Effectiveness of Banana Peel-Based Liquid Organic Fertilizer Application as Potassium Source for Eggplant (Solanum melongena L.) Growth and Yield

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Abstract. Banana peel is an organic waste, which has nutrients that are useful for plants. This study was aimed to determine the effectiveness of liquid organic fertilizer (LOF) made by banana peel (BP) as a potassium source for eggplant (Solanum melongena L.) growth and determine the right balance between the use of BP-LOF and anorganic KCl fertilizer. The study was conducted in the Agricultural Experiment Field of UMY from September to November 2018. The study was conducted using a Completely Randomized Design (CRD), which consisted of 6 treatments namely (1) 100% BP-LOF, (2) 80% BP-LOF + 20% KCl fertilizer, (3) 60% BP-LOF + 40% KCl fertilizer, (4) 40% BP-LOF + 60% KCl fertilizer, (5) 20% BP-LOF + 80% KCl fertilizer, and (6) 100% KCl fertilizer as control. The results showed that the comparison of BP-LOF application gave similar results to the growth and yield of eggplant.

Keywords: banana peel waste, liquid organic fertilizer, potassium, eggplant

1. Introduction

Eggplant is a vegetable that can be processed by frying, boiling, sautéing, or consumed in its raw form. From 2012 to 2017, there was an increase in an average of 9.38 tons/hectare [1]. In 2009, the amount increased to 10.59 tons/hectare with a harvest area of 50.875 hectares. According to Retno et al. [6], bananas are a type of tropical fruit that Indonesia produces a lot. Java and Madura have a production capacity of banana approximately 180.153 tons per year. Indonesia is known as one of the largest banana-producing countries in Asia. The production and consumption of banana keeps increasing every year, but on the other hand, the banana peel waste also increase tremendously as well. This banana peel contains high level of nutrients (such as fat, protein, and carbohydrate), but remain unknown to be recycled by most people [2].

The banana peel, which has been considered as rubbish and smelly, apparently contains many chemical elements or compounds that are beneficial to plants. Research conducted by Tuapttinayya et al. [12] showed that the application of 200 ml/liter liquid fertilizer from banana peel waste had a significant effect on plant height, fresh tuber weight, tuber diameter, and dry weight onion bulbs. This part of banana has a lot of benefits because liquid fertilizer from banana peel waste has more potassium content than the other elements. So, it provides influence on the lower plant organs (tubers). Banana peels contain 15% potassium and 2% higher content of phosphorus than the one in the banana flesh. Besides...
containing P and K, banana peels also contain elements of magnesium, sulfur, and sodium. Banana peel waste belongs to wet organic waste. Organic fertilizer is beneficial to improve agricultural production both in quality and quantity, reducing environmental pollution, and improving land quality in a sustainable manner. Artificial chemical fertilizers can be easily washed out of the water and do not pollute rivers, lakes, and other water sources [4]. In addition, the prolonged use of artificial chemical fertilizers in soils with low organic matter content can cause the soil to be quickly eroded by wind and rain.

2. Materials and Methods
The study was conducted using a single factor experimental method arranged in a Completely Randomized Design (CRD). The treatments tested consisted of 6 treatments repeated 3 times. The experimental treatments were as follows: (P1) 100% BP-LOF (banana peel-liquid organic fertilizer), (P2) 80% BP-LOF + 20% KCl fertilizer, (P3) 60% BP-LOF + 40% KCl fertilizer, (P4) 40% BP-LOF + 60% KCl fertilizer, (P5) 20% BP-LOF + 80% KCl fertilizer, and (P6) 100% KCl fertilizer as control.

3. Results and Discussions
The results of variance in the number of leaves tested at α level 5% showed no significant difference between the treatments given, while the average number of leaves can be seen in Table 1. The results of variance in the number of leaf parameters showed that the treatment of BP-LOF application at week 5 gave no significant effect (Table 1). These results can indicate that the need for potassium in all BP-LOF treatments could be fulfilled and replaced the use of inorganic KCl fertilizer as its potassium source. According to Gardner et al. [3], potassium has an essential role in the process of photosynthesis because it can increase growth and leaf area index, increase CO2 assimilation, and increase translocation of photosynthetic results out of leaves.

Table 1. Effect of BP-LOF application on number of leaves, plant height, leaf area, fresh weight, and dry weight at the 5th week.

| Treatments          | No. leaves | Height (cm) | Leaf area (cm) | Fresh weight (gram) | Dry weight (gram) |
|---------------------|------------|-------------|----------------|--------------------|-------------------|
| 100% BP-LOF         | 31.00 a    | 44.27 a     | 3274.67 a      | 229.78 a           | 28.47 a           |
| 80% BP-LOF + 20% KCl| 24.00 a    | 43.37 a     | 2198.00 a      | 176.76 a           | 21.66 a           |
| 60% BP-LOF + 40% KCl| 29.67 a    | 43.17 a     | 1711.00 a      | 147.59 a           | 17.48 a           |
| 40% BP-LOF + 60% KCl| 32.00 a    | 45.77 a     | 2362.67 a      | 237.39 a           | 28.50 a           |
| 20% BP-LOF + 80% KCl| 27.67 a    | 46.23 a     | 2851.67 a      | 204.25 a           | 26.12 a           |
| 100% KCl            | 29.67 a    | 46.33 a     | 1834.67 a      | 174.94 a           | 22.04 a           |

Number followed by the same letter in the same column was no significant difference based on the F-test with α level 5%.

Figure 1 showed the increase in the number of leaves each week. An increase in the number of leaves indicates continued plant growth. According to Gardner et al. [3], leaf growth is influenced by nitrogen nutrients. Deficiency of N elements will limit cell enlargement and division. The N element always moves in the body of the plant and moves to younger tissue. Younger leaves will attract N more strongly so that with sufficient N elements, the cell division in young leaves will continue and the number of leaves increases.

Plant height is a parameter that is tested to determine plant growth. As the height of the plant increases, so does the number of leaves. The process of plant growth is influenced by genetics, environment, and physiology of plants. The results of variance in the number of leaves tested at α level of 5% showed no significant difference between the treatments given, while the average number of leaves can be seen in Table 1. Table 1 showed that between the treatments tested, there are no significant differences. This finding indicates the need for potassium in eggplant plants is fulfilled. 100% K.
treatment of BP-LOF can replace inorganic fertilizer because the results are the same as all treatments. With sufficient potassium nutrients, the body of the plant can be sturdy so that the plant does not collapse easily. Potassium nutrients can also help maintain osmotic potential and water uptake so that plants will not quickly wither [3].

As plant height increases, the number of leaves also increases. For the highest height found in the treatment, namely P6 is 46.33 cm, while for the parameter with the highest number of leaves is in P4 with 32 strands of leaves. The number of branches influence a large number of leaves. Even though, the treatment of P6 showed the highest height, but it does not affect the number of leaves. This finding can be known if the treatment of P4 were not tall but have many branches and remained producing a lot of leaves. Based on Figure 1, application of BP-LOF on all treatment provides the same effect on the parameters of the eggplant plant height. Based on observation made at the beginning of planting or week 0 to week 5, there was a height increase in each treatment tested. The highest height increase occurred at the 4th week, which was about 25 cm.

![Graph of eggplant height and number of leaves](image)

Figure 1. Comparison of eggplant height (left) and number of leaves (right) after the application of various concentration of BP-LOF.

The growth of stem height occurs in the intercalary meristem of elongated segments as a result of increasing cell numbers, which can increase stem height. Observation of plant height in eggplant plants increased in each treatment. The height increase graph can be seen in Figure 2. The results of leaf area variance tested at α level 5% showed no significant difference between the treatments given, while the average leaf area can be seen in Table 1. The results of variance in leaf area parameters gave no significant effect. Based on Table 1, the highest average leaf area was found in the treatment of 100% potassium from banana peels, which was 3.274.67 cm². Besides containing potassium, BP-LOF also have other nutrients such as nitrogen, phosphorus, and organic C so that the nutrients are more abundant than other treatments. In Nasution et al. [4], it stated that the total N in BP-LOF was 0.18%.

When compared with other treatments, 100% potassium treatment of banana peels certainly also provides the highest nitrogen nutrients so that sufficient nitrogen nutrients are also fulfilled. According to Gardner et al. [3], the application of nitrogen has a significant effect on leaf expansion, especially on the width and width of the leaf. The highest leaf area in the P1 treatment was also thought to be a large number of leaves and broad leaves. When compared with the highest number of leaves, in the treatment P4 only had a leaf area of 2,362.67 cm², it can be due to a large number of leaves but the small leaves so that the leaf area was low.

Fresh weight can indicate plant metabolic activity and tissue water and nutrient content [7]. Metabolism results also affect wet plant weight values. The results of variance on the parameters of the fresh weight of eggplant showed no significant difference in all treatments. There is no real difference because this nutrient requirement in all treatments was fulfilled. Fresh weight are also an image of
photosynthesis as long as plants grow. The results of the variety of fresh weight tested at α level of 5% showed no significant difference between the treatments given. Meanwhile, the mean fresh weight can be seen in Table 1. These results showed 100% of BP-LOF can replace the element of potassium needed by eggplant. By providing organic fertilizer, available nutrients can be well absorbed by plants because the leaves grow wider and photosynthesis occurs more often [9]. The results of photosynthesis are used to make stem cells, leaves, and roots so that it can affect the fresh weight of the canopy.

Nutrient availability factors can affect plant growth and development, so that it affects the fresh weight of the crown [11]. This statement implied that the nutrients contained in the treatment of 100% BP-LOF can be available or absorbed by plants through the root so that it affects the results of photosynthesis which will affect the fresh weight of the plant. The higher the biomass of a plant is, the larger the nutrient content in the soil absorbed by plants will be. The results of the variety of fresh weight of plants tested at α level of 5% showed that there were significant differences between the treatments given, while the mean fresh weight of plants can be seen in Table 1.

The results of the mean variation in plant dry weights showed no significant difference between treatments. This finding indicated that all treatments can be fulfilled the needs of the nutrients. The calculation of plant dry weight is essential because dry weight is used to see plant metabolism [8]. Dry weight can represent the results of plant metabolite because it contains the leaves and other organs. Dry weight increase is used as an indicator of plant growth. It reflects the accumulation of organic compounds that plants have successfully synthesized from inorganic compounds, namely water, and CO2.

The best treatment in terms of dry wet weight parameters was P4 treatment, namely giving 40% potassium from BP-LOF and 60% potassium from KCl. The dry weight of P4 treatment was 28.50 gram, and fresh weight was 237.39 gram. It is because the P4 treatment is the best treatment that makes plants able to absorb nutrients optimally. Besides, it can ultimately increase the dry weight of plants due to CO2 uptake and produce a net accumulation of CO2 assimilation results. The higher the dry weight in plants is, the more photosynthesis produced by plants will be. So, the results of photosynthesis transplanted to plants are also more numerous. The results of photosynthesis are used by plants to carry out the process of growth and development, including increasing the plant height, the formation of new leaves and branches.

Results of variance in the number of fruits tested at α level of 5% showed no significant difference between the treatments given, while the average number of fruits can be seen in Table 2. All treatments had similar number of fruits and treatment 40% BP-LOF with 60% KCl had the highest value of 6.55 pieces. It was assumed that the application of BP-LOF could replace the availability of potassium from inorganic fertilizer. In addition, liquid organic fertilizer given was the optimal dose, so that it can provide nutrients needed by the eggplant during the generative phase during fruit development.

**Table 2.** Effect of BP-LOF application on number of fruits, fruit weight, fruit weight per plant, fruit length and diameter at 10th week.

| Treatments          | No. fruits | Fruit weight (g) | Fruit weight/plant (g) | Fruit length (cm) | Fruit diameter (cm) |
|---------------------|------------|------------------|------------------------|-------------------|---------------------|
| 100% BP-LOF         | 5.77 a     | 142.11 a         | 834.60 a               | 15.77 a           | 4.67 a              |
| 80% BP-LOF + 20% KCl| 5.78 a     | 125.29 a         | 710.60 a               | 14.87 a           | 4.36 a              |
| 60% BP-LOF + 40% KCl| 5.67 a     | 118.85 a         | 661.90 a               | 15.74 a           | 4.45 a              |
| 40% BP-LOF + 60% KCl| 6.55 a     | 122.71 a         | 797.50 a               | 15.38 a           | 4.34 a              |
| 20% BP-LOF + 80% KCl| 5.11 a     | 127.90 a         | 655.20 a               | 14.90 a           | 4.43 a              |
| 100% KCl            | 5.78 a     | 123.23 a         | 702.90 a               | 14.64 a           | 4.39 a              |

Number followed by the same letter in the same column was no significant difference based on the F-test with α level 5%.

The results of the variation of fruit weight tested at α level of 5% showed no significant difference between the treatments given (Table 2). Table 2 showed that the highest fruit weight obtained from the
application of 100% BP-LOF (P1). This phenomenon happened due to the availability of potassium in all treatments can be fulfilled and absorbed optimally by plants. The use of organic fertilizers on agricultural soils can improve soil conditions which add organic material, and the soil can bind more water. Potassium has a positive effect on stomatal closures so that it can help maintain osmotic potential and water uptake. Plants with enough potassium will lose less water so that plants can use water for growth processes such as photosynthesis. Water that is maintained in the body of the plant also serves to fill the fruit. Therefore, the larger the size of the fruit is, the more mass increases will be.

The results of the variation of fruit weight per plant tested at α 5% level showed no significant difference between the treatments given (Table 2) indicating that each treatment has similar weight of fruit per plant. Application of 100% BP-LOF (P1) resulted the highest fruit weight per plant up to 834.60 grams (Table 2). Regarding the fruit weight, the P1 treatment also had the highest average weight. It is suspected that application of BP-LOF could provide the sufficient amount of potassium needed by plants. Besides having potassium nutrients, BP-LOF also contain nitrogen and phosphorus. The use of a balanced fertilizer can reduce damage to fruit [5].

The results of the analysis of the length of the fruit tested at α level 5% showed no significant difference between the treatments given, where the highest value found in the application of 100% BP-LOF with 15.76 cm (Table 2). It means that nutritional needs can be met and absorbed by plants. The nutrients nitrogen and potassium influence the increase in the length of the purple eggplant. These nutrients play an important role in the process of photosynthesis. They can increase leaf area and can accelerate the conversion of carbohydrates into proteins so that they can be used to arrange cell walls. Furthermore, the element phosphorus is also useful to stimulate plant cell division and enlarge cell tissue.

The results of the variation of fruit length and diameter tested at α level 5% showed no significant difference between the treatments given indicating that each treatment has similar size in both parameter (Table 2). Table 2 also showed that each treatment has nearly the same average of fruit diameter and the highest one obtained from the application of 100% BP-LOF with 4.67 cm (Table 2). Similarly, the application of 100% BP-LOF also exhibited the highest fruit diameter (Table 2). It is suspected that plants can meet their nutritional needs and absorption is also running optimally. The addition of fruit diameter due to plants continued to do cell division in young tissue. The element nitrogen is an essential element in the preparation of amino acids, amides, nucleotides, and nucleoproteins, as well as necessary for cell division, and cell enlargement for growth. In addition, the element phosphorus is also influential in stimulating plant cell division and enlarging cell tissue. The element of potassium has a role in increasing leaf area so that the process of photosynthesis can run more. Besides, the results of photosynthesis can be channeled to the fruit.

4. Conclusion

Application of BP-LOF as a source of potassium was found to be potential as the substitute for KCl fertilizer indicated by the plant response in terms of growth and yield. Each comparison of the tested BP-LOF showed comparable growth and yield performance in eggplant.

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