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Optimization of Liquid Organic Fertilizer Concentration of Banana Stem on Cucumber Plant Growth (*Cucumis sativus* L)

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Abstract

Cucumber (*Cucumis sativus* L.) is a vegetable from the Cucurbitaceae family. Cucumbers are fruit vegetables that offer numerous benefits in people's daily lives, leading to a high demand for this commodity. This fruit is popular across all levels of society, necessitating a relatively large and sustainable supply. This study examined the growth of cucumber plants under the influence of banana stem liquid organic fertilizer (LOF). The research employed a non-factorial Randomized Block Design (RAK) with two replications to assess how banana stem LOF impacts the growth of cucumber plants. Six treatment doses were used: 0 (control), 30%, 35%, 40%, and 45%. The results revealed that plants treated with a 200ml dose of LOF exhibited a higher growth rate than other doses. At the same plant age, the tallest plants were observed at the 200ml dose, while the lowest number of leaves was recorded at the 0 dose. The study identified that applying a 200ml dose of LOF at 5MST significantly impacted plant growth compared to other treatments. The findings suggest that a 200ml dose of banana stem LOF is highly suitable for promoting the growth of cucumber plants. These results can serve as a guideline for achieving optimal cucumber plant growth.

Keywords: Concentration, Cucumber plants (*Cucumis sativus* L.), Growth, LOF Banana Corm, Production

1. Introduction

Cucumber (*Cucumis sativus* L.) is a vegetable from the Cucurbitaceae family. Cucumbers are fruit vegetables that offer numerous benefits in people's daily lives, leading to a high demand for this commodity. This fruit is popular among all levels of society, making cucumbers necessary in large and sustainable quantities. The demand for cucumbers continues to rise due to population growth, increasing living standards, higher education levels, and growing public awareness of their nutritional value (Ari, 2009).

One of the main challenges in cucumber cultivation is the failure to achieve maximum production, often due to factors such as non-intensive cultivation systems and low soil fertility. Therefore, improving cucumber cultivation techniques is essential. Fertilization is one of the intensive cultivation techniques that can enhance cucumber production (Karimuna, 2012).

Fertilization is a common cultivation action that increases production. Adding organic materials such as liquid organic fertilizer from banana stumps is one of the better cultivation techniques in terms of technical, economic, social and environmental aspects because it does not cause pollution and can improve the physical, chemical and biological properties of the soil. In addition, this fertilizer also has a binding agent, so the plants can directly absorb the fertilizer solution given to the soil surface. In its manufacturing process, liquid organic fertilizer (LOF) requires a faster time than solid organic fertilizer (Siboro et. al., 2013).

Banana stumps are one of the remaining organic materials from banana plantations. Banana stumps can be used as the main ingredient in making fertilizers, which are widely found around us. Bananas are monocarpus plants, so the banana tree will die after bearing fruit (Cahyono, 2016). Banana stumps are waste from banana trees that have not been developed and utilized optimally, even though banana stumps contain various microorganisms and stated that banana stumps contain 66.2% carbohydrates. 100 g of dried banana stem material contains 66.2 g of carbohydrates, and fresh banana stem contains 11.6 g of carbohydrates. High carbohydrate content will stimulate the development of microorganisms. The high carbohydrate content in banana

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stems allows for fermentation, converting carbohydrates to produce acid. (Sukasa, 1995). Meanwhile, according to Suhastyo (2011), the banana stem contains N 2.2 ppm, Fe 0.09 ppm, and Mg 800 ppm, and also contains microbes that decompose organic materials; these decomposing microbes are located on the outside and inside of the banana stem, the types of microorganisms identified in banana stem include Bacillus sp, Aeromonas sp, Aspergillus sp, Phosphate solvent microbes and cellulolytic microbes that can be used as liquid fertilizers.

Ragil (2016) found that using liquid organic fertilizer made from banana stem leaves at a 60% concentration can enhance the height of cucumber plant stems and increase the number of leaves. Similarly, Karolina's (2018) study demonstrated that applying liquid organic fertilizer derived from banana stem kepok at a 30% concentration yielded optimal results for plant growth.

Building on these findings, the author conducted a study titled "The Impact of Liquid Organic Fertilizer from Banana Stems on the Growth and Yield of Cucumber Plants (*Cucumis sativus* L.)".

2. Material and Methods

The research was conducted from December 2023 to February 2024 in Tanjung Sarang Elang, Dusun Kuala, Panai Hulu District, Labuhan Batu Regency. The seeding process took place in baby bags for 13-15 days. After this period, the seeds were transferred to the planting medium on prepared soil beds. LOF was applied when the plants were 5 days old, and data collection began at 7 days old. The materials used included cucumber seeds of the Mars Baby variety, banana stems, EM-4, 10 x 15 cm polybags, 30 x 45 cm polybags, and topsoil. Tools such as hoes, shovels, machetes, ropes, bamboo, sprayers, meters, research labels, sharp knives, calipers, pH meters, and scales were used in the study. The research followed the Randomized Block Design method with four replications. Observations on cucumber plant growth focused on vegetative characters, including plant height percentage, stem diameter, and leaf number.

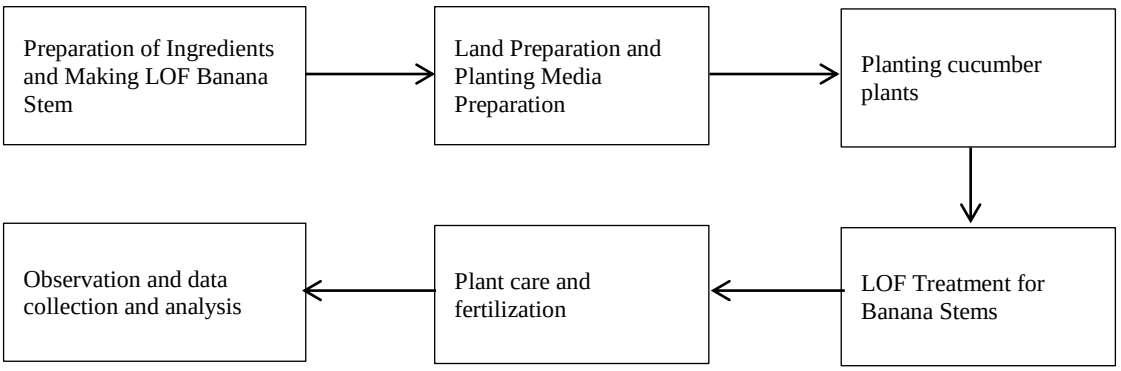

Figure 1. Research flow diagram

3. Results and Discussion

3.1. Plant Height (cm)

The stem height of cucumber plants (*Cucumis sativus* L.) var. Roman was measured in centimeters (cm). The measurements were taken at the time that the cucumbers began to germinate after being sown. Subsequently, sprouts with nascent leaves that had bloomed for 2 (5 days) were transferred to polybags, and measurements were continued after the administration of liquid organic fertilizer derived from banana stems. The mean sprout stem height was recorded as 5.13 centimeters, while the data following the administration of liquid organic fertilizer derived from banana stems is presented below:

Table 1. Cucumber Plant Stem Height Data

Treatment	Average Stem Height (cm)
Control	13.650 ± 0.6948 b
LOF 30 %	8.950 ± 0.0433 c
LOF 35 %	13.9417 ± 2.0030 b
LOF 40 %	15.4583 ± 2.2436 a
LOF 45 %	13.9917 ± 1.6367 b

The results showed that the treatment of liquid organic fertilizer (LOF) with various concentrations significantly affected the height of plant stems. The 40% LOF treatment produced the highest stem height, which was 15.4583 ± 2.2436 cm, significantly different from other treatments. These results indicate that the 40% LOF concentration is the optimum dose to support plant stem growth. According to [Prasetya et al., 2020], the administration of liquid

organic fertilizer at the appropriate concentration can increase the availability of essential nutrients such as nitrogen, phosphorus, and potassium, which support plant vegetative growth, including stem height. In addition, the microbial content in liquid organic fertilizer also increases soil enzymatic activity, which supports nutrient absorption by plants (Rahman et al., 2021).

On the other hand, the 30% LOF treatment produced the lowest stem height (8.950 ± 0.0433 cm), significantly different from other treatments. This shows that the nutrient concentration at 30% LOF is insufficient for plant needs for optimal growth. According to (Wibowo et al., 2019), too low a fertilizer dose can cause nutrient deficiencies, thereby limiting physiological processes such as photosynthesis and cell division, which has an impact on plant growth.

Other treatments, such as LOF 35%, LOF 45%, and control, produced stem heights that were not significantly different, namely 13.9417 ± 2.0030 cm, 13.9917 ± 1.6367 cm, and 13.650 ± 0.6948 cm, respectively. The high value in the control (without LOF treatment) may be caused by the remaining nutrients in the planting medium, which are still sufficient to support the plant's initial growth. However, increasing the LOF dose to 45% does not provide significant additional benefits. This phenomenon follows the findings of (Utami et al., 2020), which states that giving liquid organic fertilizer at too high a dose can decrease nutrient absorption efficiency due to increased salinity around the roots. In general, this study's results indicate that using liquid organic fertilizer at the right concentration, such as LOF 40%, provides the best results in increasing plant stem height growth. This emphasizes the importance of determining the appropriate dosage to maximize yield without causing environmental stress to the plants.

3.2. Stem Diameter

The diameter of the cucumber plant (*Cucumis sativus*L.) var. Roman is measured in centimetres (cm) and can be seen in the table below:

Table 2. Cucumber Plant Stem Diameter Data

Treatment	Average Stem Diameter (cm)
Control	0.507 ± 0.0208 b
LOF 30 %	0.497 ± 0.0201 c
LOF 35 %	0.487 ± 0.0238 c
LOF 40 %	0.620 ± 0.0240 a
LOF 45 %	0.520 ± 0.0222 b

The results of the BNT test on the bar chart at the 5% level of 40% concentration treatment (P4) were significantly different compared to the other concentrations. Administration of the control concentration, 30%, 35%, and 45% concentrations showed results that were not significantly different at the 5% level. The most significantly different treatment was shown at a concentration of 35% against a concentration of 40% and 40% against a concentration of 35%. The BNT Test Table can be seen in Appendix 2 of the BNT test output on stem diameter.

Analysis of the average stem height (cm) in different treatments showed a significant effect of the concentration of liquid organic fertilizer (POC) on plant growth. Treatment with 40% POC showed the highest average stem diameter (0.620 ± 0.0240 cm), significantly outperforming other treatments. These results indicate that a concentration of 40% provides optimal nutrient balance for stem elongation and development. Organic fertilizers, such as POC, are known to increase the availability of nutrients in the soil and stimulate microbial activity, which can improve nutrient absorption and plant growth (Arancon et al., 2004; Zhang et al., 2019).

The control treatment resulted in an average stem diameter of 0.507 ± 0.0208 cm, which was significantly lower than the 40% POC treatment but higher than the 30% POC (0.497 ± 0.0201 cm) and 35% POC (0.487 ± 0.0238 cm) treatments. This suggests that although the essential soil nutrients were adequate for minimal growth, the absence of additional fertilizer limited the plants' growth potential. The suboptimal POC concentrations (30% and 35%) likely failed to meet the nutrient requirements for optimal growth, as indicated by the low stem diameters in these treatments. Studies have shown that inadequate nutrient supply can lead to plant growth restriction due to nutrient deficiency (Hartz & Johnstone, 2006).

Interestingly, the 45% POC treatment (0.520 ± 0.0222 cm) did not result in better growth than the 40% POC treatment. This may be due to nutrient imbalance or toxicity at higher fertilizer concentrations. Excessive application of organic fertilizers can cause osmotic stress, nutrient antagonism, or microbial competition, negatively impacting plant growth (Zhang et al., 2019).

These findings highlight the importance of optimizing fertilizer doses to avoid the adverse effects of over-fertilization. Overall, these data emphasize the importance of selecting the right concentration of POC to maximize plant growth. The superior performance of the 40% POC treatment is in line with sustainable agricultural practices, which emphasize the role of organic inputs in enhancing crop productivity while maintaining environmental health. (Tilman et al., 2002).

3.3. The Number of Leaves

The number of leaves per cucumber plant (*Cucumis sativus* L.) Var. Roman can be obtained as follows:

Table 3. Cucumber Plant Leaf Number Data

Treatment	Average number of leaves (blades)
Control	2.17 ± 0.167 b
LOF 30 %	2.50 ± 0.000 a
LOF 35 %	1.83 ± 0.083 c
LOF 40 %	2.67 ± 0.083 a
LOF 45 %	2.17 ± 0.220 b

The BNT test followed the ANOVA test results. The BNT test results at a 5% significance level indicated that the treatment with a 45% concentration did not show a significant difference compared to the control treatment, while the most noticeable difference was between the 40% treatment (P4) and the 35% treatment (P3). The BNT test table data can be found in Appendix 2, showing the output of the BNT test on leaves.

The impact of various concentrations of organic liquid fertilizer (LOF) on the number of leaves was significant based on the analysis of the average number of leaves. The control treatment, without LOF, resulted in an average of 2.17 ± 0.167 leaves, similar to the 45% LOF treatment (2.17 ± 0.220 leaves). This result suggests that the 45% LOF concentration did not have a significant additional effect compared to no treatment. On the other hand, the 30% and 40% LOF treatments showed the best results, with averages of 2.50 ± 0.000 leaves and 2.67 ± 0.083 leaves, respectively. These treatments significantly differed from the control and 45% LOF, indicating that these concentrations are optimal for increasing the number of leaves. This yield aligns with Taiz et al.'s (2015) explanation that providing nutrients in appropriate doses can enhance photosynthesis and leaf growth.

However, an increase in the LOF concentration to 35% resulted in a significant decrease in the number of leaves with an average of 1.83 ± 0.083 strands, significantly different from all other treatments. This finding suggests that the LOF concentration of 35% is less effective in promoting leaf growth, which may be attributable to the adverse effects of excess nutrients. This observation aligns with the findings of Brady and Weil (2016), who posited that the provision of fertilizers that surpass the plant's nutritional requirements can induce physiological stress, thereby impeding growth. Furthermore, the LOF treatments of 30% and 40% exhibited low standard errors, suggesting that these two treatments yielded consistent data. Conversely, LOF 45% exhibited a higher standard error, suggesting greater outcome variability.

4. Conclusion

The findings of the present study indicate that the dosage of LOF banana corm, in conjunction with its interactive effects, significantly influences the growth of cucumber plants. It was observed that increasing the administered dose resulted in a corresponding increase in the observed effects on plant height, stem diameter, and the number of leaves.

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