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Effect of applying POC of *Musa paradisiaca* peel on the growth and production of tomato plants (*Solanum lycopersicum*)

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Abstract

The peel of the kepok banana (*Musa paradisiaca*) is frequently perceived as pointless garbage by individuals after they have consumed the fruit. Nevertheless, the conversion of kepok banana husks into liquid organic fertilizer (POC) provides a number of benefits. The objective of this investigation is to determine the optimal concentration of POC for tomato cultivation as well as the impact of POC from kepok banana peels on the growth and yield of tomato plants Tomato Plants . The study implements a complete random design (RAL) with four interventions and five replicates: P0 = 0% (no fertilizer), P1 = 15%, P2 = 30%, and P3 = 45%. Using the ANOVA test, SPSS-25 software facilitated the analysis of the collected data. The results suggested that the growth of tomato plants at 12, 18, and 24 days after sowing (HST) was substantially influenced by the use of POC derived from kepok bananas, particularly in terms of plant height and leaf area. However, the quantity, weight, and size of the produce did not significantly change at 42, 46, and 50 HST. The recommended dosage for tomato plants is 15%.

Keywords: POC; Kepok Banana Peel; Musa paradisiaca; Tomato

1. Introduction

Waste refers to the byproduct or effluent resulting from an industrial process or human activity, which no longer holds economic value for the individuals involved [1]. Waste management may generate Liquid Organic Fertilizer (POC). The decomposition of organic materials, such as plant wastes, animal dung, and human waste, yields POC, a solution that contains numerous nutritional elements [2].

POC offers numerous advantages, including enhanced availability, minimal soil and plant damage, and a binding solution that allows for direct application to plants. Additionally, you can administer it through both the roots and leaves, as it decomposes the nutrients for optimal absorption. One plant that can benefit from POC is the tomato plant [3].

The tomato Tomato Plants is a widely grown horticultural commodity. The community extensively consumes tomatoes, commonly using them as a cooking ingredient, processing them into juice, or utilizing them as a fundamental component in beauty products. They also serve as a raw material for industrial products, particularly in the food sector.

The majority of the population in Parigi Moutong, a regency in Central Sulawesi, works in agriculture, primarily as tomato producers. Data from the Central Statistics Agency of Parigi Moutong indicates a consistent annual fall in tomato crop yield. This transpired as a result of a reduction in the utilization of arable land attributed to several external reasons [6].

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The physical state of the soil, which is deteriorating owing to the persistent use of inorganic fertilizers, requires significant care. The use of inorganic fertilizers in agriculture significantly affects soil conditions. This occurs owing to the accumulation of fertilizer residues, including salts and other chemicals, which can compromise soil structure and render the soil dense and challenging to cultivate. Consequently, soil production diminishes, rendering the land less productive [7]. The ongoing application of inorganic fertilizers undoubtedly diminishes soil quality. Consequently, POC may serve as an alternate remedy to mitigate soil degradation resulting from the overuse of inorganic fertilizers. Kapok banana peels provide a viable choice among organic wastes [8].

Many people use the conversion of organic waste into liquid organic fertilizer (POC) due to its many advantages, which include improved plant absorption, ease of application, and uniform distribution on the soil surface [2].

A study concluded that banana peels remain viable as organic fertilizers due to their content of N, P, K, Ca, Mg, Na, and Zn. These chemicals facilitate plant growth and development, thereby enhancing plant production [9]. Therefore, it is crucial to examine the growth and yield of tomato plants exposed to different concentrations of POC derived from kepok banana peels, in order to evaluate its influence on tomato plant growth and production, and to explore its potential as a substitute for inorganic fertilizers.

2. Approach

The study's goals are to find out how liquid organic fertilizer (POC) made from kepok banana peel (Musa paradisiaca) affects the growth and yield of tomato plants Tomato Plants and to find the best POC concentration for these plants. A completely randomized design (CRD) was used in this study to look at the effects of different amounts of liquid organic fertilizer (POC) made from kepok banana peels. The concentrations tested were P0 = 0% (control), P1 = 15 ml/polybag, P2 = 30 ml/polybag, and P3 = 45 ml/polybag, each with five replicates.

2.1. POC Creation

The procedure for producing POC from Kepok bananas starts with the collection of the peels. The quantity of banana peels utilized is 10 kg, with the base and ends excluded as they are not employed. We then dice the banana peel into small fragments to aid in the smoothing process. We smooth the banana peel with a blender to achieve a more uniform consistency. Next, we place the meticulously processed kepok banana peel into a storage container to combine it with additional ingredients: 250 ml of EM4, 250 g of crumbled brown sugar, and 10 liters of water. Blend the components thoroughly. We then place the mixture into jerry cans for fermentation. We secure the Jerry cans housing the POCs and shield them from direct sunlight exposure. Furthermore, we conduct the fermentation procedure for two weeks to ensure the appropriate decomposition of the components and the production of usable POC. We subsequently filter the fermentation results to extract the banana peel pulp from the liquid. We now prepare the POC for dilution and application. The concentrations employed were P0 = 0% (control), P1 = 15%, P2 = 30%, and P3 = 45%.

2.2. Seed Preparation and Transplanting

We plant tomato seeds in seedling pots filled with a 1:2:1 mixture of rice husks, loose soil, and sandy soil. Each seedling pot cavity subsequently receives the seeds. The sowing procedure lasts about 14 days, during which maintenance involves the daily watering of tomato seeds. We conduct the transplantation procedure on the fifteenth day, which includes 1 HST. The seedbed products are subsequently placed into a 40×50 cm polybag containing an identical planting medium, namely a blend of rice husks, loose soil, and sandy soil.

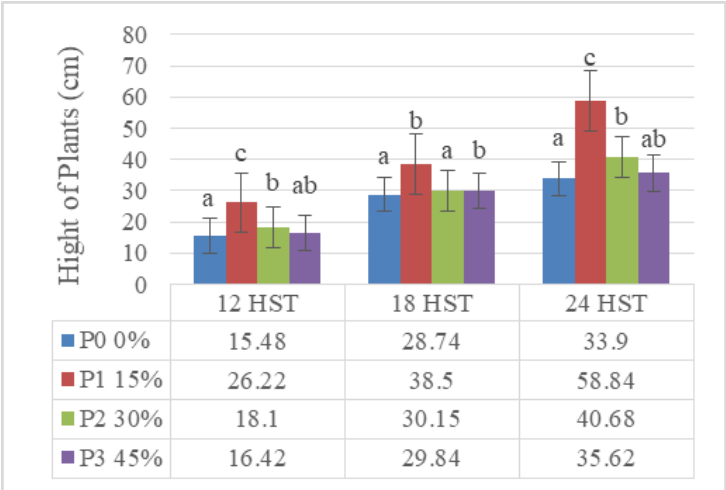
2.3. Data observation and Analysis

We conducted observation and data collection six times: three times during the vegetative phase and three times during the generative phase. We collect data every 6 days during the vegetative phase at 12 HST, 18 HST, and 24 HST, and every 4 days during the generative phase at 42 HST, 46 HST, and 50 HST. The data collected originated from measurement parameters, specifically the vegetative stage (plant height and leaf area) and the generative period (number of fruits, fruit weight, and fruit area). We measure the plant height using a meter, quantify the leaf and fruit areas using ImageJ software, and record the tomato weight using a digital scale. We subsequently documented and analyzed the acquired data using SPSS-25.

3. Results and discussion

3.1. Plant Height

We measured the height of tomato plants three times: 12 hours after sowing (HST), 18 HST, and 24 HST. Figure 4.1 below illustrates the typical measurements of tomato plant height.



	12 HST	18 HST	24 HST
P0 0%	15.48	28.74	33.9
P1 15%	26.22	38.5	58.84
P2 30%	18.1	30.15	40.68
P3 45%	16.42	29.84	35.62

Figure 1 Average Tomato Plant Height. The letter notations a, b, c, and ab signify that the treatment corresponding to the same letter is distinct and not genuine. Conversely, the BNT test revealed a significant difference in the treatment following different letters at the 5% level

The observations indicate a significant disparity in plant height growth across all treatments. The observations and measurements indicate that the optimal plant height growth occurs in the P1 treatment (15%), measuring 26.22 cm, 38.5 cm, and 58.84 cm. The results of the ANOVA test revealed significant differences between the observed samples, with a significance value of 0.000, less than 0.05, at 12 HST, 18 HST, and 24 HST.

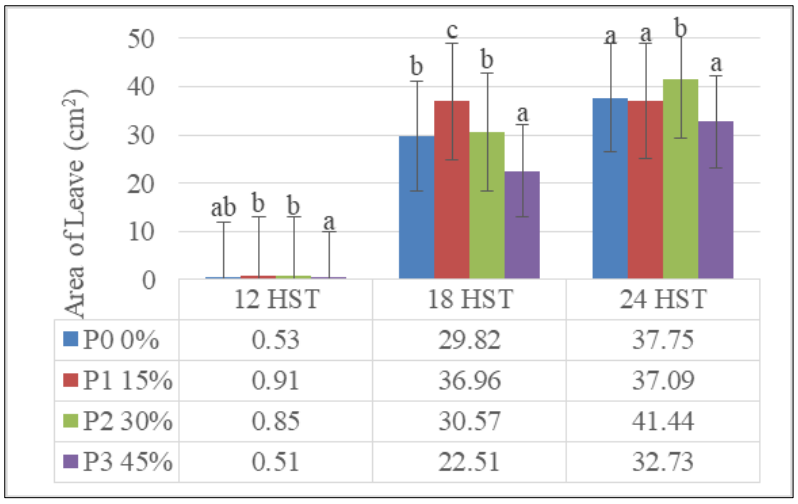
The nutrients nitrogen (N), phosphorus (P), and potassium (K) present in the POC of kepok banana skin are crucial for plant development. Element N is crucial in promoting the overall vegetative growth of plants, particularly in the development of roots, stems, and leaves [10]. Nitrogen is a crucial ingredient in protein synthesis and contributes to the stimulation of plant stem, branch, and leaf development, as well as chlorophyll creation. Banana peels, like organic materials, also possess potassium. Potassium is crucial for photosynthesis, protein, and cellulose production, as well as for reinforcing plant stems and enhancing plant resilience.

3.2. Leaf Area

We calculated the leaf area using image analysis tools, specifically ImageJ. The image below displays the average leaf area of tomato plants.

The observations and measurements indicated that optimal plant height growth occurred in the P1 treatment (15%) at 12 HST and 18 HST, whereas the P2 group (30%) yielded the greatest results at 24 HST. The examination of leaf area indicated that POC derived from banana peels significantly affected the findings, with significance values of $0.019 < 0.05$ at 12 HST, $0.000 \leq 0.05$ at 18 HST, and $0.025 \leq 0.05$ at 24 HST.

The nitrogen that is supplied influences leaf growth, particularly by augmenting the leaf area. Nitrogen availability in the soil can enhance photosynthesis and vegetative development in plants. Sourced from the peel of the kepok banana, the nitrogen in POC plays a crucial role in the synthesis of proteins and other essential molecules, thereby facilitating cell development and chlorophyll production. Respiration then converts the product of photosynthesis into energy, facilitating cell division and allowing the leaves to elongate and expand.

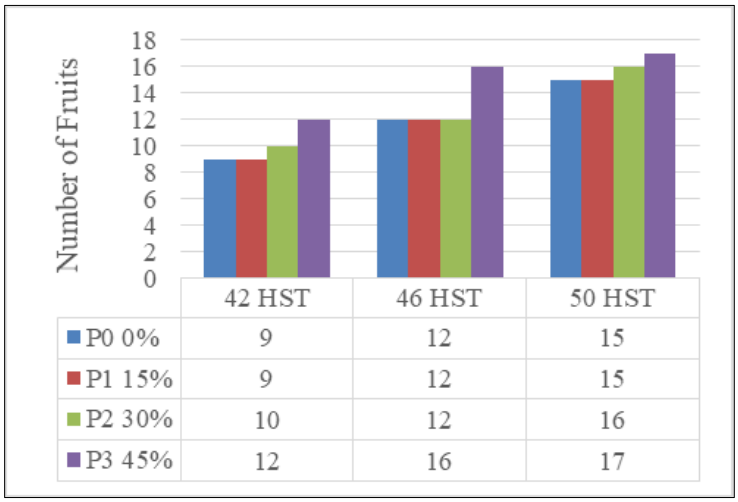


	12 HST	18 HST	24 HST
P0 0%	0.53	29.82	37.75
P1 15%	0.91	36.96	37.09
P2 30%	0.85	30.57	41.44
P3 45%	0.51	22.51	32.73

Figure 2 Average Plant Leaf Area. The letter notations a, b, c, and ab signify that the treatment corresponding to the same letter is distinct and not genuine. Conversely, the BNT test revealed a significant difference in the treatment following different letters at the 5% level

3.3. Number of Fruits

The enumeration of tomato plants occurs every four days, commencing at 42 HST, 46 HST, and 50 HST. The numbered fruit is a ripe, brilliant red tomato on the vine. Figure 4.3 below illustrates the average yield of tomato plants.



	42 HST	46 HST	50 HST
P0 0%	9	12	15
P1 15%	9	12	15
P2 30%	10	12	16
P3 45%	12	16	17

Figure 3 Number of Fruits

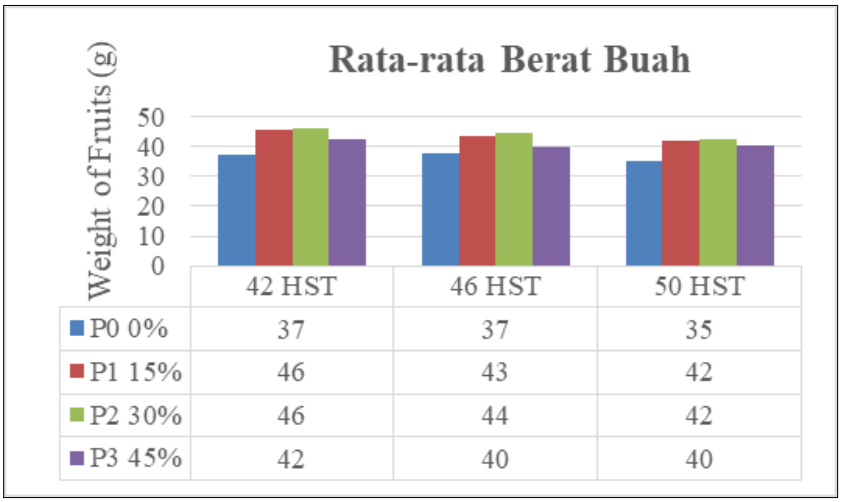
Observations of fruit production conducted three times throughout the harvest season revealed that P0 (control) yielded the lowest output, producing 9 fruits at 42 HST, 12 fruits at 46 HST, and 15 fruits at 50 HST. Simultaneously, the P3 treatment group had the greatest yield at 45%. The study findings revealed a negligible variation in the quantity of fruits gathered, from 42 HST to 50 HST, with values of 0.768, 0.295, and 0.615. This variation led to the rejection of H1 and the acceptance of H0. The discrepancy likely stems from the infrequent fertilizer delivery to the plant, which occurred only once at 26 hours after sowing, despite tomato plants needing substantial nutrients for optimal fruit production.

The equilibrium of phosphorus and potassium is crucial for the reproductive development of tomato plants. Phosphorus facilitates the conversion of carbohydrates into sugars essential for fruit development, while potassium functions to inhibit floral abscission. It's possible that using more liquid organic fertilizer (POC) during the reproductive phase could help plants make more flowers and fruits, since the nutrients in POC are important for both stages of plant growth [15].

Nitrogen is a vital nutrient that is crucial for the synthesis of proteins and amino acids, which are needed for the growth and development of plant tissues. During the generative phase, nitrogen deficiency in plants results in reduced protein synthesis and therefore hinders flower development. Consequently, the quantity of blooms produced diminishes. The reduction in the quantity of blooms directly affects the fertilization process, leading to a decreased amount of fruit production. The ultimate consequence of a nitrogen deficit is a reduction in overall crop yields, attributable to the decreased quantity of fruits generated by the plant. This may result in a substantial decline in production and crop quality [16].

3.4. Fruit Weight

We use a digital scale to measure the weight of the fruit and average the results of all repetitions according to a specified treatment group.



	42 HST	46 HST	50 HST
P0 0%	37	37	35
P1 15%	46	43	42
P2 30%	46	44	42
P3 45%	42	40	40

Figure 4 Average Fruit Weight

We conducted the fruit weight observation three times, and found that the P0 (control) group had the lowest average yield at 42 HST and 46 HST, weighing around 37 g, while at 50 HST, the tomatoes' weight dropped to 35 g. The P1 therapy group (15%) exhibited the most favorable outcomes at 42 HST and 50 HST, yielding 46 g and 42 g, respectively, whereas the P3 treatment group (45%) achieved the greatest results of 46 g, 44 g, and 42 g, respectively. The test findings indicated that the acquired data had an insignificant effect. Minimal variations in the weight of harvested fruits are evident, with significant values recorded at 42 HST to 50 HST, namely 0.304, 0.295, and 0.615. This indicates that POC derived from kepok banana peels has a significant impact on the weight of fruit produced by tomato plants.

The diminutive weight and size of tomato fruits result from inadequate nutritional treatment for the plant. The diminutive weight and size of tomato fruits result from inadequate nutritional treatment for the plant. Boron, alongside nitrogen, phosphorus, and potassium, is a crucial element involved in cell wall construction and the transportation of sugars in plants. A deficiency in boron can disrupt the process, leading to the production of tiny and hollow fruit. When the soil has adequate nutrient levels and is accessible to plants, it achieves optimal crop yield. Cellular and tissue activities such as photosynthesis, transpiration, and respiration, along with external influences like water availability, sunshine, and temperature, influence plant production [19].

3.5. Fruit Area

The assessment of the fruit area of tomato plants occurs concurrently with the measurement of fruit weight. We calculate the leaf area by analyzing photos with the freeware ImageJ.

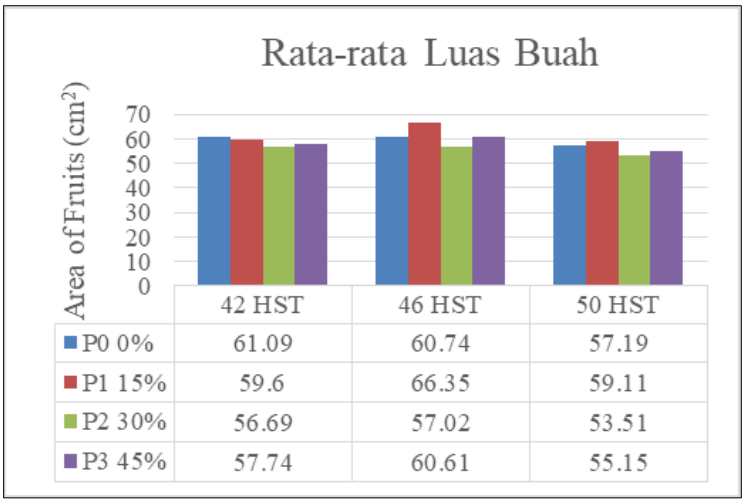


Figure 5 Average Fruit Area

The observational findings showed that the P2 treatment group (30% POC) had the lowest fruit area of tomato plants, specifically at 42 HSTs with a fruit area of 56.695 cm2, 46 HSTs with a fruit area of 57.023 cm2, and 50 HSTs with a fruit area of 53.513 cm2. The reduction in the fruit area is attributable to insufficient pollination during the reproductive phase. The P0 (control) group achieved optimal outcomes at 42 hours post-treatment, exhibiting a fruit area of 61.096 cm2. At ages 46 HST and 50 HST, the P1 treatment group (15% POC) yielded optimal outcomes, with fruit areas of 66,353 cm2 and 59,118 cm2, respectively.

The data analysis findings showed that the changes in fruit yield from 42 HST to 50 HST were negligible, specifically 0.902, 0.279, and 0.918. Consequently, it can be asserted that POC derived from kepok banana peel exerts a significant impact on the yield of tomato plants.

A lack of any of these nutrients may lead to growth problems and reduced production. In order for food crops to grow normally and reach the production phase, it is important to make sure that they have access to important minerals like nitrogen, phosphorus, and potassium in the right amounts to keep biochemical, physiological, and metabolic processes running smoothly. In this study, the nitrogen levels in the planting media diminished owing to irregular fertilization [20]. Kepok banana peel waste produces liquid organic fertilizer with a comprehensive nutritional profile, containing 6.19% organic carbon, 1.34% total nitrogen, 0.05% phosphorus pentoxide, 1.478% potassium oxide, a carbon-to-nitrogen ratio of 4.62%, and a pH of 4.8 [21].

4. Conclusion

The research shows that kepok banana peel (Musa paradisiaca)-based liquid organic fertilizer (POC) at concentrations of 15%, 30%, and 45% has a big effect on the growth phase of tomato plants Tomato Plants , but not on the production phase. Among the studied concentrations of POC, a 15% concentration yielded the most favorable outcomes for the development and output of the tomato plant.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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