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The Effect of Dosage and Application Time of Liquid Organic Fertilizer From Papaya (POCpy) on The Growth and Production of Soybean Plants (Glycine max L) in Ultisol Oil

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Abstract

This study aims to determine the effects of applying papaya liquid organic fertilizer and varying the timing of application on the growth and yield of soybean (Glycine max L.) plants in Ultisol soil. The study employed a factorial randomized block design with two studied factors: 1. The first factor is papaya liquid organic fertilizer (P), which has four treatment levels: P1 = 75 ml/polybag; P2 = 150 ml/polybag; P3 = 225 ml/polybag; and P4 = 300 ml/polybag. The second factor is application time (W), which consists of three treatment levels: The second factor is application time (W), consisting of three treatment levels: W1 = at planting; W2 = one week before planting; and W3 = two weeks before planting. The observed parameters are plant height, number of branches, number of pods per polybag and filled pod weight. The research results indicate that applying liquid organic papaya fertilizer significantly affects the number of branches, number of pods per polybag and filled pod weight. However, it had no significant effect on soybean plant height. The timing of the application treatment non significantly affected plant height, number of branches, number of pods per polibag, filled pod weight. The interaction between the application of liquid organic papaya fertilizer and application time did not significantly affect plant height, number of branches, number of pods per polybag and filled pod weight.

Keywords: *Liquid organic papaya fertilizer, Application time, Ultisol*

1. INTRODUCTION

Soybean (*Glycine max*) is a type of legume belonging to the Leguminosae family and serves as an essential food crop. As one of the main food commodities after rice, soybeans hold considerable economic value, primarily due to their role as a source of plant-based protein for human consumption. In 2010, soybean production reached 905,020 tons, but this figure marked a decline of 69,500 tons (7.13%) compared to production in 2009. This decrease was likely due to a reduction in harvested area by 50,550 hectares (6.99%) and a slight drop in productivity of 0.02 quintals per hectare (0.15%) (Litbang Deptan, 2011).

Liquid organic fertilizer (commonly abbreviated as POC) is a type of fertilizer rich in organic carbon and essential macro- and micronutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), boron (B), zinc (Zn), copper (Cu), manganese (Mn), cobalt (Co), molybdenum (Mo), and iron (Fe). This type of

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fertilizer offers several benefits, including stimulating root development and enhancing overall plant growth and performance (Hamzah, 2014).

Ultisols are a category of acidic soils characterized by high solubility of aluminum (Al), iron (Fe), and manganese (Mn), alongside low availability of phosphorus (P) and molybdenum (Mo). The high solubility of Al and Fe tends to bind phosphate, reducing the availability and absorption of phosphorus by plants. One effective way to address the low phosphorus availability in Ultisols is by applying humic acid. Humic acid is a macromolecular polyelectrolyte that contains functional groups such as carboxyl (-COOH), phenolic hydroxyl (-OH), and alcoholic hydroxyl (-OH), allowing it to form complexes with metal ions (Balai Penelitian Tanah, 2005)

Plants of the *Carica* genus, particularly papaya, are widely cultivated by farmers due to the desirable taste of their fruit. Papaya is among the most popular and widely consumed tropical fruits. It has soft flesh, comes in red or yellow varieties, and has a sweet and refreshing taste owing to its high water content. Papaya is also an ideal fruit for people on a diet, given its very low fat content (only 0.1%), with carbohydrates ranging from 7–13% and calorie content between 35–59 kcal per 100 grams (Balai Penelitian Tanaman Buah, 2001).

Liquid organic fertilizer is available in liquid form, making the nutrients it contains more easily absorbed by plants. It can be produced using a variety of organic materials, including fresh or waste forms of fruits and vegetables. These materials may come from household waste, restaurants, traditional markets, agricultural residues, livestock farms, or other organic sources. This study aims to examine the effects of papaya-based liquid organic fertilizer (Syahputriani, 2017).

Ultisols cover a vast area in Indonesia, accounting for nearly 25% of the country's total land surface. They offer significant potential for agricultural development. Ultisols are typically derived from old parent materials and present several common challenges: low pH, limited availability of nitrogen (N) and phosphorus (P), deficiencies in calcium (Ca), magnesium (Mg), potassium (K), and molybdenum (Mo), excess levels of manganese (Mn) and iron (Fe), and high aluminum solubility (Adijaya, 2014)

2. METHOD

This study was conducted at the experimental farm of the Faculty of Agriculture at the University of Islam in North Sumatra, located on Jalan Karya Wisata in the Medan Johor District of Medan City in North Sumatra Province. The site is approximately 25 meters above sea level and has flat topography and an ultisol soil type. The study took place from December 2022 to February 2023.

This study used a factorial randomized block design (RBD) with two factors studied, namely: 1. The first factor was Papaya Liquid Organic Fertilizer (P) consisting of 4 treatment levels, namely: P1 = 75 ml/polybag, P2 = 150 ml/polybag, P3 = 225 ml/polybag, P4 = 300 ml/poly bag. 2. The second factor is Application Time (W), which consists of 3 treatment levels, namely: W1 = At planting, W2 = 1 week before planting, W3 = 2 weeks before planting. Parameters observed were plant height, number of branches, number of pods per polybag, and Filled Pod Weight

3. RESULTS AND DISCUSSION

3.1 Plant Height

Table 1 shows that the effects of liquid organic fertilizer (POCpy), application time treatment, and the combination of both treatments had no significant effect on soybean plant height at 5 WAP. This can be seen in the table.

Table 1. Average height of soybean plants under papaya liquid organic fertilizer treatment and application time at 5 WAP on Ultisol soil

Treatment POCpy	Application Time			Average
	W_1	W_2	W_3	
P_1	47,83	44,50	45,33	45,89
P_2	43,00	45,83	50,17	46,33
P_3	49,50	47,00	48,17	48,22
P_4	43,17	47,83	44,83	45,28
Average	45,88	46,29	47,13	

Table 1 shows that the application of papaya liquid organic fertilizer had no significant effect on the height of soybean plants at 5 weeks after planting, with treatment P3 (225 ml/polybag) showing the highest plant height at 48.22 cm. The timing of application also had no significant effect on plant height. The W3 treatment (1 week before planting) showed a plant height of 47.13 cm, which was better. The statistical analysis results were not significantly different, but the plant height itself was already within the description of the plant.

Based on Table 1, it can be seen that the treatment of liquid organic papaya fertilizer at 5 WAP resulted in the best results in P3 (63.83 cm), which was not significantly different from the other treatments. This is because the initial soil analysis showed that the nitrogen (N) nutrient content was relatively low, so the treatments applied could not supply nitrogen at different dose levels to demonstrate differences in plant height. It can be explained that the content and availability of nutrients during application are closely related to soybean plant height, but this does not have a significant effect because the nutrient balance has not yet been fully established.

Liquid papaya organic fertilizer not only provides the nutrients needed by plants. When applying liquid papaya organic fertilizer, it is important to pay attention to the dosage applied to the plants. Based on several research results, it has been shown that applying liquid papaya organic fertilizer in the right dosage can increase N, thereby stimulating overall plant growth, especially plant height (Musnamar, 2003).

Plant growth and productivity are greatly influenced by the availability of nutrients in the soil. Plants can only grow optimally if the essential nutrients they need are available in sufficient quantities and in the right balance in the root environment. Nitrogen (N), phosphorus (P), and potassium (K) are among the six most vital macronutrients for plant survival. Imbalances or deficiencies in any of these three nutrients can hinder plant physiological processes, ultimately having a negative impact on growth and crop yield (Fageria et al., 2016; Marschner, 2012).

The interaction between the two treatments had no significant effect on soybean plant height at 5 weeks after planting, but there was a tendency for plant height to increase

with increasing treatment doses. This means that the two treatments were not yet interrelated in increasing soybean plant height at 5 weeks after planting.

3.2 Number of Branches

Table 2 shows that liquid organic fertilizer (POCpy) treatment had a significant effect on the number of productive branches, but the application time and interaction of the two treatments had no significant effect on the number of productive branches of soybean plants at 12 WAP. This can be seen in Table 2.

Table 2. Average Number of Productive Soybean Branches in papaya liquid organic fertilizer Treatment and Application Time at 12 WAP Age on Ultisol Soil

Treatment POCpy	Application Time			Average
	W_1	W_2	W_3	
P_1	8,33	8,00	7,50	7,94c
P_2	7,83	9,50	8,33	8,56b
P_3	8,67	8,17	9,33	8,72b
P_4	9,67	9,33	9,33	9,44a
Average	8,63	8,75	8,63	

Note: Figures followed by the same letter in the same row are not significantly different at the 5% level based on the DMRT test.

As shown in Table 2 above, the application of papaya liquid organic fertilizer had a significant effect on the number of productive branches of soybean plants at 12 weeks after planting. The treatment with papaya liquid organic fertilizer at the P4 level (300 ml/Polybag) resulted in 9.44 branches, which was the highest number of productive branches and significantly different from the P3 treatment (8.72), P2 (8.56), and P1 (7.94). The timing of application had no significant effect on the number of productive branches of soybean plants. Application one week before planting resulted in the highest number of productive branches, at 8.75 branches.

Based on the research findings and statistical analysis, the application of papaya-based liquid organic fertilizer (POCpy) had a significant effect on increasing the number of productive branches in soybean plants. Every treatment level produced more productive branches than the control, indicating that the nutrients in POCpy help stimulate branch development. This result is consistent with Setroyini et al. (2006), who noted that liquid organic fertilizers supply a relatively complete profile of macro- and micronutrients albeit in smaller amounts than inorganic fertilizers yet still sufficient to support optimal plant growth and development.

Liquid organic fertilizer has the advantage of providing macro nutrients such as nitrogen, which is essential for vegetative growth. According to Hanafiah (2005), nitrogen is needed in large quantities for the formation of vegetative parts such as leaves, branches, stems, and roots.The relationship between the number of soybean branches and POCpy is linear with the equation $\hat{Y} = 0.0062x + 7.5$, $r = 0.95$, as shown in Figure 1 below.

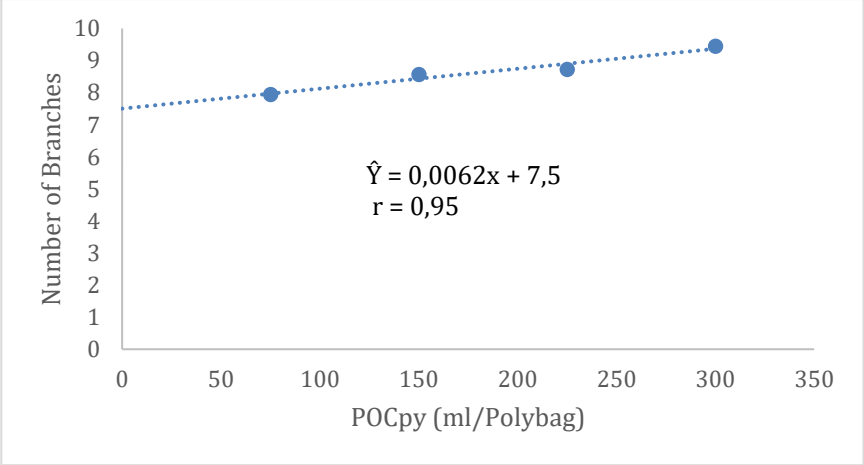

Figure 1. The Relationship between POCpy Application and the Number of Soybean Branches in Ultisol Soil

The figure above shows that the higher the dose of POCpy administered, the higher the number of productive branches on soybean plants, with a correlation coefficient of 95% (r = 0.95), meaning that 95% of the number of productive branches on soybean plants is influenced by POCpy.

The interaction between the two treatments had no significant effect on the number of branches in soybean plants at 12 WAP, where the two treatments did not interact in increasing the number of productive branches in the plants.

3.3 Number of Pods per Polybag

Table 3 shows that the application of liquid organic fertilizer (POCpy) had a significant effect on the number of soybean pods, but the timing of application and the interaction between the two treatment factors had no significant effect on the number of soybean pods at 12 weeks after sowing. This can be seen in Table 3 below.

Table 3. Average Number of Soybean Pods in papaya liquid organic fertilizer Treatment and Application Time at 12 WAP Age on Ultisol Soil

Treatment	Application Time			Average
POCpy	W_1	W_2	W_3	
P_1	60,17	62,50	63,00	61,89c
P_2	64,50	66,33	66,83	65,89b
P_3	66,33	64,17	64,33	64,94b
P_4	67,00	67,83	67,33	67,39a
Average	64,50	65,21	65,38	

Note: Figures followed by the same letter in the same row are not significantly different at the 5% level based on the DMRT test

Table 3 shows that the application of POCpy had a significant effect on the number of soybean pods at 12 weeks after planting, where the POCpy P4 treatment (300 ml/Polybag) showed the highest number of soybean pods at 67.39, which was significantly different from the other treatments. However, the application time treatment showed no significant effect on the number of soybean pods at 12 weeks after

planting. The application time of 1 week before planting did not differ significantly from the other treatments. The interaction between the two treatments also did not have a significant effect on the number of pods, meaning that the two treatments did not interact to increase the number of soybean pods.

The average number of pods in Table 4 shows that plants treated 2 weeks before planting had the highest average increase in the number of pods compared to other treatments. Plants that were given the application time at planting had the lowest number of pods. This may be because at planting, the nutrients in POCpy were not yet available, resulting in a significantly lower number of pods. Although the analysis showed no significant difference, the average results were already close to the plant description.

The timing of application did not have a significant statistical effect, but as shown in Table 3, the number of pods increased. It is suspected that the application time for soybean plants has not been fully absorbed by the plants, so that at all application times, the number of pods has not shown a different impact. This is consistent with Syafrudin's (2012) opinion that plants cannot fully absorb the available nutrients for their growth process.

The results of the research and statistical tests show that the application of POCpy has a significant effect on the number of soybean pods, indicating that POCpy application can provide the nutrients needed by soybean plants. The higher the dose applied, the greater the number of pods. According to Sutedjo (2002), plants will produce well if the nutrients needed by the plants are sufficiently available and in doses appropriate for absorption by the plants, thereby increasing plant production.

The relationship between the number of soybean pods and POCpy application is linear with the equation $\hat{Y} = 0.0223x + 60.66$, r = 0.94, as shown in Figure 2 below.

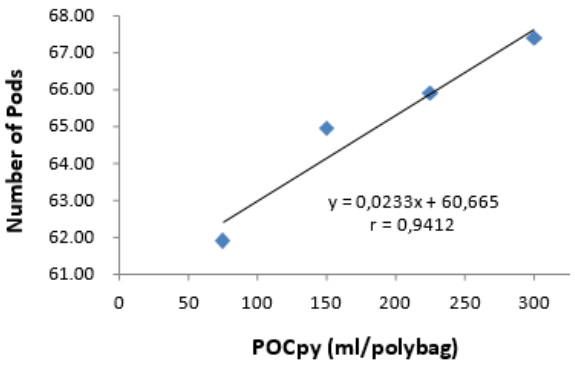

Figure 2. The Relationship between POCpy Application and the Number of Soybean Pods in Ultisol Soil

The figure above shows that as the POCpy dose increases, the number of pods also increases. With a correlation coefficient of 94% (r = 0.94), this means that 94% of the number of soybean pods is influenced by POCpy. It is known that POCpy can supply

nutrients such as nitrogen (N) in large quantities required in large quantities for growth and crop yield. Nitrogen plays a key role in chlorophyll production and protein synthesis. Chlorophyll is the green plant pigment responsible for photosynthesis; when nitrogen is deficient, it causes yellowing or pale leaves and stunted growth. It also functions in the vegetative parts of the plant such as leaves, stems, and roots (Rismunandar, 2004).

3.4 Filled pod weight

Table 4 shows that the POCpy treatment had a significant effect on the filled pod weight of soybean plants, while the application timing and the interaction between the two treatment factors had no significant effect on the filled pod weight at 12 weeks after planting (WAP). This can be seen in Table 4 below.

Table 4. Average Filled Pod Weight of Soybean under POCpy Treatment and Application Time at 12 WAP on Ultisol Soil

Treatment POCpy	Application Time W_1	W_2	W_3	Average
P_1	28,17	31,00	31,50	30,22c
P_2	31,50	31,33	31,33	31,39b
P_3	31,00	32,33	32,67	32,00b
P_4	34,00	34,33	32,50	33,61a
Average	31,17	32,25	32,00	

Note: Figures followed by the same letter in the same row are not significantly different at the 5% level based on the DMRT test.

Table 4 shows that the application of POCpy had a significant effect on the pod weight of soybean plants at 12 weeks after planting, where the POCpy P4 treatment (300 ml/polybag) at 33.61 showed the best pod weight, significantly different from P3 (32.0), P2 (31.39), and P1 (30.22). The application timing treatment and the interaction between the two treatments had no significant effect on soybean pod weight. In the application timing treatment, the highest results were observed at 1 week before planting, which was not significantly different from the application timing at planting and 2 weeks before planting.

The relationship between soybean pod weight and POCpy application is linear, with the equation $\hat{Y} = 0.0144x + 29.11$, r = 0.97, as shown in Figure 3 below.

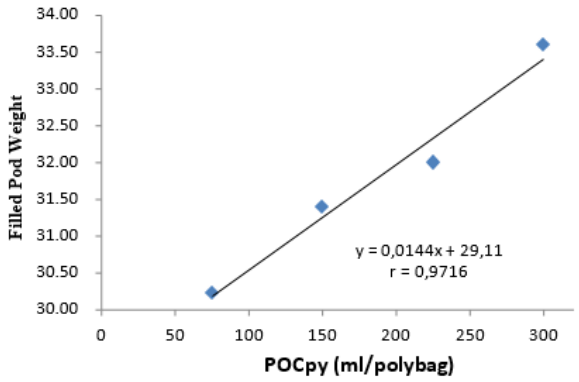

Figure 3. Relationship between POCpy application and soybean pod weight in Ultisol soil

Based on Figure 3 above, it can be seen that the soil given a POC concentration of 300 ml/polybag had the highest average pod weight compared to other treatments. This may be due to the nitrogen content in POC, which plays a role in the formation of leaf chlorophyll for photosynthesis, thereby indirectly increasing the pod weight of soybean plants (Lakitan, 2004).

The application of POCpy can enhance the effectiveness of rhizobium bacteria, which form a symbiotic relationship with soybean plants and are capable of fixing atmospheric N2, thereby fulfilling nitrogen requirements through this N2 fixation process (Adnyana, G. M. 2012). Furthermore, Wibawa (2008) explains that good plant growth can be achieved if the required nutrients are available in a balanced form and at optimal concentrations, supported by environmental factors.

It is known that the timing of application does not significantly affect soybean pod weight. Pod weight is influenced by environmental factors, such as nutrient content and light. The timing of application has not been able to provide the necessary nutrients for pod weight. Light assists in the process of photosynthesis, producing photosynthates that provide energy for rhizobium bacteria. This aligns with Novriani's (2011) view that pod weight is influenced by environmental factors, such as nutrient content and light. Additionally, crop production can be influenced by genetic and environmental factors, such as temperature, sunlight, and rainfall.

4. CONCLUSIONS

The research results indicate that applying liquid organic papaya fertilizer significantly affects the number of branches, number of pods per polybag and filled pod weight. However, it had no significant effect on soybean plant height. The timing of the application treatment non significantly affected plant height, number of branches, number of pods per polibag, filled pod weight. The interaction between the application of liquid organic papaya fertilizer and application time did not significantly affect plant height, number of branches, number of pods per polybag and filled pod weight.

5. ACKNOWLEDGE

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