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Optimization of Concentration and Frequency of Liquid Organic Fertilizer Application on Cherry Tomato Plants (*Lycopersicum esculentum* var. Ruby) Growth and Yield

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Abstract

Cherry tomatoes (*Lycopersicum esculentum* var. Ruby) represent a significant segment of global vegetable production. In Indonesia, there is a notable demand for cherry tomatoes, as they serve dual purposes: they can be enjoyed fresh as a dessert or thirst quencher, and they can also be incorporated into a variety of culinary dishes and beverages. Their distinctive flavor and appearance make them popular for diverse culinary applications. The economic potential of cherry tomatoes is substantial, driven by strong demand in both local and international markets. However, cherry tomato cultivation's low productivity levels do not match this high consumer interest. An alternative approach to enhance productivity is using liquid organic fertilizer (LOF), which is rich in various macro and micronutrients. This research aims to assess the impact of different concentrations and application frequencies of Hantu LOF on the growth and yield of cherry tomato plants. A factorial randomized block design was employed, focusing on two primary variables: the concentration of Hantu LOF (0 ml/l, 5 ml/l, 10 ml/l, and 15 ml/l) and the frequency of application (every 4 days, 7 days, and 10 days). Key parameters measured included plant height, leaf count, fruit quantity, and weight. Findings indicated that a concentration of 10 ml/l applied every 7 days yielded optimal results. Conversely, extending the application beyond 7 days resulted in suboptimal outcomes, with an average plant height of 49.44 cm and a total fruit weight of 311.94 grams. This study underscores the importance of identifying Hantu LOF's appropriate concentration and application frequency to enhance cherry tomato production and promote sustainable agricultural practices.

Keywords: Horticulture Microorganisms, Nutrition, Sustainable Agriculture

1. Introduction

The variety of *Lycopersicum esculentum* is known as cherry tomatoes. The Ruby (Rubiaceae family) is recognized as a significant vegetable commodity worldwide. The market demand for cherry tomatoes has experienced a steady annual increase; however, this heightened consumer interest is not counterbalanced by the comparatively low productivity of cherry tomato plants. The production of cherry tomatoes is confronted with multiple obstacles predominantly stemming from inadequate variety selection, deficient soil management, insufficient irrigation, and improper fertilizer application. According to the BPS (2023) report, tomato production in East Java Province increased from 931,206 quintals per hectare in 2021 to 1,021,085 quintals per hectare in 2022. The insufficient utilization of fertilizers is a significant factor that results in the decreased productivity of cherry tomato plants. Imbalances in the levels of essential nutrients in plants can greatly influence their overall development and production ability. Inadequate levels of nitrogen in the soil can have a significant impact on both the yield and quality of plant crops. The absence of nitrogen in the soil results in stunted plant growth, diminutive and yellowed leaves, and a decreased number of flowers.

The cherry tomato plants can adequately fulfill their nutrient requirements by utilizing LOF (Liquid Organic Fertilizer). Alongside N, P, and K, this fertilizer includes

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micronutrients and organic material that contribute to the sustenance of soil microorganisms and essential nutrients. The production of LOF using natural organic materials aligns with the principles of sustainable agriculture. Organic fertilizers are vital in sustaining agricultural sustainability by preserving soil fertility, enhancing the abundance of microorganisms, and improving the soil's ability to retain moisture. One approach to strengthening soil quality is through the provision of organic materials. However, it is essential to note that the nutrient content of 122 organic materials is typically lower than chemical fertilizers. Organic materials can generally enhance the soil's physical, chemical, and biological characteristics (Pramana and Heriko, 2020). The significance of organic fertilizers in promoting plant growth and yield is of great importance, thus highlighting the high demand for quality organic fertilizer products, as noted by Afmerta et al. (2019). In the present circumstance, LOF is a category of natural fertilizer that can be efficiently applied.

Ghost Liquid Organic Fertilizer (Ghost LOF) has been demonstrated to enhance the productivity of cherry tomato plants. The manufacturing process of Ghost LOF involves the fermentation of diverse organic materials, including livestock waste and plant residues. This fertilizer has been shown to have a comprehensive effect on increasing plant productivity. The formulation of Ghost LOF includes various growth hormones, such as gibberellate, IAA, zeatin, kinetin, and 17 amino acid variants. The fertilizer is enriched with essential minerals such as Pb, Cd, Ni-63, P-14, Mg, Ti, Fe, Mn, Zn, Co, and vitamins A, D, E, and K. The complete macro and micronutrient content of Ghost LOF suggests a significant positive impact on increasing agricultural yields.

The employment of LOF Hantu at an optimal concentration has been demonstrated to enhance fertility and improve the physical quality of the soil, thereby fostering the growth and productivity of cherry tomato plants. Applying LOF Hantu at a ratio of 3 milliliters per liter of water on cayenne pepper plants resulted in optimal growth, as evidenced by a plant height of 32.25 centimeters. Furthermore, the plants exhibited favorable outcomes in additional aspects, such as the most expeditious flowering time at 91.69 days, yielding 12.44 fruits per plant, with a fruit weight reaching 15.45 g, and demonstrating robust root development, as evidenced by the substantial wet weight of the roots.

The precision in the frequency of LOF application is crucial for enhancing the growth and productivity of cherry tomato plants. This systematic approach guarantees that the plants receive a steady influx of nutrients throughout their developmental stages, facilitating the development of vegetative structures and the optimal formation of fruits. Each growth stage of the plant has distinct nutritional requirements. The efficiency of fertilizer utilization is improved by tailoring the frequency of LOF application to meet these specific nutrient demands. This is corroborated by studies on shallots, which indicated a favorable response to LOF applications conducted three times post-planting on days 7, 14, and 21. The beneficial impacts were observed across various growth metrics, including plant height, leaf area, bulb count per clump, and fresh and wet bulb weights.

While LOF has demonstrated efficacy in cultivating cayenne pepper and shallots, further studies are necessary to ascertain the optimal concentration level and interval of Hantu LOF application to enhance the growth and productivity of cherry tomato plants. The planned research will examine the effect of various concentration levels and frequencies of Hantu LOF application on growth parameters and cherry tomato yields, as well as evaluate the effectiveness of Hantu LOF on plant productivity.

2. Material and Methods

This study was conducted from May to October 2024 in Lidah Wetan Village and Lakarsantri District, Surabaya City, East Java, which is located at an altitude of 5 meters above sea level with geographical coordinates of 7°18′26.197″S and 112°39′57.181″E. The average maximum air temperature is 34.05°C, and the average minimum air temperature is 23.1°C, with an average maximum air humidity of 94.75% and an average minimum humidity of 46.08%. In addition, the average annual rainfall in this area is 177 mm. This study used tools, including hoes, shovels, scissors, watering cans, knives, seedling trays, 3-liter buckets, analytical scales, meters, 500 ml measuring cups, stationery, and 48 MP cellphone cameras. The materials used in this study were cherry tomato seeds of the ruby variety (*Lycopersicum esculentum* var. Ruby), soil, manure, rice husk charcoal, NPK Mutiara 16-16-16, Hantu Organic Liquid Fertilizer, 40 x 40 cm polybags, 10 x 3 cm labels, raffia rope, wood, water, curacron 500 EC insecticide, antracol 70 WP fungicide, and amistartop.

This research was structured as a factorial experiment utilizing a Randomized Block Design (RBD) incorporating two distinct factors. The first factor pertains to the concentration of Hantu Liquid Organic Fertilizer, which was tested at four treatment levels: 0 ml/l Hantu LOF water combined with 100% NPK, 5 ml/l Hantu LOF water with 50% NPK, 10 ml/l Hantu LOF water with 50% NPK, and 15 ml/l Hantu LOF water with 50% NPK. The second factor involves the frequency of Hantu Liquid Organic Fertilizer application, which was evaluated at three treatment levels: application every 4 days, every 7 days, and every 10 days. Should the F test indicate a significant effect, subsequent analysis will be conducted using the Honestly Significant Difference test at a significance level of 5% (HSD 0.05). The parameters measured in this study included plant height, recorded from the base of the stem to the apex using a meter, conducted when the plants were 7 days old post-planting. The leaf count was determined by

counting the leaves that had fully opened 7 days after planting. The fruit count was conducted from the onset of the harvest period until its conclusion, tallying the number of fruits harvested from each plant. Additionally, fruit weight was assessed by summing the weights of all fruits collected during each harvest for each plant, utilizing an analytical scale for accuracy.

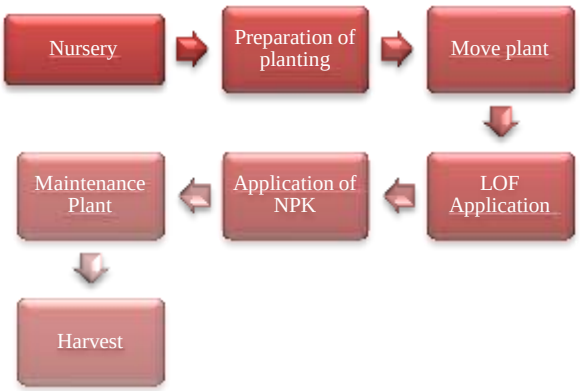

Figure 1. Research flow diagram

3. Results and Discussion

3.1. Plant Height (cm)

The results of the analysis of variance demonstrated that, at the age of 77 hours after sowing (HAS), the concentration and frequency treatments of Hantu Liquid Organic Fertilizer significantly interacted with the height of cherry tomato plants (*Lycopersicum esculentum* var. Ruby). The concentration treatment exhibited a substantial impact on the height of cherry tomato plants at the 42- and 84-day after-sowing (DAS) stages, while the frequency treatment did not demonstrate a significant effect on plant height at the 77-day after-sowing (77 DAS) stage.

Table 1. Average Height of Cherry Tomato Plants in Combination of Concentration Treatment and Frequency of Ghost LOF Application at 77 HST

Frequency of Ghost LOF Administration (days)	Plant Height (cm)			
	Concentration of Liquid Organic Fertilizer Ghost (ml/l water)			
	0	5	10	15
4	126.44 ± 1.46 a	129.44 ± 0.48 ab	132.89 ± 1.09 ab	128.67 ± 1.64 ab
7	125.56 ± 1.30 a	134.78 ± 1.28 bc	135.89 ± 0.77 c	128.11 ± 2.05 ab
10	128.67 ± 2.88 ab	125.44 ± 0.77 a	129.89 ± 1.78 ab	128.56 ± 0.22 ab
BNJ 5%	2.42			

Information: Numbers followed by the same letter indicate no significant difference in the 5% BNJ test.

The most effective treatment for promoting the growth of tall cherry tomato plants at 77 days after planting was a combination of K2F2, as indicated in Table 1. The growth rate of cherry tomato plants was significantly influenced by the concentration and frequency of application of ghost liquid organic fertilizer (LOF) during the specified developmental stage. More precisely, the application of Ghost LOF at a concentration of 10 ml/l of water every week resulted in the highest growth rate of plants, reaching 135.89 cm. The findings indicated that the chosen concentration and frequency of application could effectively strike a balance between the fertilizer supply and the plants' nutritional requirements. Conversely, increasing the application frequency to once every ten days decreased plant height despite the rise in LOF concentration to 15 ml/l of water (128.56 cm). This suggests that despite the increased concentration of fertilizer, its effectiveness can be diminished by infrequent application. On the other hand, escalating the frequency of application to once every four days led to only a minor uptick in plant growth, suggesting that widespread application did not substantially enhance growth. An adequate root system improves the effectiveness of nutrient uptake, thus mitigating nutrient imbalance within plants. Root pruning can influence the function of the nitrate reductase enzyme, which is involved in the process of nitrogen metabolism.

The diversity of soil organisms, such as bacteria, fungi, and earthworms, influences the soil's chemical, physical, and biological properties. The decrease in the diversity of these organisms can disrupt soil fertility and plant productivity. Drought stress triggers plant stress, disturbing physiological processes and functional activities, including the root system. Significant temperature intensity, frequency, and rainfall changes increase the risk of severe plant water deficits. The effect of ghost LOF concentration on corn plants in Kediri Regency. The treatments used were 0 ml/l of water, 2 ml/l of water, 4 ml/l, and 6 ml/l of water. The results showed that applying ghost liquid organic fertilizer was carried out based on varying concentrations and treatment durations. These concentrations include 0 ml/1 liter of water, 2 ml/1 liter of water, 4 ml/1 liter of water, and 6 ml/1 liter of water. The impact of concentration variations is recommended to use a concentration of 6 ml for optimal results. Giving a concentration of 6 ml/l of water affects plant height, number of leaves, average stem diameter, length of cob per planting, weight of cob with husk per planting, and weight of 1000 seeds.

Table 2. Average Height of Cherry Tomato Plants in Each Concentration Treatment and Frequency of Ghost LOF Application at Ages 35, 42, 49, 56, 63, 70, and 84 HST

Treatment	Plant Height (cm)						
	35 HST	42 HST	49 HST	56 HST	63 HST	70 HST	84 HST
Ghost LOF Concentration (ml)							
0	71.81	84.19 ± 10.23a	94.52 ± 8.01a	100.85 ± 6.28a	107.04 ± 3.36a	115.19 ± 2.98 a	136.33 ± 1.53 a
5	74.44	88.55 ± 11.78 ab	98.11 ± 12.06ab	103.81 ± 9.07ab	109.85 ± 6.85ab	117.41 ± 5.56 a	140.07 ± 7.46 ab
10	81.85	95.44 ± 12.12b	104.22 ± 11.84b	108.70 ± 9.61b	112.89 ± 6.35b	121.48 ± 5.58 b	142.63 ± 4.90 b
15	75.41	87.96 ± 5.07ab	96.59 ± 4.59ab	102.74 ± 2.21a	109.41 ± 2.23a	117.96 ± 2.05 a	138.19 ± 1.30 a
BNJ 5%	tn	7.69	6.93	4.98	3.41	2.92	3.98
Ghost LOF Frequency (days)							
4	71.94 ± 3.82a	87.81 ± 6.69a	96.83 ± 6.07a	102.89 ± 4.68a	109.47 ± 3.54a	117.64 ± 3.91 a	138.72 ± 4.64 ab
7	83.89 ± 9.22b	95.06 ± 8.85b	104.11 ± 8.82b	108.28 ± 7.52b	112.64 ± 5.07b	120.47 ± 4.96 b	141.31 ± 6.68 b
10	71.78 ± 8.95a	84.22 ± 7.13a	94.14 ± 5.37a	100.92 ± 4.43a	107.28 ± 2.98a	115.92 ± 3.44 a	137.89 ± 2.36 a
BNJ 5%	8.48	6.01	5.42	3.90	2.67	2.28	3.11

Information: Numbers followed by the same letter in the same column and treatment show no significant difference in the 5% BNJ test.

Table 2 illustrates the impact of Hantu Liquid Organic Fertilizer (LOF) on the growth rate of cherry tomato plants from 42 days after planting (DAP). The absence of Hantu LOF results in slower growth rates for the plants, as this fertilizer does not supply additional nutrients. Among the various concentrations tested, a dosage of 10 milliliters per liter of water proved the most effective. Higher concentrations may lead to diminished effectiveness due to nutrient excess. In Hantu LOF, nitrogen plays a crucial role in the development of stems, branches, and roots, as it is essential for protein synthesis and the growth of meristematic tissues. From 35 DAP onward, administering Hantu LOF every seven days positively influenced the height of the cherry tomato plants. This application frequency promotes optimal nutrient absorption and utilization, preventing any nutrient surplus that could hinder growth. Previous research has indicated that a seven-day interval for LOF application in lettuce resulted in superior plant growth compared to four- and ten-day intervals, attributed to the adequate availability of nutrients during the vegetative growth phase.

3.2. Number of Leaves (petioles)

The analysis of variance revealed a highly significant interaction between the concentration and frequency of Ghost Liquid Organic Fertilizer treatments on the number of leaves of cherry tomato plants at 63-84 hours after sowing. The number of leaves of cherry tomato plants at the age of 63-84 hours after sowing (HST) was significantly influenced by each treatment. 1984 HST. Table 3 displays the mean quantity of cherry tomato leaves from combining treatments.

Between 63 and 84 DAP, the combination of K2F2 treatments proved to be the most effective in increasing the number of leaves of cherry tomato plants, as shown in Table 3. Application of 50% NPK and 10 ml/l of water every 7 days resulted in the highest number of leaves during the monitoring period. In contrast, infrequent application and low concentration resulted in fewer leaves. In addition, frequent application and high concentration inhibited leaf growth. These results indicate that nutrient availability is increased with an ideal balance between the concentration of Hantu LOF and the appropriate frequency of application. This promotes leaf growth effectively. Nitrogen is essential in cell division and elongation in plants in this case.

The treatment will be better with a concentration of 10 ml/l LOF Hantu per liter of water. This contribution increases the growth of cherry tomato leaves because it provides better nutrition to help photosynthesis, metabolism, and the development of vegetative organs. Tomato plants require a lot of nitrogen (N), phosphorus (P), and potassium (K), especially during the vegetative phase, namely the growth of roots, stems, and leaves. The application interval of 7 days allows plants to utilize and absorb nutrients optimally, ensuring sufficient nutrition without disrupting plant physiology. The provision of LOF Hantu has a significant effect on the growth and productivity of Chinese cabbage. The best results were obtained with a treatment of 3 ml/l with a height of 37.90 cm and 13.55 leaves. (Maghfirah et al ., 2018).

Table 3. Average Number of Cherry Tomato Leaves in Combination of Concentration Treatment and Frequency of Ghost LOF Application at Ages 63, 70, 77, and 84 HST.

Age	Frequency of Application of Liquid Organic Ghost Fertilizer Treatment (days)	Number of leaves (leaf stalks)			
		Concentration of Liquid Organic Fertilizer Ghost (ml/l water)			
		0	5	10	15
63 HST	4	31.78 ± 0.77 a	34.44 ± 2.29 a	34.56 ± 1.05 a	31.78 ± 0.72 a
	7	31.78 ± 0.44 a	32.00 ± 1.26 a	40.78 ± 0.48 b	34.78 ± 0.48 ab
	10	32.00 ± 2.11 a	32.78 ± 0.40 a	32.56 ± 1.11 a	33.56 ± 0.29 a
	BNJ 5%	6.15			
70 HST	4	35.89 ± 0.72 a	37.89 ± 1.68 a	38.11 ± 1.17 a	37.11 ± 0.72 a
	7	36.11 ± 0.11 a	35.67 ± 1.07 a	45.44 ± 0.11 b	38.11 ± 1.05 a
	10	35.44 ± 2.23 a	37.22 ± 0.44 a	36.33 ± 1.50 a	37.78 ± 0.90 a
	BNJ 5%	6.06			
77 HST	4	38.22 ± 0.48 a	39.89 ± 1.68 a	38.22 ± 0.72 a	39.00 ± 0.69 a
	7	39.11 ± 0.29 a	38.11 ± 0.58 a	46.33 ± 0.50 b	39.11 ± 0.94 a
	10	38.33 ± 1.89 a	39.00 ± 0.50 a	40.11 ± 0.77 a	40.11 ± 0.58 a
	BNJ 5%	4.96			
84 HST	4	42.00 ± 0.57 a	43.00 ± 1.50 a	43.89 ± 0.48 a	42.33 ± 0.57 a
	7	42.00 ± 0.38 a	41.56 ± 1.12 a	49.44 ± 0.11 b	42.22 ± 0.58 a
	10	41.44 ± 1.92 a	42.11 ± 0.48 a	41.56 ± 1.12 a	42.67 ± 0.69 a
	BNJ 5%	5.00			

Information: Numbers followed by the same letter indicate no significant difference in the 5% BNJ test.

3.3. Number of Fruits

The analysis of variance test revealed no significant interaction between the concentration and frequency of application of Hantu Liquid Organic Fertilizer and the number of cherry tomatoes produced. However, both concentration and frequency significantly impacted the number of fruits produced. The mean number of fruits per cherry tomato plant for each concentration and frequency treatment is presented in Table 4.

Table 4. Average Total Number of Fruits per Cherry Tomato Plant in Each Concentration Treatment and Frequency Treatment of Ghost LOF Application

Treatment	Total Number of Fruits
Ghost LOF Concentration (ml)	
0	53.78 ± 9.89 a
5	63.52 ± 22.26 b
10	89.15 ± 18.51 c
15	60.04 ± 14.63 ab
BNJ 5%	7.59
Ghost LOF Frequency (days)	
4	58.92 ± 22.96 a
7	76.67 ± 27.05 b
10	64.28 ± 21.23 a
BNJ 5%	5.94

Information: Numbers followed by the same letter indicate no significant difference in the 5% BNJ test.

Table 4 shows a significant increase in fruit production after applying Hantu LOF concentration of 10 ml/l to the air. Hantu LOF contains plant growth regulators (PGRs), which stimulate flowering, fruiting, and ripening. On the other hand, root damage inhibits the absorption of air and nutrients, which causes lower growth and fruit production. In the generative phase of plants, nutrients such as nitrogen, phosphorus, and potassium are essential and impact the number of fruits produced. These three nutrients are necessary for tomatoes, so they must be provided according to their needs (Ang et al ., 2023).

Treatment every 7 days increases fruit yield by improving nutrient absorption and utilization (Figure 2). Compared to other intervals, this application of Hantu LOF increases cherry tomatoes. Tomato yields have increased by 14.5% thanks to combining organic fertilizers with the correct application method. Hantu LOF 3 ml/l of water shows plant growth at the age of 2 weeks after planting, producing gelantik eggplant plants with a height of 7.43 cm. A concentration of 4 ml/liter Hantu LOF can provide better plant growth, greener and brighter leaves, and accelerate the process of flower emergence in tomato plants.

3.4. Fruit Weight (gr)

Variance analysis showed a highly significant interaction between the concentration and frequency of application of Ghost Liquid Organic Fertilizer (LOF) and

the total fruit weight of cherry tomato plants (*Lycopersicum esculentum* var. Ruby). Different concentrations and frequencies of LOF also had a significant impact on total fruit weight. Table 5 shows detailed data on the average fruit weight per cherry tomato plant resulting from combining LOF concentration and frequency treatments.

Figure 2. Cherry Tomato Plant Harvest Results

Table 5. Average Total Fruit Weight per Cherry Tomato Plant in Combination of Concentration Treatment and Frequency Treatment of Ghost LOF Application

Frequency of Application of Liquid Organic Ghost Fertilizer (days)	Total Fruit Weight of Plant (gr)			
	Concentration of Liquid Organic Fertilizer Ghost (ml/l water)			
	0	5	10	15
4	236.67 ± 5.35 bcd	204.90 ± 1.75 b	265.33 ± 12.40 d	159.06 ± 6.78 a
7	251.67 ± 1.92 cd	223.50 ± 7.29 bc	311.94 ± 10.30 e	238.33 ± 11.09 bcd
10	209.31 ± 8.29 b	235.13 ± 6.29 bcd	214.50 ± 6.24 bc	222.47 ± 6.52 bc
BNJ 5%	40.12			

Information: Numbers followed by the same letter indicate no significant difference in the 5% BNJ test.

The findings in Table 5 indicate that the optimal combination of treatments to enhance cherry tomato fruit weight is the K2F2 treatment. The application frequencies of fertilizer, at both 10 ml/L of water, yielded fruit weights of 265.33 g and 311.94 g, respectively. Consequently, the K2F2 treatment combination yielded the highest cherry tomato fruit weight. Gibberellin has been demonstrated to enhance turgor pressure in plant cell walls, thereby facilitating the expansion and growth of plant cells.

At a concentration of 10 ml per liter of water, the LOF Hantu solution delivers the optimal blend of nutrients for the fruit, significantly increasing its overall weight. The fruit's reduced weight is attributed to an imbalance of nutrients that hinder flowering metabolism, mainly when the water concentration is at 15 ml/l. Potassium nutrients play a critical role in the transportation of carbohydrates, influencing the weight, sugar content, and overall growth of fruits. The cucumber plants were subjected to various concentrations of water treatments, including 0 ml/l, 1 ml/l, 2 ml/l, and 3 ml/l. The findings indicated that the application of 3 ml/l of water (H3) resulted in the greatest plant height of 76.81 cm, the largest plant stem diameter of 5.73 mm, the greatest yield per sample of 362.00 g, and the highest yield per plot of 5.76 kg. Applying liquid organic fertilizer Hantu at a concentration of 3 ml per liter of water proved to be the most effective treatment in enhancing the growth and yield of cucumber plants.

4. Conclusion

The interaction of Liquid Organic Ghost Fertilizer, with a concentration of 10 ml/l of water and a frequency of application once every 7 days, yielded optimal results on plant height at 77 HST, number of leaves at 63-84 HST, and fruit weight. The treatment of each Liquid Organic Ghost Fertilizer with a concentration of 10 ml/l of water and a frequency of application once every 7 days yielded optimal results on plant height at 42-84 HST, number of leaves at 63-84 HST, number of fruits, and fruit weight.

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