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Liquid organic fertilizer concentration of pineapple peel on the growth and production of black potato, *Plectranthus rotundifolius* (poir.) Spreng

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ABSTRACT

The research aimed to determine the effect of applying liquid organic fertilizer from pineapple peel on the growth of black potato, *Plectranthus rotudifolius* (poir) Spreng. In this research the method used was Randomized Block Design (RBD) method with six treatment levels, each treatment repeated four times across four blocks, resulting in 24 experimental units. In this study, six treatments were applied, consisting of various concentrations of liquid organic fertilizer from pineapple peel P0=no treatment, P1=10%, P2=15%, P3=20%, P4=25% and P5=30. The research used manure and NPK fertilizer as basic fertilizer in soil planting media. The results showed that the application of pineapple peel had a significant effect on the growth parameters of black potatoes, especially on root fresh weight, shoot fresh weight and tuber volume, treatment P4 (25%) produced the highest shoot fresh weight, average 535.75 g, while P2 the lowest average was 332.25 g, the highest fresh root weight was 18.25 g, while the lowest P1 was 10.75 g and tuber volume had a significant effect on treatment P2 (15%) producing the highest volume namely 4.89 g, while the lowest was 4.10 g. The application of 15% pineapple peel liquid organic fertilizer significantly increased crown fresh weight, root fresh weight, and tuber volume of black potato, while having no significant effect on other growth parameters.

Keywords: black potato, growth and yield, liquid organic fertilizer, pineapple peel, sustainable agriculture

INTRODUCTION

Black potato, as a horticultural crop (Natasya et al., 2022), serves as an alternative and useful diet (Muchlisyiyah et al., 2022). The plant exhibits a rather high nutritious composition, comprising sugar (26 mg/100 g), protein (13.6 to 14.6 mg/100 g), crude fat (1.2%), crude fibre (1.6%), phosphorus (36 mg/100 g), calcium (29 mg/100 g), and vitamins A (13.6 mg/100 g) and C (10.3 mg/100 g) (Jaseena, 2023). Moreover, black potatoes possess antioxidant characteristics and antiproliferative effects that may impede cancer cell proliferation and mitigate the risk of diabetes and obesity (Ammanni & Aparanjani, 2016). According to food consumption statistics, black potato output declined by 2.547 in 2020 (Ngadiani & Andriani, 2023). This indicates that the cultivation of black potatoes has garnered insufficient attention from farmers. Moreover, farmers exhibit a significant reliance on chemical fertilisers (Hasibuan et al., 2022). The overuse of chemical fertilisers adversely affects soil fertility, contributes to environmental degradation (including soil, water, and air), and diminishes food quality (Thorat & More, 2022).

To address the reduction in black potato production, one alternative was the utilisation of new superior varieties, enhanced varieties, and indigenous black potato cultivars (Devaux et al., 2020). One initiative to diminish the use on chemical fertilisers was the transition to organic fertilisers (Lu et al., 2024). Organic fertilisers are natural mineral resources that provide sufficient quantities of plant nutrients (Dayera et al., 2024).

These fertilisers could be derived from agricultural byproducts, livestock excrement, and plant- beneficial microorganisms (Zhou et al., 2022). An instance of organic fertiliser was liquid organic fertiliser, which employs agricultural waste (Sutikarini, 2023). POC comprises organic chemicals that may exist as solids or liquids, either partially or entirely produced from organic substances, in both solid and liquid states (Kurniawan et al., 2024). Liquid fertilisers comprise comprehensive nutrients, including organic matter, nitrogen, phosphorus, potassium, organic carbon, copper, zinc, iron, and complete humic acids (Haryanta et al., 2022) essential for plant growth (Seman & Adam, 2023). Pineapple peel waste is a compelling option among various agricultural wastes for the production of liquid organic fertiliser (Suryani et al., 2022).

Research by Setyawan et al. (2022) demonstrated that the use of POC elevated soil pH and nitrogen levels. Despite the rise in pH and nitrogen levels, no targeted research has investigated the effect of pineapple peel POC on black potato plants. Further investigations are required to ascertain the impact of pineapple peel POC on the growth and yield of black potatoes. Evaluating the prospective application of pineapple peel as a liquid organic fertilizer (Suryani et al., 2022).

This research was crucial for sustainable agriculture, as the use of liquid organic fertiliser derived from pineapple peel waste could enhance the productivity of black potato plants while diminishing reliance on chemical fertilisers that may harm the environment. This study's results are anticipated to offer a more ecofriendly alternative for farmers, enhance the sustainability of natural resources, and eventually improve the welfare of individuals reliant on agriculture. The objective of this research was to yield novel insights into sustainable agricultural management and enhance the production of black potato crops in Indonesian.

MATERIALS AND METHODS

Research Method

The study used a Randomized Block Design (RBD) with 6 treatments and 4 replications, resulting in 24 experimental units. The study used manure and NPK fertilizer as the basic fertilizer on soil planting media. This study used 6 POC concentration treatments, namely:

P0= Control (Chicken manure and NPK fertilizer as basic fertilizer)
P1= Concentration of 10% pineapple peel liquid organic fertilizer solution
P2= Concentration of 15% pineapple peel liquid organic fertilizer solution
P3= Concentration of 20% pineapple peel liquid organic fertilizer solution
P4= 25% concentration of pineapple peel liquid organic fertilizer solution
P5= Concentration of 30% pineapple peel liquid organic fertilizer solution (Ciptono et al., 2022).

Research Implementation

Preparation of Pineapple Peel Liquid Organic Fertilizer POC

The preparation of pineapple peel POC began with the provision of equipment, including buckets, jerry cans, plastic measuring cups, and wooden stirrers. The materials used consisted of pineapple peel, 500 ml of EM4, 500 g of brown sugar, and 12 L of rice washing water. The pineapple were chopped into small pieces, blanded into a jerry can. Sliced brown sugar, rice washing water and EM4 were then added, followed by thorough mixing until homogeneous. The mixture was subsequently fermented for 30 days (Cristina et al., 2022).

Preparation of Planting Media

The planting medium consisted of topsoil that had been sieved and air-dried. The soil was then placed into polybags measuring 40 × 35 cm using a shovel.

Basic Fertilization

As in general cultivation, basic fertilization by mixing 150 g of manure and 9 g of NPK fertilizer evenly on the experimental polybags.

Black Potato Planting

The planting material was tubers obtained from black potato cultivation. Black potato tubers were selected that were good and guarantee quality to become planting material. Potato tubers that were ready to be planted were tubers that have sprouted with the characteristics of a shoot length of 2 cm.

Plance of Research

This research was conducted in Bangun Jaya Village, Tanjung Batu District, Ogan Ilir Regency, South Sumatra with coordinates 3˚23'00.2 S and 104°35'14.2 E. While the analysis activities were carried out at the Plant Physiology Laboratory, Department of Agronomy, Sriwijaya University in June 2023.

Maintenance

The maintenance of black potato plants was carried out through watering using a watering could in the morning and afternoon, manual weeding once a week, and pest and disease control by pruning the affected plant parts. The pest observed was grasshoppers, while no diseases were found. The planting medium consisted of topsoil that had been sieved and air-dried, which was then placed into polybags measuring 40 × 35 cm. Basal fertilization was performed by evenly mixing 150 g of farmyard manure and 9 g of NPK fertilizer into each experimental polybag.

Application of Liquid Organic Fertilizer (LOF)

POC was applied eight times at one-week intervals, starting at 2 weeks after planting (WAP) until 9 WAP. Prior to application, pineapple peel POC was diluted with water according to the treatment dosage and concentration (10%=100 ml POC + 900 ml water, 15%= 150 ml POC + 850 ml water, 20%= 200 ml POC + 800 ml water, 25%= 250 ml POC + 750 ml water, and 30% = 300 ml POC + 700 ml water) and mixed until homogeneous. The application was carried out in the afternoon by evenly pouring it onto the planting medium according to the predetermined concentrations.

Harvesting

Harvesting of black potatoes was done at 70 HST by carefully pulling the plants up to the roots. This harvesting was done in the morning.

Data Analysis

The data obtained will be analyzed using variance analysis (ANOVA) with a Randomized Block Design (RBD). If the results indicate that the calculated F value exceeds the F-table value at the 5% significance level, it implies that the treatment had a significant effect on the observed variables. To determine which treatment levels result in significant differences in response, a 5% Smallest Significant Difference (BNT) test will be conducted.

RESULTS

Black Potato Growth and Yield Results

Black Potato Growth and Yield Results Based on the analysis of variance of the observed data, it was shown that the application of pineapple peel liquid organic fertilizer in various treatments had a significant effect on several parameters, namely root fresh weight, crown fresh weight, and tuber volume. Furthermore, there were variables that did not show a significant effect, such as plant height, number of leaves, number of branches, number of tubers, crown dry weight, root dry weight, and tuber weight per plant. Data transformation was conducted using a log transformation due to the high coefficient of variation. The coefficient of variation data were presented in bold indicated the transformed data (Table 1).

Table 1. Results of analysis of variance on all Variables

Variables	F Value	CV (%)
Plant Height	1.30^{tn}	7.30
Number of Leaves	1.63^{tn}	4.52
Number of Branches	2.40^{tn}	21.86
Number of Bulbs	2.24^{tn}	10.98
Tuber Volume	4.14*	6.68
Crown Fresh Weight	2.94*	21.51
Crown Dry Weight	2.32^{tn}	12.41
Root Fresh Weight	2.97*	23.10
Root Dry Weight	0.77^{tn}	18.16
Planted Tuber Weight	1.77^{tn}	11.13
F Table 5%	2.90	
F Table 1%	4.56	

Note: *= significantly, **= very significant effect, tn= no significant effect, CV = coefficient of variation

Plant Height

Based on the results of the study, the application of liquid organic fertilizer from pineapple peels at various doses showed no significant effect on plant height. Overall, the P1 treatment showed the highest results in most observations, although the application of liquid organic fertilizer had no significant effect on plant height (Figure 1).

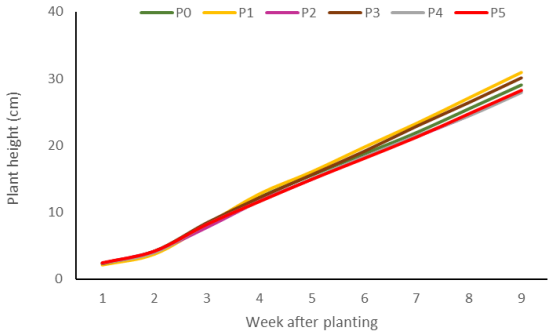

Figure 1. The average plant height under various treatments

Number of Leaves

The average growth in the number of leaves of black potato plants showed significant variations at each growth period (MST). The P3 treatment showed consistent results from the beginning to the end of the growth period, while the P0 treatment also showed good results at more advanced MST (Figure 2).

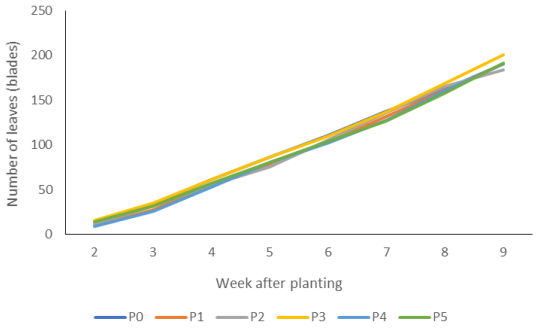

Figure 2. Average number of leaves in various treatments

Number of Branches

The application of pineapple peel liquid organic fertilizer at various doses showed that there was no significant effect on the number of plant branches. Observations of the number of branches at each growth period (MST) showed that treatment P5 consistently produced better results in branch growth than the other treatments at each MST observed (Figure 3).

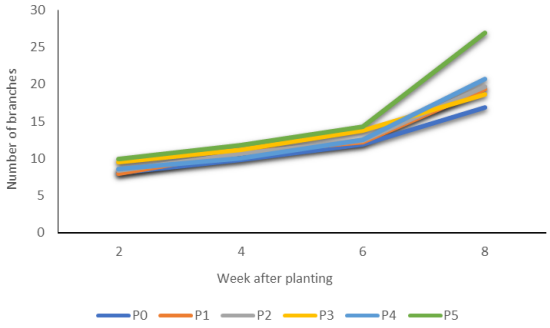

Figure 3. Average number of branches in various treatments

Crown Fresh Weight

The application of pineapple peel liquid organic fertilizer gave a significant effect on crown fresh weight. The results showed that the P4 treatment produced the highest average crown fresh weight of 535.75 g, while the P2 treatment recorded the lowest average of 332.25 g. Based on the analysis using the Least Significant Difference (LSD) test at the 5% level, the P4 treatment showed significant differences compared to the P2 and P1 treatments. This finding indicated that the application of pineapple peel liquid organic fertilizer in treatment P4 contributed more effectively to the growth of crown fresh weight (Figure 4).

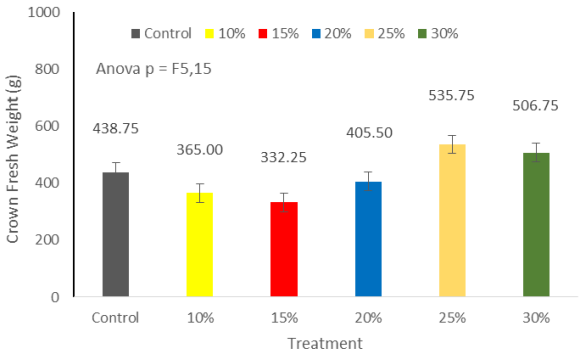

Figure 4. Average crown fresh weight in various treatments

Crown Dry Weight

The application of pineapple peel liquid organic fertilizer at various doses showed no significant effect on crown dry weight. The highest crown dry weight was obtained in treatment P5 (194.00 g), while the lowest average crown dry weight was obtained in treatment P2 (68.00 g). The original data were transformed using a log transformation before processing (Figure 5).

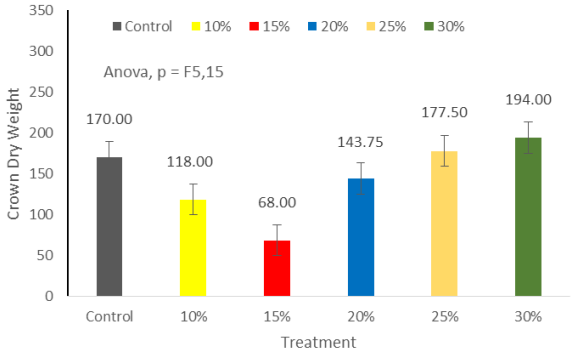

Figure 5. Average crown dryness in various treatments

Root Fresh Weight

The application of pineapple peel liquid organic fertilizer gave a significant effect on the fresh weight of roots, with the highest mean obtained in treatment P4 (18.25 g) and the lowest mean in treatment P0 (10.75 g). Based on the 5% LSD test, treatment P4 showed a significant difference compared to treatments P3 and P1 (Figure 6).

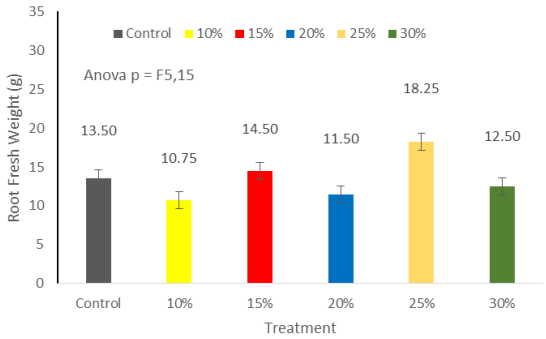

Figure 6. Average fresh weight of roots in various treatments

Root Dry Weight

Based on the results of the study, the application of pineapple peel liquid organic fertilizer at various doses showed no significant effect on the root dry weight variable. The highest root dry weight was obtained in the P4 treatment (5.00 g), while the lowest root dry weight was obtained in the P1 treatment (3.00 g). The original data for the root dry weight variable were transformed using root transformation before processing (Figure 7).

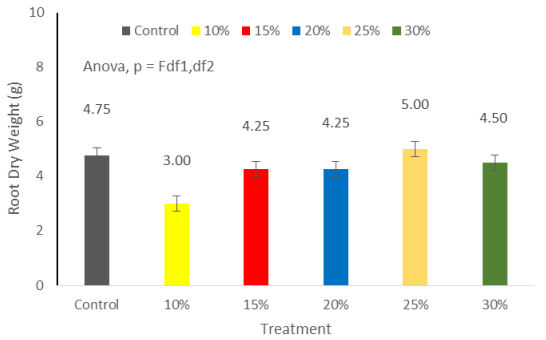

Figure 7. Average root dry weight in various treatments

Planted Tuber Weight

The application of pineapple peel liquid organic fertilizer at various doses showed no significant effect on the tuber weight per plant variable. The highest tuber weight was obtained in the P2 treatment (61.38 g), while the lowest average tuber weight was obtained in the P0 treatment (32.44 g). For the tuber weight parameter, the original data were transformed using a log transformation before processing (Figure 8).

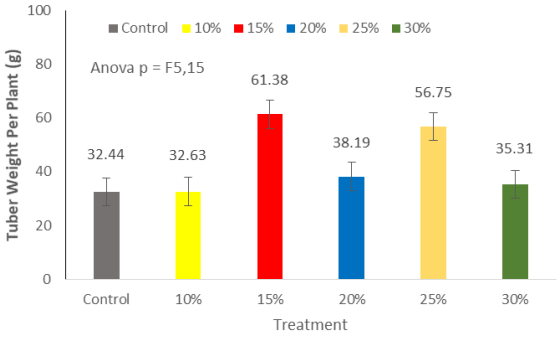

Figure 8. Average crown dry weight across treatments

Number of Tubers per Plant

The application of pineapple peel liquid organic fertilizer at various doses did not show a significant effect on the number of tubers per plant. The results showed that the P2 treatment produced the highest number of tubers with an average of 34.13 g, while the P0 treatment recorded the lowest average number of tubers at 14.15 g (Figure 9).

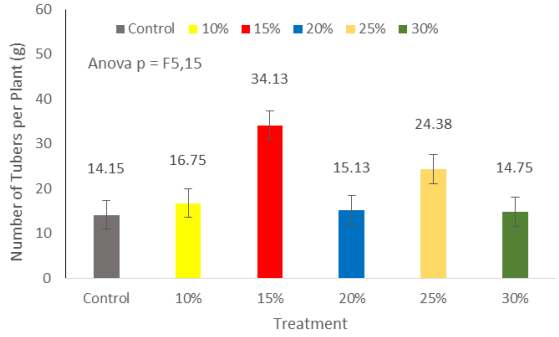

Figure 9. Average number of tubers in various treatments

Tuber Volume

Based on the results of the study, the application of pineapple peel liquid organic fertilizer gave a significant effect on the variable of plant tuber volume. The highest average volume of tubers was obtained in the P5 treatment, which was 4.89 g, while the lowest average was recorded in the P0 treatment with a value of 4.10 g. Analysis using the Least Significant Difference Test (BNT) at the 5%

level showed that the P2 treatment had a significant difference compared to the P0 and P1 treatments. This finding indicated that the application of pineapple peel liquid organic fertilizer in treatment P2 contributed positively to the increase in tuber volume, which could have implications for better yields and higher plant productivity (Figure 10).

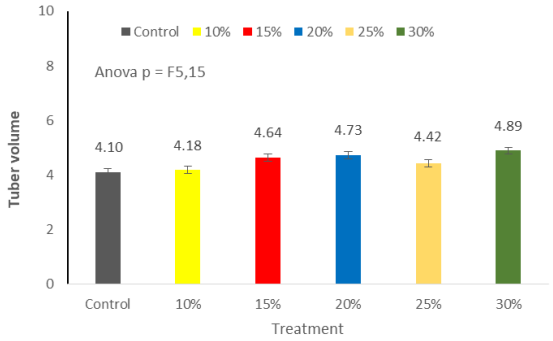

Figure 10. Average number of tubers in various treatments

DISCUSSION

According to the study's findings, optimal growth of black potatoes can be achieved by meeting the plant's nutritional needs, thereby promoting healthy plant development. Fertilizer acts as the primary source of essential nutrients that profoundly influence plant growth and yield. Indonesia offers a range of fertilisers, including poultry manure (Manogaran et al., 2022). The high nitrogen content in chicken manure is a great resource for enhancing the physical, chemical, and biological properties of soil (Altuntaş et al., 2022). Furthermore, manures can contribute supplementary organic matter to the growing medium. In addition to being an organic substance, the husk can enhance the drainage of the growing medium (Amanah et al., 2022). It enhances the soil's water retention capacity, improves aeration, elevates organic carbon content, raises pH levels, and fosters the proliferation of soil microorganisms, including worms and other species (Singh et al., 2021).

The utilisation of liquid organic fertiliser derived from pineapple peel on the growth of black potatoes demonstrated no impact on plant height, leaf count, branch count, tuber quantity, root dry weight, crown dry weight, and tuber weight. The application of liquid organic fertiliser significantly influences the parameters of crown fresh weight, root fresh weight, and tuber volume. The analysis of that the concentration of liquid organic fertilizer had no significant impact on plant height. In terms of plant height, the optimal therapy was identified in treatment P5, which involved a dosage of 30% POC from 1000 ml, equivalent to 300 ml POC per 700 ml of water. This assessment was based on measurements taken two weeks after planting and three weeks post-planting, where treatment P5 showed the most effective results, utilizing a dosage of 20% POC from 1000 ml, or 200 ml POC per 800 ml of water. Further evaluations of plant height at four, five, six, seven, eight, and nine weeks post-planting revealed that treatment P1, with a dosage of 10% POC from 1000 ml (100 ml POC per 900 ml of water), was the most effective. The optimal plant height in week 9 was recorded in treatment P1, averaging 30.94 cm, while the lowest average was observed in treatment P4 at 27.94 cm. These results suggest that increased dosages do not consistently yield ideal outcomes, indicating that the POC may not have been fully assimilated by the plants (Hapsari & Suparno, 2023).

Concurrently, the results of the statistical variance analysis indicated that the concentration of liquid organic fertilizer did not substantially influence the leaf count. During the observations conducted at 2, 3, and 4 weeks post-planting, the most effective treatment was P3, utilizing a dosage of 20% POC from 1000 ml, equivalent to 200 ml POC per 800 ml of water. The optimal treatment for the quantity of leaves at 5, 6, and 7 weeks post-planting was PO without treatment. Regarding the number of leaves at 8 and 9 weeks post-planting, the optimal treatment was identified in the P3 treatment, which utilized a dosage of 25% POC from 1000 ml, equating to 250 ml POC per 750 ml of water, yielding an average of 201.00 leaflets. Conversely, the P2 treatment recorded the lowest average at 183.75 leaflets.

This suggests that while POC might enhance early development, plants may adapt to conditions without fertilizer application, highlighting the significance of balanced fertilization. The quantity of leaves on Black potato plants fluctuates based on the POC volume treatment and nutrient accessibility. The nitrogen included in POC has a crucial function

in facilitating leaf proliferation (Sepbrie & Suparti, 2023).

The application of liquid organic fertiliser concentration did not significantly influence the number of branches. In the variable parameter concerning the number of branches. Observations conducted at 2, 4, 6, and 8 weeks post planting indicated that the most effective treatment was the P5 treatment with a 30% POC concentration. Regarding the number of branches, the optimal result in week 8 was observed in treatment PS with an average of 26.88, while the lowest was recorded in treatment PO with an average of 16.88. The optimal bud branches are typically situated at the terminal ends of the plant branches, as they contain auxin compounds. Auxin compounds are responsive to light cues, promoting development in the direction of sunshine. This may result from the action of auxin compounds on branch growth, which can be affected by environmental conditions including light, temperature, water, organic matter, and nutrition availability (Aini et al., 2023).

The statistical analysis revealed that the concentration of pineapple peel liquid organic fertilizer significantly influenced crown fresh weight. The optimal crown fresh weight in the variable parameter is observed in the P4 treatment, which utilizes a 25% POC concentration, yielding the highest average of 535.75 g. This is followed by P5, P0, P3, and P1, with P2 exhibiting the lowest average at 332.25 g. The least significant difference test (BNT) for the fresh weight of the crown was conducted, yielding a BNT value of 161.21 at the 5% significance level, indicating that numbers sharing the same letter exhibited no significant difference. The treatment of P4 and P2 shows a drastic difference. The wet weight of a plant increases with its size. As the number of leaves produced increases, the fresh weight of the plant will likewise rise (Panataria et al., 2024).

However, the application of pineapple peel liquid organic fertiliser concentration did not significantly alter the crown dry weight. The treatment P5, with a 30% POC concentration, exhibited the highest average beat crown dry weight at 194.00 g, followed by treatments P4, P0, P3, P1, and the lowest, P2, with an average of 68.00 g. This phenomenon is thought to arise from respiration surpassing photosynthesis, resulting in the plant suffering a reduction in dry weight due to water loss during the desiccation process (Lestari & Mutryarny, 2020).

The statistical analysis indicated that the concentration of pineapple peel liquid organic fertilizer significantly influenced root fresh weight. The optimal root fresh weight is observed in the PO treatment, which exhibits the highest average of 18.25 g, followed by P2, P4, P5, and P3, while the lowest average of 10.75 g is recorded in the PI treatment. The least significant difference test (BNT) for root fresh weight parameters, at a 5% level, is 5.43, indicating that values sharing the same letter demonstrate no significant difference. Meanwhile, treatments P0 and P1 exhibited significant differences. This is believed to result from the availability of essential nutrients in suitable forms, facilitating direct absorption to promote growth, particularly root formation (Rizar et al., 2023).

The analysis of variance (ANOVA) results indicated that the concentration of liquid organic fertilizer derived from pineapple peel significantly influenced the fresh weight of the roots. The optimal characteristics for root fresh weight were observed in treatment P0, which exhibited the highest average of 18.25 g, followed by treatments P2, P4, P5, and P3, while treatment P1 recorded the lowest average at 10.75 g. A least significant difference test (BNT) was performed on the root fresh weight parameter, resulting in a BNT value of 5.43 at the 5% significance level; values sharing the same letters indicate no significant difference. At the same time, treatments P0 and P1 showed significant differences. This is believed to be due to the impact of root length and nutrient absorption on root dry weight. The roots of the plants, characterized by extensive coverage and superior nutrient absorption, are likely to have greater weight (Shitophyta et al., 2023). The analysis of variance (ANOVA) results indicated that the concentration of pineapple peel liquid organic fertilizer did not significantly influence the dry weight of plant roots. The optimal root dry weight was observed in the P4 treatment at a 25% POC concentration, yielding the highest average of 5.00 g, followed by P0, P5, P3, P2, with P1 showing the lowest average at 3.00 g. The application of manure may not consistently

lead to superior root dry weight in plants, despite having similar ratios in root dry weight. The analysis of variance results indicated that the concentration of pineapple peel liquid organic fertilizer did not significantly influence the weight of plant tubers. The optimal plant tuber weight was observed in the P2 treatment with a 15% POC concentration, yielding an average of 61.38 g. This was followed by treatments P4, P3, P5, and P1, with the lowest average recorded in the PO treatment at 32.44 g. The analysis results also showed that the concentration of pineapple peel liquid organic fertilizer did not substantially influence the number of tubers per plant. The optimal number of tubers per plant was observed in the P2 treatment with a 15% POC concentration, yielding the highest average of 34.13 g. This was followed by treatments P4, P1, P3, and P5, with the lowest average recorded in the PO treatment at 14.15 g. In black potato plants, a greater number of branches leads to an increased quantity of tubers and their respective weights. The limited number of branches is believed to correlate with a reduced quantity and weight of tubers produced per plant, thereby making it less effective. The analysis of variance results indicated that the concentration of pineapple peel liquid organic fertilizer significantly influenced tuber volume. The optimal tuber volume was observed in the P2 treatment with a 15% POC concentration, yielding the highest average of 4.89 g, followed by treatments P3, P5, P4, and P1, while the lowest average of 4.10 g was recorded in the PO treatment. A least significant difference test (BNT) for the tuber volume parameter was conducted, yielding a BNT value of 0.53 at the 5% significance level, indicating that values sharing the same letter showed no significant difference. The P2 and PO treatments exhibited significant differences, confirming that the application of liquid organic fertilizer produces better results compared to no treatment. The results of this study indicate that.

CONCLUSSION

This study demonstrates that the application of liquid organic fertilizer (POC) made from pineapple peel has an effect on certain aspects of the growth and production of black potato plants. The application of POC at a 15% concentration yielded the best results by significantly increasing crown fresh weight, root fresh weight, and tuber volume compared to the control treatment. However, POC did not have a significant effect on plant height, number of leaves, number of branches, number of tubers, or the dry weight of shoots and roots. Therefore, pineapple peel POC at specific concentrations has been proven to support vegetative growth and improve the yield of black potato plants.

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