crucial for the optimal growth of bitter mustard plants. Nitrogen contributes to protein synthesis and leaf development, phosphorus is vital for root and flower formation, and potassium aids in stem growth and boosts disease resistance. Conversely, liquid organic fertilizer from banana stems can enhance the availability of plant nutrients and the activity of beneficial soil microorganisms. Consequently, this study aims to provide valuable insights into enhancing the growth of bitter mustard greens efficiently by utilizing NPK fertilizer and liquid organic fertilizer from banana stems.

2. MATERIAL AND METHODS

This research was conducted in Dusun Sidodadi, Pangkatan Subdistrict, Labuhanbatu Regency, North Sumatra Province, with geographical coordinates (latitude 2º17’-2º50' N, longitude 99º46’-100º20’ E). The study was carried out from January to March 2024.

The materials to be used include bitter mustard seeds (*Brassica juncea* L.), NPK fertilizer, banana pseudostem liquid fertilizer (Musa paradisiaca), 3 kg polybags (25 cm × 40 cm), water, and soil. The equipment employed includes hoes, measuring tapes, plastic string, scissors, seed trays, shade nets, measuring cups, calipers, name boards, buckets, cameras, writing tools, additional cameras, and laptops.

The design to be used is a factorial Randomized Block Design (RBD) consisting of 2 factors and 3 replications. The data obtained from field observations will be distributed to an Analysis of Variance (ANOVA) to analyze the data (Xie & Yan, 2023). If significant differences are found, follow-up tests using the DMRT method will be conducted at a 5% significance level (Parasmita et al., 2022). The software used for data analysis is SPSS 25.

The observed variables include vegetative growth (plant height and leaf count) and yield growth (fresh weight of the plants).

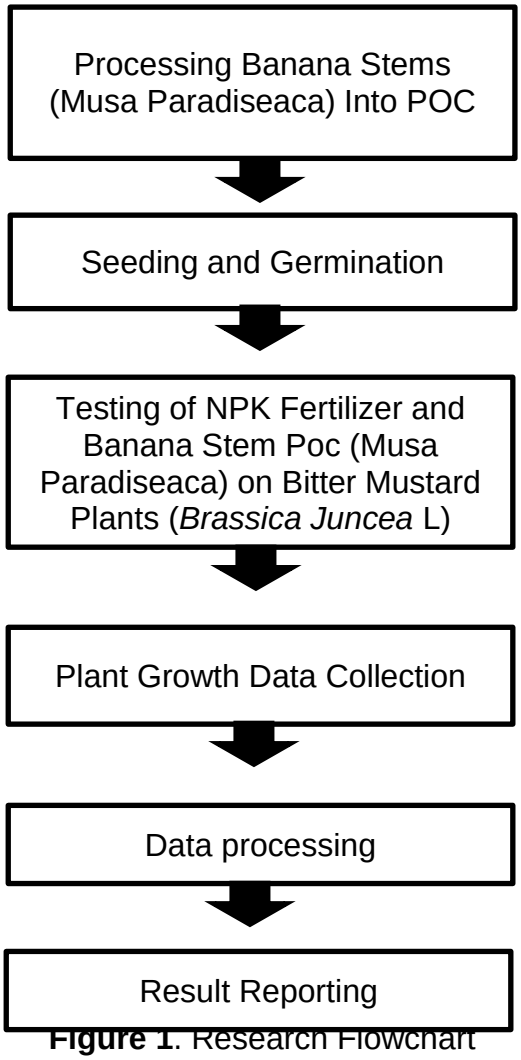

Figure 1. Research Flowchart

3. RESULT AND DISCUSSION

Plant height is a crucial parameter for assessing the development and well-being of plants, including bitter mustard greens (*Brassica Juncea* L.). Several factors, such as soil composition, water availability, sunlight exposure, and fertilizer usage, can impact the height of bitter mustard plants. Studies have demonstrated that applying organic and inorganic fertilizers can substantially enhance the vertical growth of bitter mustard plants. Furthermore, implementing sound agricultural techniques, such as pest management, disease prevention, and weed control, is vital in promoting optimal plant growth. An ideal plant height signifies efficient nutrient uptake and favorable growing conditions, enabling bitter mustard plants to flourish with lush foliage and expedited maturation for harvesting. The findings regarding plant height measurements are detailed in Table 1.

The findings indicated that the 10g NPK + 100ml POC Pisang Batang treatment consistently yielded the highest average height of bitter mustard greens at each observation stage (1 WAP: 7.97 cm, 2 WAP: 11.97 cm, 3 WAP: 19.97 cm, 4 WAP: 27.97 cm). These results significantly differed from most other treatments at the 5% significance level (DMRT 5%). This is consistent with Nugroho's (2020) previous research, which demonstrated that specific combinations of NPK fertilizer and organic fertilizer can optimize plant growth. However, these findings differ from Putra et al.'s (2021) research, which suggested that treatment with only liquid organic fertilizer was adequate for

achieving favorable growth results for bitter mustard plants without additional NPK fertilizer. These disparities may be attributed to variations in environmental conditions, soil type, or even the plant varieties utilized in each study.

Table 1. Average height of bitter mustard plants

NPK and POC	Average Plant Height Weight (Cm)			
	1 MST	2 MST	3 MST	4 MST
Control	6.98±0.67ab	9.98±0.32a	15.98±2.32a	21.98±4.35a
0+100 ml	6.90±0.05a	10.90±0.05b	18.90±0.05ab	26.90±0.05a
0+200 ml	7.20±0.05ab	11.20±0.05bcd	19.20±0.05ab	27.20±0.05a
5g+0	7.10±0.05ab	11.10±0.05bc	19.10±0.05ab	27.10±0.05a
5g+100ml	7.50±0.05ab	11.50±0.05cde	19.50±0.05b	27.50±0.05a
5g+200ml	7.90±0.05ab	11.90±0.050e	19.90±0.05b	27.90±0.05a
10g+0ml	7.60±0.05ab	11.60±0.05de	19.60±0.05b	27.60±0.05a
10g+100ml	7.97±0.03c	11.97±0.03e	19.97±0.03b	27.97±0.03a
10g+200ml	8±0c	12±0e	20±0b	28±0a

Note: The average value in each column followed by the same letter indicates that it is not significantly different at 5% DMRT

3.1 Number of Leaves (Strands)

The quantity of leaves on bitter mustard plants (*Brassica Juncea* L.) is a crucial factor in assessing the development and yield of this particular plant. Various factors related to cultivation, including the type of fertilizer, the intensity of sunlight, and the watering frequency, can impact the quantity of leaves produced. According to academic research, the application of NPK fertilizer and liquid organic fertilizer derived from banana weevils has been found to have a pronounced impact on the leaf count of bitter mustard plants, leading to a significant increase. The analysis of the variance test and subsequent post-hoc tests using Duncan's multiple range test in this research indicated that a specific combination of NPK and liquid organic fertilizer resulted in a higher leaf count than alternative treatments. This demonstrates that the appropriate use of fertilizer can enhance the quality of bitter mustard plants by increasing the number of leaves, thereby enhancing the plant's production and economic value. The findings from the examination of leaf quantity are outlined in table 2.

Table 2. Results average number of leaves

NPK and POC	Average Number of Leaves (Strands)			
	1 MST	2 MST	3 MST	4 MST
Control	3.90±1.70a	5.40±1.20a	6.90±0.70a	8.40±0.20a
0+100 ml	2.90±0.05a	4.90±0.05a	6.90±0.05a	8.90±0.05b
0+200 ml	3.20±0.05a	5.20±0.05a	7.20±0.05ab	9.20±0.05bc
5g+0	3.10±0.05a	5.10±0.05a	7.10±0.05ab	9.10±0.05b
5g+100ml	3.50±0.05a	5.50±0.05a	7.50±0.05ab	9.50±0.05c
5g+200ml	3.90±0.05a	5.90±0.05a	7.90±0.05ab	9.90±0.05de
10g+0ml	3.60±0.05a	5.60±0.05a	7.60±0.05ab	9.60±0.05cd
10g+100ml	3.97±0.03a	5.97±0.03a	7.97±0.03ab	9.97±0.03e
10g+200ml	4±0a	6±0a	8±0b	10±0e

Note: The average value in each column followed by the same letter indicates that it is not significantly different at 5% DMRT

The research findings indicated that the application of 10g NPK + 200ml Banana Stem POC resulted in the highest number of bitter mustard leaves at each observation stage (1 WAP: 4 pieces, 2 WAP: 6 pieces, 3 WAP: 8 pieces, 4 WAP: 10 pieces), and these results were significantly different from other treatments at a 5% significance level (DMRT 5%). Similarly, the treatment of 10g NPK + 100ml POC Banana Stem also demonstrated comparable results, particularly at 3 WAP and 4 WAP, with 7.97 and 9.97 leaves, respectively. This finding is consistent with Setiawan et al. (2022), who also found that combining chemical and organic fertilizers increased the leaf count in spinach plants, which share similar growth characteristics with bitter mustard greens.

Additionally, Hartono (2019) suggested that the use of biological fertilizer can yield optimal results in the leaf count of bitter mustard plants, indicating that biological fertilizer, containing microorganisms that enhance nutrient absorption, can be an effective alternative to NPK fertilizer. The observed differences in results may be attributed to variations in environmental conditions, soil type, or cultivation methods employed in the respective studies.

3.2 Plant fresh weight (g)

The evaluation of productivity and quality of the harvest is significantly influenced by the fresh weight of bitter mustard greens (*Brassica Juncea* L.). Factors such as the type of fertilizer used, water availability, and overall plant management can impact the plant's fresh weight. The research findings indicate that a combination of NPK fertilizer and liquid organic fertilizer from banana weevils positively affects the fresh weight of bitter mustard plants. The variance and follow-up tests with DMRT revealed that specific treatments resulted in significantly higher plant fresh weight than other treatments. This highlights the importance of appropriate fertilizer application in increasing the yield of bitter mustard plants, thereby supporting the availability and quality of supplies for consumers and local markets. The application of NPK and banana stem POC fertilizers has been shown to increase the fresh weight of bitter mustard plants significantly. This contrasts with previous research by (Susanti, A., Haryanto, B., and Rahmawati, 2020), which demonstrated that giving NPK to green spinach only increased biomass without a combination with organic fertilizer. The results of observations of plant fresh weight are detailed in Table 3.

The findings indicated that bitter mustard plants treated with 10g NPK + 200ml POC Banana Stem exhibited the highest fresh weight across all observation stages (1 WAP: 8.80 g, 2 WAP: 23.80 g, 3 WAP: 46.03 g, 4 MST: 80.03 g), consistently outperforming other treatments. Similarly, the 10g NPK + 100ml POC Banana Stem treatment yielded comparable results, particularly during stages 3 WAP and 4 WAP, with fresh weights of 44.33 g and 78.33 g, respectively. These outcomes align with Wijayanti et al.'s (2021) research, which demonstrated that a blend of chemical and organic fertilizers enhances the fresh weight of green mustard plants, sharing growth characteristics with bitter mustard greens. Combining chemical and organic fertilizers can offer a more comprehensive and balanced nutrient supply, promoting plant growth and increasing fresh weight.

Susanto (2020) found that using compost fertilizer can lead to superior outcomes regarding the fresh weight of bitter mustard plants. This suggests that compost fertilizer can serve as a viable alternative without the necessity of being combined with NPK fertilizer. Compost contains microorganisms that can enhance the absorption of nutrients, potentially accounting for the observed disparities in results. These variations may stem from differences in environmental conditions, soil

composition, or cultivation techniques employed in the respective studies. The key disparity between this study and previous research is that, according to Susanto, applying organic fertilizer alone can yield optimal results. In contrast, this study utilizes a combination of two fertilizers to enhance fresh-weight yields in mustard plants.

Table 3. Yield Average fresh weight of plants

NPK and POC	Average Fresh Weight of Plants (g)			
	1 MST	2 MST	3 MST	4 MST
Control	6.98±0.67	16.13±2.37	28.30±6.43	53.80±14.93
0g+100 ml	7.20± 0.05	19.80±0.17	37.03±0.29	71.03±0.29
0g+200 ml	7.60± 0.05	20.40±0.17	38.63±0.29	72.63±0.29
5g+0ml	7.10± 0.05	20.30±0.17	38.53±0.29	72.53±0.29
5g+100ml	7.90± 0.05	21.60±0.17	40.83±0.29	74.83±0.29
5g+200ml	8.40± 0.05	22.30±0.17	42.53±0.29	76.53±0.29
10g+0ml	7.60± 0.05	21.80±0.17	42.03±0.29	76.03±0.29
10g+100ml	8.30± 0.05	23.10±0.17	44.33±0.29	78.33±0.29
10g+200ml	8.80± 0.05	23.80±0.17	46.03±0.29	80.03±0.29

Note: The average value in each column followed by the same letter indicates that it is not significantly different at 5% DMRT

The research results are shown in the image below:

Figure 1. Sowing and planting bitter mustard seeds

Figure 2. Growth of bitter mustard plants

Figure 3. Bitter mustard plant

Figure 4. The harvest of bitter mustard plants

4. CONCLUSION

Applying 10g NPK + 100ml POC Banana Stem and 10g NPK + 200ml POC Banana Stem consistently resulted in the most favorable outcomes across various growth parameters of bitter mustard plants. Specifically, the 10g NPK + 100ml POC Banana Stem treatment exhibited the tallest average plant height during each observation stage, whereas the 10g NPK + 200ml POC Banana Stem treatment yielded the highest number of leaves and plant fresh weight at each observation stage. The combination of NPK fertilizer and banana hump liquid organic fertilizer (N2B1 and N2B2 treatments) has demonstrated its effectiveness in enhancing plant height, leaf count, and fresh weight of bitter mustard plants.

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