AGARICUS: Advances Agriculture Science & Farming
Vol. 6 No. 2 August 2026, Page. 228 - 233
E-ISSN: 2797-0884

Growth and Fresh Biomass Responses of Red Onions (*Allium ascalonicum* L.) to Banana Stem Compost (*Musa paradisiaca*)

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ABSTRACT
To identify the effectiveness of introducing liquid organic fertilizer (POC) made from banana stems, this study examined the dynamics of several shallot vegetation indicators, including plant height, leaf quantity, and fresh weight. The study was conducted from October to December 2025 at the experimental site in Denanyar Village, Jombang Subdistrict, Jombang Regency, East Java. This study employed a quantitative methodology based on a Completely Randomized Design (CRD). This method applied six treatments: P0 (Control), P1 (Application of 75 ml/L banana stem POC), P2 (application of 150 ml/L banana stem POC), P3 (application of 225 ml/L banana stem POC), P4 (application of 300 ml/L banana stem POC), and P5 (application of 375 ml/L banana stem POC). The application of banana stem liquid organic fertilizer (POC) was found to have no significant effect on the vegetative performance of shallot plants. This was confirmed by an analysis of variance (ANOVA) on the parameters of plant height (calculated F = 1.10 < 5% critical F = 2.38), leaf area (calculated F = 0.53 < 5% critical F = 2.38), and fresh weight (calculated F = 1.16 < 5% critical F = 2.38), where all calculated F values did not exceed the critical F threshold at the 5% significance level. The absence of these statistical differences confirms that the application of liquid organic fertilizer has not yet been able to significantly influence plant growth dynamics.

***Keywords**: Liquid Organic Fertilizer, Banana Pseudostem, Shallot.*

INTRODUCTION
Shallots play a vital role in Indonesia as a major horticultural commodity, given their essential use in enhancing the flavor of various dishes. Farmers cultivate this crop across a wide range of vegetation zones (from coastal areas to highlands). Thanks to massive market demand and its high financial potential, red onions (Allium cepa) have been established as a priority agribusiness product. Furthermore, the tendency toward unstable price dynamics has spurred the expansion of red onion cultivation across the archipelago as a measure to maintain the consistency of supply (Wandita et al., 2018). Its diverse nutritional profile and the presence of various bioactive compounds make the red onion a crucial horticultural commodity. Based on a review of the literature, the composition of nutrients such as ascorbic acid, potassium, fiber, folic acid, calcium, and iron in red onions makes an essential contribution to maintaining the body's physiological functions (Aryanta, 2019).

Previous literature has shown that the application of liquid organic fertilizer (LOF) derived from banana stems induces a favorable response in red onion plants, specifically in growth parameters such as plant height and number of leaves. Research by Wibowo et al. (2024) indicates that the application of banana stem-based POC to local red onions contributes substantially to both plant height and bulb weight under certain conditions, although the number of leaves showed fluctuating responses. Furthermore, the application rate of POC was found to influence the rate of vegetative growth in red onions, although the degree of response is highly dependent on the solution concentration, growing medium composition, and cultivation conditions.

Nevertheless, previous research still shows variations in plant responses to banana stem POC

application. Some studies assessed its effects on growth and yield, while others focused only on the early vegetative phase or used combinations of other treatments; thus, they have not fully addressed how red onions respond to variations in banana stem POC concentrations under specific cultivation conditions. This gap forms the basis of this study, which aims to evaluate the effects of various concentrations of banana stem POC on red onion growth in a more focused manner.

Based on this academic gap, the urgency of this investigation lies in evaluating the efficacy of banana stem liquid organic fertilizer (POC) on the vegetative dynamics of red onions, specifically covering plant height, number of leaves, and fresh weight. The findings of this study are projected to serve as a scientific foundation for formulating the precise application of banana stem POC in shallot cultivation.

METHOD

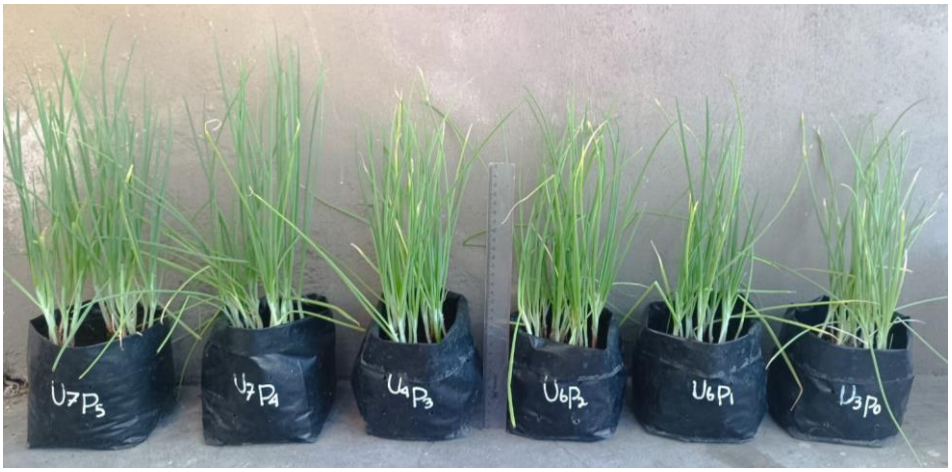
Using the polybag cultivation technique, this study was conducted at the experimental garden in Denanyar Village, Jombang Subdistrict, Jombang Regency, East Java. The study was carried out from October to December 2025. The materials required for this study were: 180 Bima Brebes variety red onion bulbs sourced from farmers in Brebes, 1 kg of banana stems of any variety, 1.5 ounces of granulated sugar, composted soil, 3 liters of rice washing water, and EM4 (agricultural decomposing microbes). The equipment used in this study includes: a machete, a bucket, a pestle, a stirring rod, 25x25 polybags, and a TDS meter.

This study was a single-factor experiment using a randomized block design (RAL) with 6 treatments, and each experimental unit consisted of 10 samples; thus, each polybag contained 3 shallot bulbs, with the following details: P0 = Control, P1 = 75 ml/L banana stem POC, P2 = 150 ml/L banana stem POC, P3 = 225 ml/L banana stem POC, P4 = 300 ml/L banana stem POC, P5 = 375 ml/L banana stem POC.

The variables evaluated included vegetative height growth (cm) and leaf quantity at intervals of 14, 28, 42, and 56 days after planting (DAP). Fresh plant biomass (g) was measured at harvest, which occurred at 70 DAS. All observational data were analyzed using analysis of variance (ANOVA) at a 95% confidence level ($\alpha = 0{,}05$). If a significant effect was detected, the analysis continued using the Least Significant Difference (LSD) test at the 5% level.

RESULT AND DISCUSSION

Measurements of leaf abundance and plant height of shallots following the application of banana stem POC were conducted periodically (14 to 56 days after planting), while the determination of fresh mass of plant organs was only performed at 70 days after planting.



P5 P4 P3 P2 P1 P0

Figure 1: Plant images for each treatment

Notes: P0 (Control), P1 (75 ml/L) banana stem POC, P2 (150 ml/L) banana stem POC, P3 (225 ml/L) banana stem POC, P4 (300 ml/L) banana stem POC, P5 (375 ml/L) banana stem POC.

Research

Plant Height (cm)

Red onions treated with banana stem POC showed the highest average plant height in treatment P3 (225 ml/L) and the lowest in treatment P5 (375 ml/L). The overall average plant height at 14 days after transplanting was 27.12 cm. At this stage, plant height was relatively uniform across treatments. The highest value was observed in treatment P5 (375 ml/L) at 28.82 cm, while the lowest value was in treatment P1 (75 ml/L) at 26.10 cm. Subsequently, at 28 HST, there was a fairly rapid increase in plant height, with an average of 33.54 cm. The highest result was actually achieved by P0 (Control) at 36.79 cm, and the lowest was in treatment P3 (225 ml/L) at 29.28 cm. This indicates that at 28 HST, the control plants were still able to grow optimally using the soil's inherent nutrients without additional POC. Subsequently, at 42 HST, the average plant height stabilized at 33.72 cm. The P0 (Control) treatment still showed the highest value (36.71 cm), while P4 (300 ml/L) showed the lowest result (30.33 cm). At this stage, plant height growth began to slow down as the plants prepared to enter the generative phase. Subsequently, at 56 HST, the average plant height was 34.28 cm. In this final observation, treatment P3 (225 ml/L) showed the best performance with a height of 36.31 cm, while the lowest was in treatment P5 (375 ml/L) at 32.39 cm. At 56 days after sowing, the plants had entered the tuber maturation phase, so plant height growth tended to remain constant or stop. Table 1 below shows the results of the post-hoc test for the number of leaves parameter:

Table 1 Average Plant Height of Red Onions with Banana Stem POC Application

Plant Age (HST)	Treatment Mean						Average
	P0	P1	P2	P3	P4	P5	
14	26.49	26.10	26.95	28.11	26.25	28.82	27.12
28	36.79	36.50	33.58	29.28	30.59	34.49	33.54
42	36.71	36.45	32.25	33.46	30.33	33.08	33.72
56	35.42	34.98	32.42	36.31	34.14	32.39	34.28

Number of Leaves

Red onions treated with banana stem POC had the highest average number of leaves in treatment P4 (300 ml/L), while the lowest number of leaves was observed in treatment P2 (150 ml/L). The highest average in treatment P5 (375 ml/L) resulted in the largest number of leaves, namely 15.60 leaves. At this stage, the plants had just begun to form a canopy. Treatment P5 showed a good initial response to the macronutrients in the POC, although the difference was not significantly different from the P0 control at 13.63 leaves. Subsequently, at 28 days after planting (DAP), Treatment P0 (Control) led with 19.16 leaves. Upon entering the active vegetative phase, plant samples in the control group recorded a higher number of leaves compared to the other liquid organic fertilizer (POC) treatment groups. This indicates that, at certain concentrations, banana stem POC has not yet been able to surpass the natural growth of plants without the addition of liquid fertilizer. Subsequently, at 42 HST, Treatment P4 (300 ml/L) produced the highest average of 20.55 leaves. There was a fairly uniform increase in the number of leaves across all treatments, with an overall average reaching 19.42 leaves. This phase marks the peak of leaf formation before the plants shift their focus to tuber formation. Subsequently, at 56 HST, the highest average for Treatment P4 (300 ml/L) remained the highest at 22.61 leaves, followed by P0 (Control) at 22.49 leaves. Meanwhile, the lowest average was found in Treatment P2 (150 ml/L) with only 18.32 leaves. At 56 HST, leaf growth began to slow down or level off as the plants entered the bulb maturation phase. Table 2 below shows the results of the post-hoc test for the number of leaves parameter:

Table 2 Average Number of Red Onion Leaves with Banana Stem POC Application

Plant Age (HST)	Treatment Mean						Average
	P0	P1	P2	P3	P4	P5	
14	13.63	13.17	13.50	12.97	13.37	15.60	13.70
28	19.16	17.42	16.73	13.48	16.04	18.72	16.93
42	19.79	19.49	17.59	19.68	20.55	19.43	19.42
56	22.49	20.79	18.32	21.15	22.61	20.68	21.01

Fresh Plant Weight (g)

Red onions treated with banana stem-based liquid organic fertilizer (POC) had the highest average fresh weight in treatment P3 (225 ml/L), while the lowest was in treatment P4 (300 ml/L). Average fresh weight of red onion plants after treatment with banana stem-based liquid organic fertilizer (POC) at various concentrations. Empirical findings indicate that during the harvest phase, the application of banana stem-based Liquid Organic Fertilizer (POC) at a concentration of 225 ml/L (P3) resulted in a fresh biomass weight that tended to be higher compared to the other treatments. However, statistical calculations indicate that this disparity is not statistically significant when compared to the control treatment. As shown in Table 3, this finding is reflected in the calculated F-value (1.16), which is relatively lower than the critical F-value (2.38) at the 5% significance level (calculated F < critical F). Consequently, no significant effect of banana stem POC exposure on the fresh weight of shallot plants was found at the 5% significance level (95% confidence level). Table 3 below shows the results of the post-hoc test for the number of leaves parameter:.

Table 3 Average Fresh Weight of Red Onions with Banana Stem POC Application

Treatment	Mean
P0	16.77
P1	17.81
P2	16.14
P3	20.04
P4	15.60
P5	18.18
Calculated F for treatment	1.1602215
F table at 5%	2.3860699
BNT	tn

Note: tn = No significant difference at a 95% confidence level (α=0.05)

Discussion

Plant Height

Based on the data presented in Table 1, the application of liquid organic fertilizer (POC) made from banana stems at various concentrations did not have a significant effect on the increase in red onion plant height. Based on an analysis of variance, the variation in mean plant height among treatments was found to be insignificant at the 5% confidence level, indicating that the treatment interventions did not have a significant effect on the increase in red onion plant height. This lack of a significant difference is believed to be due to the fact that the nutrient availability from the banana stem-based liquid organic fertilizer (POC) was insufficient to optimally stimulate the vegetative phase of the plants beyond that of the control treatment. Furthermore, the fertility level and initial nutrient content of the growing medium were estimated to have already met the plants' basic needs, so the POC supplement administered did not trigger a statistically significant growth response. Consistent with the findings of Dewi and Miftakhurrohmat (2022), the application of liquid organic fertilizer (POC) made from banana stems does not always have a significant impact on the vegetative growth of plants. The effectiveness of this treatment depends on various factors (quality of the raw material, precision of the fermentation process, application rate, and growing medium conditions). Tando (2019) noted that the rate of vegetative growth is determined by the adequacy of nutrient supply (particularly nitrogen) as well as the absorption capacity of plant organs. If nutrient availability remains limited, the effect of treatment variables on plant height increase tends to be uniform or not significantly different. Septirosya et al. (2019) demonstrated that high-concentration POC increases soil salinity, making it difficult for roots to efficiently absorb water and nutrients.

Number of Leaves

Because they contain chlorophyll, leaves play a crucial role as the primary site of photosynthetic conversion. Consequently, an increase in leaf mass expands the photosynthetic surface area, which significantly contributes to meeting the plant's intrinsic energy needs. A deficiency in nitrogen (N) can

inhibit chlorophyll formation and reduce the plant's ability to form and stimulate the growth of new leaves. The low number of leaves is due to severely insufficient nutrient uptake. The liquid organic fertilizer (POC) derived from banana stems likely does not provide enough nutrients to trigger massive leaf growth compared to the plant's needs. Based on the detailed average data in Table 2, the application of liquid organic fertilizer (POC) from banana stems at various concentrations did not substantially affect the number of leaves on red onion plants. Rahma et al. (2019) explain that leaf development is strongly influenced by the balance of internal (endogenous) hormones that regulate plant growth processes (such as auxin and cytokinin). If the banana stem POC contains more decomposing microbes than readily available nutrients, then stimulation of leaf formation will not occur immediately during the vegetative phase.

According to Putra, H. E., et al. (2020), the application of organic fertilizer at an inappropriate concentration can disrupt the nutrient uptake ratio within plant tissues. Excess potassium from liquid organic matter can suppress nitrogen uptake, which visually results in no significant increase in the number of leaves compared to plants without additional treatment. Hairuddin & Airani (2017) explain that plant response to liquid organic fertilizer has certain limits; an increase in concentration beyond optimal requirements will cause growth to stagnate or decline due to disruption of internal physiological processes.

Fresh Weight of Plants

Based on the data presented in Table 3, the pre-application of banana stem-derived Liquid Organic Fertilizer (LOF) at various concentrations did not show a substantial effect on the fresh weight of shallot vegetation. Statistical analysis results indicate that the differences between treatments were not significantly different at the level of significance used. Fresh weight is an indicator of the total accumulation of water and organic matter in plant tissues at the time of harvest. Although banana stem POC contains phosphate-solubilizing bacteria (Bacillus sp.), phosphorus is often "bound" in the soil (fixed by aluminum (Al) or iron (Fe) in acidic soils, and by calcium (Ca) in alkaline soils). Siregar et al. (2017) noted that the efficiency of phosphorus uptake from liquid organic fertilizer is often low unless accompanied by growing medium conditions that support the solubility of this element. Hidayat, A., & Rosliani, R. (2018) explained that phosphorus plays a role in cell wall formation and the strengthening of storage tissues in tubers. Insufficient P intake results in suboptimal tuber formation, which statistically reduces the overall fresh weight of the plant. Higher doses may abruptly alter the pH of the root zone, which in turn inhibits microbial activity. Prasetyo et al. (2023) state that the population of phosphate-solubilizing bacteria reaches peak activity at a specific medium concentration. If concentrations are too high, bacterial metabolism can be inhibited by the accumulation of their own organic byproducts.

Putra et al. (2020) state that an imbalance in organic fertilizer dosage can trigger antagonistic interactions among nutrients, which in turn reduces the plant's vegetative growth rate. In plant physiology, increasing fertilizer dosage will only enhance growth up to a certain point. Once the optimum point is reached, further fertilizer application no longer yields a positive response and may even result in a decline. High concentrations create osmotic pressure that inhibits water uptake. Since fresh weight is highly dependent on the water content within the tissues (cell turgor), Septirosya et al. (2019) explain that excessively concentrated liquid fertilizer solutions can damage root hairs and reduce the plant's water-holding capacity, which directly results in low fresh weight at harvest.

CONCLUSIONS

The study's findings demonstrate that the concentration of liquid organic fertilizer (POC) derived from banana stems, as applied, did not have a substantial effect on vegetative growth (including plant height and number of leaves) or the fresh weight of harvested shallots, based on ANOVA test criteria at a significance level of $\alpha = 0.05$ (5%). This lack of effectiveness indicates that the nutrient content of POC, particularly nitrogen and phosphorus, has not been able to optimally meet the plants' physiological needs. Additionally, nutrient imbalances and osmotic effects at high concentrations may actually inhibit nutrient uptake. Consequently, the current dosage and formulation of liquid organic fertilizer (POC) made from banana stems are not yet adequate to serve as the primary nutrient source for boosting the vegetative phase or the productivity of red onions until the concentration and composition are further refined (adjusted)

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