JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 7 NO. 2 May 2025

DOI :https://doi.org/10.36378/juatika.v7i2.4758
eissn 2656-1727
pissn 2684-785X
pages : 654 – 659

RESEARCH ARTICLE Open Access

Application of Liquid Organic Fertilizer (LOF) from Bamboo Leaves on the Growth and Production of Green Mustard Plants (*Brassica juncea* L.)

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Abstract

Green mustard (*Brassica juncea* L.) is a popular vegetable among Indonesians across all social classes. It has high nutritional value and is rich in vitamins A, B, C, E, and K. This study aims to determine the effect of liquid organic fertilizer (LOF) on the vegetative growth of green mustard (*Brassica juncea* L.). The research employed analysis of variance (ANOVA) for data analysis, using a Completely Randomized Design (CRD). If significant differences were found, further testing was conducted using the smallest real difference test. The results showed that treatment with 90 ml/L of LOF derived from bamboo leaf waste consistently produced the best growth results over three weeks of observation, with plant height reaching 21.00 cm, the number of leaves reaching 9.67, and the largest leaf width measuring 6.33 cm. These data indicate that applying 90 ml/l of bamboo leaf waste LOF significantly improves plant morphology and health compared to other treatments, suggesting that this treatment can be an effective strategy to increase the productivity of green mustard.

Keywords: Green Mustard Plants, Mustard Growth, Mustard Production, Liquid Organic Fertilizer, Bamboo Leaves

1. Introduction

Green mustard greens (*Brassica juncea* L.) are a type of vegetable that is popular among Indonesians. From the lower to the upper classes, mustard greens are highly nutritious and rich in vitamins A, B, C, E, and K (Bungaalus et al., 2023). They also contain carbohydrates, protein, and healthy fats, all of which are beneficial for overall health. The non-nutritional content of mustard greens is primarily attributed to their high fiber content (Sari et al., 2023). Mustard Greens (*Brassica juncea* L.) are used in many Indonesian dishes, both as a staple ingredient and as a complement.

Green Mustard Plants (*Brassica juncea* L.) are plants that are resistant to weather. In the rainy season, they are resistant to rainwater exposure, while in the dry season, they are also resistant to hot weather, as long as they are accompanied by regular watering (Septia et al., 2023). In the future, agricultural development reforms will focus on the development and growth of agribusiness and agro-industrial systems. Mustard plants are considered one of the most ideal types of vegetables. Leaf vegetables are a rich source of essential vitamins and minerals that the human body needs. Additionally, they contain a high fiber content that facilitates digestion and may help prevent cancer (Putra et al., 2023).

The part of the mustard plant used as food and having high economic value is the leaves. Therefore, efforts are made to increase the vegetative weight of the plant due to the numerous benefits obtained from consuming it and its ease of cultivation. There is a need for increased production to meet the growing demand for mustard greens. Currently, high-quality, healthy, and safe vegetables for consumption include Green Mustard Greens (*Brassica juncea* L.). To achieve sustainable mustard greens cultivation, it must be carried out sustainably by reducing inorganic fertilizers and increasing organic fertilizers. The quality standards used for organic farming tend towards pesticide residues below the permitted threshold and vegetables that are not hollow or rotten (Septia et al., 2023).

Fertilizer is a supplementary material essential for

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plant growth, just as humans require nutrients. To improve the utilization of organic fertilizers, farmers must be provided with proper guidance on how to use them, including the correct dosage and the types of organic fertilizers best suited to their specific soil and crop conditions. Publicizing the role of organic fertilizers is highly beneficial. The application not only facilitates access to information but also helps farmers monitor and cultivate their land more efficiently. With this application, it is hoped that soil quality can be improved sustainably, ultimately increasing agricultural productivity (Rachmadtullah, 2024). The use of organic fertilizers in farming can increase crop yields. Farmers can also use organic fertilizers to enhance plant resistance to pests and diseases. Meanwhile, from an economic perspective, the use of organic fertilizers can reduce expenses, allowing farmers to generate more profits (Septia et al., 2023).

Excessive and prolonged use of chemical fertilizers can damage soil structure. With the advancement of technology, there are numerous ways to address this issue, including creating our fertilizer using household waste, such as dried bamboo leaves. Bamboo leaves (Bambuseae) are a plant well-known to Indonesians and are widespread throughout the archipelago. Bamboo leaves contain numerous beneficial active substances, including polysaccharides, amino acids, vitamins, microelements, phosphorus, potassium, and flavonoids (Karim et al., 2023).

Liquid Organic Fertilizer (LOF) also helps plants increase production or optimize and overcome macro-nutrient deficiencies because it functions as a catalyst to make the use of macro-nutrients more effective or optimal, allowing plants to achieve high productivity. In addition, it is easily absorbed through both leaves and roots, providing a rapid response, especially during the vegetative and generative phases (Amin et al., 2023). Liquid organic fertilizer (LOF) can support agricultural development and produce materials free from chemical content, making plant cultivation clean and healthy for consumption (Wiyoto, 2024). Bamboo leaves are one of the plants used as an ingredient in liquid organic fertilizers, as their population is quite large. However, it is still not optimally utilized by the community, especially farmers, because according to the community, bamboo leaves are just garbage or waste that must be burned. In contrast, bamboo leaves offer numerous benefits, including the presence of active compounds such as flavonoids and polysaccharides, and can be used to produce liquid organic fertilizer (LOF). Liquid organic fertilizer does not cause adverse effects on plant health because it is made from natural ingredients, allowing it to be easily absorbed by plants (Septia et al., 2023).

On Jl. Sartika Gang Tutwuri, located in Rantau Selatan District, an area that supports agricultural activities, particularly the cultivation of green mustard (*Brassica juncea* L.). This village is situated in an area lacking in micro- and macro-nutrients and experiencing soil degradation. Therefore, research is needed to educate the community on cultivating green mustard (*Brassica juncea* L.) using liquid organic fertilizer (LOF).

2. Material and Methods

2.1. Time and Place of Research

This activity took place from January until completion. This research was conducted at the experimental site in Tutwuri Alley, Jl. Sartika Rantau Selatan, Labuhan Batu Regency, North Sumatra, with coordinates approximately 2.096° N and 99.830° E, and an altitude of 45 meters above sea level.

2.2. Tools and materials

This research utilized primary materials, including mustard greens seeds from Jember and Tangerang, dried bamboo leaves, molasses or brown sugar, EM4, rice washing water, topsoil, rice husks, and sufficient water. To support the smooth research process, several tools were also utilized, including a 16-liter jar, a knife, a hoe or machete, writing instruments, a tape measure or ruler, 25x20 cm polybags, buckets, and labels to mark the treatments or samples.

2.3. Experimental Design

This research method uses a Completely Randomized Design (CRD). In this study, an experiment was conducted with one factor, the treatment of liquid organic fertilizer (LOF) from bamboo leaves on Green Mustard plants (*Brassica juncea* L.), with four levels of treatment and repeated three times, resulting in 12 experiments in polybags. The concentration of liquid organic fertilizer from bamboo leaves consists of four levels, namely: control, 30 mL/L of water (LOF from bamboo leaf waste), 60 mL/L of water (LOF from bamboo leaf waste), and 90 mL/L of water (LOF from bamboo leaf waste).

2.4. Analysis Method

The research data will be analyzed using Analysis of Variance (ANOVA). The data analysis used a completely randomized design (CRD). If significant differences are found, further testing will be conducted using the Smallest Real Objects (SRO) test to determine which treatment produces the best results. Data processing will be performed using SPSS version 24.

2.5. Research implementation flow chart

Bamboo leaves (Bambusease) used for fermentation of Liquid Organic Fertilizer (LOF) are taken from dry and fallen bamboo leaves, Prepare a 16 L plastic jar, then add enough water, then add 2 ounces of brown sugar that has been cut into small pieces into the jar containing water and stir until evenly distributed, after the brown sugar is sufficiently dissolved add 200ml of EM4 to the jar, then stir again until the solution becomes homogeneous, after the

solution is sufficiently homogeneous add two plastic bags of bamboo leaf waste and add 3 L of rice water then stir until evenly distributed, after all the mixture is stirred evenly close the jar tightly, then the mixture is left for approximately 1 month, so that the decomposition/decay process in the LOF fermentation of bamboo leaf waste is successful.

2.6. Research Implementation

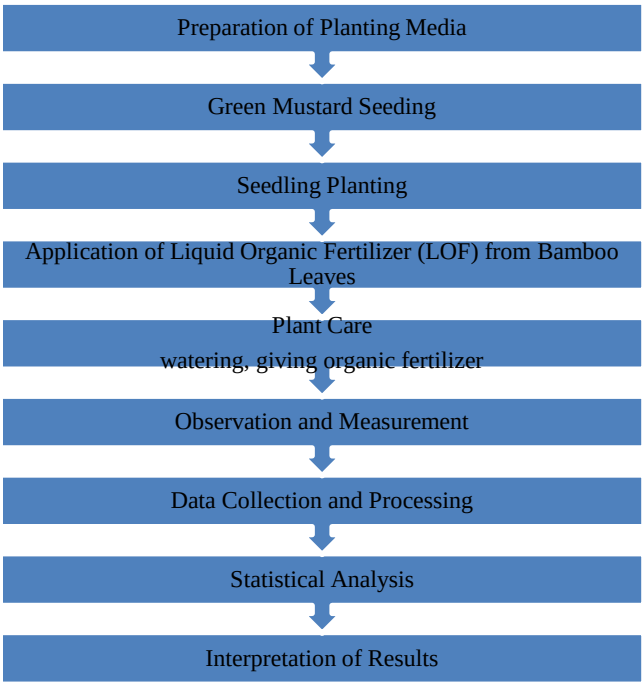

Figure 1. Research flow diagram

2.7. Observation Parameters

2.7.1. Plant Height (cm)

The height of the mustard greens is measured from the base of the stem to the tip of the longest leaf. This measurement is carried out periodically from when the plants are moved until they are ready to be harvested. Observations of the height of the green mustard plants can be carried out using a ruler/meter measuring tool.

2.7.2. Number of leaves (blades)

To observe the number of leaves, count the leaves that have fully opened. Observations are carried out periodically, once a week, until harvest.

2.7.3. Leaf width (cm)

To observe the width of the leaf, use a ruler/meter measuring tool, starting from the edge of the leaf and perpendicular to the widest part of the leaf vein.

3. Results and Discussion

3.1. Plant Height

Based on the results of field observations and data analysis, the plant height data are presented in Table 1. The observation results showed that the treatment with 90ml/L water (Bamboo Leaf Waste LOF) had the most significant effect on the growth of mustard greens in all weeks of observation. At 1 MST, plants in the treatment of 90ml / L Water (Bamboo Leaf Waste LOF) reached an average height of 12.67 cm (LSD notation a), much higher than the control which was only 4.00 cm (d), 30ml / L Water (Bamboo Leaf Waste LOF) of 7.67 cm (c), and 60ml / L Water (Bamboo Leaf Waste LOF) of 8.67 cm (b). This pattern continued at 2 WAP, where 90ml/L Water (Bamboo Leaf Waste LOF) remained the highest with 15.00 cm (a), followed by 60ml/L Water (Bamboo Leaf Waste LOF) (14.00 cm, ab), 30ml/L Water (Bamboo Leaf Waste LOF) (11.33 cm, b), and Control (6.67 cm, c). At 3 WAP, the highest growth was still shown by 90ml/L Water (Bamboo Leaf Waste LOF) with 21.00 cm (a), followed by 30ml/L Water (Bamboo Leaf Waste LOF) and 60ml/L Water (Bamboo Leaf Waste LOF) which were not statistically significantly different with heights of 17.67 cm and 17.33 cm, respectively (b), and control which was the lowest with 10.33 cm (c). These data indicate that the 90ml/L Water (Bamboo Leaf Waste LOF) treatment consistently increased the height of mustard greens significantly compared to other treatments.

Table 1. High Yield of Mustard Greens

Treatment	Plant Height (cm)		
	1 MST	2 MST	3 MST
Control	4.00±0.40d	6.67±0.52c	10.33±1.73c
30ml/L Water (Bamboo Leaf Waste LOF)	7.67±0.40c	11.33±0.52b	17.67±1.73b
60ml/L Water (Bamboo Leaf Waste LOF)	8.67±0.40b	14.00±0.52ab	17.33±1.73b
90ml/L Water (Bamboo Leaf Waste LOF)	12.67±0.40a	15.00±0.52a	21.00±1.73a

3.2. Number of Leaves

Based on the results of field observations and data analysis, the number of leaves is presented in Table 2. Based on the observation results of the number of plant leaves from the first week to the 3rd week, it was observed

that the 90ml/L Water (Bamboo Leaf Waste LOF) treatment consistently produced the highest number of leaves compared to other treatments. At 1 MST, the 90ml / L Water (Bamboo Leaf Waste LOF) treatment showed an average number of leaves of 5.67 strands and was significantly different from other treatments (notation a), followed by 30ml / L Water (Bamboo Leaf Waste LOF) (4.00 strands, b), control (3.67 strands, bc), and 60ml / L Water (Bamboo Leaf Waste LOF) which was the lowest (3.00 strands, c). At 2 WAP, 90ml/L Water (Bamboo Leaf Waste LOF) still produced the highest number of leaves, namely 7.00 leaves (a), followed by 60ml/L Water (Bamboo Leaf Waste LOF) (5.67 leaves, ab), 30ml/L Water (Bamboo Leaf Waste LOF) (4.67 leaves, b), and the lowest control (3.67 leaves, b). Meanwhile, at 3 WAP, there was no significant difference between treatments, because all treatments had the same notation (a), with the highest number of leaves at 90ml/L Water (Bamboo Leaf Waste LOF) (9.67 leaves) and the lowest at 30ml/L Water (Bamboo Leaf Waste LOF) (7.67 leaves). These results indicate that the 90ml/L Water (Bamboo Leaf Waste LOF) treatment had a positive effect on increasing the number of leaves of mustard greens, especially in the early stages of growth. This study differs from Fatihuddin et al.'s (2022) study, which found significant differences. However, the combination of vegetable waste LOF with manure and vegetable waste LOF alone did not significantly differ in terms of leaf number.

Table 2. Results of the Number of Mustard Greens Leaves

Treatment	Number of Leaves (Sheets)		
	1 MST	2 MST	3 MST
Control	3.67±0.33bc	3.67±0.91b	8.00±2.04a
30ml/L Water (Bamboo Leaf Waste LOF)	4.00±0.33b	4.67±0.91b	7.67±2.04a
60ml/L Water (Bamboo Leaf Waste LOF)	3.00±0.33c	5.67±0.91ab	8.33±2.04a
90ml/L Water (Bamboo Leaf Waste LOF)	5.67±0.33a	7.00±0.91a	9.67±2.04a

3.3. Leaf width

Based on the results of field observations and data analysis, the leaf width data are presented in Table 3. The results of leaf width measurements revealed significant differences between treatments during the three-week observation period. In the first week (1 week after planting), the 90ml/l water (bamboo leaf waste LOF) treatment produced the largest leaf width of 5.33 cm with the notation "a", while the control treatment, 30ml/l water (bamboo leaf waste LOF), and 60ml/l water (bamboo leaf waste LOF) were in the lower group with leaf widths ranging from 2.33 to 3.67 cm and the notation "b". Furthermore, in the second week (2 weeks after planting), 90ml/l water (bamboo leaf waste LOF) still maintained the largest leaf width of 5.00 cm (notation "a"), followed by 60ml/l water (bamboo leaf waste LOF) with 3.67 cm (notation "b"), and 30ml/l water (bamboo leaf waste LOF) as well as the control showed smaller leaf widths with the notations "bc" and "c". In the third week (3 weeks after planting), 90ml/l of water (bamboo leaf waste LOF) again recorded the largest leaf width of 6.33 cm (notation "a"), while 60ml/l of water (bamboo leaf waste LOF) and 30ml/l of water (bamboo leaf waste LOF) had leaf widths of around 4.33 to 4.67 cm (notation "b" and "bc"), and the control remained at the lowest position with a leaf width of 3.33 cm (notation "c"). These data indicate that the 90ml/l of water (bamboo leaf waste LOF) treatment consistently provided the best effect on increasing plant leaf width compared to other treatments.

Table 3. Results of Mustard Green Leaf Width

Treatment	Leaf Width (cm)		
	1 MST	2 MST	3 MST
Control	2.33±0.94b	2.33±0.57c	3.33±0.74c
30ml/L Water (Bamboo Leaf Waste LOF)	3.33±0.94b	3.33±0.57bc	4.67±0.74bc
60ml/L Water (Bamboo Leaf Waste LOF)	3.67±0.94b	3.67±0.57b	4.33±0.74b
90ml/L Water (Bamboo Leaf Waste LOF)	5.33±0.94a	5.00±0.57a	6.33±0.74a

3.4. Discussion

The observation results showed that the 90ml/L water (bamboo leaf waste LOF) treatment had the most significant effect on the growth of mustard greens during the three-week observation period. Plant height in the 90ml/l water (bamboo leaf waste LOF) treatment was consistently above that of the other treatments, with a statistically significant difference, ranging from 12.67 cm in the first week to 21.00 cm in the third week. This result suggests that the 90ml/l water (bamboo leaf waste LOF)

treatment may contain more optimal growth-supporting factors, such as nutrients, suitable growing media conditions, or hormonal stimulation, that support maximum plant elongation and development. This treatment can be a valuable alternative in efforts to increase mustard greens production efficiently. Other treatments, namely control, 30ml/l water (bamboo leaf waste LOF), and 60ml/l water (bamboo leaf waste LOF), showed varying but consistently lower growth rates than 90ml/l water (bamboo leaf waste LOF). For example, the control had the lowest plant height, ranging from 4.00 cm to 10.33 cm, which could indicate that this treatment may not meet the nutritional needs or optimal environmental conditions for mustard green growth. The 30 ml/L water (bamboo leaf waste pot) and 60 ml/L water (bamboo leaf waste pot) were positioned in the middle, performing reasonably well but not optimally. Factors such as seed quality, nutrient content, or soil moisture levels can cause these differences.

Leaf number is an important indicator in assessing plant health and productivity. The 90 ml/L water (bamboo leaf waste) treatment produced the highest number of leaves during the first two weeks of observation, namely 5.67 leaves in the first week and seven leaves in the second week, indicating optimal vegetative growth stimulation. A greater number of leaves allows plants to perform photosynthesis optimally, thus potentially increasing yields. In the third week, there were no significant differences between treatments, which may indicate that the plants were entering a more stable phase and slowing down in leaf growth. The control and 60ml/L water (bamboo leaf waste LOF) treatments tended to have lower leaf numbers and less even growth than the 90ml/L water (bamboo leaf waste LOF). This result could be due to a lack of growth-supporting factors, such as inadequate nutrient availability or suboptimal environmental conditions, including poor lighting and humidity. According to Fatihuddin et al. (2022), a significant difference in leaf number was observed, with results similar to those in the stable phase during the third week. Another possible problem is a pest or disease attack that has not been detected, but can physiologically reduce the number of leaves.

The leaf width of plants treated with 90 ml/l water containing bamboo leaf waste LOF was recorded as the largest throughout the three weeks of observation. This result indicates that the treatment had a positive effect not only on the number and height of the plants but also on the development of leaf morphology. Wider leaves enhance the plant's ability to capture sunlight and perform photosynthesis, a vital process for growth and yield formation. The consistent production of wider leaves under the 90 ml/l bamboo leaf waste LOF treatment confirms its significant role in increasing the photosynthetic efficiency of mustard plants. Although the 90 ml/L water treatment with bamboo leaf waste LOF showed superior results, several potential challenges must be considered in field applications. Uneven water availability, poor soil fertility, pest and disease infestations, and variability in seedling quality can hinder achieving optimal outcomes. Therefore, comprehensive management of the planting environment is recommended, including regular irrigation, appropriate fertilization, and integrated pest control. Further research is also needed to identify the specific components of the 90 ml/L bamboo leaf waste LOF treatment that contribute most significantly to improved plant growth.

Figure 2. Research Documentation

4. Conclusion

Research has shown that using the active ingredients in Root Up leads to a higher quantity of shoots, more leaves, and longer shoot lengths compared to treatments like Liquinox Start and shallots.

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