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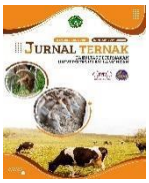

"The Effect of Providing Liquid Organic Fertilizer with Different Compositions on the Growth of Strawberry Plants (Fragaria sp.)"

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ABSTRACT

If the strawberry harvest is insufficient, market demand cannot be met. However, if the harvest is excessive, the strawberries are only used as animal feed or left to rot and become fertilizer. The aim of this study is to determine the effect of different compositions of liquid organic fertilizer on the growth of strawberry plants (Fragaria sp.). The research was conducted over 5 months from January to May 2024. The research method used a Completely Randomized Design (CRD). This study consisted of 4 (four) treatments and 3 (three) replications. The liquid organic fertilizer was made using organic materials, namely 0.5 kg of cow rumen, 0.2 l of molasses, 1 l of rice washing water, 0.5 l of rabbit urine, 0.5 kg of banana peels, 1 l of coconut water, and 0.5 kg of moringa leaves. The research treatments were as follows: P0 (liquid organic fertilizer at a concentration of 0 ml/1000 ml water), P1 (liquid organic fertilizer at a concentration of 100 ml/1000 ml), P2 (liquid organic fertilizer at a concentration of 200 ml/1000 ml), and P3 (liquid organic fertilizer at a concentration of 300 ml/1000 ml). Fertilization was done once a week for 1 month. The plant growth variables observed were plant height, number of leaves, number of stolon runners, and fruit weight. Based on the research results, the plant height variable for P2 resulted in the highest average plant height of 19.1 cm and was significantly different from the P0 and P3 treatments, but not significantly different from the P1 concentration. The leaf variable for the P2 liquid organic fertilizer treatment resulted in the highest average number of leaves at 15.7 leaves, followed by P1 and P3, with no significant difference. For the stolon runner variable, P2 produced the highest number of stolon runners at 1.0 stem, with no significant difference from the P0, P1, and P3 concentrations. The fruit weight variable for P2 produced the highest fruit production at 3.7 grams, with no significant difference from the P0, P1, and P3 concentrations.

1. PENDAHULUAN

Based on observations and interviews with the head of the Tourism Awareness Group (Pokdarwis) and farmers in Pancasari Village, it was found that in strawberry plantation management, the fluctuating availability of harvest products is the main issue. When the harvest yield is insufficient, it cannot meet market demand; however, when there is an oversupply, the harvest is often used as animal feed or even left to rot and become compost. (Elfarosa, Widiantara, Sukraini, Utami, 2021).

According to the Regulation of the Minister of Agriculture No. 2/Pert./HK.060/2/2006, organic fertilizer is fertilizer composed mostly or entirely of organic materials. These organic materials can originate from plant residues, animals, or other organic waste. Through an engineering process, these

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organic materials are transformed into a form that is more easily utilized by plants. Organic fertilizers play a crucial role in improving the physical, chemical, and biological properties of soil. (Directorate of Production Facilities, 2006).

Strawberry plants are among the crops with high economic value. In 2004, strawberry fruit exports averaged 3,971.4 kg per year, which increased to 27,000 kg per year in 2011 (Statistika, B.P., 2012). Moreover, strawberries are highly favored by local consumers as fresh fruit and are processed into jam, syrup, dodol (traditional sweets), candied fruit, juice, and ice cream.

The increasing demand for strawberries drives the need for efforts in both the extensification and intensification of its cultivation. Generally, strawberry plants produce fruit at 8 weeks after planting (WAP). During this period, stolons are also produced. Stolons are strawberry runners that grow horizontally along the soil surface (creeping). (Budiman, 2006). Stolons are utilized for vegetative propagation, but their presence can inhibit the development of strawberry flowers and fruit. One effort to optimize strawberry fruit production is the regulation of stolon cutting, which can enhance fruit productivity while still allowing stolon production for plant propagation.

2. Method

The research on the effect of applying liquid organic fertilizers with different compositions on the growth of strawberry plants (*Fragaria sp.*) will be conducted on Jalan KH Wahid Hasyim, Gang Tangkis, Bandar Lor Village, Mojotoro Subdistrict, Kediri City. This study will be carried out over 5 months, from January to May 2024, with tests focusing on organic materials such as N,P_2O,K_2O

The research method uses a Completely Randomized Design (CRD), consisting of 4 (four) treatments and 3 (three) replications. The treatments are as follows:

Table 1 Treatment Concentratio

Treatment	Ratio of Liquid Organic Fertilizer (POC) to Water (L)	Concentration POC : water (ml)
P0	0	0 ml/1000 ml
P1	100	100 ml/1000
P2	200	200 ml/1000
P3	300	300 ml/1000

P0 = Liquid organic fertilizer with a concentration of 0 ml/1000 ml water per replication.
P1 = Liquid organic fertilizer with a concentration of 100 ml/1000 ml per replication.
P2 = Liquid organic fertilizer with a concentration of 200 ml/1000 ml per replication.
P3 = Liquid organic fertilizer with a concentration of 300 ml/1000 ml per replication.
The mathematical model of the design (Nugroho, 2008) as cited in (Sulaiman, 2018) is:
$Yij=\mu+\tau i+ (i)$

Explanation:

- Yij = Observational value for the i -th treatment and the j -th replication.
- μ = General mean value.
- τi = Effect of the i-th treatment.
- (i) =Deviation of the i-th treatment and j-th replication from the treatment mean.
- i: Four (4) treatments.
- j: Three (3) replications.

Observed Variables

a) Plant height
b) Number of leaves
c) Stolon offshoots
d) Fruit weight

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a) Tools Used

Buckets, spoon/stirrer, gallon containers, strainer, polybags, trowel, ruler, scales

b) Materials Used

Rabbit urine, coconut water, rice washing water, banana peels, sugarcane molasses, moringa leaves, cow rumen

c) Procedure

This research is carried out in one phase, which involves mixing the materials used:

Liquid Organic Fertilizer (POC):

1. Prepare the tools that have been provided.
2. Wash all tools thoroughly using water.
3. Prepare 9 gallons for fermentation and label them as Gallon 1: P1, Gallon 2: P2, Gallon 3: P3, including their replications.
4. Place these materials into the fermentation gallons.
5. Stir all the gallons until well mixed.
6. Close the gallons and ferment for 1 month.
7. Package the liquid organic fertilizer into bottles.
8. Stir all the gallons until well mixed.
9. Close the gallons and ferment for 1 month.
10. Package the liquid organic fertilizer into bottles.

Plants:

1. Prepare the planting media and polybags.
2. Prepare the strawberry seedlings.
3. Place the planting media into the polybags along with the strawberry seedlings.
4. Apply liquid organic fertilizer (POC) once a week.
5. The compositions are:
    - P0: without POC
    - P1: POC 1:10 water
    - P2: POC 2:10 water
    - P3: POC 3:10 water

Making Liquid Organic Fertilizer (POC)

There are several material compositions in the production of POC, namely:

Ingredients	Composition
Cow rumen	0.5 kg
Molasses	0.2 L
Rice washing water	1 L
Rabbit urine	0.5 L
Banana peel	0.5 kg
Coconut water	1 L
Moringa leaves	0.5 kg

The production of POC requires a fermentation period of approximately 2 months and is applied to plants after the fermentation process is complete.

sources of references in the Introduction and a minimum of 20 sources in all the contents. The sources must be obligated from journals and proceedings associated with your research and should be up to date, a maximum of five years from the day of publication. Journals and proceedings are mainly indexed by Scopus, Clarivate Analytics Web of Science (SCIE & SSCI), PubMed, DOAJ, or database entries of IEEE, ACM, Proquest, CABI, Gale, and EBSCO. Please be sure that each of the references cited in texts

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3. Results and Discussion

Table 1. Based on the laboratory analysis results from PT Perkebunan Nusantara 1 Regional 4 Kediri, the data on N, P, K, and organic C content in the liquid organic fertilizer are as follows:

POC	N	P_2O_5	K_2O
	0,12	0,06	0,49

Source = PT Perkebunan Nusantara 1 Regional 4 Kediri

Based on the data above, it is shown that the amount of each nutrient element in the liquid organic fertilizer is as follows: nitrogen (N) content is 0.12%, total phosphorus (P2O5) content is 0.06%, and total potassium (K2O) content is 0.49%.

According to the Regulation of the Minister of Agriculture (Permentan) Number 261 of 2019, liquid organic fertilizer (POC) is an engineered product derived from organic materials that have undergone processing. POC plays a significant role in improving soil quality by increasing organic matter content, enhancing soil structure, and providing nutrients for plants. Based on this regulation, the minimum technical requirements for liquid organic fertilizer include: a minimum organic C content of 6%; a maximum of 2% impurities such as plastic, glass, and gravel; and maximum heavy metal contents of 0.5 ppm for Cd, 12.5 ppm for Pb, 0.25 ppm for Hg, and 2.5 ppm for As. The pH level must range from 4 to 9, and the macro-nutrient content should consist of 3%-6% N, 3%-6% P2O5, and 3%-6% K2O.

Strawberries are among the plants with high economic value. In 2004, strawberry exports averaged 3,971.4 kg per year, and by 2011, this increased to 27,000 kg per year (Statistika, B.P., 2012). Additionally, strawberries are highly favored by local consumers as fresh fruit and are also processed into jam, syrup, candy, preserved fruit, juice, and ice cream.

Table 2. Average Height of Strawberry Plants (Fragaria Sp) with the Application of Liquid Organic Fertilizer

Treatment	Concentration POC (ml): water (L)	Height (cm)
P0	0	15,6a
P1	100	18,2bc
P2	200	19,1c
P3	300	17,9b

The numbers followed by the same lowercase letters differ significantly based on the DNMRT test at the 5% level.

The data in Table 2 show that the application of liquid organic fertilizer as a nutrient solution at concentration P2 resulted in the highest average plant height, which was 19.1 cm, and this was significantly different from treatments P0 and P3, while not significantly different from concentration P1.

The application of liquid organic fertilizer as a nutrient solution at concentration P2 is believed to have met the nutritional needs of the plants and supported the vegetative growth of strawberry plants in a hydroponic system for 8 weeks after planting. Plants will grow well if the required nutrients are available in sufficient and balanced amounts. This is supported by the statement of Buckman and Brady (2001), who stated that plants will grow optimally if all the necessary nutrients are available and can be absorbed by the plants.

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Liquid organic fertilizer greatly aids in the growth of strawberry plants. From the table data above, it can be concluded that plants given POC grow faster than those without POC. However, generally, the height of strawberry plants can reach 25 cm at 3 months old. This is influenced by several factors in this study, such as cultivation in lowland areas, occasional hot and rainy weather, and unstable temperatures, which hinder the growth of strawberry plants (Oktarina, D. O., Armaini, A., & Ardian, A. 2017).

Table 3. Average Number of Leaves of Strawberry Plants (*Fragaria sp*) with Liquid Organic Fertilizer Application

Treatment	Concentration POC (ml): water (L)	Leaflets
P0	0	13,67a
P1	100	14,67ab
P2	200	15,7b
P3	300	14,67ab

The numbers followed by the same lowercase letters differ significantly according to the DNMRT test at the 5% level.

The data in Table 3 show that the application of liquid organic fertilizer at P2 resulted in the highest average number of leaves, which was 15.7 leaflets, followed by P1 with 14.67 and P3 with 14.67, so the number of leaflets did not differ significantly.

Similar to the factors affecting plant height, the availability of nutrients in adequate and balanced amounts can improve plant height growth, and this also influences the number of leaves. This statement is supported by research conducted by Mappanganro et al. (2011), which found that the number of leaves is related to stem growth or plant height, where the stem consists of internodes that stretch between the nodes where leaves are attached.
In all treatments, the nutrients provided were still in very small amounts and did not meet the plant's nutritional requirements. This is supported by Hartus (2002), who stated that the key to success in hydroponic farming is a nutrient solution that must meet the proper nutrient concentration and the volume provided must match the plant's needs.

Additionally, the porous nature of the media also affects the availability of nutrients provided. The ability of the media to store the nutrient solution will influence the availability of nutrients in the growing medium. The effect of low nutrient availability will hinder the physiological processes of strawberry plants, resulting in slow growth.

Simorangkir's research showed an interaction between rabbit urine fertilizer and KNO3 on strawberry plant growth and yield. The treatment with 60 ml/L of rabbit urine fertilizer combined with 4 g/L of KNO3 showed the best effect on the number of leaves, which was 19.16 leaflets per plant.

The data in Table 4.4 below show that the application of liquid organic fertilizer as a nutrient solution at P2 resulted in the highest number of stolon shoots, which was 1.0 stem, and all averages did not differ significantly from the treatments at concentrations P0, P1, P2, and P3. This suggests that P2 is the best concentration for supporting the generative growth of strawberries.

Table 4. Stolon Shoots of Strawberry Plants (*Fragaria sp*) with Liquid Organic Fertilizer Application

Treatment	Concentration POC (ml): water (L)	stolons
P0	0	0,33

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P1	100	0,33
P2	200	1,0
P3	300	0,67

From the ANOVA test of a completely randomized design, the average stolon shoot results did not differ significantly.

Axillary buds on strawberry plants can grow into new shoots or stolons. Stolons typically grow horizontally and produce several potential new plants. A stolon is a small branch that grows horizontally or creeps along the ground. Stolons can produce new shoots of strawberry plants. The shoots formed from stolons are vegetative shoots that have the same traits and characteristics as the parent plant (Kurnia, 2005).

At concentrations P0 and P1, the lowest stolon shoot numbers were recorded, at 0.33 stems. This is believed to be because the plants did not receive any additional nutrients, only water, so the essential nutrients, especially phosphorus (P) and potassium (K), required for fruit formation, were insufficient. At the liquid organic fertilizer concentrations, it is suspected that the available nutrients were lacking in the elements needed by the plants, which inhibited strawberry production. Purwendro and Nurhidayat (2006) stated that in vegetable, fruit, and ornamental plant cultivation, plants will grow well if the required nutrients are sufficiently available and balanced.

Table 5. Weight of Strawberry Fruit (*Fragaria sp*) with Liquid Organic Fertilizer Application

Treatment	Concentration POC (ml): water (L)	Variable (gram)
P0	0	0
P1	100	1,67
P2	200	3,7
P3	300	1,33

From the ANOVA test of a completely randomized design, the average fruit weight results did not differ significantly.

The data in Table 5 show that the application of liquid organic fertilizer as a nutrient solution at P2 resulted in the highest fruit production, which was 3.7 grams, and did not differ significantly from the treatments at P0, P1, and P3. It is suspected that P2 is the best concentration for supporting the generative growth of strawberries, but for P0, no fruit was produced at all.

The production obtained in this study is still considered very low compared to the average production values stated by Budiman and Saraswati (2008), who mentioned that the average weight or production of conventionally grown strawberry plants is 150 grams per plant, while according to Mappanganro (2011), the average weight of hydroponically grown strawberry plants is around 198 grams per plant at 3-4 months of age.

The low production was caused by several factors, one of which was the fluctuating temperature and humidity conditions during the study. The relatively high temperature during the research affected the flowering and fruiting processes of the strawberry plants. The highest average temperature reached 33°C, and the lowest air humidity was 71%. According to Kurnia (2005), in tropical regions like Indonesia, strawberries will grow well at elevations above 600 meters above sea level, with an optimal air temperature of 17–20°C. At cool temperatures and with high relative humidity (RH) between 80% and 90%, strawberry growth will be good because they will not experience stress due to high temperatures and high transpiration rates. This is supported by Abidin

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(1992), who stated that during the generative phase, from flowering to fruit production, phosphorus (P) and potassium (K) are the most needed nutrients, with other nutrients supporting this process.

Organic fertilizers come in many forms, such as compost, green manure, and others. Organic fertilizers have dual functions: they provide nutrients and add organic matter to the soil. Organic matter is useful for maintaining the optimal function of the soil. Organic fertilizers have the advantage of slow-release, meaning that the nutrients in the fertilizer are released gradually and continuously over a certain period, reducing nutrient loss due to leaching by water. The release of nutrients is assisted by the activity of microorganisms in the soil or those carried by the organic fertilizer. Nutrient release is supported by the abundance of microorganisms such as bacteria, fungi, algae, protozoa, and nematodes (Wiyana, 2008).

4. Conclusions

The results of the study on the effect of liquid organic fertilizer with different compositions on the growth of strawberry plants (*Fragaria sp.*) show the following conclusions:

1. The application of liquid organic fertilizer with different compositions had a significantly different effect on the growth of strawberry plants (*Fragaria sp.*), including plant height.
2. The application of 200 ml/L of liquid organic fertilizer resulted in the best outcomes for all parameters, including plant height, number of leaves, stolon shoots, and fruit weight.

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