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Banana Peel Liquid Organic Fertilizer Effects on Shallot Growth And Yield**Langimanapa Sofia Demmassabu¹, Jeanne Martje Paulus^{1*}, Paula Clara Heiny Supit¹, Annatje Inkiriwang²**¹Agronomy Study Program, Faculty of Agriculture, Sam Ratulangi University²Agrotechnology Study Program, Faculty of Agriculture, Sam Ratulangi University

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Abstract. Shallot is an important horticultural commodity in Indonesia, and locally available organic residues may provide supplementary materials for crop nutrient management. Banana peels can be processed into liquid organic fertilizer (LOF), but crop responses must be assessed under defined application concentrations. This study evaluated the growth and yield responses of shallot to banana peel LOF and identified the best-performing concentration among the treatments tested. The experiment was conducted in Bahu, Malalayang District, Manado, Indonesia, during April–October 2026. A randomized complete block design comprised five LOF concentration treatments (0, 50, 100, 150, and 200 mL/L), each replicated three times. Plant height, number of bulbs per plant, plant fresh weight, plant air-dried weight, and bulb air-dried weight were evaluated using analysis of variance, followed by a 5% least significant difference test when appropriate. LOF application significantly affected plant height and the three weight parameters but did not significantly affect bulb number. The highest plant height was recorded at 150 mL/L (45.30 cm). The 200 mL/L treatment produced the greatest numerical plant fresh weight (141.52 g), plant air-dried weight (93.24 g), and bulb air-dried weight (84.50 g). However, bulb air-dried weight at 200 mL/L was not significantly different from that at 150 mL/L (83.50 g). Thus, both concentrations showed favorable responses for bulb air-dried weight under the conditions evaluated, without establishing a universally optimal concentration.

Keywords: *Banana peel waste; Bulb air-dried weight; Liquid organic fertilizer; Shallot; Yield response.*

INTRODUCTION

Shallot (*Allium ascalonicum* L.) is an economically important horticultural crop in Indonesia. Improving shallot productivity requires appropriate nutrient management, particularly where soil conditions and cultivation inputs are variable. Recent experimental studies have examined the contribution of organic fertilizers, compost, and combined nutrient sources to shallot growth and yield (Mato et al., 2022; Rasyid et al., 2022; Ruhimat et al., 2023). These findings support the continued evaluation of locally accessible organic inputs rather than assuming that a single fertilizer

strategy performs equally well across growing conditions.

The conversion of organic residues into agricultural inputs is one potential approach to improving the use of locally available resources. Banana peels are a relevant candidate because they contain organic materials and mineral nutrients and can be processed into fertilizer preparations. A recent review summarized several banana-peel fertilizer preparation methods, including liquid formulations, while emphasizing that preparation and application practices can influence plant responses (Khanyile et al., 2024). Nonetheless, the nutrient composition and fertilizer performance of individual



preparations cannot be presumed to be identical.

Liquid organic fertilizer (LOF) prepared from plant residues has been evaluated in several crops. Hariyanti *et al.* (2024) observed a fresh-weight response to banana peel LOF in *Corchorus aestuans*, whereas other measured parameters did not respond significantly. Likewise, Maulidina *et al.* (2025) investigated banana-derived LOF in pakcoy. Research using mixed fruit-waste LOF also reported concentration-dependent growth responses in kailan (Sri Rahayu *et al.*, 2024). Collectively, these findings indicate that crop species, fertilizer formulation, and application levels should be considered when evaluating LOF performance.

Evidence specifically addressing shallots has continued to develop. Triharyanto *et al.* (2022) investigated LOF and shallot yield under different fertilizer combinations. Novianto and Prihatiningrum (2023) studied banana-stem LOF applications, while Aulady *et al.* (2024) evaluated banana-peel LOF in shallot production alongside inorganic fertilizer management. Sa'diah *et al.* (2025) examined growing-media composition and banana-waste-based LOF in another shallot variety. More recently, Ayu *et al.* (2026) investigated LOF together with mulching, and Navitasari and Budianto (2026) evaluated organic and biological fertilizers in shallot cultivation.

Previous research illustrates both the promise and variability of organic inputs. For example, Tuhuteru *et al.* (2023) documented differences among shallot varieties under suboptimal growing conditions, while Ruhimat *et al.* (2023) demonstrated the importance of the composition of organic amendments and the planting medium. Broader evidence also indicates that organic amendments may affect soil microbial functioning and crop outcomes, although such mechanisms require direct measurement

in any individual study (Shu *et al.*, 2022). Consequently, effects reported for one fertilizer formulation or cropping system should not be treated as proof of the same mechanism in another.

Although banana-derived liquid fertilizers have been examined previously, the response across a defined concentration range of banana-peel LOF in the Bima shallot variety under the local growing conditions of Bahu, Manado, remains a practical question. The contribution of this study is a comparison of five concentration treatments using the same cultivation framework and a set of growth and yield-related measurements. Accordingly, this study aimed to evaluate the effects of 0, 50, 100, 150, and 200 mL/L banana peel LOF on shallot growth and yield and to identify the best-performing concentration among those evaluated.

MATERIAL AND METHODS

Study Area and Experimental Materials

The experiment was carried out in Bahu Urban Village, Malalayang District, Manado, North Sulawesi, Indonesia, during April–October 2026. Shallot bulbs of the Bima variety were used as planting material. Other materials included banana peel waste, Effective Microorganisms 4 (EM4), molasses or brown sugar, rice-washing water, soil, rice husk charcoal, manure, NPK Phonska fertilizer, and polybags. Equipment included covered fermentation containers, a sprayer, a digital weighing scale, a ruler, and routine cultivation tools.

Experimental Design

A randomized complete block design (RCBD) was used with five banana peel LOF concentration treatments: P0 (0 mL/L, control), P1 (50 mL/L), P2 (100 mL/L), P3 (150 mL/L), and P4 (200 mL/L). Each treatment was replicated in three blocks, yielding 15 experimental

units. Based on the authors' clarification, each experimental unit comprised approximately three to five polybags containing shallot plants. The blocking approach was intended to accommodate environmental heterogeneity across the study area. The growing medium consisted of soil, rice husk charcoal, and manure at a volumetric ratio of 2:1:1.

Banana Peel LOF Preparation and Crop Management

Banana peels were chopped into smaller pieces and prepared as liquid organic fertilizer using EM4, molasses or brown sugar, and rice-washing water. The preparation was fermented anaerobically in covered containers for approximately 14–21 days. The resulting LOF was applied to the root zone at the designated concentrations. All treatments received the same basal application of NPK Phonska fertilizer before planting. Cultivation included routine watering, weeding, and pest and disease management.

Figure 1 summarizes the fertilizer preparation, treatment levels, experimental structure, and measured endpoints reported in the study.

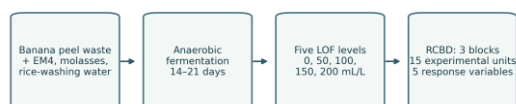


Figure 1. Schematic overview of the reported banana peel LOF preparation and shallot experimental design. The diagram is a conceptual summary, not a reconstruction of actual block positions or treatment randomization.

Observation Parameters and Data Analysis

The measured variables were plant height (cm), number of bulbs per plant, plant fresh weight (g), plant air-dried weight (g), and bulb air-dried weight (g). According to the authors' clarification, plant and bulb samples were air-dried in a

shaded place at ambient temperature for several days until their weights stabilized. The terms “plant air-dried weight” and “bulb air-dried weight” are used throughout to distinguish these measurements from oven-dried mass.

The original study reported analysis of variance (ANOVA) at $\alpha = .05$ for each measured variable. Where the overall treatment effect was significant, treatment means were compared using the least significant difference (LSD) test at $\alpha = .05$.

RESULTS AND DISCUSSION

Results

Plant Height

The reported ANOVA indicated a significant effect of banana peel LOF concentration on shallot plant height (Table 1). The greatest mean height occurred at 150 mL/L (45.30 cm). The 100, 150, and 200 mL/L treatments were statistically comparable, whereas all three differed significantly from the control. The 50 mL/L treatment was not significantly different from the control or the higher concentrations based on the reported LSD letters.

Table 1. Effect of banana peel liquid organic fertilizer on shallot plant height

Treatment	Mean (plant height (cm))	LSD group
P0 (0 mL/L)	37.77	a
P1 (50 mL/L)	41.37	ab
P2 (100 mL/L)	43.03	b
P3 (150 mL/L)	45.30	b
P4 (200 mL/L)	44.07	b
LSD (5%)	4.28	

Note. Means sharing at least one letter are not significantly different according to the LSD test at $\alpha = .05$.

Number of Bulbs per Plant

The concentration treatments did not show a significant effect on the number of bulbs per plant (Table 2). The numerical means ranged from 7.00 bulbs in the control to 9.67 bulbs at 150 mL/L. Because the overall ANOVA was not significant, the original LSD grouping letters have been omitted to avoid implying that an LSD test was performed.

Table 2. Effect of banana peel liquid organic fertilizer on the number of shallot bulbs per plant

Treatment	Mean (number of bulbs per plant)
P0 (0 mL/L)	7.00
P1 (50 mL/L)	9.00
P2 (100 mL/L)	8.33
P3 (150 mL/L)	9.67
P4 (200 mL/L)	9.00

Note. The overall treatment effect was not significant in ANOVA ($\alpha = .05$); the LSD test was not performed.

Plant Fresh Weight

Plant fresh weight differed significantly among the five treatments (Table 3). The means increased across the evaluated concentrations from 61.26 g in the control to 141.52 g at 200 mL/L. The reported LSD grouping indicated that each treatment differed significantly from the others, including the contrast between 150 mL/L (136.47 g) and 200 mL/L (141.52 g).

Table 3. Effect of banana peel liquid organic fertilizer on shallot plant fresh weight

Treatment	Mean (plant fresh weight (g))	LSD group
P0 (0 mL/L)	61.26	a
P1 (50 mL/L)	72.28	b
P2 (100 mL/L)	89.73	c
P3 (150 mL/L)	136.47	d

P4 (200 mL/L)	141.52	e
LSD (5%)	2.46	

Note. Means sharing at least one letter are not significantly different according to the LSD test at $\alpha = .05$.

Plant Air-Dried Weight

The 200 mL/L treatment produced the greatest numerical plant air-dried weight (93.24 g), followed closely by 150 mL/L (92.51 g) (Table 4). These two treatments shared the same LSD group and therefore did not differ significantly. Both had significantly higher means than the 0, 50, and 100 mL/L treatments.

Table 4. Effect of banana peel liquid organic fertilizer on shallot plant air-dried weight

Treatment	Mean (plant air-dried weight (g))	LSD group
P0 (0 mL/L)	35.25	a
P1 (50 mL/L)	43.25	b
P2 (100 mL/L)	62.00	c
P3 (150 mL/L)	92.51	d
P4 (200 mL/L)	93.24	d
LSD (5%)	3.20	

Note. Means sharing at least one letter are not significantly different according to the LSD test at $\alpha = .05$.

Bulb Air-Dried Weight

Bulb air-dried weight showed a significant treatment response (Table 5). The 200 mL/L treatment produced the greatest numerical mean (84.50 g); however, it did not differ significantly from 150 mL/L (83.50 g). Both treatments produced significantly higher bulb air-dried weights than the remaining concentrations. This distinction between numerical ranking and statistical grouping is important when identifying the best-performing treatments.



Table 5. Effect of banana peel liquid organic fertilizer on shallot bulb air-dried weight

Treatment	Mean (bulb air-dried weight (g))	LSD group
P0 (0 mL/L)	30.25	a
P1 (50 mL/L)	35.51	b
P2 (100 mL/L)	53.06	c
P3 (150 mL/L)	83.50	d
P4 (200 mL/L)	84.50	d
LSD (5%)	1.63	

Note. Means sharing at least one letter are not significantly different according to the LSD test at $\alpha = .05$.

The response of bulb air-dried weight across the evaluated LOF concentrations is presented visually in Figure 2. The figure reproduces the reported means and LSD groupings without estimated error bars or additional statistical calculations.

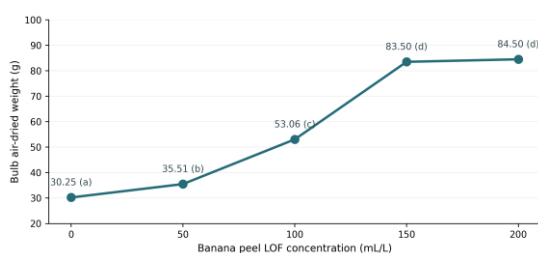


Figure 2. Mean shallot bulb air-dried weight at the five banana peel LOF concentrations. Letters indicate the LSD groupings reported in Table 5 ($\alpha = .05$); points show treatment means only, without error bars.

Discussion

The observed differences in plant height and weight-related variables suggest that banana peel LOF can contribute to shallot performance within the concentration range examined. This pattern is broadly consistent with studies reporting responses to LOF, compost, or related organic inputs in shallot production (Triharyanto *et al.*, 2022; Ruhimat *et al.*, 2023; Ayu *et al.*, 2026). Nevertheless, the direction and size of

fertilizer responses depend on the formulation and cultivation context; results from these studies cannot be compared as equivalent dose-response experiments.

Banana peel LOF has been studied in crops other than shallot, with varying effects across endpoints. For instance, Hariyanti *et al.* (2024) reported a significant fresh-weight response, but not uniformly significant changes in all measured vegetative parameters. Maulidina *et al.* (2025) and Sri Rahayu *et al.* (2024) also described responses to banana-derived or mixed fruit-waste liquid fertilizers in leafy crops. Such variability supports evaluating each response variable separately instead of assuming that a fertilizer concentration affects all growth and yield components in the same way.

The absence of a significant response in bulb number, despite substantial differences in plant and bulb weights, indicates that yield-related changes in this experiment were expressed more clearly through mass measurements than through the number of bulbs. This does not establish the cause of the pattern. In related shallot work, differences in cultivar, organic amendment type, planting medium, and other management factors have been associated with different growth outcomes (Rasyid *et al.*, 2022; Tuhuteru *et al.*, 2023; Sa'diah *et al.*, 2025).

Both 150 and 200 mL/L formed the highest statistical group for bulb air-dried weight and plant air-dried weight. Although 200 mL/L had slightly higher numerical means, the reported LSD test did not establish a difference from 150 mL/L for these parameters. It would therefore be inappropriate to claim that 200 mL/L is a uniquely optimal concentration. Moreover, earlier banana-peel LOF research on shallot involved different fertilizer combinations and control conditions, limiting direct comparison of absolute concentration levels (Aulady *et al.*, 2024).



Banana peels have been described as potential fertilizer raw materials because their mineral and organic composition may support nutrient management (Khanyile et al., 2024). However, the banana peel LOF composition was not chemically analyzed in the present experiment. Consequently, the measured increases in plant and bulb weights cannot be attributed specifically to potassium, nitrogen, phosphorus, or any other individual nutrient. Although wider research has documented connections among organic amendments, soil microbial functioning, and crop productivity (Shu et al., 2022), microbial populations, soil nutrient status, and nutrient uptake were not measured here. Such pathways remain possible explanations, not mechanisms directly demonstrated in this study.

For applied agroecotechnology, the study provides locally observed treatment-response evidence concerning a banana-peel-derived fertilizer used alongside a common basal fertilizer. The similarly high bulb air-dried weights at 150 and 200 mL/L indicate that both concentrations warrant consideration under comparable experimental conditions. Practical recommendations regarding input efficiency, fertilizer substitution, or wider field adoption would require verified application quantities, fertilizer composition, and further evaluation across cultivation settings. Navitasari and Budianto (2026) likewise illustrate that changes in fertilizer sources do not invariably lead to significant yield differences, underscoring the importance of evidence-based recommendations.

CONCLUSION

Within the concentrations evaluated, banana peel liquid organic fertilizer significantly affected shallot plant height, plant fresh weight, plant air-dried weight, and bulb air-dried weight, but did not significantly affect the number of bulbs

per plant. The 150 mL/L treatment produced the highest plant height (45.30 cm), while 200 mL/L produced the highest numerical bulb air-dried weight (84.50 g). However, bulb air-dried weight at 200 mL/L was not significantly different from the value at 150 mL/L (83.50 g). Thus, 150 and 200 mL/L were the best-performing tested concentrations for bulb air-dried weight under the reported conditions. Their practical efficiency and generalizability require further evaluation.

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