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Growth and Yield Response of Lettuce (*Lactuca Sativa* L) Plants due to The Application of Several Concentrations of Liquid Organic Fertilizer From Papaya Fruit Waste (*Carica papaya* L.)

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A B S T R A C T
The study titled "Growth Response and Yield of Lettuce (Lactuca sativa L.) in Response to Various Concentrations of Liquid Organic Fertilizer from Papaya Fruit Waste (Carica papaya L.)" was conducted at the experimental field of the Faculty of Agriculture, Muhammadiyah University of West Sumatra. The research site is located in Tanjung Gadang Koto Nan Ampek Village, West Payakumbuh District, Payakumbuh City, with Inceptisol soil at an elevation of approximately 514 meters above sea level. The study was carried out in 2024 between July and August. The purpose of this study was to ascertain the ideal concentration of liquid organic fertilizer (POC) to boost the productivity and growth of lettuce plants grown from papaya fruit waste. Five treatments and four replications were used in this study's Randomized Block Design (RBD), yielding a total of 20 experimental plots. Sixteen lettuce plants were planted in each 1 m x 1 m plot, and three plant samples were selected at random for examination. The treatments applied included varying concentrations of papaya fruit waste POC: 0% (Control), 5% (50 ml/liter of water), 10% (100 ml/liter of water), 15% (150 ml/liter of water), 20% (200 ml/liter of water). The results demonstrated that applying papaya fruit waste POC at concentrations ranging from 10% (100 ml/liter of water) to 20% (200 ml/liter of water) effectively improved both growth and yield of lettuce plants compared to lower concentrations or untreated control.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is very popular among the public due to its abundant nutritional content and significant profit potential. Besides being rich in calcium, iron, phosphorus, and iodine, this vegetable is also high in fiber and vitamin A, which are useful for the body in improving digestive health. The annual production of lettuce dropped to 39,289 tons in 2019 from 41.11 tons in 2018. Demand for lettuce is increasing as the population increases, but local supply cannot keep up with consumption levels.

This decline in production is caused by a number of things, such as the increasing cost of fertilizers and the lack of interest among farmers to grow lettuce. One of the steps to increase agricultural yields is to use organic fertilizers. Crop yields can be increased and soil quality can be improved with organic farming practices. Papaya fruit, which is no longer edible, can be used to make liquid organic fertilizer as it contains nutrients that promote plant growth.

Papaya fruit waste aids plant growth as it contains essential minerals including potassium, phosphate and nitrogen. According to previous studies, the use of liquid organic fertilizer made from papaya waste can improve the development and productivity of various crops, including kale, cucumber and green beans. Twenty percent, or 200 milliliters per liter of water, is the most commonly used amount of liquid fertilizer. Furthermore, it has been shown that applying liquid fertilizer made from papaya waste can increase the growth and yield of lettuce plants (Isnawati, 2022).

Nitrogen in organic fertilizers is essential for the process of protein synthesis in plant cells. Soil microorganisms can decompose proteins in tofu liquid waste, producing nitrogen that can be absorbed by plant roots The chemical content in tofu liquid waste is Pb (0.24 mg/L), Ca (34.03 mg/L), Fe (0.19 mg/L), Cu (0.12 mg/L), and Na (0.59 mg/L). According to research conducted by Desiana et al. (2013), plant height, fresh weight, and dry weight can be increased by adding tofu liquid waste at a dose of 80 milliliters per kilogram of soil. (Asmoro, 2008).

Optimal plant growth can be achieved if soil conditions support root development well. One method that can be applied to maintain soil fertility is the use of organic mulch. The use of mulch can maintain several physical characteristics of the soil, such as aggregate stability, soil density, and the ability to inhibit weeds. In addition, the use of mulch can also increase the content of soil organic matter, reduce the impact of erosion due to rainwater, and maintain the stability of soil temperature so that the nutrients needed by plants can be available optimally (Gulat, 2012)

Rice straw is one of the most frequently used organic mulches in agriculture. It is possible to reduce weed growth, retain soil moisture, and increase soil organic matter. According to research conducted by Samsudin, Sangadji, and Adriyanton (2015), banggai yam (*Dioscorea alata* L.) plants can grow better with 5 tons of straw per hectare. It also helps retain soil moisture so that there is sufficient water supply. In addition, (Pipit Muliyah, Dyah Aminatun, Sukma Septian Nasution, Tommy Hastomo, Setiana Sri Wahyuni Sitepu, 2020) emphasizes the importance of implementing effective soil management

approaches so that plants can obtain adequate water supply during their growth phase.

LITERATURE REVIEW

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METHODOLOGY

Provide clear and concise versions of your methods of conducting research, population and samples, and data analysis tools. The experimental area of the Faculty of Agriculture of Muhammadiyah University of West Sumatra is located in Tanjung Gadang Koto Nan Ampek Village, West Payakumbuh District, Payakumbuh City, where this research was conducted. The research was conducted on Inceptisol soil type at an altitude of about 514 meters above sea level (masl). The study was conducted from August to October 2024.

Grand Rapid lettuce seeds, papaya fruit waste, EM4, 20 liters of water, palm sugar, and urea fertilizer were used in this study. Burlap, plastic, bucket, hoe, sickle, scissors, knife, meter, brand board, rope, watering can, calculator, and various stationery were the equipment used in this study.

A total of 20 experimental plots were established using the Randomized Block Design (RAK) research method which included four groups and five treatments. A total of 16 lettuce plants were planted on each plot measuring one meter x one meter. Three plants were randomly selected from each plot to be used as research samples. Furthermore, to test the results of observations, statistical tests were used in the form of the F test with a significance level of 5%. The DNMRT test was used at the 5% significance level to continue the research if the F test results showed significant differences.

Five concentrations of liquid organic fertilizer (POC) from papaya fruit waste were used in this research treatment, namely papaya fruit POC 0 ml/liter of water (0% control), 50 ml/liter of water (5% concentration), 100 ml/liter of water

(10% concentration), 150 ml/liter of water (15% concentration), and 200 ml/liter of water (20% concentration).

There are several steps that must be taken to convert papaya fruit waste into liquid organic fertilizer. The main elements for this process are, first and foremost, 60 milliliters of EM4, 6 kilograms of papaya fruit waste, 6 liters of water, and brown sugar that has been dissolved with papaya waste and combined with EM4 as a decomposing agent to speed up the fermentation process to 2000 grams. After the papaya pulp is crushed, it is mixed with the brown sugar solution and EM4. In addition, before being applied to plants, this mixture is fermented for two weeks and mixed thoroughly.

Clearing the land of weeds during the first week prior to the research was the first step in land preparation. To stabilize the soil, the first stage of tillage was then completed by hoeing the soil and leaving it for a week. Afterwards, soil clods were crushed to provide a looser texture for the second stage of tillage.

Experimental plots were made with a size of 1 m × 1 m, a plot height of 30 cm, and a distance of 50 cm between plots. After the plots were established, cow manure was used as the base fertilizer at the rate of 10 tonnes/ha or 1 kilogram per plot. After that, soil and fertilizer are mixed until ready for planting. In addition, labeling was done according to the planned experimental strategy.

Grand Rapid type lettuce seeds were used in this study. Plants that had been grown for about two weeks were used to select the seeds for planting. Four to five leaves, consistent light green leaf color, and pest and disease free condition were some of the requirements for seed selection. Seedlings were spaced 25 cm x 25 cm and planted to a depth of about 5 cm.

Table 1. Plant height and number of lettuce leaves due to the application of various concentrations of Liquid Organic Fertilizer from papaya fruit waste

POC concentrations of waste papaya	**plant height (cm)**	**Numbers of Leaves**
0 liter of water (0%)	21,63	15,33
50 liter of water (0%)	22,25	15,17
100 liter of water (0%)	22,00	15,33
1500 liter of water (0%)	22,46	15,92
200 liter of water (0%)	22,79	16,33
KK	3,10%	4,14%

the figures in the same column differ insignificantly according to test F at a significance of 5%

RESEARCH RESULT

Plant Height (cm)

F-test was used at 5% significance threshold to assess the statistical data of plant height and number of leaves of lettuce given various concentrations of Liquid Organic Fertilizer (LFO) from papaya fruit waste. Table 1 and Appendix 6.1 and 6.2 present the findings of the analysis.

Based on the results presented in Table 1, it can be seen that the treatment of POC from papaya fruit waste at (0%, 5%, 10%, 15%, and 20%) concentration was not significantly different on plant height or number of leaves. However, there was a consistent pattern of increase in both variables as the concentration of POC given increased.

Leaf Length (cm)

Comparing differences between treatments, the F test at a real level of 5% was used to statistically analyze the length and width of the leaves of lettuce plants given various concentrations of POC from papaya fruit waste. If significant differences were found, the analysis was continued with the DNMRT test at the 5% real level. The results of the analysis of variance are presented in Appendix 6.3 and Appendix 6.4, and the data from the analysis are presented in Table 2.

Table 2. Effect of concentration of papaya fruit waste Liquid Organic Fertilizer on length and width of lettuce leaves

POC concentrations of waste papaya	Long Leaves (cm)	Numbers of Leaves
200 liter of water (0%)	16,33 a	15,08 a
150 liter of water (0%)	16,04 a	13,83 a
100 liter of water (0%)	15,83 a	13,58 ab
50 liter of water (0%)	14,88 ab	12,67 ab
0 liter of water (0%)	14,38 b	12,25 ab
KK	6,54 %	7,19 %

The numbers in the same column followed by the same lower case letters do not show a significant difference according to the DNMRT test at a real level of 5 %

Based on the results shown in Table 2, the use of POC on papaya fruit waste with a concentration of 200 ml/liter of water (20%) produced the longest leaf length, which was 16.33 cm. This result was not significant with the treatment with POC 150 (15%), 100 (10%), 100 *and 50 ml/liter of water (5%),* but there was a significant difference compared to the treatment without POC 0 ml (0%).

However, for the treatment with 50 ml/liter of water (5%) there was no significant difference with the control treatment.

Weight Per Plant, Per Plot, and Per Hectare of Plants

The F test was used at the 5% significance level to analyze the weight per plant, weight per plot, and weight per hectare of lettuce plants given various concentrations of Liquid Organic Fertilizer (POC) from papaya fruit waste. To explain differences between treatments, the DNMRT test was conducted at the 5% significance level if significant differences were found. While the analysis of variance is contained in Appendix 6.5, 6.6, and 6.7, the observation data are shown in Table 3.

Table 3. Effect of Liquid Organic Fertilizer Concentration from Papaya Fruit Waste on Weight Per Plant, Weight Per Plot, and Weight Per Hectare of Lettuce Plants

POC concentrations of waste papaya	weight per plant (gr)	weight per square (kg)	weight per hectare (ton)
200 ml/liter of water (20%)	136,25 a	1,50 a	15,03 a
150 ml/liter of water (15%)	125,58 a	1,40 a	14,00 a
100 ml/liter of water (10%)	120,50 a	1,26 a	12,60 a
50 ml/liter of water (5%)	91,17 ab	0,91 ab	9,13 ab
0 ml/liter of water (0%)	90,50 b	0,65	6,50 a
KK	16,85 %	23,92 %	23,92 %

The numbers in the same column followed by the same lower case letters do not show a significant difference according to the DNMRT test at a real level of 5 %

The treatment with POC at 200 milliliters per liter of water (20% concentration) gave the best results for all observed variables, namely weight per plant of 136.25 grams, weight per plot of 1.50 kilograms, and weight per hectare of 15.03 kilograms, according to the results presented in Table 3.

This treatment was not significantly different compared to 150 (15%) and 100 ml/liter of water (10%), but a significant difference was observed when compared to 50 ml (5%) and the control. In addition, the treatment with 50 ml/liter of water (5%) also showed no significant difference with 100 ml/liter of water (10%), but significantly different compared to the control.

DISCUSSION

The general purpose of using organic fertilizers is to improve the biological and physical properties of the soil. Although organic fertilizers usually contain fewer nutrients than inorganic fertilizers, changes in soil chemical composition can benefit from improvements in soil physical characteristics. Furthermore, organic fertilizers improve soil structure and biological activity while increasing the amount of organic matter (Saragih, 2023).

Essential nutrients such as potassium (3.28%), phosphorus (3.13%), and nitrogen (1.87%) have been found in papaya fruit waste. These ingredients are excellent for enhancing plant growth and development. By breaking down the nutrients in papaya fruit, the microbe-assisted decomposition process increases the plant's capacity to absorb the nutrients it needs.

The research findings show that the use of POC made from papaya fruit waste at concentrations ranging from 100 ml/liter of water (10%) to 200 ml/liter of water (20%) can increase the growth and yield of lettuce plants. This is thought to be because fertilizer with waste material from papaya fruit can help increase the availability of nutrients in the soil so as to increase the growth and yield of cultivated lettuce plants. This is in line with the opinion of Nugroho (2012) Organic fertilizers contain macro and micro nutrients needed by plants, in addition to being able to improve the physical properties of the soil, the microbes contained in organic fertilizers are also able to help increase soil fertility through Nitrogen binding, and also help in the mineralization process of chemical compounds in the soil. Organic fertilizers also contain hormones and antibiotic substances that are important for plant growth (Ohorella, 2012).

The study also showed that the height of lettuce and the number of leaves did not have a big difference in these two parameters but with the addition of concentration per each experiment mengalmi a slight increase while for leaf width and leaf length there was the biggest difference between the highest concentration of 200 milliliters per liter of water with 0% concentration, while for the other three treatments there was no difference. While the weight per plant, weight per plot, and weight per hectare also showed the same results, with the provision of this fertilizer at a concentration of 100 and 150 is the most optimal for the growth of lettuce plants.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the study, the development and productivity of lettuce plants can be improved by applying papaya fruit waste POC at concentrations ranging from 100 ml/liter of water (10%) to 200 ml/liter of water (20%). To get the best results, it is recommended that lettuce be grown with papaya fruit waste POC at a concentration of 100 ml/liter of water (10%), according to the conclusion of the study.

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