





VARIETAL ADAPTATION AND PERFORMANCE OF SHALLOT UNDER FLOATING CULTIVATION WITH CHICKEN MANURE APPLICATION IN TROPICAL LOWLAND WETLANDS

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Abstract

Shallot (*Allium ascalonicum* L.) can be cultivated across a wide range of altitudes, from lowlands to highlands; however, production in Indonesia is predominantly conducted on dryland areas. In response to the national program promoting shallot production expansion outside Java, the development of shallot cultivation in South Sumatra faces challenges due to extensive wetland conditions. Floating cultivation systems offer a potential alternative for optimizing wetland utilization. This study aimed to evaluate the adaptability and performance of several shallot varieties under floating cultivation with different rates of chicken manure application. Plant analysis was carried out at the Plant Physiology Laboratory, and the experiment was carried out from June to August 2024 at the Embung (research reservoir) and Experimental Garden, Faculty of Agriculture, Sriwijaya University, Indralaya. A randomized block design with two factors and three replications was applied. The first factor consisted of four shallot varieties (Tajuk, Bauji, Batu Ijo, and Bima Brebes), while the second factor involved chicken manure rates of 0, 10, 20, and 30 t ha⁻¹. Data were analyzed using RStudio and presented in tables and figures. The results showed that the Bauji variety exhibited superior growth and yield compared to the other varieties. Increasing chicken manure application up to 20 t ha⁻¹ significantly improved shallot growth and productivity. It can be concluded that the Bauji variety, combined with 10 t ha⁻¹ chicken manure, is suitable for cultivation using a floating system in tropical wetlands.

Keywords: Bulb, Extensification, Variety, Yield



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INTRODUCTION

Shallot (*Allium ascalonicum* L.) is one of the most important horticultural commodities in Indonesia, contributing substantially to food supply, farmers' income, and the national agricultural economy. Increasing population growth has led to a continuous rise in shallot demand, which must be balanced by efforts to enhance domestic production capacity. Expansion of harvested area remains a key

factor influencing shallot availability and market supply (Mas'ud & Wahyuningsih, 2023; Wibowo & Surbakti, 2023; Dewi et al., 2024).

In addition to its essential role as a culinary spice in both household and food industries, shallot also possesses medicinal value. This crop can be cultivated across a wide range of agroecological zones, from lowlands to highlands up to approximately 1000 m above sea level, with optimal growth generally occurring at altitudes of 0–450 m above sea level (Sutrisno, 2015). In Indonesia, shallot production is predominantly carried out on drylands during the dry season, while cultivation during the rainy season is limited due to high disease incidence. Recently, water scarcity during certain growing periods has emerged as an additional constraint affecting shallot productivity.

To support national production targets, the Indonesian government initiated a program in 2019 to develop shallot production centers outside Java. South Sumatra remains one of the provinces that still depends on supply from other regions. Efforts to develop shallot cultivation in this area can be approached through both intensification and extensification strategies. Several studies related to intensified cultivation practices have been conducted (Kurnianingsih et al., 2018; Susilawati et al., 2018; Susilawati et al., 2022). However, extensification is challenged by the dominance of suboptimal wetland ecosystems, particularly in Ogan Ilir Regency, where Sriwijaya University is located. Previous research on crop varieties under wetland conditions has shown that certain cultivars exhibit higher tolerance to inundation, as demonstrated by the superior agronomic performance of Kiyu F1 chili under flooded environments (Susilawati et al., 2012a; 2012b).

In recent years, Ogan Ilir Regency has shown increasing potential for shallot production development. Cultivation can be implemented using both conventional methods and floating cultivation systems. Previous studies indicate that shallot has promising prospects under floating systems, which maintain continuous water availability beneath the planting medium and help prevent water stress (Susilawati et al., 2024; Idly et al., 2023). Water level beneath the planting media has been reported to significantly influence root development and overall plant growth in various vegetable crops (Susilawati & Lakitan, 2019; Susilawati et al., 2019; Susilawati et al., 2021; Susilawati et al., 2022a; Susilawati et al., 2022b; Muhammad et al., 2023). Moreover, varietal differences strongly determine plant responses to environmental conditions (Askari-Khorasgani & Pessarakli, 2020). Therefore, research is needed to identify shallot varieties that are adaptive to wetland environments using floating cultivation systems.

RESEARCH METHOD

The study was conducted in two locations: the Experimental Garden, Faculty of Agriculture, Sriwijaya University, Indralaya, Ogan Ilir, at coordinates 3°13'29.74" South Latitude and 104°38'13" East Longitude, and the Embung (research reservoir), at coordinates 003°13'16" South Latitude and 104°39'03" East Longitude. The Plant Physiology Laboratory at Sriwijaya University's Faculty of Agriculture conducted the plant analysis. The research was conducted between June and August of 2024.

This study employed a randomized block design with three replicates and two factors as its experimental design. The first factor is variety, which includes Tajuk, Bauji, Batu Ijo, and Bima Brebes. The second factor is fertilizer made from chicken dung, with P0 = 0 tons/hectare, P1 = 10 tons/hectare, P2 = 20 tons/hectare, and P3 = 30 tons/hectare. R-studio software was used to analyze the data, which was then presented as tables and figures.

Planting material preparation: Select bulbs of relatively similar size and cut off 1/3 of the tip. The next step is planting; insert the bulbs into planting holes 2-3 cm deep, planting with the bulb cut side up above the surface of the growing medium. Fertilization is based on treatment; inorganic fertilizers consist of urea at a dose of 0.3 g/polybag, KCl at a dose of 0.3 g/polybag, and ZK fertilizer at a dose of 0.75 g/polybag, sprinkled around the plants 7 and 25 days after planting.

Leaf length (cm), number of leaves, number of tillers, leaf chlorophyll index, leaf chlorophyll content, bulb diameter per plant, number of bulbs per plant, fresh weight of bulbs per plant, dry weight of roots per plant, and estimated production per hectare were all measured. Tables and figures exhibit data that was processed using R-studio software.

RESULTS AND DISCUSSION

A. LEAF CHARACTER

Plant height (cm)

Floating cultivation in wetlands has not yet been commonly applied to shallot (*Allium ascalonicum* L.), which is usually grown in dry land during the dry season (in season). However, this conventional system often faces constraints due to water shortages. Therefore, floating cultivation emerges as a potential alternative because it can continuously provide water (Siaga et al., 2018; Susilawati et al., 2021). Weather data indicate that during the period from June to August, significant changes in climatic conditions occurred. Air temperature gradually decreased from 30.25°C in June to 29.03°C in July and 28.24°C in August. Relative humidity increased from 76.20% in June to 79.25% in July, then sharply declined to 63.19% in August. Meanwhile, rainfall showed a drastic reduction, from 478.03 mm in June to 8.01 mm in July, and no rainfall at all in August. Overall, the weather conditions during the study transitioned from wet to drier conditions (Table 1).

Table 1. Weather conditions during research period

Weather	Month		
	June	July	August
Temperature (oC)	30.25	29.03	28.24
Humidity Relative (%)	76.20	79.25	63.19
Rainfall (mm)	478.03	8.01	0.00

Source: Meteorology, Climatology and Geophysics Agency of South Sumatra, 2024

Research findings on several shallot (*Allium ascalonicum* L.) varieties cultivated in lowland wetlands using floating systems with chicken manure fertilizer revealed significant effects on growth and yield. Differences in plant height responses among varieties were observed, influenced by genetic factors and adaptation to the floating system. Peak growth occurred in the third week, after which plants entered either a stable or declining phase. The Tajuk variety demonstrated superior early growth performance, while Batu Ijo maintained more stable growth until the end (Arifah et al., 2024; Romo-Pérez et al., 2026). Application of chicken manure fertilizer did not consistently enhance plant height; in fact, at certain doses (20 tons/ha), growth was reduced. The floating system ensured optimal water availability, making additional fertilizer inputs more efficient (Figure 1A & 1B).

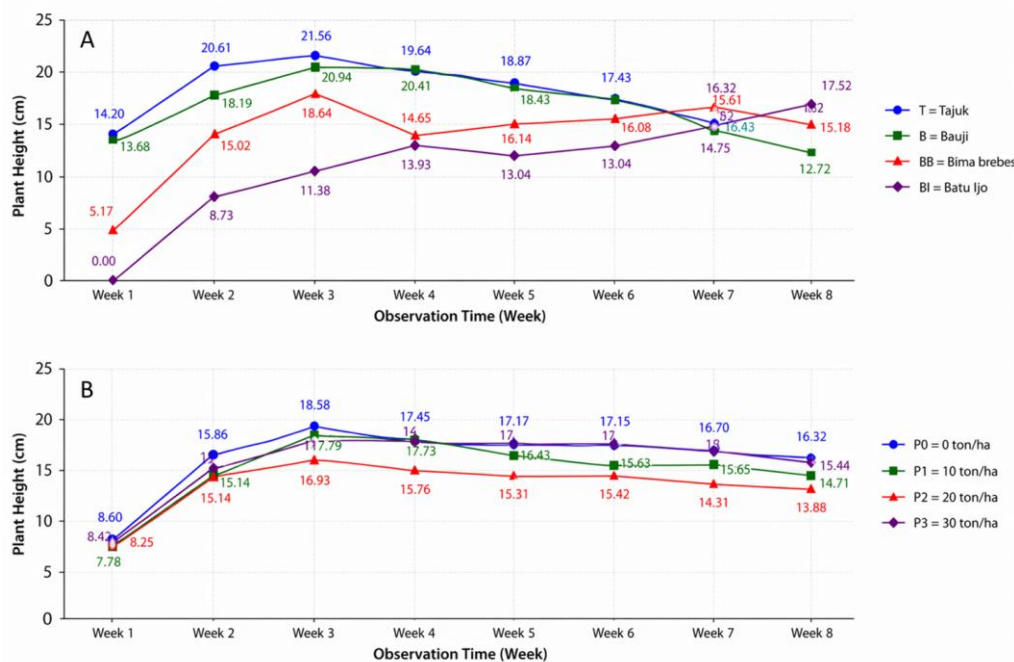


Figure 1. Plant height based on shallot variety (1A) and chicken manure fertilizer treatment (P₀=0 tons/ha; P₁=10 tons/ha; P₂=20 tons/ha; P₃=30 tons/ha) (1B)

Genetic factors, climate, and environmental conditions can influence plant growth and biomass allocation. The combination of shallot varieties and chicken manure doses in floating cultivation is strongly affected by these three factors (Figure 2) (Wang et al., 2019; Chen et al., 2023; Maida et al., 2024; Ali et al., 2025).

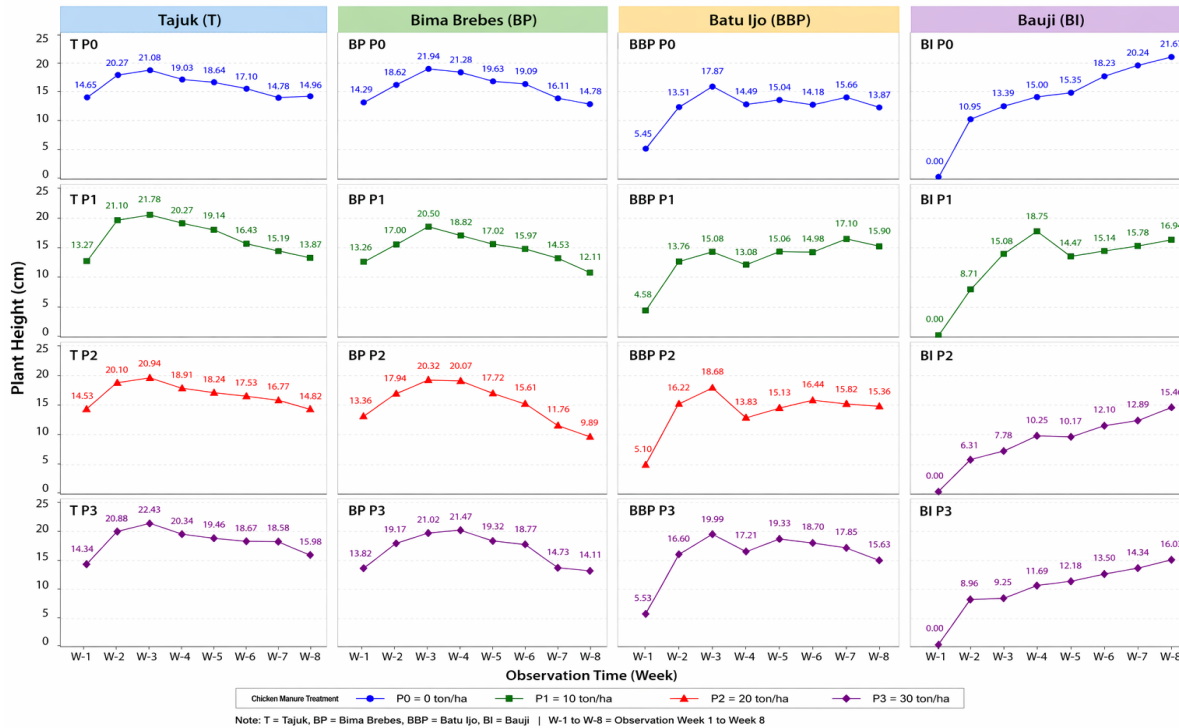


Figure 2. Plant height based on the combination of shallot varieties (Tajuk; Bauji; Bima Brebes; Batu Ijo) and chicken manure fertilizer treatment (P₀=0 tons/ha; P₁=10 tons/ha; P₂=20 tons/ha; P₃=30 tons/ha)

Number of leaves

The growth characteristics of shallots can be determined by the number of leaves formed. The use of bulbs as planting material for shallots is more effective than using seeds (Purba et al., 2020). The four varieties used had different bulb weights, ranging from 5-12 grams for Tajuk, 6-10 grams for Bauji, 2.5-4 grams for Bima Brebes, and 15-25 grams for Batu Ijo. Research on bulb size as planting material indicates that larger bulbs produce more leaves (Liu et al., 2024).

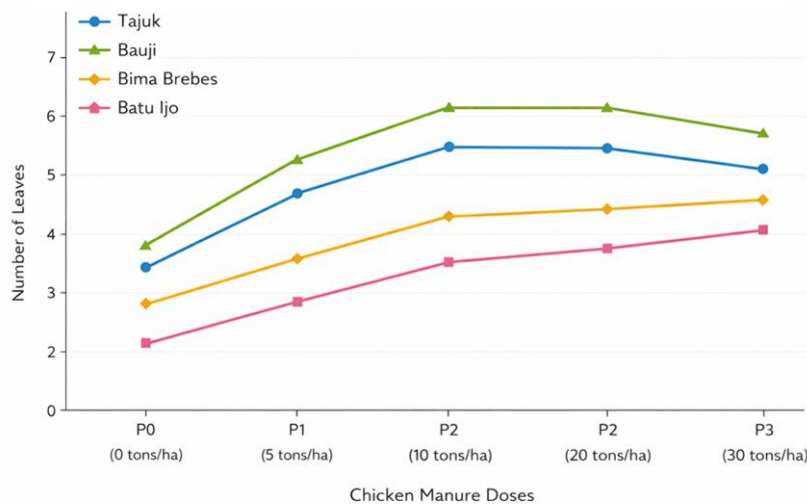


Figure 3. Number of leaves based on the combination of shallot varieties (Tajuk; Bauji; Bima Brebes; Batu Ijo) and chicken manure treatment (P₀=0 tons/ha; P₁=10 tons/ha; P₂=20 tons/ha; P₃=30 tons/ha)

Increase of leaf length (cm)

Shallots are monocotyledonous plants that can be propagated by vegetative bulbs or seeds. Because shallot bulbs have a layered structure and their leaves emerge one after the other, each clump's leaf growth is asynchronous. Each leaf has a lifespan of one to twenty-four days, from emergence to senescence. There are daily variations in leaf elongation, with nighttime growth typically outpacing daytime growth.

Plants have simultaneous photosynthesis, respiration, and transpiration during the day, which can lower turgor pressure and cell water content. On the other hand, at night, transpiration rates drop, enabling cells to sustain higher turgor pressure, which promotes leaf elongation. A similar growth trend was seen in all treatments: leaf length steadily rose, peaked, and then started to decline as the leaves started to fall.

The Bauji variety exhibited greater fluctuations in leaf elongation compared to the other varieties, indicating a more dynamic growth response under floating culture conditions. Turgor pressure plays a crucial role in cell expansion and morphogenesis, where organ growth is regulated by complex biochemical and mechanical interactions at the cellular and tissue levels. Previous research has highlighted the importance of turgor-driven processes in regulating plant growth dynamics, including cell elongation and organ development (Figure 4). This suggests that environmental factors and fertilizer treatments play a crucial role in accelerating leaf elongation to the lodging phase (Beauzamy et al., 2016; Ali et al., 2019; Creff et al., 2021; Xu et al., 2024).

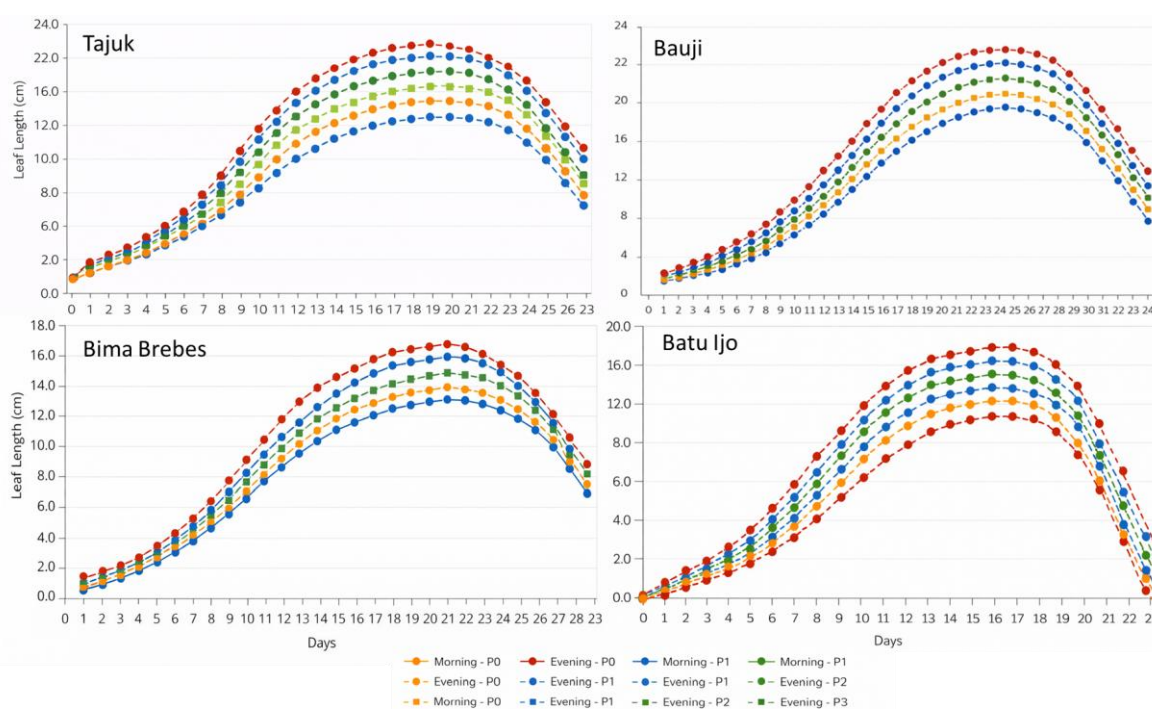


Figure 4. Increase in leaf length until falling based on the combination of shallot varieties (Tajuk; Bauji; Bima Brebes; Batu Ijo) and chicken manure treatment ($P_0=0$ ton/ha; $P_1=10$ ton/ha; $P_2=20$ ton/ha; $P_3=30$ ton/ha)

SPAD Value

SPAD readings are commonly used as an indicator of leaf greenness and nitrogen use efficiency in plants. In this study, the application of chicken manure resulted in variations in SPAD values across different shallot varieties and fertilization rates. The SPAD meter has been widely utilized as a rapid and non-destructive tool to estimate chlorophyll concentration and leaf nitrogen status, although the strength of the correlation between SPAD readings and actual chlorophyll content may vary among varieties and

environmental conditions (Xiong et al., 2015; Mehrabi & Sepaskhah, 2022; Wei et al., 2024). The four shallot varieties exhibited different responses to chicken manure treatments, indicating varietal differences in physiological adaptation. Among the tested varieties, Batu Ijo showed the highest SPAD values compared to the others. Such variation may reflect differences in genetic characteristics as well as environmental adaptation, since changes in growing conditions can influence chlorophyll accumulation and nitrogen dynamics in leaves (Han et al., 2022; Simkó & Veres, 2019) (Figure 5).

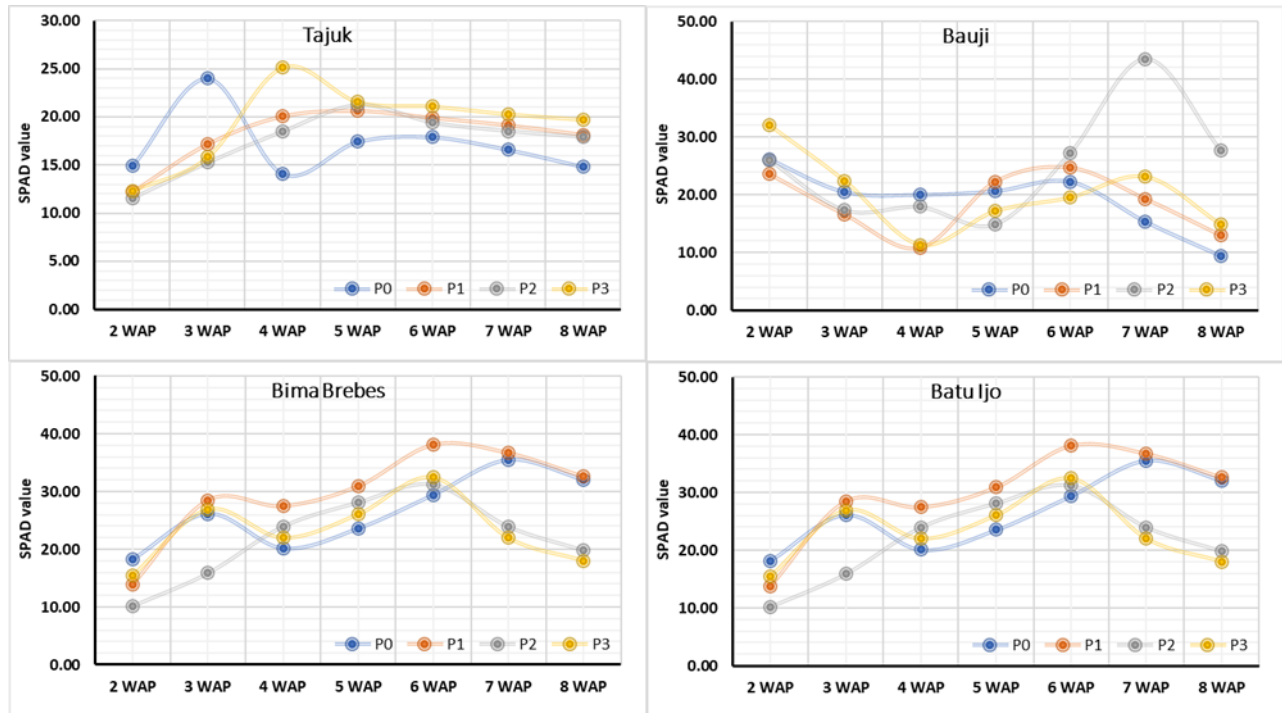


Figure 3. SPAD value based on the combination of shallot varieties (Tajuk; Bauji; Bima Brebes; Batu Ijo) and chicken manure treatment (P0=0 tons/ha; P1=10 tons/ha; P2=20 tons/ha; P3=30 tons/ha)

B. BULBS CHARACTERISTICS

Number, Length, Diameter and Volume of Bulbs

Varietal differences resulted in distinct responses in terms of bulb number, length, diameter, and volume. The results indicated that the Bauji variety produced the highest bulb number, diameter, and volume compared to the other tested varieties. In contrast, the greatest bulb length was observed in the Batu Ijo variety. The average number of bulbs produced by Tajuk, Bauji, Bima Brebes, and Batu Ijo varieties were 8.0, 12.0, 5.0, and 5.33 bulbs per plant, respectively. The longest bulb length reached 2.79 cm in Batu Ijo, whereas the shortest was recorded in Bauji at 1.97 cm. Meanwhile, the Bauji variety exhibited the largest bulb diameter and volume, measuring 3.26 cm and 27.43 cm³, respectively. Chicken manure application also influenced bulb characteristics, where the P1 treatment (10 t ha⁻¹) consistently resulted in the highest values for bulb number, length, diameter, and volume across varieties. Evaluation of bulb traits, alongside vegetative characteristics such as leaf growth, is essential for determining varietal suitability and potential for shallot development programs (Sembirin, 2017; Atman et al., 2021) (Figure 6).

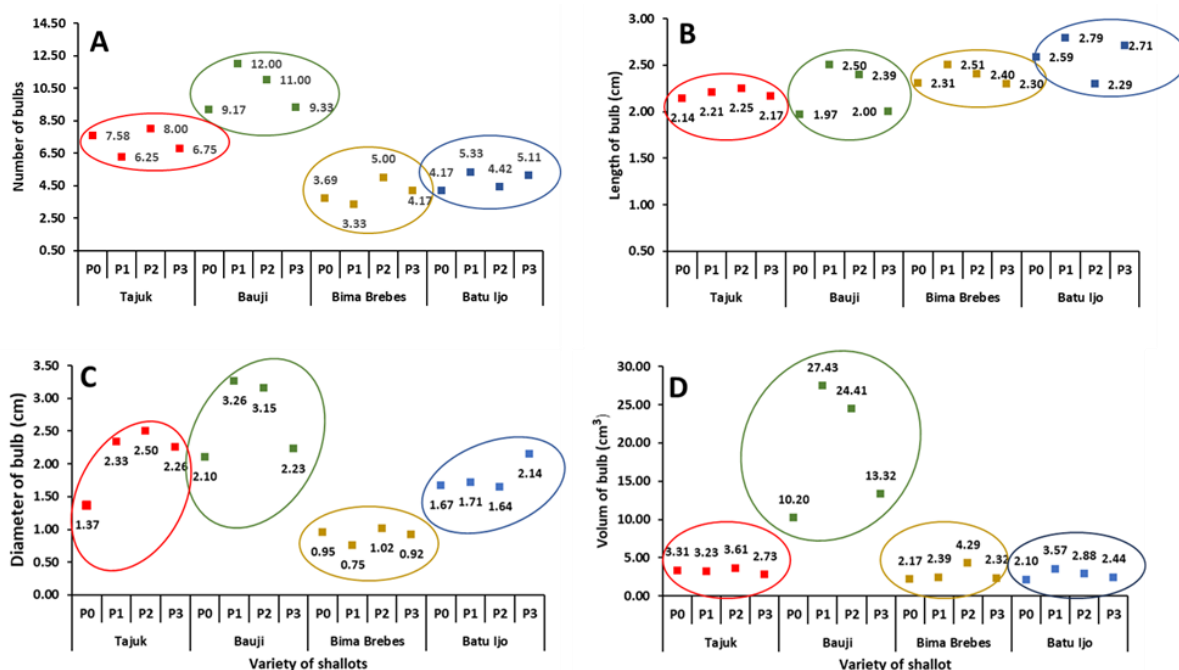


Figure 6. Bulb number (A), bulb length (B), bulb diameter (C) and bulb volume (D) with the application of chicken manure (P₀=0 tons/ha; P₁=10 tons/ha; P₂=15 tons/ha; P₃=20 tons/ha) in each variety

Fresh weight of bulbs, Dry weight of bulbs, Shrinkage and Estimated production

The economic value of shallot production is closely related to the proportion of marketable bulbs, defined as fresh bulbs that have undergone a postharvest drying process. Drying is typically conducted under shaded conditions using air circulation or smoking methods rather than direct sun exposure to maintain bulb quality. Varietal differences resulted in significant variation in both fresh and dry tuber weights. Among the tested varieties, Bauji produced the highest fresh and dry bulb weights, reaching 16.52 g and 15.67 g per plant, respectively. In contrast, the lowest production was observed in the Bima Brebes variety, with fresh and dry weights of 10.90 g and 8.93 g, respectively.

The response of each variety to chicken manure fertilization also varied. In Tajuk and Bima Brebes, the highest fresh and dry bulb production was achieved under the P2 treatment (20 t ha⁻¹), whereas Bauji and Batu Ijo showed optimal production at the P1 rate (10 t ha⁻¹) (Figure 7A). These findings indicate a strong interaction between genotype and environmental conditions, which plays an important role in determining plant growth, development, and yield performance (Rabinowitch & Goldstein, 2020; Geleta et al., 2024; Chavarria et al., 2020).

The transition from fresh to dry bulb weight, often referred to as the shrinkage process, is a critical factor influencing the proportion of economically valuable bulbs. The percentage reduction in bulb weight varied among varieties, ranging from 15.79–20.68% in Tajuk, 5.15–29.51% in Bauji, 11.03–23.11% in Bima Brebes, and 19.64–27.31% in Batu Ijo. Application of chicken manure influenced both shrinkage percentage and yield estimation, although the responses differed among varieties.

Chicken manure, as an organic fertilizer, contributes to improved physical properties of the growing medium, including enhanced aeration, better structure, and increased water-holding capacity, which ultimately support root development and sustainable crop production (Adekiya et al., 2020; Dahunsi et al., 2021; Alami et al., 2024; Cao et al., 2024; Garwa & Veerwal, 2024). Nevertheless, the results of this study indicate that increasing chicken manure application beyond 20 t ha⁻¹ did not further enhance shallot growth or yield under floating cultivation conditions (Figure 7B).

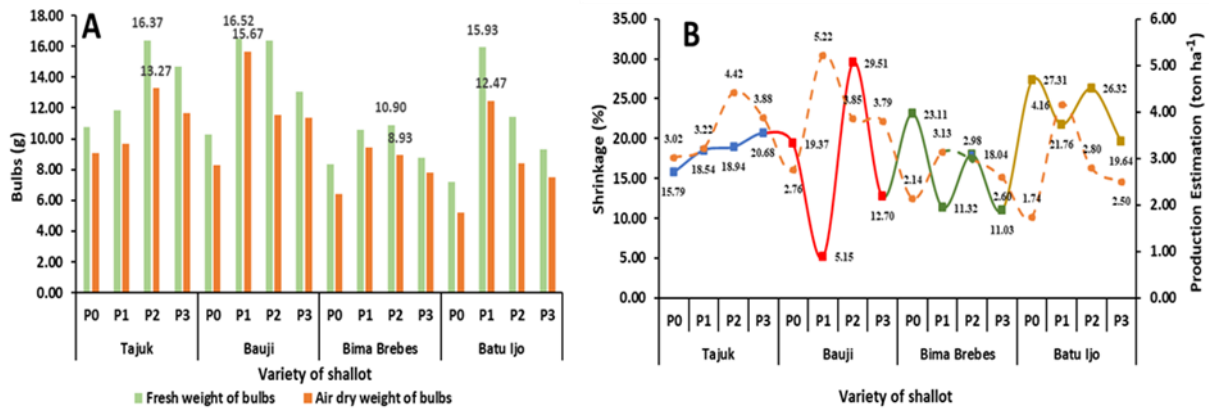


Figure 7. Number, Length, Diameter and Volume of bulbs with the application of chicken manure (P₀=0 tons/ha; P₁=10 tons/ha; P₂=15 tons/ha; P₃=20 tons/ha) in each variety

CONCLUSION

Based on the findings of this study, Bauji variety demonstrated superior growth and yield performance compared with Tajuk, Bima Brebes, and Batu Ijo under floating cultivation conditions. Application of chicken manure influenced shallot growth and productivity, although an optimum dose was not clearly defined. Overall, chicken manure rates ranging from 10 to 20 t ha⁻¹ showed favorable responses across the tested varieties, indicating their potential suitability for shallot cultivation in tropical wetland environments.

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AUTHOR CONTRIBUTIONS

Conceptualization, I.W.; Methodology, I.W., S.W.; Software, I.W., W.H.; Validation, I.W., S.W.; Formal Analysis, I.W.; Investigation, I.W., H.L., R.I.; Resources, I.W.; Data Curation, I.W., H.L., R.I.; Writing – Original Draft Preparation, H.L., R.I.; Writing – Review & Editing, I.W., S.W.; Visualization, I.W., W.H.; Supervision, S.W.; Project Administration, I.W.; Funding Acquisition, I.W. All authors have read and agreed to the published version of the man-uscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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