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EFFECTS OF CHICKEN MANURE AND MUNG BEAN SPROUT EXTRACT ON GROWTH AND YIELD OF SHALLOTS (*ALLIUM CEPA* VAR. AGGREGATUM) FROM TRUE SHALLOT SEED

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ABSTRACT

The high cost of conventional inputs and soil degradation challenges in shallot cultivation have driven the search for effective organic alternatives, such as chicken manure and plant-based biostimulants like sprout extract. This study aimed to evaluate the effects of chicken manure and sprout extract on the growth and yield of shallots (*Allium cepa* var. aggregatum) derived from True Shallot Seed (TSS). The experiment was conducted from July to November 2024 in Karanganyar, Central Java, Indonesia, using a Randomized Complete Block Design (RCBD) with two factors: chicken manure dosage (0, 15, 30, and 45 tons ha^{-1}) and sprout extract concentration (0, 20, and 40 mL L^{-1}). Chicken manure application significantly improved the vegetative growth of shallots, with optimal results observed at 10–30 tons ha^{-1}. Conversely, mung bean sprout extract showed no marked influence on plant development or final yield, and no interactive effects between the two treatments were detected. Although the direct yield enhancement from chicken manure was moderate, with a 5–6% increase, it substantially boosted soil fertility and plant health. This study confirms that chicken manure is a valuable organic input for sustainable shallot cultivation, whereas the efficacy of the sprout extract as a biostimulant remains unconfirmed under the tested conditions. These findings underscore the efficacy of chicken manure as a soil amendment for sustainable shallot production, while highlighting the need for further optimization of sprout extract formulation and application timing to leverage its full potential as a biostimulant.

Keywords: shallot, True Shallot Seed, chicken manure, sprout extract, organic fertilizer, plant growth regulator

INTRODUCTION

Shallots (*Allium cepa* var. aggregatum) represent a crucial horticultural crop in Indonesia, valued for their distinctive flavor and aroma in culinary applications, food processing, and traditional medicine. National demand continues to escalate with population growth. Statistics (BPS, 2023) indicate that while production reached 1.985 million tons in 2023, domestic household consumption was 797.32 thousand tons. Although productivity has slightly increased to 10.74 tons ha^{-1}, this remains substantially below the potential yield of over 20 tons ha^{-1}, highlighting an urgent need for improved cultivation technologies.

A primary constraint is the prevalent use of low-quality planting material. Farmers typically rely on bulbs that often carry viral or bacterial pathogens. The Indonesian Vegetable Research Institute (Gunaeni et al., 2021) reported viral infections in more than 90% of shallot crops in Brebes, causing significant yield decline.

True Shallot Seed (TSS) offers a promising solution, being free from bulb-borne diseases and capable of producing healthier plants with superior bulb size and yield (Rosliani et al., 2015). Nevertheless, TSS adoption remains limited in Indonesia, hindered by insufficient technical guidance and farmer inexperience with the technology (Sahara et al., 2021). Nutrient management presents another major challenge. Excessive dependence on chemical fertilizers has led to soil acidification and degradation (Zhang et al., 2024).

Organic alternatives like chicken manure can enhance soil structure, stimulate microbial activity, and supply essential nutrients (He et al., 2025). Notably, chicken manure possesses higher concentrations of N, P, and K compared to other animal manures (Adekiya et al., 2020). Furthermore, shallots derived from TSS frequently exhibit slower initial growth due to limited endogenous hormone reserves (Sudaryono & Prahardini, 2021). Natural biostimulants such as sprout extract contain phytohormones (auxin, gibberellin, cytokinin) known to enhance root development and bulb formation (Jing et al., 2023)

While the individual benefits of organic fertilizers and biostimulants are recognized, their combined effect on TSS-derived shallots remains inadequately explored. Therefore, this study aimed to: (1) evaluate the individual and interactive effects of chicken manure and mung bean sprout extract on the growth and yield of TSS-derived shallots, and (2) determine the optimal dosage and concentration for enhancing productivity.

MATERIALS AND METHODS

Experimental Site and Conditions

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The experiment was conducted from July to November 2024 in Ngringo Village, Jaten District, Karanganyar, Central Java, Indonesia (7°32’59.3” S, 110°52’07.9” E; altitude 119.6 m). The soil was classified as *Grumosol* with low organic matter and macronutrient levels (N = 0.09%, P = 0.15%, K = 0.06%, C-organic = 1.14%, pH = 7.28). Climatic conditions included average temperatures of 25–34°C and relative humidity of 38–85%.

Experimental Design

The study was arranged in a Randomized Complete Block Design (RCBD) with a factorial treatment structure. The factors were factor 1: Chicken manure dosage (P_0 = 0, P_1 = 15, P_2 = 30, P_3 = 45 tons ha^{-1}) and factor 2: Bean sprout extract concentration (E_0 = 0, E_1 = 20, E_2 = 40 mL L^{-1}). This resulted in 12 treatment combinations with 36 experimental units.

Fertilizer and Extract Preparation

Chicken manure was analyzed for nutrient composition (N = 4.55%, P_2O_5 = 3.38%, K_2O = 6.39%, C-organic = 42.22%, pH = 8.12). Sprout extract was prepared by blending 250 g of sprouts in 250 mL of distilled water, filtered, and diluted to 1 L. The extract was applied at a rate of 2 mL per plant during each application at 15, 30, and 45 days after transplanting.

Crop Management and Observations

Seedlings were grown from TSS of the Sanren variety and transplanted 40 days after sowing into plots spaced 15 cm × 10 cm. Standard cultural practices—irrigation, weeding, and pest management—were maintained. Parameters observed were plant growth: plant height, leaf number, shoot fresh and dry weight and yield: bulb number, bulb diameter, fresh bulb weight, dry bulb weight, yield per hectare.

Statistical Analysis

Data were analyzed using ANOVA (5% significance level). Orthogonal polynomial were used to determine the linear and quadratic responses of shallot growth to increasing rates of chicken manure and sprout extract concentration.

RESULTS AND DISCUSSION

Environmental and Soil Conditions

During the experimental period (September–November 2024), environmental factors deviated from the optimal conditions for shallot cultivation. Average temperatures ranged from 24.8–34.2°C, slightly exceeding the ideal 25–32°C range, which can accelerate respiration and reduce photosynthetic efficiency. Relative humidity fluctuated widely (38–85%). The study period (September–November 2024) coincided with the onset of the rainy season, which began in late

September 2024 in Central Java (BMKG, 2024a). Total rainfall was relatively high (133–243 mm month^{-1}), and importantly, meteorological reports (BMKG) confirmed warnings for extreme weather including moderate to heavy rainfall events in the Karanganyar region during the initial plant growth and extract application period (e.g., September 23–25, 2024) (BMKG, 2024b). These conditions are known to promote foliar diseases and significant nutrient leaching. Moreover, the Grumosol soil used in this study exhibited low fertility, with very low N (0.09%), P (0.15%), and K (0.06%) levels, and only 1.14% organic C. Such constraints underscore the importance of organic amendments to restore soil structure, enhance microbial activity, and improve nutrient availability (Mulatu & Bayata, 2024).

The results of the analysis of variance (ANOVA) showed that the application of chicken manure significantly affected plant height, shoot fresh weight, and shoot dry weight of shallots while the mung bean sprout extract (used as a natural plant growth regulator, PGR) and their interaction had no significant effect on most parameters (Table 1).

Table 1: ANOVA summary of shallot growth and yield under manure dose and sprout extract concentration treatments

Parameter	F-calc (5%)		
	Chicken Manure Dose (P)	Sprout extract Concentration (E)	Interaction
Plant height	3.507*	0.370 ns	0.207 ns
Number of leaves	2.079 ns	0.136 ns	0.68 ns
Number of bulbs	0.414 ns	2.250 ns	0.227 ns
Bulb diameter	0.410 ns	0.783 ns	0.257 ns
Shoot fresh weight	4.929*	2.850 ns	0.845 ns
Shoot dry weight	4.858*	3.025 ns	0.697 ns
Fresh bulb weight	0.160 ns	2.419 ns	0.169 ns
Dry bulb weight	0.230 ns	1.080 ns	0.296 ns
Dry bulb weight per hectare	0.230 ns	1.082 ns	0.296 ns

Note: *= significant effect ($p < 0.05$); ns = not significant; P × E = interaction between chicken manure dose and sprout extract concentration

The significant response of vegetative growth to chicken manure application indicates that nutrient availability, particularly nitrogen (N), phosphorus (P), and potassium (K), increased in the soil, improving chlorophyll formation and photosynthetic activity. This finding aligns with Ning et al. (2022), who reported that substituting mineral N with chicken manure enhanced nitrogen recovery and crop yield due to gradual nutrient release and improved soil structure. Similarly, Agbede &

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Oyewumi (2023) observed that poultry manure improved shoot biomass and nutrient composition in sweet potato, primarily through enhanced microbial activity and cation exchange capacity.

Plant height and leaf number increased with higher doses of chicken manure, confirming the essential role of organic amendments in improving soil fertility and plant vigor. Chicken manure contains easily mineralizable organic matter, which improves soil aeration and water-holding capacity, thereby promoting better root proliferation and nutrient uptake (Agbede, 2025). However, the positive response was not linear across all parameters; biomass and height gains tended to plateau at higher manure doses (Figure 1), suggesting a threshold of nutrient utilization. Over-application of manure can result in nutrient imbalance or salinity effects that suppress further growth (Agbede, 2025). Thus, the observed optimum response around 30 t ha^{-1} corresponds with earlier findings that excessive organic input may not proportionally enhance vegetative growth and could increase nutrient loss risks.

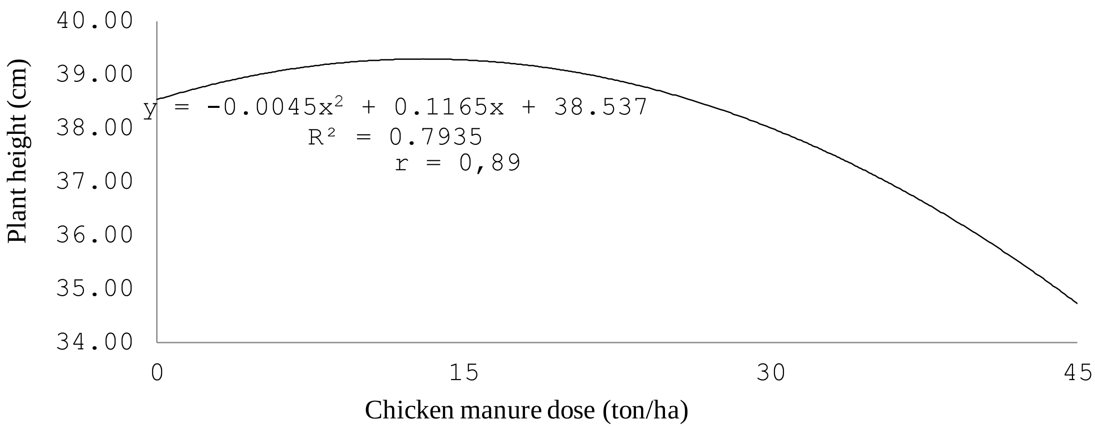

Figure 1: Shallot plant height under different chicken manure doses.

Although the mung bean sprout extract (MBSE) treatment showed a slight increase in growth parameters, the effect was statistically insignificant (Figure 2). While the specific hormonal profile of the extract used in this study was not analyzed (a limitation of this research), previous studies have confirmed that mung bean (*Vigna radiata*) sprout extract is a rich source of phytohormones. These include significant levels of auxins (e.g., IAA), gibberellins (e.g., GA_3), and cytokinins (e.g., kinetin and zeatin) (Putra et al., 2022; Sari & Sipayung, 2021). The limited efficacy observed in our experiment, therefore, likely stems not from a lack of active compounds, but from their instability under field conditions. This supports our original hypothesis that these phytohormones degrade rapidly under high light intensity or temperature (Wu et al., 2016; Castroverde& Dina 2021), as compounds like auxin are known to be highly sensitive to photodegradation (Hasan et al., 2023).

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Furthermore, the timing and frequency of foliar applications play a critical role in determining the physiological response. Kessy et al. (2024) demonstrated that repeated low-concentration applications of plant extracts were more effective than single, high-dose sprays, suggesting that the application method in this study might not have been optimal for sustained hormone absorption (Sun et al., 2024). Environmental conditions during the experiment strongly support this hypothesis. High rainfall (133–243 mm month^{-1}) was recorded, and more specifically, official BMKG warnings confirmed moderate to heavy rainfall events in Karanganyar precisely during the initial foliar application windows (e.g., late September 2024) (BMKG, 2024b). This high-intensity rainfall likely washed off the active phytohormone compounds before they could be adequately absorbed by the leaves (Behrens & Elakkad, 1981; Pérez-Rodríguez et al., 2017). Furthermore, this study did not measure *in-situ* soil moisture dynamics, which is a limitation. The combination of heavy rainfall events on Grumosol soil could have led to periods of excessive soil saturation (anaerobic conditions) affecting root health, thereby potentially masking any subtle positive effects from the biostimulant. Future research should integrate soil moisture monitoring to better model these complex environmental interactions.

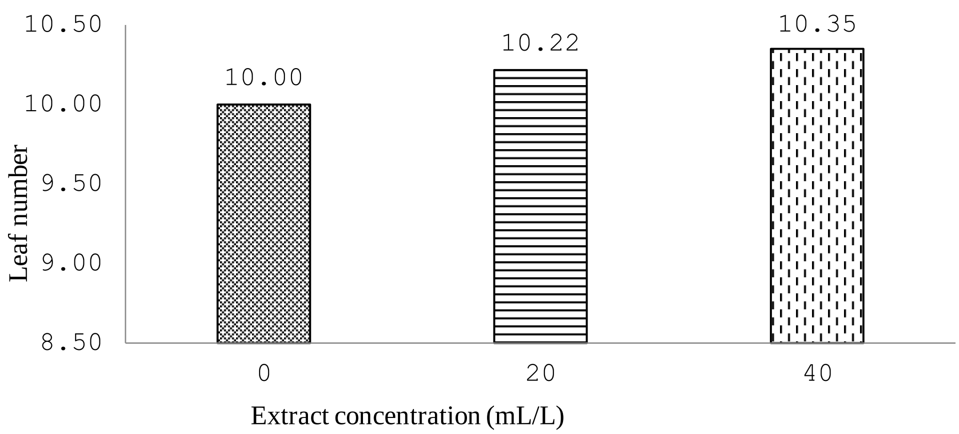

Figure 2: Number of shallot leaves at at several extract concentration

Both shoot fresh and dry weights significantly increased with rising manure doses up to 30 tons ha^{-1} (Figure 3 and 4), highlighting the role of organic matter in enhancing soil fertility and root function. Organic inputs improve soil porosity, stimulate beneficial microbes, and facilitate nutrient mineralization, all of which contribute to higher photosynthetic capacity (Ning et al., 2022). These findings corroborate results by Peng et al., (2023), who reported increased microbial biomass and aggregate stability following integrated organic fertilization in allium crops. Conversely, the absence of response to sprout extract likely resulted from adverse field conditions—particularly rainfall soon after foliar application—which could have washed away hormonal compounds

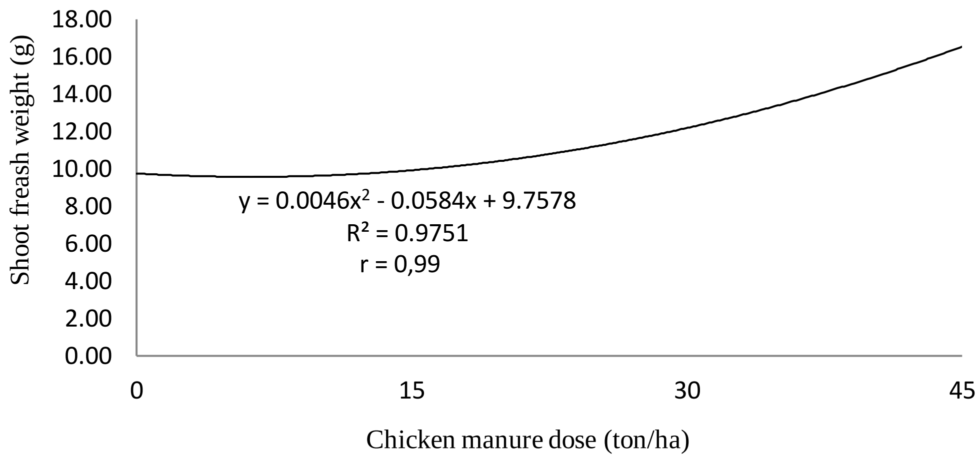

Figure 3: Shallot shoot fresh weight at several doses of chicken manure.

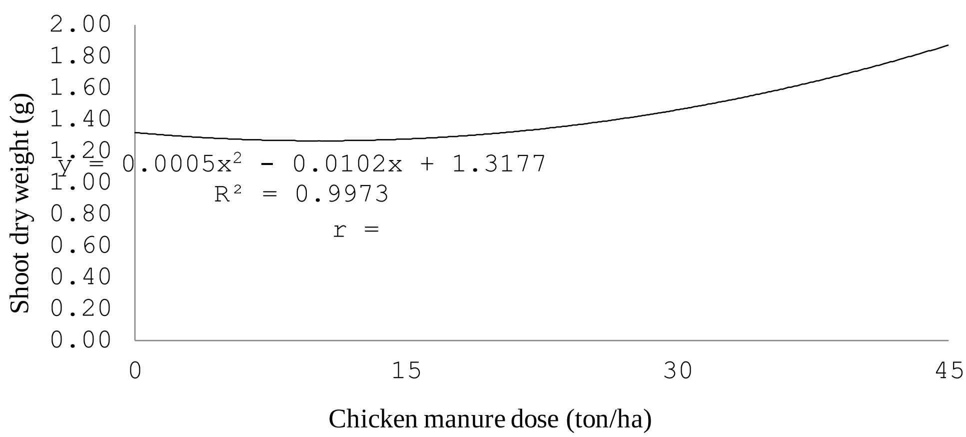

Figure 4: Shallot shoot dry weight at several doses of chicken manure.

Yield components such as bulb number, bulb diameter, and dry bulb weight were not significantly affected by either chicken manure dose or MBSE concentration (Figure 5, 6, 7, 8, 9, 10, 11 and 12). While vegetative growth improved, the transition to reproductive development (bulb formation) is more sensitive to photoperiod, temperature, and soil water balance than to moderate variations in nutrient availability. Previous studies have noted that shallot yield formation depends heavily on genotype–environment interaction rather than on nutrient supply alone (Galingging & Bhermana, 2020). The relatively stable yield parameters observed here suggest that the growth-promoting effects of manure and PGRs primarily enhance vegetative traits but do not always translate into higher bulb yield under suboptimal environmental conditions.

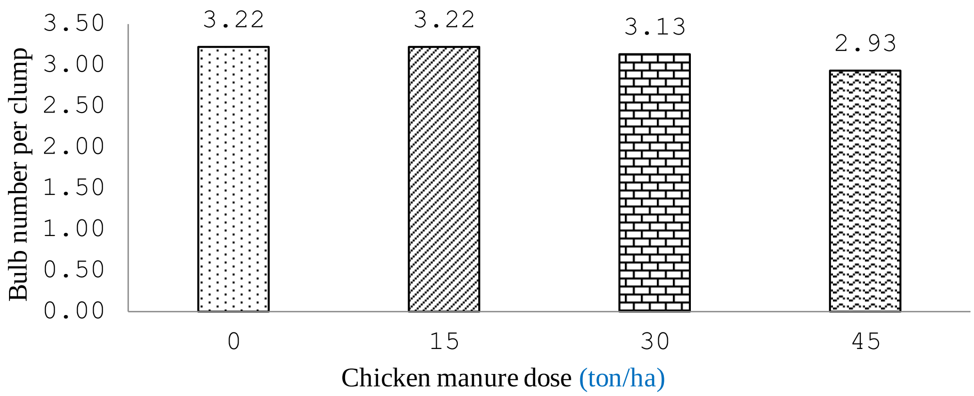

Figure 5: Shallot bulb number at several doses of chicken manure.

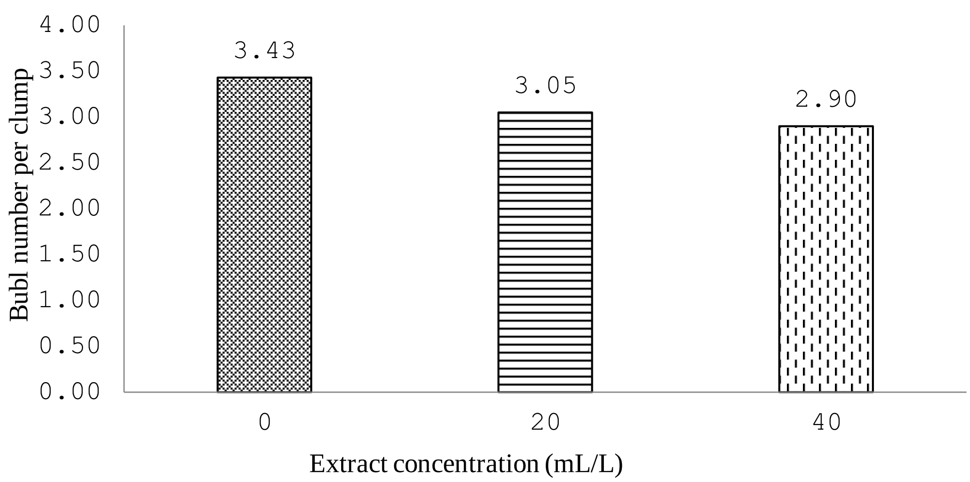

Figure 6: Shallot bulbs number at several extract concentrations.

Neither chicken manure nor sprout extract significantly influenced bulb number or diameter (Figures 5, 6, 7 and 8). The average of 2–4 bulbs per clump corresponded to the genetic potential of the Sanren variety. Slightly larger bulbs in manure-treated plots indicate improved carbohydrate allocation under enhanced soil fertility. However, the generally small bulb size may have been affected by high soil pH (7.28), which limits P and K availability critical for bulb filling.

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Figure 7: Shallot bulbs diameter at several doses of chicken manure.

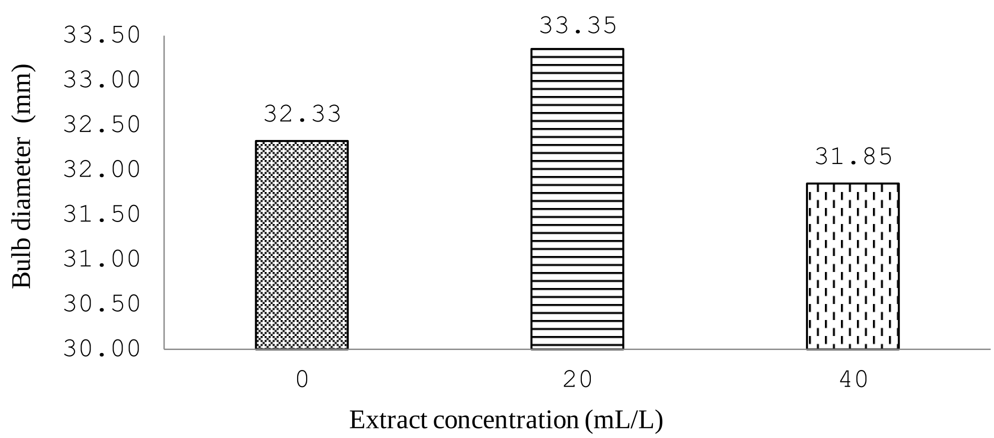

Figure 8: Shallot bulbs diameter at several extract concentration.

Although the highest bulb weight was obtained at 30 tons ha^{-1}, differences among treatments were not statistically significant. This pattern implies that moderate organic inputs can sustain bulb formation without excessive nutrient accumulation. However, the relatively high C/N ratio of the manure could have temporarily immobilized nitrogen, reducing its immediate availability for bulb growth (Lang et al., 2025). Similarly, the sprout extract showed no notable effect, likely due to hormonal instability—phytohormones such as auxins and gibberellins in plant extracts degrade rapidly under light and heat exposure (Bawa et al., 2020). Supra-optimal concentrations can also disrupt hormonal balance, inhibiting bulb formation rather than promoting it.

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Figure 9: Shallot bulbs fresh weight at several chicken manure dosage

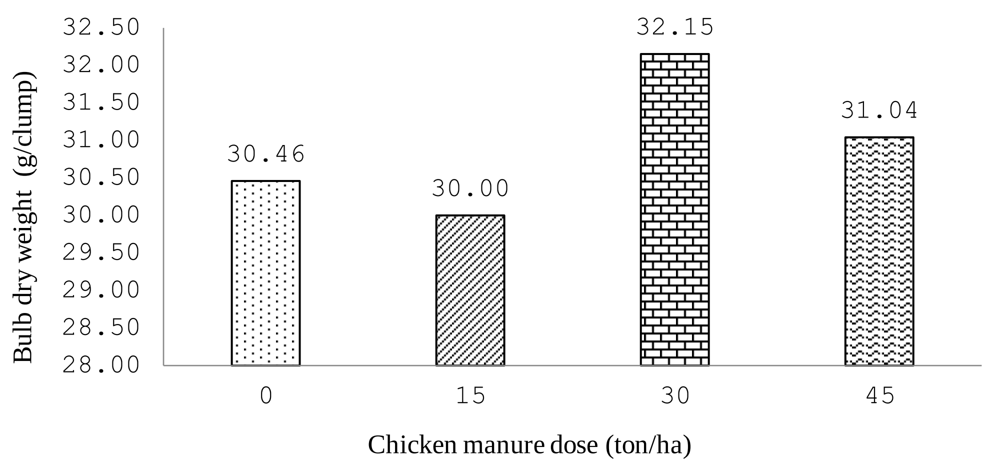

Figure 10: Shallot bulbs dry weight at several chicken manure dosage

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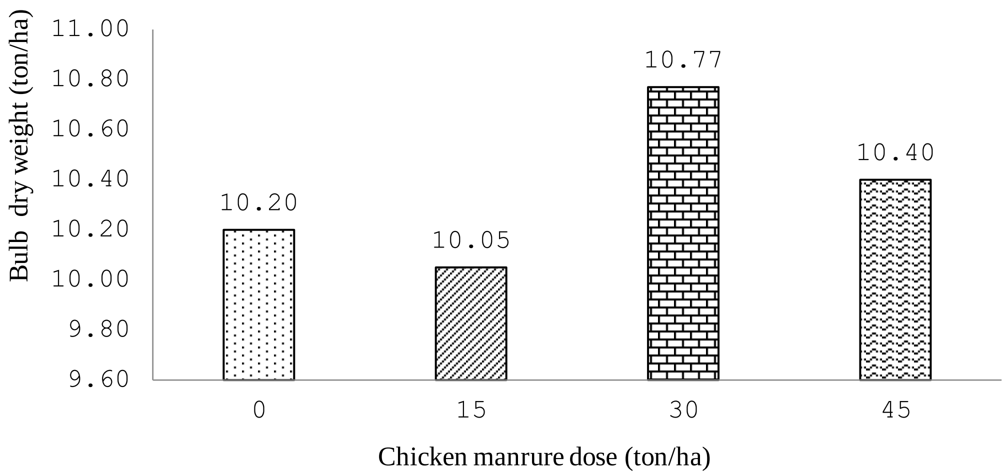

Figure 11: Shallot bulbs dry weight per hectare at several chicken manure dosage

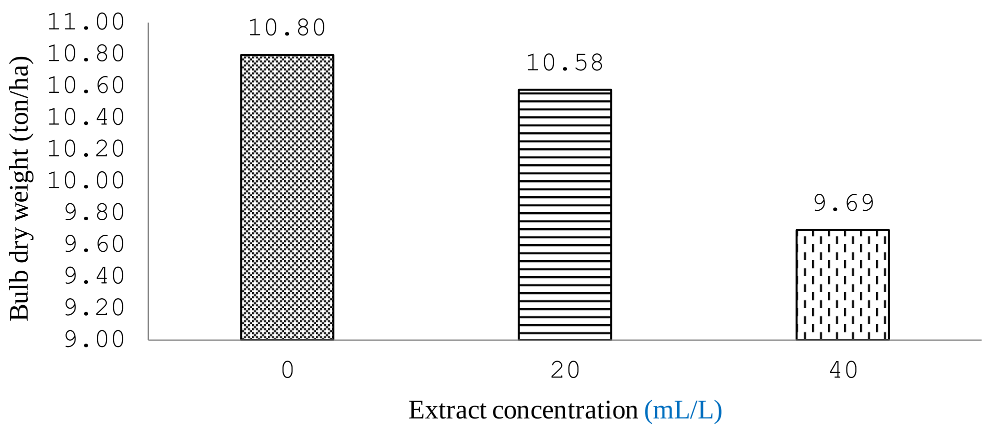

Figure 12: Shallot bulbs dry weight per hectare at several extract concentration

Plots treated with 30 tons ha^{-1} of chicken manure achieved 5.0–5.6% higher yields than the control, a non-significant yet positive trend indicating improved soil health and yield stability. The improvements in soil microbial activity and structure underpin long-term sustainability and resilience of the production system (Yu et al., 2022). Meanwhile, the limited response to sprout extract suggests that formulation, concentration, and timing require further refinement. Repeated low-dose applications or the addition of adjuvants to reduce photodegradation may enhance efficacy under open-field conditions (Martínez-Lorente et al., 2024).

No significant interaction (P × E) was detected between manure dose and sprout extract concentration for any measured variable. This indicates that both factors acted independently on plant growth. The lack of synergistic effect could be attributed to the sufficient nutrient supply from chicken manure, rendering additional hormonal stimulation redundant. Similar findings were reported by Pagliarini et al. (2024), who found that once optimal soil fertility was achieved through

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organic amendment, the incremental benefits of biostimulant application diminished. Nevertheless, such combinations may still enhance yield quality traits, such as total soluble solids or antioxidant activity, in subsequent trials with optimized timing and formulation of plant-based extracts.

Overall, the results suggest that chicken manure application effectively promotes vegetative growth of shallots by improving soil fertility and plant nutrient uptake, while mung bean sprout extract at the tested concentrations and application frequency did not produce significant physiological effects. For future research, it is recommended to investigate the efficacy of lower concentrations of mung bean sprout extract applied at higher frequencies, or in combination with adjuvants to reduce photodegradation, under more controlled environmental conditions.

Economic Viability and Practical Implications

To evaluate the financial feasibility of the tested cultivation practices, a cost-benefit analysis was conducted. This analysis calculated the *Revenue/Cost (R/C) Ratio* for the treatment representing the research findings (P_2: 30 tons ha^{-1} of manure and E_1: 20 mL L^{-1} of bean sprout extract). Details of the production cost (input), revenue (output), and income components are presented in Table 2.

Table 2: Cost Components of Shallot Farming per Harvest per Hectare

Farming Cost Components	unit	Total price ($)
Urea fertilizer 2 sacks @ 50 kg	bag	$ 47.65
K2O fertilizer 2 sacks @ 50 kg	bag	$ 48.87
Chicken manure 600 sacks @ 50 kg	bag	$ 733.05
Bean sprouts 5 kg	kg	$ 15.27
Pesticides	package	$ 458.16
Labor	package	$ 733.05
Sanren TRUE SHALLOT seeds, 1 kg	kg	$ 244.35
Biosolar for water pump, 300 liters	liter	$ 119.12
Land rent 1 ha/year	ha	$ 458.16
Depreciation of agricultural machinery/year	package	$ 244.35
Red onion farming costs/season/ha		**$ 3,102.02**

Yield per harvest per hectare		
Red onion yield 10.58 tons/ha		
Average price of red onions in June 2025	$ 16.37	
Revenue from red onion sales		**$ 16,127.06**

Description	Amount ($)

Total Revenue	$	**16,127.06**
Total Expenses	$	**3,102.02**
Income	$	**13,025.05**

Based on the analysis in Table 2, the total production cost per hectare per growing season is \$3,102.02, while the total revenue from the estimated harvest (10.58 tons/ha) reaches \$16,127.06. This results in a net income of \$13,025.05. The main financial feasibility indicator, the Revenue/Cost (R/C) Ratio, was recorded at 4.2. An R/C Ratio value that is substantially greater than 1 (R/C > 1) indicates that the TSS shallot cultivation system with an input of 30 tons ha^{-1} of manure is highly feasible and economically profitable. This finding provides crucial practical context to the agronomic results of the study. Although the application of 30 tons ha^{-1} of manure did not result in a statistically significant increase in yield compared to other treatments (Table 1), this economic analysis confirms that the level of production achieved (10.58 tons/ha) is already highly profitable. This reinforces the argument that the use of high doses of organic fertilizer not only serves as a long-term investment in soil fertility, but is also an integral component of cultivation practices that are proven to be financially robust.

CONCLUSION AND RECOMMENDATIONS

This study concludes that chicken manure significantly increases the vegetative growth of TSS shallots, confirming it as a fundamental input for sustainable production and long-term soil fertility improvement. However, these vegetative benefits did not translate into increased bulb yield, a disconnect likely caused by high soil pH (7.28) which immobilized phosphorus (P) and potassium (K), crucial for bulb filling. Conversely, bean sprout extract at the tested concentration did not produce a significant effect, likely due to the degradation of phytohormones and leaching by heavy rainfall. Therefore, we recommend that farmers adopt manure as a long-term soil improvement investment to reduce dependence on chemical fertilizers, with a dose of 15 tons ha^{-1} offering the best economic compromise between input costs and soil improvement benefits. The use of bean sprout extract with the methods and concentrations tested in this study is not recommended.

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