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GROWTH RESPONSE OF TOMATO PLANTS (*Lycopersicum esculentum* Mill.) TO LIQUID ORGANIC FERTILIZER (LOF) APPLICATION

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Abstract

This study aimed to determine the effect of liquid organic fertilizer on tomato plant growth. This study was conducted at the Field Laboratory of Experimental Garden 2, Faculty of Agriculture, Halu Oleo University, from November 2025 to February 2026. This study used a Randomized Block Design (RBD) consisting of four levels: Nitrogen 95.2 g, Potassium chloride as 47.6 g, SP-36 119 g plot-1 (P0 = control), LOF 60 mL L-1 water (P1), LOF 100 mL L-1 water (P2), and LOF 140 mL L-1 water (P3). Each treatment was replicated four times, resulting in 16 experimental units. The observation variables in this study were plant height, number of leaves, stem diameter, number of branches, total leaf area, and flowering age. Observational data were analyzed using analysis of variance (ANOVA), followed by an Honestly Significant Difference Test (HSDT) at a 95% confidence level. The results showed that the application of liquid organic fertilizer (LOF) significantly affected plant height, number of leaves at 28 and 35 days after transplanting (DAT), stem diameter at 21 and 35 DAT, and number of branches at 35 DAT. The LOF treatment with 140 mL L-1 water (P3) had the best effect on plant height, number of leaves at 28 and 35 DAT, stem diameter at 21 and 35 DAT, and number of branches at 35 DAT.

Keywords: Liquid organic fertilizer, organic waste, organic farming, tomato plants

INTRODUCTION

Tomato plants are a kind of horticultural plant that's popular among the Indonesian people (Mugiastuti *et al*., 2019). Tomatoes contain nutrients such as vitamins A, B, and C, as well as minerals that play vital roles in human health (Borguini *et al*., 2009). Tomatoes can be enjoyed in a variety of dishes, including vegetables, juice, and cooking spices. They can also be used as industrial raw materials, such as in sauces, cosmetics, and even medicines. According to Bhowmik *et al*. (2012), tomatoes contain lycopene and vitamin C and provide other antioxidants, such as beta-carotene, and phenolic compounds, such as flavonoids,

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hydroxycinnamic acid, chlorogenic acid, homovanillic acid, and ferulic acid. According to Przybylska (2020), the rich vitamin content in tomatoes is believed to cure various ailments such as night blindness, asthma, tuberculosis, and liver disease, as well as help treat acne and toothaches.

Tomatoes are a vegetable commodity whose market demand increases year after year due to their benefits and high demand. Therefore, the tomato business opportunity remains wide open, as the annual supply is insufficient to meet both domestic and international consumer needs. One of the problems with tomato farming is that productivity is unstable every year. Poor soil conditions, particularly in Southeast Sulawesi, and suboptimal fertilization are among the contributing factors to this problem. Carli *et al*. (2011) state that tomato plants require a loose growing medium, an acidity level between 5–6, soil with little sand and plenty of humus, and adequate and regular irrigation. One of the efforts that can be made to improve the quality and quantity of tomato plants is by adding organic materials to the soil, which can improve the soil structure so that it becomes loose and the plant roots can more easily penetrate the soil and absorb the nutrients in the soil

One organic material that can be used is waste kepok banana peels, which are used as liquid organic fertilizer (LOF). The use of LOF is quite effective because it is more easily absorbed by plants, so by applying LOF through watering, nutrients are more quickly absorbed by the plants. Composting this waste is a much-needed material for agriculture as an effort to improve the chemical and biological properties of the soil. The liquid organic fertilizer from banana peels plays a role in plant growth and production. The contents of organic fertilizer, such as potassium, phosphorus, magnesium, and nitrogen, are very important for improving the growth of tomato plants (Lubis *et al*., 2022).

MATERIALS AND METHOD

This research was conducted at the Field Laboratory of Experimental Garden II, Faculty of Agriculture, Halu Oleo University. The research site is located at an altitude of 20 meters above sea level, at –4.012838°S and 122.526127°E. The research began in November 2025 until February 2026.

Research Procedures

Land Preparation and Basic Fertilization: Land preparation began with clearing weeds and plant debris. Next, the soil was loosened, and experimental plots were created. The plots measured 2.8 m x 1.7 m, with a spacing of 50 cm between plots and 50 cm between treatment groups. Base fertilization was applied after plot preparation and two weeks before transplanting, using goat manure at a rate of 7 tons ha^{-1}, equivalent to 2.97 kg per plot.

Making Liquid Organic Fertilizer: The fertilizer is made by preparing 10 kg of kepok banana peel waste. The banana peel is cut into small pieces, then the banana peel pieces are put into a bucket, and 10 liters of rice washing water, 250 mL of melted brown sugar, 250 mL of EM-4 solution, and 500 mL of water. After all the ingredients are added to the bucket, stir until evenly mixed. After that, close the bucket tightly and place it in a shady place. Store for approximately 2 weeks. Every day, the material in the bucket is opened and stirred once every 2 days. After 2 weeks, the liquid organic fertilizer is filtered, and the results are stored in a new container.

Seeding: Before sowing the tomato seeds, soak them in water for 15 minutes. Seeding is done using a seedling tray with a planting medium mixed with soil and goat manure in a ratio of 2:1. Next, the seedbed is stored in a place that is not exposed to direct sunlight. During seeding, the seeds are watered twice a day, morning and evening, to maintain soil moisture. Once the seedlings are 21 days old with the appearance of 2-4 leaves, the seedlings are ready to be transplanted.

Planting: Planting begins with making a planting hole. One tomato seedling was planted in each hole with a spacing of 40 × 50 cm to obtain 20 plants per experimental plot. Before planting the seeds, they are first sorted using uniform seed criteria per group.

Application of Fertilizer: LOF application is carried out once a week during the vegetative period, namely 5 applications, starting when the plants are 14 days after transplanting (DAT). The LOF is applied by spraying it evenly over all parts of the plant with a watering concentration according to the plant treatment carried out in the morning or evening. Urea fertilizer 95.2 g $plot^{-1}$, Potassium chloride as 47.6 g $plot^{-1}$, Super Phosphate-36 (SP-36) as119 g $plot^{-1}$. Nitrogen and Potassium chloride fertilizers are given twice during the plant growth period, namely in the vegetative phase, 2 weeks after planting (WAP), and the generative phase (30 WAP). In the first fertilization, urea was applied at 95.2 g $plot^{-1}$, Potassium chloride at 47.6 g $plot^{-1}$, and SP-36 at 119 g $plot^{-1}$. At the second fertilization (30 WAP), urea and Potassium chloride were given according to the recommended dose, without adding SP-36.

Plant Maintenance: Maintenance of tomato plants includes watering, replanting, weeding, hilling, pruning, and installing stakes. Watering is done by using gembor every morning and evening if it doesn't rain, replanting is done if there are plants that don't grow or die, weeding is done twice a day by pulling out weeds that grow around the tomato plants, affixing is done by loosening the soil then piling up soil near the plants to strengthen the roots so they don't collapse easily, pruning the lower leaves is done by cutting the lower leaves that touch the ground to prevent the tomato plants from being attacked by disease and placing stakes is done so that the plants don't collapse easily.

Research Design

This study was conducted using a randomized block design (RBD) with liquid organic fertilizer (P) treatments. Nitrogen: 95.2 g; potassium chloride: 47.6 g; SP-36: 119 g $plot^{-1}$ (P0 = control); LOF 60 mL L^{-1} water (P1), LOF 100 mL L^{-1} water (P2), and LOF 140 mL L^{-1} water (P3). Each treatment was replicated four times, resulting in 16 experimental units. Each experimental unit consisted of 20 plants, resulting in a total of 320 plants.

Observation Variables

The variables observed in this study were as follows:

1. Plant height (cm) was measured from the base of the stem to the growing point at 21, 28, and 35 days after transplanting (DAT).
2. The number of leaves (leaflets) was calculated by counting all fully opened leaves at 21, 28, and 35 DAT.
3. Stem diameter (mm) was measured at the main stem 5 cm above the soil surface using a vernier caliper at 21, 28, and 35 DAT.

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4. The number of branches was calculated by counting the total number of branches on the tomato plants at 21, 28, and 35 DAT.
5. Leaf area (cm²) was measured by measuring leaf length and width, then using photo-based observations.
6. Flowering age of tomato plants was observed from the beginning of flowering until 50% of the plants reached full bloom, or 20 plants per plot. Tomato flowering was first observed when the flowers were fully open.

Data Analysis

The observed data were first tested for normality and homogeneity. If the data met the assumptions of normality and homogeneity, the analysis (ANOVA) was performed at a $P < 0.05$ level. If the calculated F-test indicated a significant effect at $P < 0.05$, the Honestly Significant Difference (HSD) test was performed at a $P < 0.05$ level. All data analysis was performed using RStudio version 2026.01.0 + 392.

RESULTS AND DISCUSSION

Plant Height, Number of Leaves, and Stem Diameter

Table 1. The Effect of LOF on Plant Height, Number of Leaves, and Stem Diameter

Plant Height (cm)			
Treatment	**21 DAT**	**28 DAT**	**35 DAT**
P0	28.4 ± 3.13 b	37.3 ± 4.93 b	48.2 ± 4.35 c
P1	30.4 ± 3.10 ab	40.6 ± 8.01 b	56.7 ± 9.12 bc
P2	35.4 ± 2.60 ab	47.0 ± 3.91 ab	64.0 ± 7.12 ab
P3	39.1 ± 6.02 a	56.2 ± 8.73 a	69.6 ± 11.12 a
Number of Leaves (sheet)			
Treatment	**21 DAT**	**28 DAT**	**35 DAT**
P0	9.8 ± 1.0 a	11.6 ± 1.75 b	15.1 ± 1.91 b
P1	10.3 ± 0.82 a	11.3 ± 0.69 b	14.8 ± 0.69 b
P2	10.1 ± 1.26 a	11.6 ± 1.10 b	16.4 ± 1.66 ab
P3	10.2 ± 1.69 a	14.8 ± 1.73 a	19.5 ± 2.57 a
Stem Diameter (mm)			
Treatment	**21 DAT**	**28 DAT**	**35 DAT**
P0	4,3 ± 0,24 ab	4,9 ± 0,23 a	5,6 ± 0,39 b
P1	4,7 ± 0,65 ab	5,2 ± 0,66 a	5,8 ± 0,61 b
P2	5,0 ± 0,39 a	5,6 ± 0,64 a	6,6 ± 0,61 ab
P3	4,0 ± 0,23 b	5,8 ± 0,38 a	7,2 ± 0,54 a

Notes: Numbers followed by the same letter are not significantly different in the Honestly Significant Difference (HSD) test at a 95% confidence level

Table 1 shows that at 21, 28, and 35 DAT, the highest plant heights were observed in the P3 treatment, namely 39.1 cm, 56.2 cm, and 69.6 cm, respectively. Plant growth in the P0 treatment using nitrogen, phosphorus and potassium fertilizers was lower, presumably because inorganic fertilizers only provided nitrogen, phosphorus, and potassium elements. In contrast, the nutrient content in LOF based on the results of laboratory analysis of LOF used in this study had a pH of 4.32 and contained nitrogen (N) of 8.42 mg L^{-1}, phosphorus (P) of 10.72 mg L^{-1}, potassium (K) of 10.11 mg L^{-1}, but also contained magnesium (Mg) of 65.70 mg L^{-1} and calcium (Ca) of 48.30 mg L^{-1}, as well as microelements such as iron (Fe) of 0.0488 mg L^{-1} and zinc (Zn) of 0.0217 mg L^{-1}. The more complete nutrient content is thought to be able to meet plant nutritional needs more optimally so that tomato plant growth is better (Yelli *et al*., 2022).

The highest number of leaves at 21 DAT was obtained in the P1 treatment, namely 10.3 leaves. At 28 and 35 DAT, the highest number of leaves was obtained in the P3 treatment, namely 14.8 and 19.5 leaves, respectively, which was significantly different from the P0 and P1 treatments, but not significantly different from the P2 treatment. The highest number of leaves was in the P3 treatment, while the P0 treatment produced a lower number of leaves. This is thought to be because in the early phase of growth, plant nutrient requirements are still low, while in the later phase, plants require more nitrogen for leaf formation. In addition to nitrogen, the magnesium and iron content in LOF also helps the formation of chlorophyll so that the process of photosynthesis takes place better (Xie *et al*., 2021).

The highest stem diameter was obtained in treatment P2, namely 5.0 mm, and the lowest in P3, namely 4.0 mm, which was significantly different from treatment P3, but not significantly different from treatments P0 and P1. At the age of 35 days after planting, the highest stem diameter was obtained in treatment P3, namely 7.2 mm, and the lowest in P0, namely 5.6 mm. Treatment P3 was significantly different from P0 and P1, but not significantly different from P2. The increase in stem diameter and number of branches in this study is thought to be due to the potassium, calcium, and magnesium content in LOF, helping to strengthen plant tissue, increase enzyme activity, and support cell division and enlargement.

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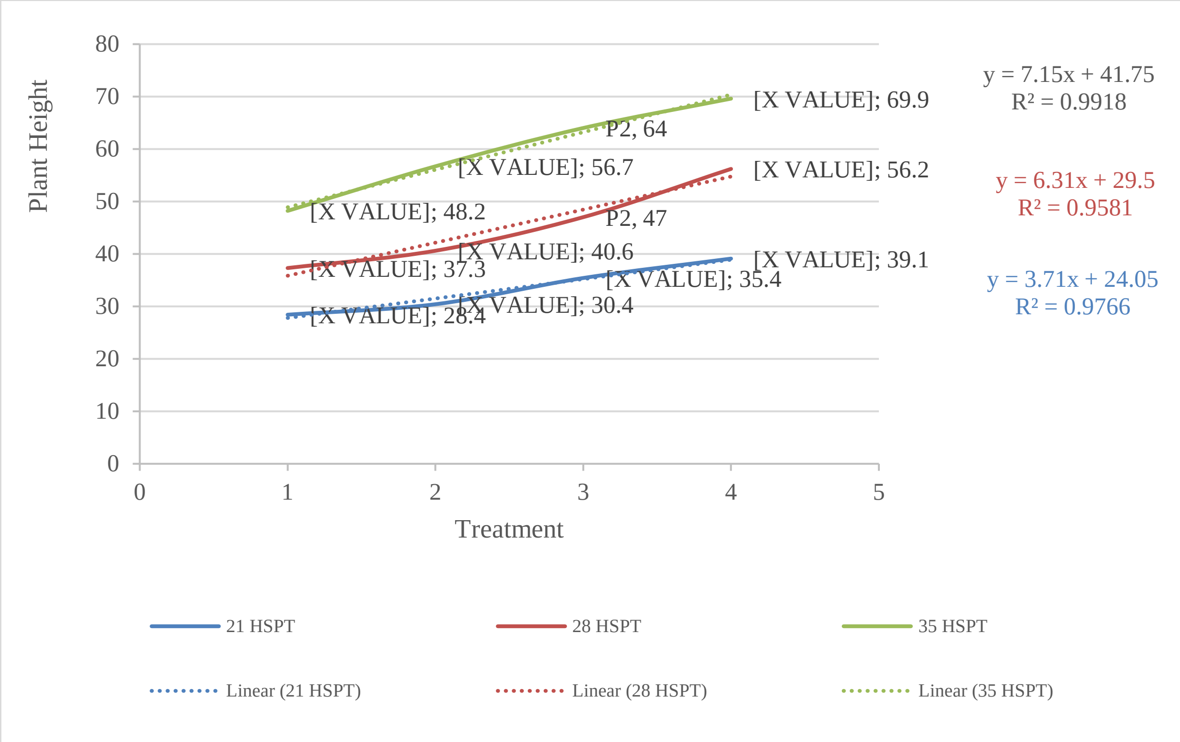

Figure 1. Curve of the Plant Height Response to LOF (HSPT = DAT)

Figure 1 shows that tomato plant height tended to increase with increasing concentration of LOF at 21, 28, and 35 DAT. The highest plant height was obtained in treatment P3. The results of this study indicate a tendency for increasing LOF concentration to be followed by an increase in plant height. This condition is thought to be because the LOF used contains macronutrients such as nitrogen, phosphorus, and potassium, which play a role in chlorophyll formation, protein synthesis, cell division, and photosynthesis, which support vegetative plant growth (Ceri *et al.*, 2023).

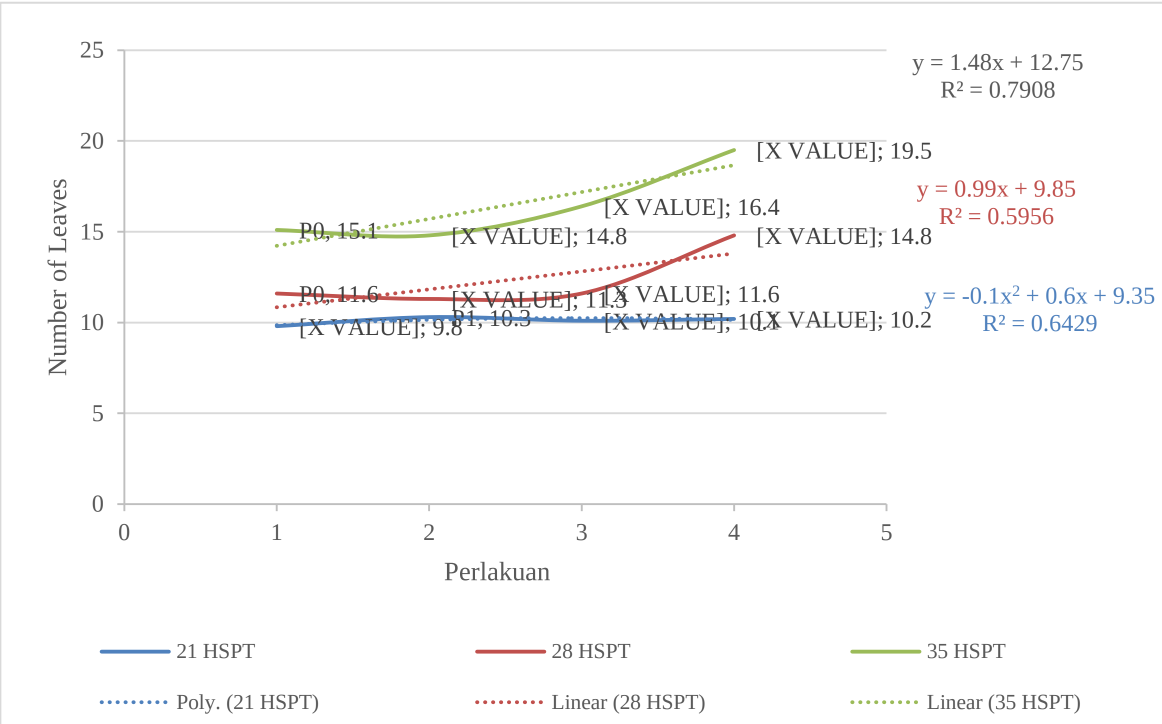

Figure 2. Curve of the Number of Leaves Response to LOF, (HSPT = DAT)

Figure 2 shows that the number of leaves did not differ significantly between all treatments at 21 DAT, but tended to increase at 28 and 35 DAT as the concentration of LOF increased. The highest number of leaves was obtained in treatment P3.

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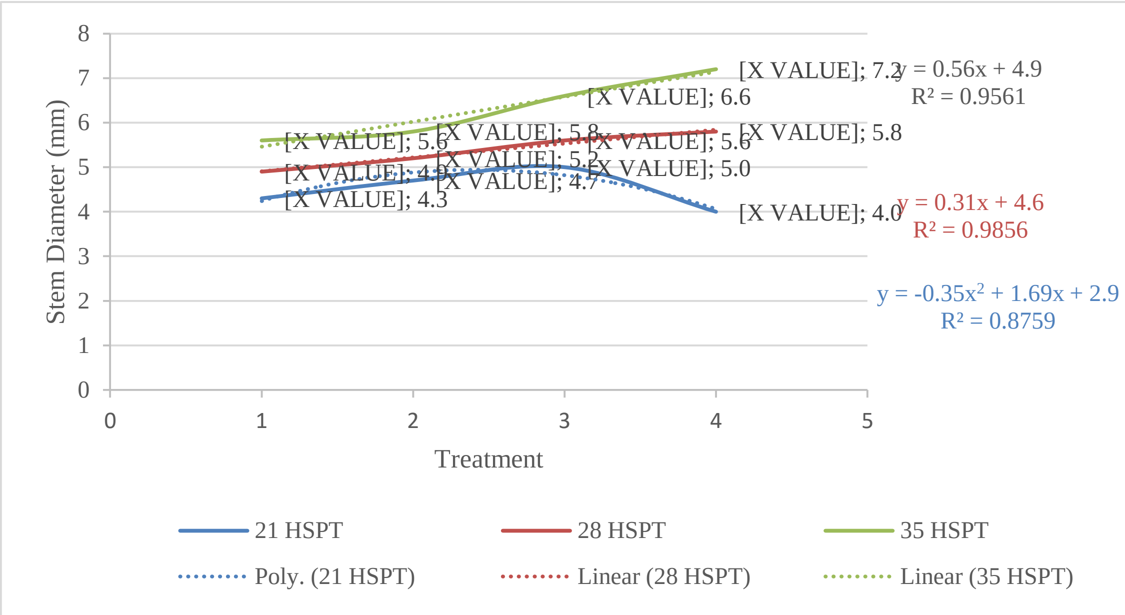

Figure 3. Curve of the Stem Diameter Response to LOF (HSPT = DAT)

Based on Figure 3, the stem diameter of tomato plants at 21 DAT showed a quadratic pattern with an R^2 value of 0.8759. At 28 and 35 DAT, it showed a linear pattern with R^2 values of 0.9856 and 0.9561, respectively, where the treatment tended to increase the stem diameter of tomato plants.

Number of Branches

Table 2. The Effect of LOF on the Number of Branches

Number of Branches		
Treatment	**28 DAT**	**35 DAT**
P0	0.5 ± 0.58 a	1.7 ± 0.72 b
P1	0.3 ± 0.32 a	1.8 ± 0.43 b
P2	0.7 ± 0.56 a	3.1 ± 0.79 ab
P3	1.2 ± 0.69 a	3.7 ± 0.93 a

Notes: Numbers followed by the same letter are not significantly different in the Honestly Significant Difference (HSD) test at a 95% confidence level

Based on Table 2, the application of LOF from banana peels at 28 DAT did not differ significantly between all treatments. At 28 DAT, the highest number of branches was obtained in treatment P3, namely 0.9 branches, and the lowest in treatments P0 and P1, namely 0.3 branches. At 35 days after planting, the highest number of branches was obtained in treatment P3, namely 3.7 branches, which was significantly different from treatments P0 and P1, but not significantly different from treatment P2. The nutrient content contained in liquid organic fertilizer can increase photosynthesis results so that more assimilates are allocated to stem and branch formation (Nurjannah and Lasmini, 2022). In addition, the availability of sufficient nutrients also supports cell division and enlargement activities, so that the growth of the stem diameter and the number of branches is better.

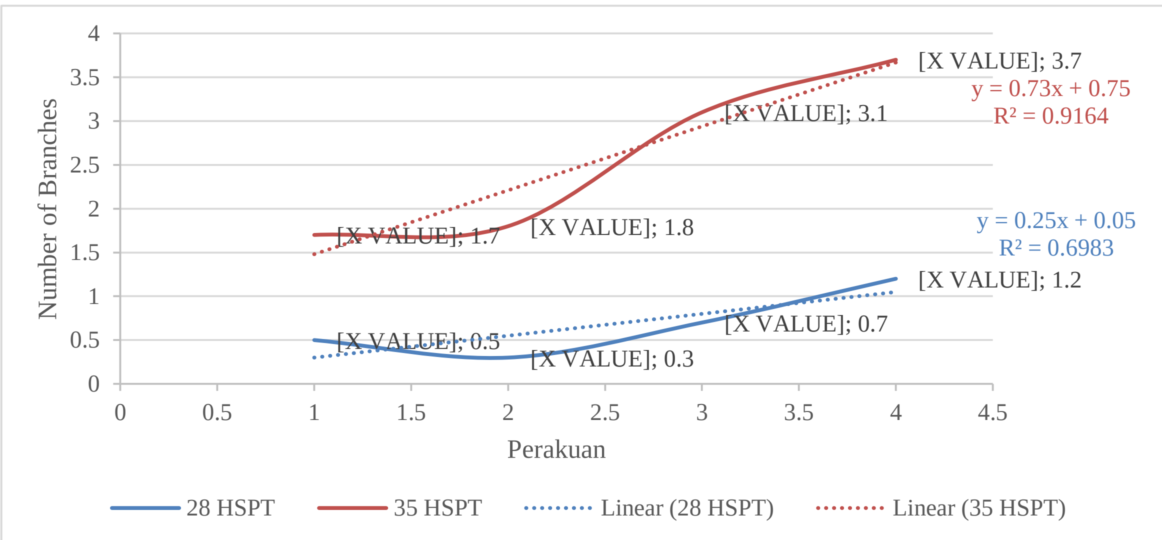

Figure 4. Curve of the Number of Branches Response to LOF, (HSPT = DAT)

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Figure 4 shows that the application of LOF increased the number of tomato plant branches at the ages of 28 and 35 DAT, with a tendency to increase the pattern on the curve. At the age of 28 DAT, the R^2 value was obtained at 0.6983, while at the age of 35 DAT, the R^2 value was 0.9164, which indicates that increasing treatment tends to be followed by an increase in the number of tomato plant branches.

Leaf Area

Table 3. The Effect of LOF on the Leaf Area

	Leaf Area (cm^2)		
Treatment	**21 DAT**	**28 DAT**	**35 DAT**
P0	303.0 ± 49.23 a	485.9 ± 112.58 a	718.3 ± 213.13 a
P1	333.7 ± 97.29 a	467.9 ± 134.12 a	793.3 ± 278.64 a
P2	359.0 ± 55.50 a	493.1 ± 183.76 a	836.8 ± 219.58 a
P3	469.1 ± 144.72 a	571.4 ± 220.33 a	881.9 ± 355.62 a

Notes: Numbers followed by the same letter are not significantly different in the Honestly Significant Difference (HSD) test at a 95% confidence level

Based on Table 3, LOF administration had no significant effect on tomato plant leaf area at 21, 28, and 35 DAT. However, the average leaf area tended to increase with plant age. At 21, 28, and 35 DAT, the highest leaf area was obtained in treatment P3. This is thought to be due to leaf area development being influenced not only by nutrients but also by genetic factors, light intensity (Condratev *et al.*, 2022), temperature, and water availability (Pengguo *et al.*, 2016). Therefore, although the nutrient content in LOF was able to increase the average leaf area, the results of the statistical analysis of leaf area showed no significant effect.

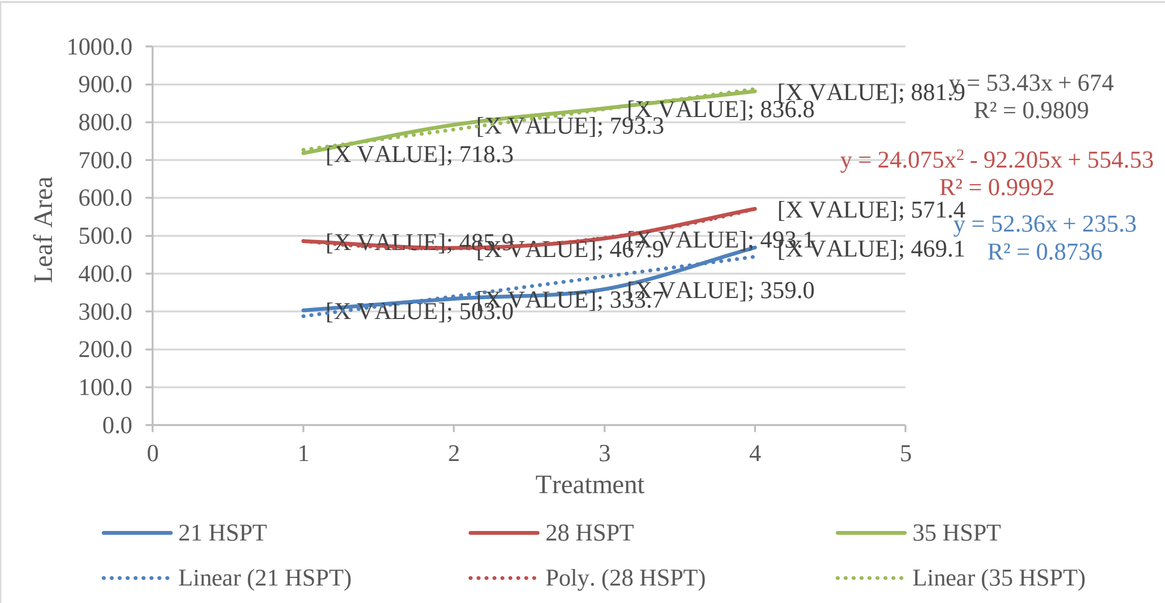

Figure 5. Curve of the Leaf Area Response to LOF (HSPT = DAT)

Based on Figure 5, the leaf area of tomato plants at the ages of 21 and 35 DAT showed an increasing trend along with the increasing concentration of LOF, with R^2 values of 0.8736 and 0.9809, respectively. At the age of 28 DAT, the DAT showed a quadratic pattern with an R^2 value of 0.9992, with the highest treatment observed in P3.

Flowering Age

Table 4. The Effect of LOF on the Flowering Age

Treatment	**Flowering Age (DAT)**
P0	37.3 ± 4.35 a
P1	37.0 ± 2.71 a
P2	35.8 ± 4.57 a
P3	38.0 ± 0.00 a

Notes: Numbers followed by the same letter are not significantly different in the Honestly Significant Difference (HSD) test at a 95% confidence level

Based on Table 4, the application of LOF did not differ significantly among all treatments. The fastest flowering age was found in treatment P2, at 35.8 DAT, while the longest flowering age was found in treatment P3, at 38.0 DAT.

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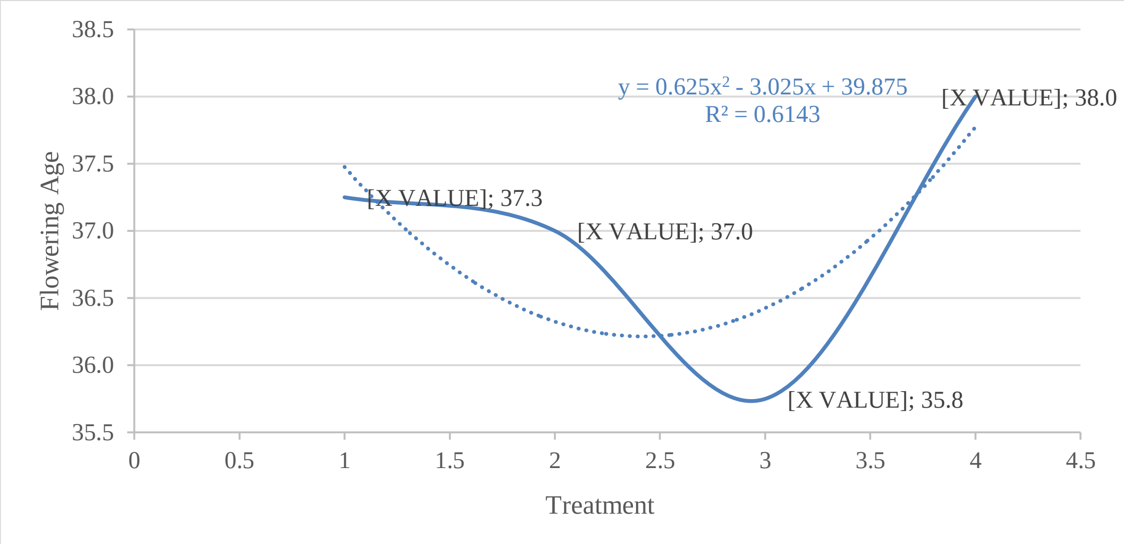

Figure 4. Flowering Age Curve of 50% of Tomato Plants

Based on Figure 4, the flowering age of tomato plants forms a quadratic pattern with an R^2 value of 0.6143. The fastest flowering age was obtained in treatment P2, namely 35.8 DAT, while the longest flowering age was found in treatment P3, namely 38.0 DAT.

CONCLUSION

Based on the research results and discussion, the following conclusions can be drawn: application of liquid organic fertilizer significantly affected plant height, number of leaves at 28 and 35 DAT, stem diameter at 21 and 35 DAT, and number of branches at 35 DAT. The LOF treatment with a concentration of 140 mL L^{-1} of water (P3) provided the best results for tomato plant growth, as indicated by the highest plant height, number of leaves, stem diameter, and number of branches.

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