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Effect of Liquid Organic Fertilizer Type and Concentration on the Growth and Production of Purple Eggplant (*Solanum melongena* L.)

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ABSTRACT

The productivity of purple eggplant has decreased and consumption continues to increase, it is necessary to increase the productivity of purple eggplant. Increasing productivity can be done by applying liquid organic fertilizer (LOF) derived from organic waste such as banana peels and fish waste. The purpose of this study was to determine the type and concentration of LOF that can help the growth and yield of purple eggplant. This research was conducted on the land of the Faculty of Agriculture, University of National Development (UPN) "Veteran" East Java in March to July 2022. The study used a factorial Randomized Block Design (RBD) consisting of 2 factors. The first factor was the LOF of banana peels and LOF of fish waste. The second factor is the LOF concentration level, namely 10%, 15%, 20%, 25% and 30%. The results showed that the treatment combination of fish waste LOF with a concentration of 30% gave plant with a biggest stem diameter of 1.01 cm. While the treatment combination of fish waste LOF with a concentration of 25% gave results with a total of 16.78 flowers and a total fruit weight of 1435.61 g/plant.

1. INTRODUCTION

Eggplant (*Solanum melongena* L.), commonly known as purple eggplant, is a widely cultivated vegetable in Indonesia. Many people are interested in eggplant because it can be consumed as fresh vegetables and in various dishes. Eggplant has a fairly high vitamin content, especially vitamin A and potassium. As stated by Sakri (2012), every 100 grams of eggplant comprises 24 calories, 1.1 grams of protein, 0.2 grams of fat, 5.5 grams of carbohydrates, 15.0 mg of calcium, 37.0 mg of phosphorus, 0.4 mg of iron, 4.0 SI of vitamin A, 5 mg of vitamin C, 0.04 mg of vitamin B1, and 92.7 grams of water.

The increasing population every year means that the value of people's consumption of vegetables, especially eggplant, is also increasing. According to data from PUSDATIN (2020), the Indonesian population's expenditure on food consumption, especially vegetables, increased in 2019 by 6.62% and in 2020 by 7.52%. This is thought to have happened because of the healthy lifestyle trend during the pandemic which made people realize the importance of maintaining health. Therefore, it is essential to boost the cultivation of vegetable crops like eggplant, tomatoes, chili peppers, and others. Based on data from BPS (2021), eggplant production in 2018 was 551,552 tons, in 2019 it was 575,393 tons and in 2020 it was 575,392 tons. Based on the aforementioned data, there is no notable rise in eggplant production. Consequently, endeavors are required to sustain the stability of eggplant cultivation to fulfill the growing demands of the society.

The continuously growing population, coupled with diminishing agricultural land, necessitates community-led initiatives for food security. This aims to meet the food needs of the community through maximum use of natural resources. One effort that could be a solution to meet household food needs is urban farming. This urban farming program is very good to be used as a food security solution, because through this model, people can utilize land as optimally as possible. According to Permana (2012), urban farming also contributes to empowering organic waste so as to create a clean city. Urban farming can also use organic fertilizer made from organic waste.

Organic waste is material that comes from the remains of industrial or household production, which can pollute the environment if it is not processed first. The improper disposal of organic waste can lead to environmental pollution, including unpleasant odors. The utilization of liquid organic fertilizer (LOF) derived from organic waste is deemed more environmentally friendly, as it avoids negative impacts on both soil and plants. The application of LOF benefits soil fertility, ensuring rapid and efficient nutrient absorption by plants due to the swift availability of essential nutrients. Liquid organic fertilizer offers advantages in swiftly addressing nutrient deficiencies, preventing nutrient leaching issues, and providing prompt nutrient supply (Nur & Elma, 2016).

Banana peels and fish waste are types of organic waste that are easy to find. As the food industry, both large and small scale, uses bananas as raw material, the resulting banana peel waste increases. The accumulation of banana peel waste, if not managed properly, can cause environmental pollution such as causing an unpleasant odor. One effort to utilize banana peel waste into products that have added value is converting it into liquid organic fertilizer (LOF). Banana peel waste contains the nutrients N, P and K which are useful as a source of nutrition for plants. According to Susetya (2012), banana peels can be used as LOF, Due to the presence of Nitrogen (N), Phosphorus (P), and Potassium (K) in banana peels, with P and K elements reaching 15% and 12% higher levels than those found in banana flesh. Nasution et al. (2014) found that banana peels, when processed into liquid organic fertilizer (LOF), exhibit a Total N content of 0.18%, P_2O_5 0.043%, K_2O 1.137%, C-Organic 0.55%, C/N 3.06%, and pH 4.5.

Rajagukguk & Nusyirwana (2018) reported that the utilization of liquid organic fertilizer (LOF) derived from banana peels, applied to curly red chili plants (*Capsicum annuum* L.) at a concentration of 300 ml/l, exhibited optimal effects on vegetative phase parameters. This included parameters such as plant height (75.66 cm), number of branches (41.33 branches), and number of leaves (276 pieces). Moreover, during the generative phase, it demonstrated superior outcomes in terms of flower emergence age (43 DAP), number of flowers (28 flowers), number of fruits (12.83 fruits), and fruit weight (40.36 g). These results surpassed those obtained with banana peel organic fertilizer treatment at a concentration of 500 ml/l. LOF treatment with a concentration of 500 ml/l resulted in plant height (55.83 cm), number of branches (28.50 branches), number of leaves (199.66), age at flower emergence (68.5 DAP), number of flowers (6 .66 flowers), number of fruit (3.33 fruit), and fruit weight (8.16 g).

Another organic waste that is often found is fish waste, because Indonesia is a maritime country, most of which is water, resulting in abundant fisheries production. The fish waste produced is in the form of fish innards, fish bones, fish scales, fish heads and fish fins. Fish waste that is not managed properly can cause pollution impacts on the environment. Fish offal has a fairly high protein content, so it has the potential to be a source of nutrition for plants.

According to Hossain & Alam (2015), fish innards comprise 14.01% protein, 20% fat, 4.75% ash, and 60.62% water. The protein content found in fish waste innards can serve as a nutritional source for plants. Suartini *et al*. (2018) state that liquid organic fertilizer (LOF) derived from fish innards contains N 3.74%, P 3.16%, and K 1.48%. Additionally, Zahroh *et al*. (2018) demonstrate that liquid organic fertilizer derived from fish waste contains 0.30% total N, 0.65% phosphorus in the form of P_2O_5, and 0.17% potassium in the form of K_2O. Barudah et al. (2020) showed that addition of LOF from fish waste to purple eggplant plants with a concentration of 25% gave the best results regarding the parameters of plant height (54.86 cm), number of fruit per plant (12.66), and fruit weight per plant (1068.35 g), which is better compared to that of 5% concentration treatment resulting plant height (50.46 cm), number of fruit per plant (8.00 fruit), and fruit weight per plant (676.92 g).

The choice of fertilizer type and concentration given must be in accordance with the plant's needs so that the effectiveness of nutrient absorption in the plant can be maximized. Each type of fertilizer contains different amounts of nutrients, so you need to pay attention to the concentration of fertilizer given to plants. Plants have certain limits to the absorption of nutrient concentrations, if the nutrient concentration provided is too low then plant growth will be hampered because the plant does not get enough nutrients for its metabolic processes. Fertilizer concentrations that are too high can cause plants to wilt due to accumulated nutrients. Testing the concentration of fertilizer is essential to identify the optimal level, ensuring the fulfillment of nutrients and enhancing plant productivity. This study aims to assess the impact of different combinations and individual treatments involving the best type and concentration of liquid organic fertilizer (LOF) on the growth and yield of purple eggplant.

2. MATERIALS AND METHODS

This study was conducted from March to July 2022 at the Experimental Field of the Faculty of Agriculture, National Development University "Veteran" East Java (latitude –7.33377852, longitude 112.79097838) with an elevation of approximately 32.7 m above sea level. Climate data for Surabaya, specifically Gunung Anyar District, indicates an average annual rainfall of 204.5 mm, an average maximum and minimum temperature of 32°C and 24.9°C, and an average maximum and minimum humidity of 89.4% and 63.2%, respectively (BPS Kota Surabaya, 2022).

2.1. Tools and Materials

The tools used in this research included seeding tanks, hand sprayer, stirrer, filter cloth, buckets, fermentation jars, measuring cup, blender, hoe, stake, raining bucket ("gembor"), spatula, tray, metering tape, knives, scale, caliper, stationery, ruler, and camera. The materials employed in this study encompassed eggplant seeds (Prince variety), banana peel waste (Kepok variety), catfish wastes, 40x40 cm polybags, NPK 16:16:16 fertilizer, EM4, water, molasses, soil, husks, rice washing water, raffia rope, and label paper.

2.2. Experimental Design

This study is a factorial experiment designed with a Randomized Group Design comprising two factors under investigation. Factor I represents the type of liquid organic fertilizer (LOF) and consists of 2 levels, namely A_1 (banana peel) and A_2 (fish waste). Factor II was concentration of LOF (K) with 5 levels, namely K_1 (10%), K_2 (15%), K_3 (20%), K_4 (25%), and K_5 (30%). The K_0 (control treatment) was used as a comparison using NPK as basic fertilizer. The two treatment factors led to the creation of 10 treatment combinations, each replicated 3 times, resulting in a total of 30 experimental units. Each replication had 3 plant samples so there were 99 plants (including control with 3 plants, repeated 3 times).

2.3. LOF Preparation

2.3.1. Banana Peel LOF

A total of 10 kg of ripe Kepok banana peel waste was removed from the base and ends, then cut into small pieces, washed clean and dried in the air. Chung crushed the banana peel using a blender, then put it in a fermentation container along with 10 liters of water, 250 ml of brown sugar solution, and 250 ml of EM4 solution, then stirred until smooth. The fermentation container was covered with plastic and left for 2 weeks. If the color of the solution turns brown and does not have a strong odor, the liquid organic fertilizer is ready for use (Rambitan & Sari, 2013).

2.3.2. Fish Waste LOF Preparation

Fish waste and banana weevils that have been washed clean are cut into small pieces and ground using a blender, then put into a bucket and mixed with 5 liters of rice washing waste, 7.5 liters of clean water, 3.75 kg of white sugar, and 375 ml of EM4. . The mixture is stirred until evenly distributed, covered tightly and placed in a place protected from direct sunlight. Every morning and evening the gas is released by opening the lid. After two weeks the fertilizer has no smell and is brownish black in color and then filtered using a filter (Murdaningsih & Rahayu, 2021). LOF nutrient content test carried out at the UPN "Veteran" East Java Integrated Laboratory are presented in Table 1.

Table 1. Nutrient content of the prepared LOF

LOF type	Nutrient content (%)			
	N-total	**P-total**	**K-total**	**C-Organic**
Banana peel waste	0.14	0.02	0.40	0.5
Fish waste	0.27	0.09	0.34	3.9

2.4. LOF Application

LOF was applied when the eggplant plants are 7 DAP (days after planting). LOF was diluted first with clean water to get suitable concentration. For K_1 treatment (10% LOF concentration), 900 ml of water was added to 100 ml of LOF. In the same way, for K_2 (15% = 150 ml LOF + 850 ml water), K_3 (20% = 200 ml LOF + 800 ml water), K_4 (25% = 250 ml LOF + 750 ml water), and K_5 (30% = 300 ml LOF + 700 ml water). The application of LOF to eggplant plants is carried out once a week at a rate of 200 ml/plant by pouring it on the soil. LOF application was carried out up to 11 times (from 7 to 77 DAP).

2.5. Data Analysis

Data on plant responses were subjected to ANOVA analysis, and if the treatment combination exhibited a significant effect (where the calculated F value surpassed the table F value at a 5% significance level), further analysis was conducted using the Least Significant Difference test. The analysis employed to assess whether there is a distinction in the optimal treatment of liquid organic fertilizer for each observed parameter compared to the control treatment using NPK fertilizer is the t-Test: Paired Two Sample for Means. The t-Test: Paired Two Sample for Means relies on hypothesis comparison; if the calculated t-value surpasses the t-table, H0 is rejected, and H1 is accepted, and vice versa. The data obtained are processed using Microsoft Excel 2013. The hypotheses in this study are:

- H_0: There is no difference between the application of liquid organic fertilizer and the application of NPK fertilizer.
- H1: There is a difference between the application of liquid organic fish fertilizer and the application of NPK fertilizer.

The hypothesis testing is based on the t-test, where the calculated t-value is compared with the tabulated t-value. If the calculated t-value > t-table, then H0 is rejected, and H1 is accepted. Conversely, if the calculated t-value < t-table, then H0 is accepted, and H1 is rejected.

3. RESULTS AND DISCUSSION

3.1. Bar Diameter (cm)

The ANOVA analysis results indicated a highly significant interaction between the combined treatment of LOF type and concentration regarding the stem diameter of purple eggplant plants at 30, 60, and 90 days after planting (DAP) (Table 2). The findings revealed that the application of liquid organic fertilizer (LOF) derived from fish waste with a 30% concentration significantly differed from all treatments but did not show a significant difference compared to the LOF treatment with a fish waste concentration of 25%. The combination of treatment with LOF type of fish waste with a concentration of 30% at the age of 30, 60 and 90 DAP resulted in stem diameters of 0.42 cm respectively; 0.81cm; and 1.01 cm. These results are greater than those of banana peel LOF with a concentration of 30%, namely 0.33 cm respectively; 0.65 cm and 0.86 cm. This best result was obtained because the LOF treatment of fish waste had a higher N nutrient content than the banana peel LOF treatment. This is evidenced by the findings of the nutrient content analysis of liquid organic fertilizer (LOF) (Table 1), indicating that the N content in fish waste-based LOF is 0.27%, surpassing the N content in banana peel-based LOF, which is 0.14%.

The macro nutrients N, P and K contained in fish waste LOF are able to stimulate plant physiological processes for growth in the vegetative phase such as stems, roots and leaves. In the vegetative phase, plants need a lot of N to synthesize chlorophyll, amino acids and proteins and stimulate cell division, as stated by Lingga & Marsono (2004) that cell division occurs in meristematic tissue at the growing points in the stems and roots. When cells begin to enlarge, vacuoles will form which can actively absorb nutrients in large quantities. As a result of absorption, cell elongation and enlargement occur so that the cell walls thicken due to the accumulation of cellulose.

The K element is equally crucial, contributing to enhancing plant vitality, thereby fortifying the stem and augmenting its diameter. The enlargement of stem diameter is related to the process of translocation of nutrients which are transported through the stem by xylem and phloem vessels from the soil to the leaves. The larger the stem diameter, the easier and smoother the process of transporting photosynthesis and nutrients. The photosynthate produced helps in the process of cell division thereby increasing stem enlargement. This is in accordance with the opinion of Fitri *et al.* (2017) The photosynthate generated contributes to cell division, consequently promoting the enlargement of the stem. This aligns with the perspective of Fitri *et al.* (2017), where the photosynthate produced supports cellular activities in plant tissues during the differentiation process, expediting the growth and development of plant components such as leaves, stems, and roots.

Table 2. Average stem diameter (cm) of purple eggplant plants due to combination treatment of type and concentration of LOF

Plant age	LOF type	LOF concentration				
		10%	**15%**	**20%**	**25%**	**30%**
30 DAP	Control (NPK)			0.56		
	Banana peel	0.29 a	0.30 ab	0.31 abc	0.32 bc	0.33 cd
	Fish waste	0.32 bc	0.35 de	0.38 ef	0.40 fg	0.42 g
	LSD 5%			0.02		
60 HST	Control (NPK)			0.93		
	Banana peel	0.58 a	0.59 ab	0.61 abc	0.63 bc	0.65 cd
	Fish waste	0.63 bc	0.68 d	0.74 e	0.79 ef	0.81 f
	LSD 5%			0.04		
90 HST	Control (NPK)			1.16		
	Banana peel	0.75 a	0.76 a	0.80 b	0.83 b	0.86 cd
	Fish waste	0.84 bc	0.90 d	0.95 e	0.98 ef	1.01 f
	LSD 5%			0.02		

Note: Numbers followed by the same letters at the same age mean not significant at the 5% LSD test.

Table 3 shows the results of the T test: Paired Two Sample for Means regarding the response of plants from several treatments to the control. The stem diameter in treatment A2(30%) produces a calculated T value of -18.3153. At the 95% confidence level, the T table is t(0.05; 2) is 2.3060. Therefore, H_0 is accepted, meaning that fish waste LOF with a concentration of 30% has the same effect as NPK fertilizer in stem diameter growth. The results in Table 2 displays the average stem diameter at 30, 60 and 90 days after planting (DAP) for a 30% LOF fish waste concentration (0.42 cm; 0.81 cm; and 1.01 cm) and NPK fertilizer as control (0 .56 cm; 0.93 and 1.16 cm). The T test: Paired Two Sample for Means results, indicate that there is no significant impact observed between LOF fish waste with a concentration of 30% and NPK fertilizer. It is suspected that the added 30% concentration of fish waste LOF content can substitute for the difference in nutrients in NPK fertilizer. The presence of macro and micro nutrients can possibly replace the difference in N, P and K.

Table 3. T-Test: Paired Two Sample for Means for LOF with control treatment on some plant responses

	Stem diameter (cm)		Leaf area (cm^2)		Number of flower		Number of fruit		. Total Fruit Weight	
	LOF A2 (30%)	Control	LOF (30%)	Control	LOF A2 (25%)	Control	LOF (25%)	Control	LOF A2 (25%)	Control
Mean	1.0078	1.165	8221.7221	8932.1623	16.7778	18.6667	10.7778	13.8889	1435.6111	2164.5556
Variance	0.000582	0.000081	385.885.5	127.788.8	0.4444	1.25	0.9444	0.8611	778.6111	336.2778
Observations	9	9	9	9	9	9	9	9	9	9
Pearson Correlation	0.0000		0.1778		0.3913		-0.3080		0.5924	
Hypothesized Mean Difference	0		0		0		0		0	
df	8		8		8		8		8	
t Stat	-18.3153		-3.2325		-5.3758		-6.0741		-96.9628	
P(T<=t) one-tail	0.000000041		0.0060		0.00033		0.00015		0.000000000000071	
t Critical one-tail	1.8595		1.8595		1.8595		1.8595		1.8595	
P(T<=t) two-tail	0.000000081		0.0120		0.00066		0.00030		0.000000000000142	
t Critical two-tail	2.3060		2.3060		2.3060		2.3060		2.3060	

Note: A2 = LOF fish waste

In relation to nutrient availability, the N element in fish waste LOF is thought to play a direct role in increasing stem diameter. According to Saragih *et al.* (2013), the element N is a constituent of plant biomass, including the diameter of plant stems. The more N given, the higher the biomass produced so that the stem diameter also increases.

3.2. Leaf Area (cm^2)

The analysis of variance results indicated that the interaction between treatment types and concentrations of LOF did not result in a significant impact on the leaf area of purple eggplant plants at 30, 60 and 90 DAP. While the various liquid organic fertilizer treatments did not significantly influence the plant area of purple eggplant plants, however the treatment involving LOF demontrated a noteworthy impact on the leaf area of purple eggplant as detailed in Table 4.

Table 4. Average leaf area (cm^2) of purple eggplant plants due to combination treatment of type and concentration of LOF

LOF Type	Average leaf area (cm^2)		
	30 DAP	60 DAP	90 DAP
Control (NPK)	1,998.52	4,390.78	8,932.1623
LOF Type			
Banana peel	483.35	1.812.73	5,211.78
Fish Waste	616.79	2.479.40	7,342.91
LSD 5%	ns	ns	ns
LOF concentration (%)			
10%	493.98 a	1,813.90 a	5,169.13 a
15%	499.03 ab	1,928.66 a	5,830.80 ab
20%	553.15 ab	2,086.99 ab	6,260.58 ab
25%	585.08 ab	2,284.34 ab	6,775.61 ab
30%	619.11 b	2,616.45 b	7,350.62 b
LSD 5%	120.22	538.62	2,049.19

Note: Numbers followed by the same letter in the same column indicate not significantly different in the 5% LSD test (ns = not significant)

According to the information presented in Table 4, there is no significant difference observed in the average leaf area for the LOF type treatment at 30, 60 and 90 DAP. Meanwhile, the LOF concentration treatment showed significant differences at 30, 60 and 90 DAP. Giving a LOF concentration of 30% was not significantly different from treatment with LOF concentrations of 15%, 20% and 25% at the age of 30 DAT and 90 DAP, additionally at 60 DAP there was no significant distinction compared to treatments with a LOF concentration of 20% and 25%. Giving LOF concentration of 30% at the age of 30, 60 and 90 HST resulted in an average leaf area of 619.11 cm^2, respectively; 2,616.45 cm^2 and 7,350.62 cm^2 which are significantly different in concentration by 10% respectively, namely 493.98 cm^2; 1,813.90 cm^2 and 5,169.13 cm^2.

Treatment with 30% LOF concentration at 90 HST resulted in an increase of 25.3%; 44.2% and 42.2% when compared with the 10% LOF concentration treatment. Indicates that as the LOF concentration increases, the nutrient levels in the planting medium also rise, leading to a corresponding enlargement of the leaf area. The more the leaf area increases, the more optimal the photosynthesis process will be, which will affect the growth of organs other than leaves, such as stem diameter. A deficiency in essential macro nutrients like N, P and K can disrupt the growth process. The N element is needed to form amino acids which function to increase the size of the leaf area. The P element helps in the development of meristem tissue which causes cells to enlarge and elongate so that the leaves and stems of plants become longer and wider. Element K plays an important role as an enzyme activator and opens and closes stomata, thereby increasing the rate of plant photosynthesis. This is corroborated by the perspective of Safei *et al*. (2014), asserting that as the plant ages, the demand for nutrients intensifies. The soil alone is incapable of fulfilling this demand, making the application of organic fertilizer crucial to enhance nutrient availability, particularly nitrogen (N), essential for the vegetative growth of the plant. Tisdale *et al*. (1990) added that the element potassium (K) can increase leaf area because potassium plays an important role in the photosynthesis process where more than 50% of the total element in leaves is concentrated in the chloroplasts.

The t-test results to compare the addition of LOF fish waste with a 30% concentration with the application of NPK fertilizer (control) also showed an insignificant effect as seen in Table 3. The T-table value was 2.3060, higher than the calculated T value. (-3.2325), so H_0 is accepted. This means that a LOF fish waste with a concentration 30% has the same effect on leaf area as NPK fertilizer as a comparison. The presence of nutrients in the soil can impact the development of leaf area, with leaf area playing a crucial role in the process of photosynthesis. The place where the photosynthesis process takes place is in the leaves, where chlorophyll captures sunlight as the main ingredient in photosynthesis. Sunlight undergoes processing with the assistance of water and carbon dioxide, leading to the formation of carbohydrates and enzymes that hold significance in the plant's structure. A broader leaf area can enhance the photosynthesis rate, resulting in an increased accumulation of produced photosynthate. This is in accordance with (Novizan, 2007) that good photosynthesis results in increasing photosynthate, so that the photosynthate results can be translocated to the vegetative parts of the plant which are beneficial for the development of plant structures such as stems, roots, and leaves.

3.3. Number of Flowers

The variance analysis results indicated a highly significant interaction in the combined treatment involving the type and concentration of LOF on the total number of flowers of purple eggplant (Table 5). Results show the combination of LOF fish waste with a 25% concentration differed significantly from all treatments but did not exhibit a significant difference compared to LOF fish waste at concentrations of 20% and 30%. The treatment between LOF type and concentration has a very significant interaction. This is believed to occur because the treatment involving the type and concentration of liquid organic fertilizer mutually influences the growth and productivity of purple eggplant plants. Consequently, each treatment has an impact on the other. The combination of LOF fish waste with a concentration of 30% produced a total number of flowers 16.78. This result was greater than the LOF of banana peel with at concentration of 25% (14.22 flowers). This best result was obtained because the LOF fish waste had a higher P nutrient content than the LOF banana peel. This is proven by the results of the LOF nutrient content test (Table 1) where fish waste LOF has a P content of 0.09% higher than banana peel LOF, namely 0.02%.

During the generative phase, plants need the nutrients P and K to maintain and accelerate the flower formation process. Plants require the nutrient phosphorus (P) as it contributes to the division and growth of meristem tissue, facilitating the acceleration of flowering, seed maturation, and fruit ripening. Meanwhile, the element potassium (K) contributes to the elongation and division of cells, especially young cells. This causes the flowering period to be faster. Element K also acts as an enzyme activator so that it can trigger enzyme work to translocate carbohydrates from leaves to other plant organs such as flowers, seeds and fruit. In the opinion of Kurniawati *et al*. (2015) the element P acts as a basic material for the formation of ATP and ADP which are needed in metabolic processes for the formation of amino acids, starch, fat and other organic compounds. Meanwhile, the K element acts as an activator for various types of enzymes, aiding in the synthesis of proteins and carbohydrates. Simultaneously, it reinforces plant structures, including leaves, flowers, and fruit, preventing easy falling and promoting photosynthetic activity.

Table 5. Average total flower count of Purple Eggplant Plants resulting from the combined treatment of LOF type and concentration

LOF Type	LOF concentration				
	10%	**15%**	**20%**	**25%**	**30%**
Control (NPK)			18.67		
Banana peel	12.78 a	13.11 ab	13.67 bc	14.22 d	15.12 def
Fish waste	15.33 c	15.56 de	16.11 efg	16.78 g	16.33 fg
LSD 5%			0,78		

Note: Numbers followed by the same letter in the same column and row indicate not significantly different in the 5% LSD test

As seen in Table 3, the T-table was 2.306, higher than the calculated T value (-5.3758), so H_0 is accepted. This implies that LOF fish waste with a 25% concentration produces a comparable impact to NPK fertilizer when assessing the total flower count. The t-test results indicate that there is no statistically significant difference between LOF fish waste with a 25% concentration and NPK fertilizer. It is suspected that the LOF content of fish waste with a concentration of 25% can substitute nutrients for NPK fertilizer. The availability of nutrients that can meet plant needs can be translocated directly to plant parts for flowering so as to increase the number of flowers per plant. The development of flowers represents a physiological transformation in plants as they transition from the vegetative phase to the generative phase. This is supported by the opinion of Lakitan (2011) which states that during the flowering process very large changes occur because the structure of plant tissue becomes very different. This transformation arises from the collective upregulation of specific genes responsible for flower development. The adequacy of nutrients supplied to plants significantly impacts their progression into the generative phase.

3.4. Number of Total Fruits

The variance analysis results revealed that there was no significant interaction between the combination of LOF types and concentrations regarding the total number of fruits in purple eggplant plants. The LOF concentration treatment had a noteworthy impact on the overall fruit count, while the LOF type did not show a significant effect (refer to Table 6). The average total fruit count per plant in the LOF treatment with a 25% concentration differed significantly from all other concentration treatments but was not significantly different from the treatment with a LOF concentration of 30%. The application of LOF at a 25% concentration yielded optimal results in terms of the total fruit weight per plant. If the concentration of fertilizer given is too concentrated, it can hamper the productivity of eggplant plants, whereas if the concentration of fertilizer given is too little, plant metabolism will be disrupted, resulting in nutrient inadequacies. This is in accordance with the statement of Gardener *et al*. (2008) that plants need nutrients in a balanced state, if the availability of nutrients is lacking, it will inhibit photosynthesis and the photosynthate produced will decrease.

Table 6. Average number of total fruits of purple eggplant plants due to combination treatment of type and concentration of LOF

Treatment	Total fruits of purple eggplant
Control (NPK)	13.89
LOF Type	
Banana peel	8.31
Fish waste	9.68
LSD 5%	ns
LOF concentration	
10%	7.67 a
15%	8.39 ab
20%	8.92 bc
25%	10.11 d
30%	9.89 cd
LSD 5%	1.01

Note: Numbers followed by the same letter in the same column indicate not significantly different in the 5% LSD test

The large number of flowers formed is not followed by the large number of fruit formed. This is because the flowers fall due to a lack of proper fertilization due to high rainfall. According to the climate records of the City of Surabaya (BPS, 2022), Gunung Anyar District in particular has an average rainfall of 204.5 mm, which is relatively high, thus affecting the fertilization process of purple eggplant plants. Excessive rainfall can lead to a reduction in both the quality and quantity of pollen during the pollination process, because rainwater causes flower loss so that fewer fruits are formed. Strong winds will also affect the activity of pollinator insects which help in the pollination process so that the pollination process decreases and affects the number of fruit on purple eggplant plants. This is in accordance with the statement by Kusumayati (2015), that bee activity decreases when it rains and strong winds or when the air temperature drops below 18°C. Evanita *et al*. (2014) also revealed that not all flowers formed can become fruit. This is due to environmental conditions that are unfavorable for plants. The environmental factor that causes the number of fruit on eggplant plants to not be significantly different is frequent rain with quite high intensity. This results in the flowers becoming fruit ovaries unable to develop because they fall due to the kinetic energy and potential energy of rainwater.

From the results of the T test (Table 3) to compare the application of LOF fish waste with a 25% concentration with NPK fertilizer (control), the T-table value is (2.3060), which is greater than the calculated T-value (-6.0741), so that H_0 accepted. This means that the application of LOF fish waste at a concentration of 25% has the same effect on the number of fruits as NPK fertilizer as a comparison. Providing LOF fish waste at a concentration of 25% can yield comparable outcomes to NPK fertilizer. This is substantiated by the study conducted by Barudah et al. (2020), which demonstrated a tangible impact on the growth and yield of purple eggplant through the application of fish waste LOF with a 25% concentration. The provision of fish waste LOF at a 25% concentration significantly influenced the parameter of fruit count per plant (12.66 fruits).

3.5. Total Fruit Weight (g)

The ANOVA analysis results indicated a noteworthy interaction in the combined treatment involving the type and concentration of liquid organic fertilizer, specifically regarding the total harvest weight per plant (refer to Table 7).

Table 7. Total fruit weight (g/plant) of purple eggplant plants due to combination treatment of type and concentration of LOF

LOF Type	LOF concentration				
	10%	15%	20%	25%	30%
Control (NPK)			2164,5		
Banana peel	1017,56 a	1045,94 ab	1068,39 b	1179,06 bc	1209,78 c
Fish waste	1182,89 c	1263,61 d	1353,11 e	1435,61 f	1386,00 e
LSD 5%			35,29		

Note: Numbers followed by the same letter in the same column and row indicate not significantly different in the 5% LSD test

The table illustrates that the application of LOF fish waste with a 25% concentration led to a total harvest weight per plant significantly differing from all other treatments. This is believed to be attributed to the richer nutrient content in fish waste LOF compared to banana peel liquid organic fertilizer. Essential macro nutrients such as nitrogen (N), phosphorus (P), and potassium (K) contribute sufficiently to the nutritional supply, enhancing the total harvest weight per plant. The augmentation of weight in purple eggplant fruits necessitates adequate levels of N, P, and K, with a particular emphasis on phosphorus (P) and potassium (K). Phosphorus (P) plays a pivotal role in cell division and tissue formation, expediting flower development, fruit ripening, and seed maturation. Meanwhile, potassium (K) facilitates the transport of photosynthate products, influencing fruit formation until maturity. This aligns with the perspective of Dewi *et al*. (2021) that the transition to the generative phase in plants requires a more dominant presence of phosphorus and potassium elements. Phosphorus is crucial for fruit formation, while potassium influences the quality of the produced fruit.

Based on the T test results in Table 3, H_0 is accepted. Providing LOF fish waste with a 25% concentration tends to enhance the overall fruit weight per plant. There is a tendency for a higher total number of flowers and the highest total fruit weight per plant at LOF fish waste with 25% concentration. The application of LOF fish waste with a 25% concentration also yields the greatest fruit count. This is attributed to the inverse relationship between the number of fruits and the total fruit weight of the harvest per plant. The limited number of fruits results in a more efficient transport of photosynthate from the leaves to the fruit, leading to an increase in the total fruit weight of the harvest per plant. This corresponds with the perspective of Candra *et al.* (2023) that crop production heavily relies on plant vegetative growth. Substantial photosynthesis occurs during the generative phase, reflecting plant productivity. The enhancement in photosynthetic assimilation results is closely associated with the role of liquid organic fertilizer, providing essential nutrients for plants. The organic content in cow dung can enhance the physical, chemical, and biological properties of the soil.

4. CONCLUSION

The combination treatment of LOF fish waste with concentrations of 25% and 30% gave the same effect as NPK fertilizer as a comparison on the parameters of stem diameter, number of flowers and total fruit weight of harvest per plant. Providing LOF concentrations of 25% and 30% also had the same effect as NPK fertilizer as a comparison on leaf area parameters and total fruit number per plant. The application of fish waste-based LOF with a 30% concentration (0.42 cm; 0.81 cm; and 1.01 cm) exhibited a significant difference from all treatments but showed no significant difference compared to the LOF treatment of fish waste with a 25% concentration concerning stem diameter parameters at 30, 60, and 90 days after planting (HST). Providing fish waste-based LOF with a concentration of 25% significantly differed from all treatments but showed no significant difference compared to LOF fish waste with concentrations of 15% and 30% in terms of the total number of flowers parameter (16.78 flowers). However, on the parameter of the total weight of fruits harvested per plant (1435.61 g), it resulted in a significant difference compared to all treatments. The average number of fruit (10.11) in the application of LOF with a concentration of 25% was significantly different from all the harvests but was not significantly different from the LOF concentration at 10%.

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