International Journal of Education, Vocational and Social Science
https://e-journal.citakonsultindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Analysis Of Agronomic And Physiological Characteristics And Antioxidant Content Of Shallots (Allium Ascalonicum L.) In Response To Za Fertilizer Application In Cultivation

Rahmaniar
Agronomy Study Program, Sriwijaya University, Indonesia
Susilawati
Agronomy Study Program, Sriwijaya University, Indonesia
Marlin Sefrila
Agronomy Study Program, Sriwijaya University, Indonesia

*Email:rniar1334@gmail.com, , susilawati12081967@gmail.com, marlinsefrila@fp.unsri.ac.id

Abstract

The demand for shallots continues to increase along with population growth and the food industry, making them a staple food for both households and the processing industry (Directorate General of Horticulture, 2024). One approach that can support this agronomic adaptation is the use of appropriate fertilizers, as growing media are limited and more dynamic. Cultivation success is also greatly influenced by variety selection. Superior varieties such as Bima Brebes, Bauji, and Tajuk are widely cultivated in Indonesia, but their response to floating cultivation systems and ZA fertilization has not been widely studied (Balitsa, 2020). This study aims to determine the response of the effect of ZA fertilizer use on the agronomic characteristics, physiology, and antioxidant activity of shallots in floating cultivation systems. The research method used was the RAK method with the treatment being the use of ZA fertilizer. Data analysis was performed using Microsoft Excel using the Analysis of Variance (ANOVA) method, followed by further tests using orthogonal polynomial regression and Turkey HSD. The Brebes variety consistently demonstrates the best performance (highest number of bulbs, largest bulb diameter, longest roots, highest leaf greenness, and strongest antioxidant capacity). A ZA fertilizer dosage of 150 kg/ha was the most efficient rate for maximizing the number of bulbs. Therefore, the combination of the Brebes variety and a ZA dosage of 150 kg/ha is recommended as a suitable shallot cultivation method for waterlogged swamp land.

Keywords:Shallots, ZA fertilizer, floating cultivation.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

INTRODUCTION

Shallot (*Allium ascalonicum* L.) is one of the world's most important bulb vegetable crops, cultivated for both culinary and medicinal purposes for centuries. Owing to its distinctive flavor, nutritional value, and rich content of bioactive compounds such as flavonoids, phenolics, and sulfur-containing metabolites, shallot has gained significant economic and health importance worldwide. Currently, it is cultivated in more than 170 countries, reflecting its broad adaptability and increasing global demand (FAO, 2018; Petropoulos et al., 2017). In Indonesia, shallot is recognized as a strategic horticultural commodity because of its substantial contribution to food security, farmer income, and the national economy. Consequently, the Indonesian Ministry of Agriculture has prioritized shallot development through programs aimed at increasing productivity, improving cultivation technologies, and expanding production areas to meet growing domestic demand while reducing market price fluctuations (Ministry of Agriculture, 2020).

The geographical characteristics of South Sumatra, particularly the Palembang region, are dominated by tidal wetlands and flood-prone lowlands that experience periodic inundation due to tidal fluctuations and seasonal rainfall. These environmental conditions present major constraints for conventional horticultural production because prolonged flooding reduces soil aeration, limits root development, decreases nutrient availability, and ultimately lowers crop productivity. With increasing climate variability and more frequent flooding events, developing adaptive cultivation technologies for wetland agriculture has become essential to ensure sustainable food production. One promising innovation is the floating farming system, in which crops are cultivated on floating media such as bamboo rafts, allowing plants to remain above fluctuating water levels while maintaining favorable root-zone conditions (Nurbaity & Ramdani, 2018; Hidayat et al., 2019). This cultivation system has considerable potential for expanding agricultural production in inundated areas that are otherwise unsuitable for conventional farming.

Among horticultural crops, shallot (Allium cepa L. Aggregatum Group) is an economically important commodity in Indonesia because of its high market demand and nutritional value. Successful shallot production under floating cultivation depends not only on the cultivation system but also on appropriate nutrient management and varietal adaptation. Ammonium sulfate (ZA) fertilizer supplies both nitrogen and sulfur, two essential nutrients involved in chlorophyll formation, photosynthesis, bulb development, and the biosynthesis of sulfur-containing compounds associated with bulb quality and antioxidant activity. Appropriate ZA fertilization has been reported to improve tuber yield, physiological performance, and antioxidant accumulation. In addition, superior varieties such as Bima Brebes, Bauji, and Tajuk are widely cultivated due to

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

their high productivity and desirable agronomic characteristics; however, their responses to floating cultivation systems combined with ZA fertilization remain insufficiently understood (Balitsa, 2020).

Although previous studies have independently investigated floating farming systems, fertilization practices, and shallot varietal performance, comprehensive research integrating these factors is still limited. In particular, there is a lack of information regarding how different superior shallot varieties respond to ZA fertilizer under floating cultivation in terms of agronomic performance, physiological traits, and antioxidant characteristics. Addressing this knowledge gap is important for developing appropriate cultivation strategies for flood-prone wetlands. Therefore, this study aimed to evaluate the agronomic, physiological, and antioxidant characteristics of Bima Brebes, Bauji, and Tajuk shallot varieties grown under a floating farming system with ZA fertilizer application, thereby providing scientific evidence to support sustainable shallot production in tidal wetland environments.

METHOD

This research was conducted at the Embung (Reservoir) of the Faculty of Agriculture, Sriwijaya University. Sample analysis was conducted at the Plant Physiology Laboratory, Faculty of Agriculture, Sriwijaya University, located in North Indralaya District, Ogan Ilir Regency, South Sumatra Province, from June to August 2025.

The research method used in this study is a Factorial Randomized Block Design (RAKF) consisting of 2 factors, the first factor is the ZA fertilizer factor, consisting of 4 levels, namely P0 = control, P1 = Dose 150 kg / ha (0.6 grams / polybag), P2 = Dose 250 kg / ha (1 gram / polybag), P3 = Dose 400 kg / ha (1.6 grams / polybag) and the second factor is the shallot plant variety factor consisting of 3 levels, namely the bauji, bima brebes, and canopy varieties, with 3 replications then each replication consists of 4 plants. So there are 144 treatment units.

Observational data obtained during the study will be analyzed using Microsoft Excel and R Studio applications using the Analysis of Variance (ANOVA) method. If F Calculation > F Table at a probability of F greater than 5% ($\alpha = 0.05$), then the difference in influence is significantly different, in the analysis of variance table is symbolized by (*). If F Calculation > F Table, then there is no significant difference or there is no difference in the effect of treatment on the observation results. Then, further tests use orthogonal polynomial regression and Turkey HSD Data analysis methods are different from data analysis techniques even though they sound similar. Methods refer more to a more general approach and within it there are techniques from that approach.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Research methods are broadly divided into two parts, namely quantitative methods and qualitative methods. while in the quantitative method itself there are various types of analysis techniques such as correlational techniques, regression, comparison, descriptive and the like.

RESULTS AND DISCUSSION

The results of the analysis of variance of the Factorial Randomized Block Design showed that the variety factor had a significant to very significant effect on the majority of observed variables, while the ZA fertilizer dose factor only had a significant effect on the number of tubers per clump and antioxidant activity. The interaction between ZA dose and variety (ZA×V) was only significant on antioxidant activity. A summary of the F-count values along with their significance and coefficient of variation (CC) for all variables is presented in Table 1.

Table 1. Results of analysis of variance and coefficient of diversity (KK) of ZA fertilizer application on observed variables.

Observation Variables	P	**S**	Interaction	**KK**
Plant height 2 MST	0.319 tn	0.088 tn	0.96 tn	19.22%
Plant height 4 MST	1,124 tn	8,532**	1.58 tn	11.78%
Plant height 6 MST	0.779 tn	6,699**	0.39 tn	16.73%
Plant height 8 MST	2,778 tn	26.87**	0.76 tn	13.74%
Number of leaves 2 MST	0.581 tn	46,219**	2.34 tn	12.10%
Number of leaves 4MST	0.751 tn	29,674**	0.63 tn	14.80%
Number of leaves 8 MST	0.215 tn	8.45**	0.86 tn	4.82%
Number of offspring	0.373 tn	1,571 tn	1.08 tn	18.35%
Greenness of leaves 8 MST	1,613 tn	26,052**	1.08 tn	16.64%
Leaf area	0.184 tn	8,208**	0.18 tn	1.99%
Leaf Lifespan	1,306 tn	19.74**	1.60 tn	16.27%
Root length	1,346 tn	149,604**	0.96 Mr.	14.02%
Observation Variables	P	**S**	Interaction	**KK**
Tuber diameter	1,197 tn	5,083*	0.68 tn	5.73%

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Tuber length	1,303 tn	0.356 tn	1.84 tn	5.26%
Number of tubers	5,216**	28,762**	1.91 tn	1.67%
Volume of tubers	1,238 tn	26.09**	0.89 tn	1.54%
Fresh weight of tubers	1.23 tn	1,187 tn	0.81 tn	1.55%
Dry weight of wind tubers	1,829 tn	0.856 tn	0.75 tn	1.59%
Wet weight of the raft	2.24 tn	4.629*	1.31 tn	1.70%
Dry weight per kilogram	2,955 tn	0.602 tn	1.34 tn	16.06%
Phenol	2,586 tn	9.54**	0.98 tn	4.85%
Flavonoid	0.524 tn	6,295**	0.80 tn	10.96%
Antioxidant activity (IC50)	5,096**	10,408**	3.62*	
F Calculate BNT 5%	3.05	3.44	2.55	
BNT 1%	4.82	5.72	3.76	

Description: KK" Coefficient of Diversity,** = very significant effect (1% level); * = significant effect (5% level); without sign or tn = no significant effect.

Plant Height (cm)

Plant height in shallots cultivated in floating systems showed an increase in plant height over time. The average plant height continued to increase from 2 WAP to 8 WAP in all treatments (Figure 1). At 8 WAP, Brebes (27.50 cm) and Bauji (27.30 cm) varieties occupied the highest positions and were not significantly different from each other, while Tajuk was the lowest (18.68 cm).

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

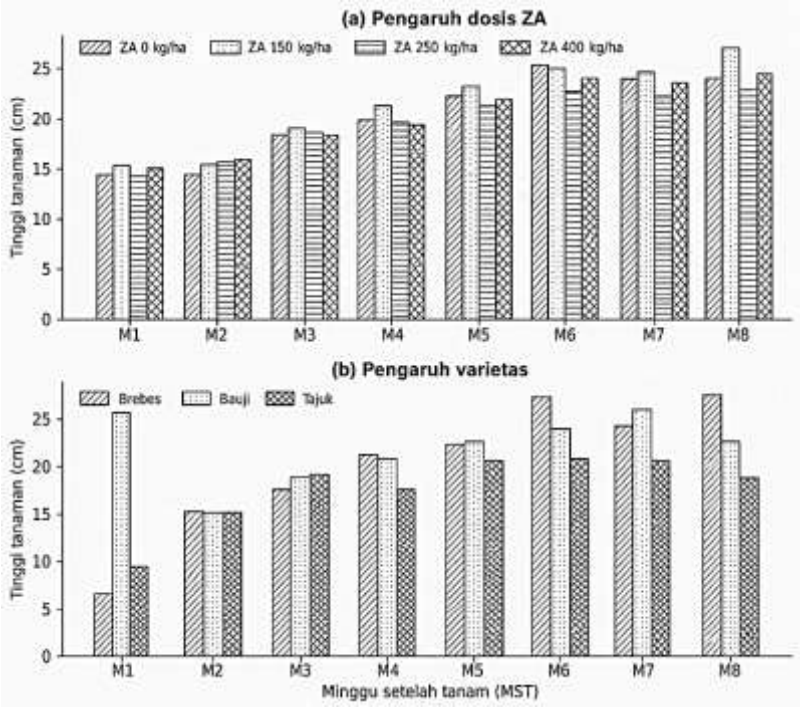


Figure 1. Average plant height per week based on (a) ZA fertilizer dose and (b) shallot variety for 8 weeks after planting in floating cultivation.

Number of leaves (blades)

Leaf number was significantly affected by variety in almost all weeks (except 2 weeks after planting), while ZA dosage had no significant effect (Table 1). Leaf number increased until approximately 6 weeks after planting, then tended to decline as the tuber formation phase began (Figure 2). At 8 weeks after planting, Bauji achieved the highest leaf number (20.58 leaves), followed by Brebes (17.01 leaves), and Tajuk (14.02 leaves) at the lowest.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsultindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

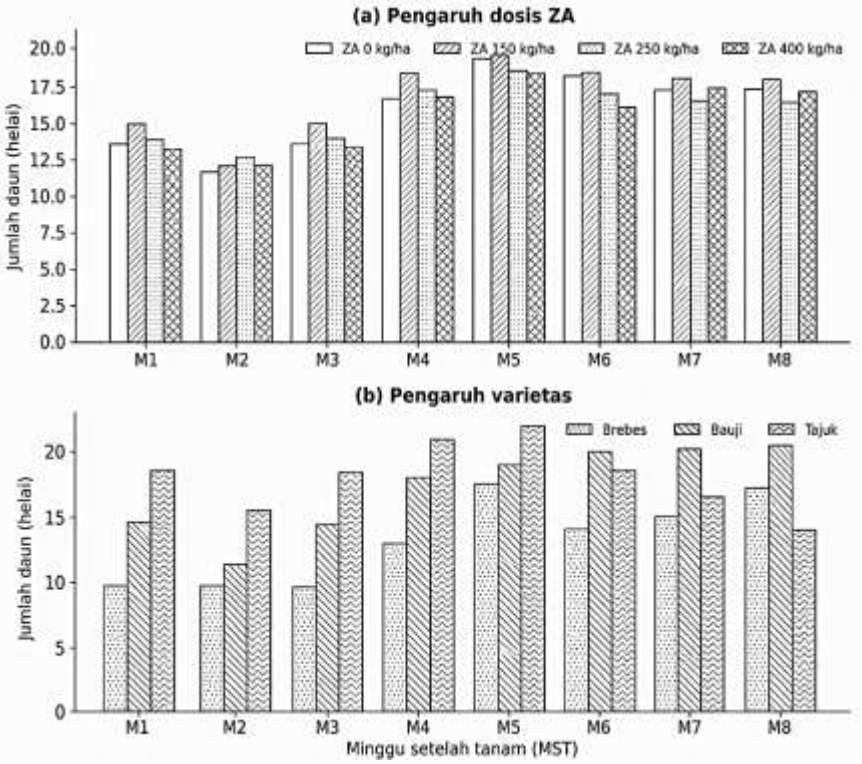


Figure 2. Average number of leaves per week based on (a) ZA fertilizer dose and (b) variety during 8 MST.

Number of Offshoots (clumps)

The number of tillers in shallots cultivated floatingly showed an increase in the number of tillers over time. The average number of tillers between treatments was relatively uniform, ranging from 4.45–5.08 tillers per clump, with the highest value in the Bauji variety (5.08) and a ZA dose of 250 kg/ha (5.01) as seen in (Figure 3).

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

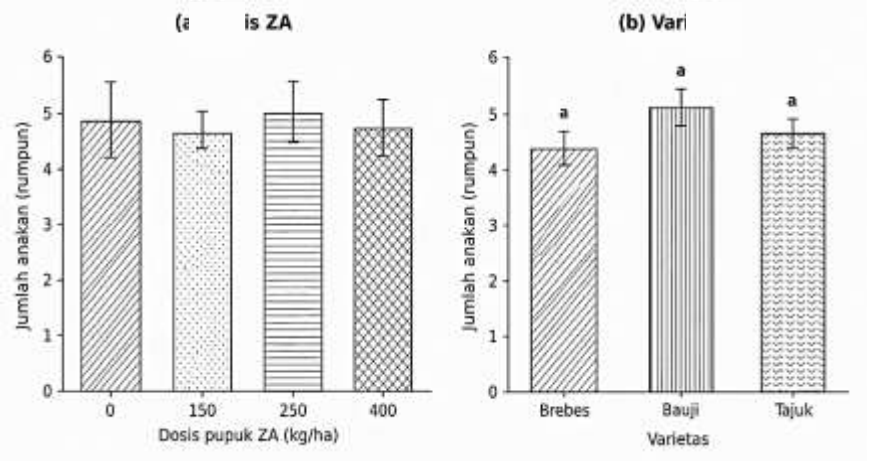


Figure 3. Average number of tillers per clump based on (a) ZA dose and (b) variety. Notation not shown due to insignificant effect.

Leaf Greenness Level / SPAD Value

The level of leaf greenness was significantly affected by variety, but not by ZA dosage (Table 1). SPAD values increased with plant age in all treatments (Figure 4). At 8 weeks post-planting (WAP), the Brebes variety had the highest leaf greenness (36.36), which was significantly different from Bauji (24.96) and Tajuk (23.76).

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

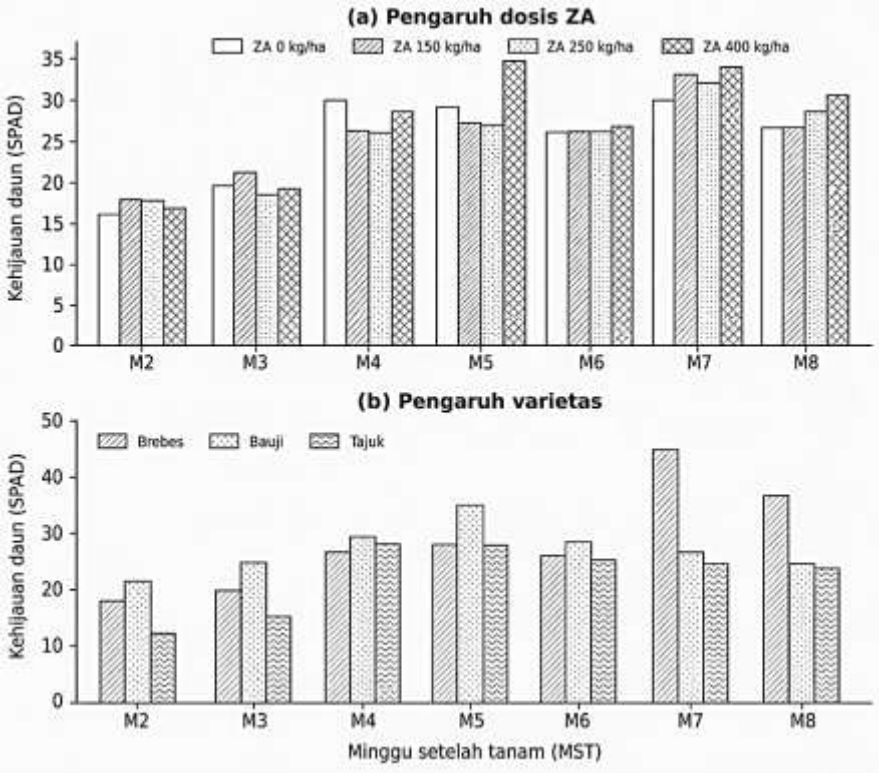


Figure 4. Average leaf greenness level (SPAD value) per week based on (a) ZA dose and (b) variety (M2–M8).

Leaf Area (cm²)

Based on the graph, the difference in treatment shows that leaf area is significantly influenced by variety, while the ZA dose has no significant effect (Table 1). The Bauji variety has the largest leaf area (25.58 cm²) which is very significantly different from Tajuk (9.46 cm²) and Brebes (4.92 cm²). (Figure 5).

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

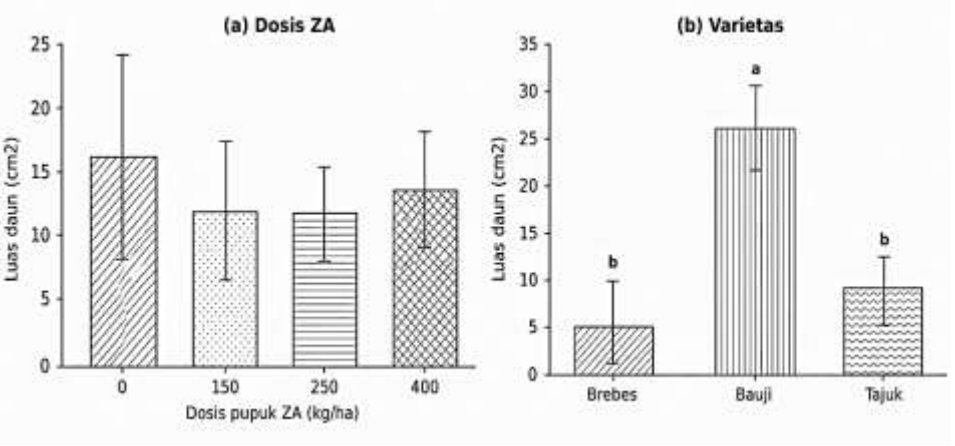


Figure 5. Average leaf area based on (a) ZA dose and (b) variety. Different letters indicate significant differences (Tukey HSD, α=0.05).

Root Length (cm)

Root length showed the sharpest intervarietal difference among all variables (F=149.60; highly significant), while ZA dosage had no significant effect (Table 1). The three varieties could be separated significantly (notation a, b, c): Brebes produced the longest roots (2.28 cm), followed by Bauji (1.08 cm) and Tajuk (0.78 cm) (Figure 6).

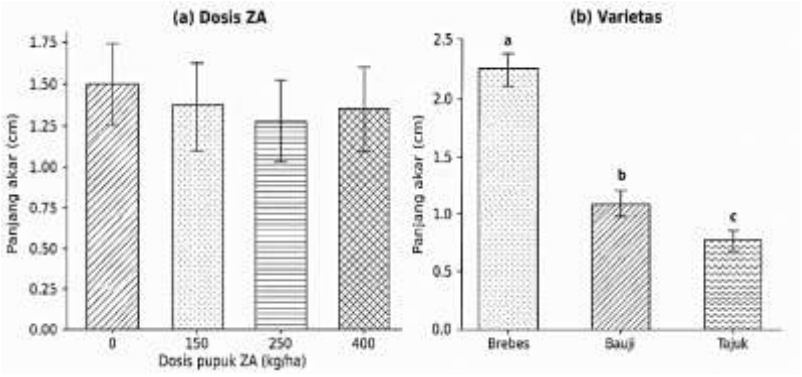


Figure 6. Average root length based on (a) ZA dose and (b) variety. Different letters indicate significant differences (Tukey HSD, α=0.05).

Tuber Diameter (cm)

Tuber diameter was significantly affected by variety, but not by ZA dosage (Table 1). The Brebes variety produced the largest tuber diameter (2.19 cm), which was significantly different

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

from Bauji (1.86 cm) and Tajuk (1.91 cm), which were equivalent (Figure 7).

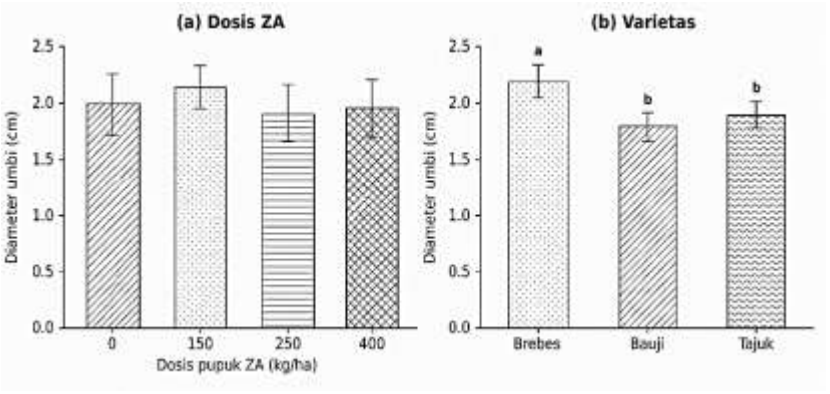


Figure 7. Average tuber diameter based on (a) ZA dose and (b) variety.

Tuber Length (cm)

Tuber length was not significantly affected by ZA dose, variety, or their interaction (Table 1). The mean between varieties ranged from 2.27 to 2.53 cm and was not significantly different (Figure 8).

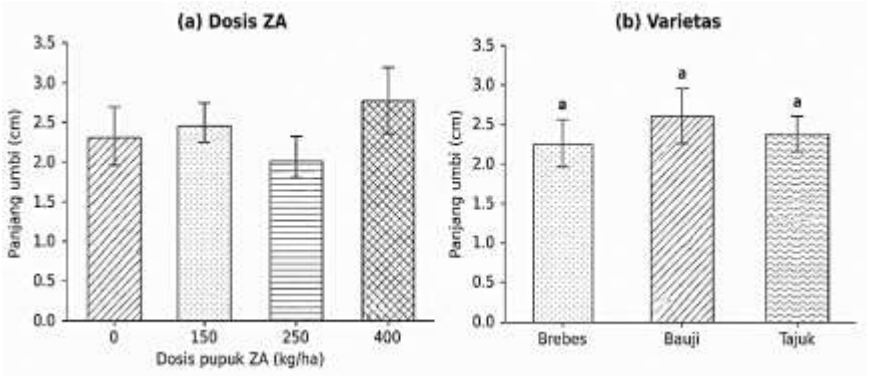


Figure 8. Average tuber length based on (a) ZA dose and (b) variety.

Number of Bulbs (cloves)

The number of tubers was one of two variables significantly affected by ZA dose, but was also significantly affected by variety (Table 1). The number of tubers peaked at a dose of 150 kg/ha (11.38 cloves) and then decreased at higher doses (Figure 9a). Varieties were significantly separated (a, b, c): Brebes was the highest (12.45 cloves), followed by Tajuk (8.65 cloves) and Bauji

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

(5.08 cloves) (Figure 9b).

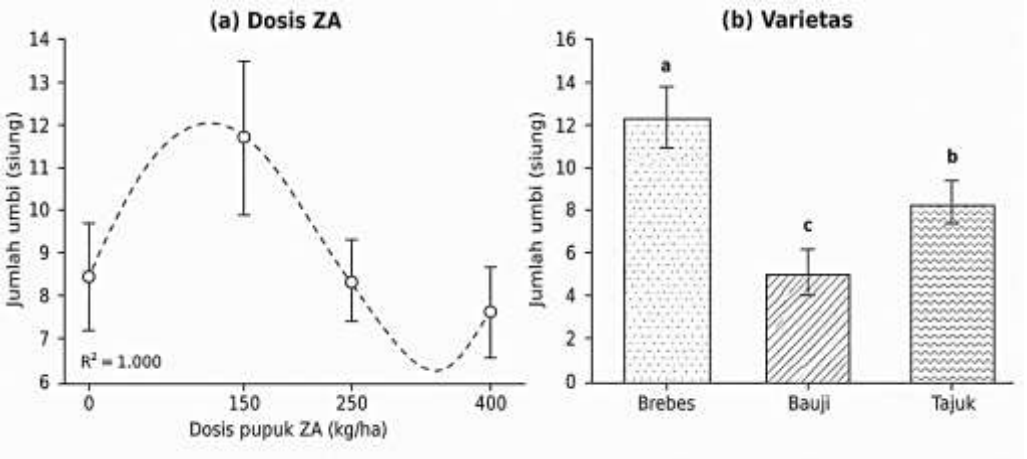


Figure 9. Number of tubers per clump: (a) response to ZA dose with orthogonal polynomial regression curve; (b) effect of variety with Tukey HSD notation.

Bulb Volume (cm³)

Tuber volume was significantly affected by variety, but not by ZA dosage (Table 1). Bauji variety had the largest tuber volume (9.30 cm³), which was significantly different from Tajuk (3.42 cm³) and Brebes (2.86 cm³) (Figure 10).

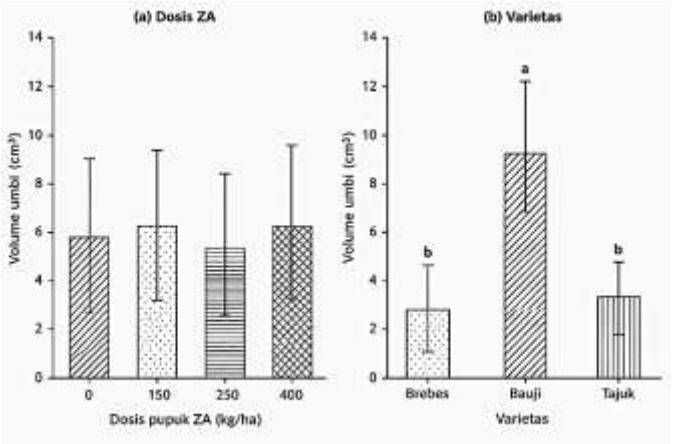


Figure 10. Average tuber volume based on (a) ZA dose and (b) variety.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Fresh Weight of Tubers (g)

Fresh tuber weight was not significantly affected by ZA dose, variety, or their interaction (Table 1). Although numerically, Brebes (23.28 g) tended to be higher than Tajuk (20.26 g) and Bauji (18.95 g), the difference was not statistically significant (Figure 11).

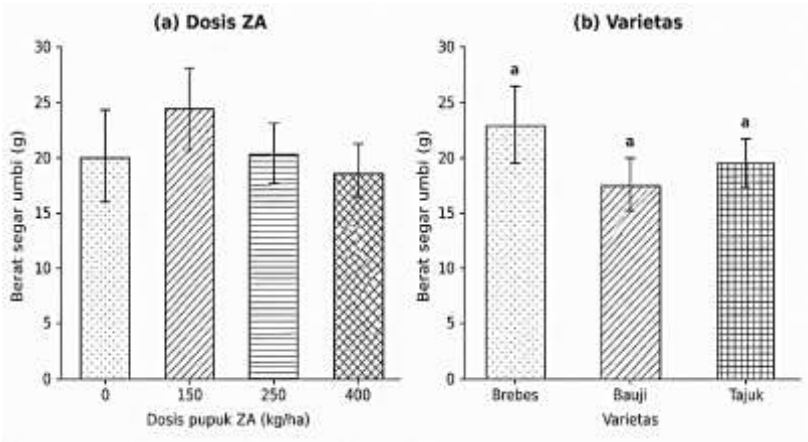


Figure 11. Average fresh weight of tubers based on (a) ZA dose and (b) variety.

Dry Weight of Wind Bulbs (g)

The dry weight of the tubers was not significantly affected by ZA dose, variety, or their interaction (Table 1). The mean between varieties ranged from 20.80 to 24.85 g with no significant differences (Figure 12).

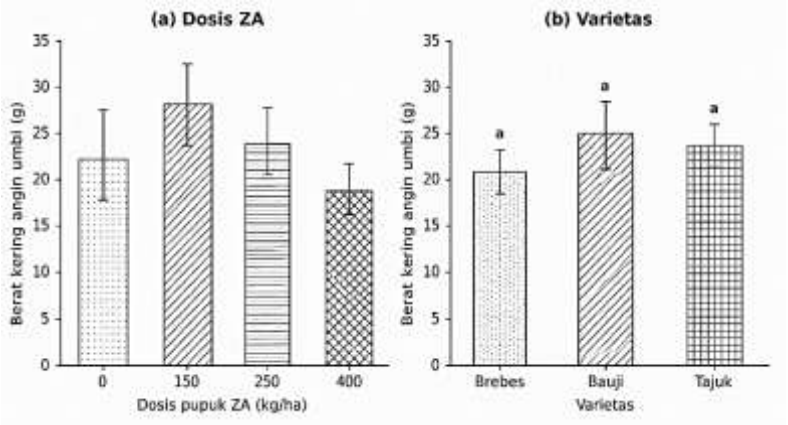


Figure 12. Average dry weight of tuber wind based on (a) ZA dose and (b) variety.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Wet Weight of Berangkasan (g)

The wet weight of the seed was significantly affected by the variety, but not by the ZA dose (Table 1). Brebes produced the highest wet weight (41.46 g), which was significantly different from Tajuk (27.48 g), while Bauji (28.92 g) was in between (Figure 13).

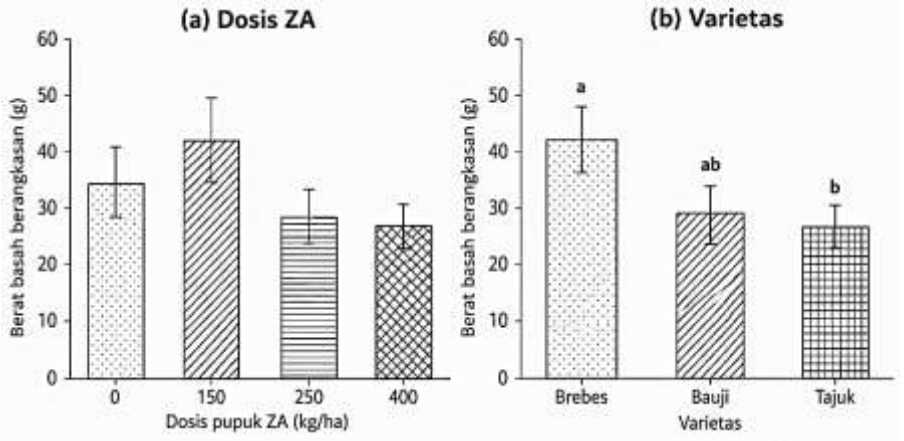


Figure 13. Average wet weight of the seedlings based on (a) ZA dose and (b) variety.

Dry Weight of the Bunch (g)

Dry weight of the seedlings was not significantly affected by ZA dose, variety, or their interaction (Table 1). The mean between varieties ranged from 24.57 to 30.42 g without significant differences; this variable also had a high CC (49.2%) (Figure 14)

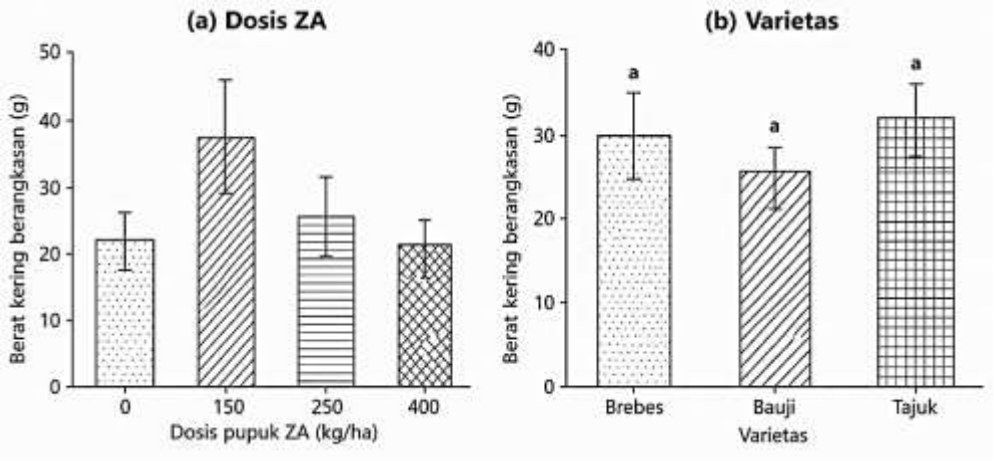


Figure 14. Average dry weight of the seedlings based on (a) ZA dose and (b) variety

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Phenol (mg GAE/g)

Phenol content was significantly affected by variety, but not by ZA dosage (Table 1). The highest phenol content was achieved by Brebes (1.65 mg GAE/g), which was significantly different from Tajuk (1.23 mg GAE/g), while Bauji (1.47 mg GAE/g) was in between (Figure 15).

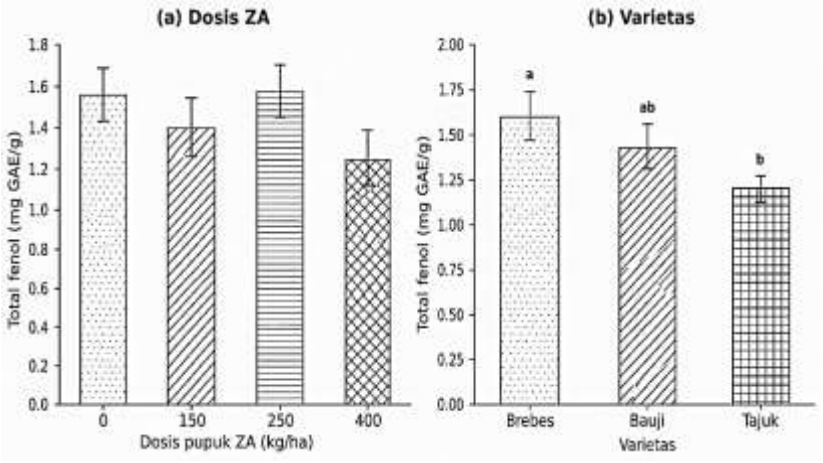


Figure 15. Average total phenols based on (a) ZA dose and (b) variety.

Flavonoids (mg QE/g)

Flavonoid content was significantly affected by variety, but not by ZA dose (Table 1). A parallel pattern was observed for total phenols: Brebes (1.37 mg QE/g) was the highest, significantly different from Tajuk (0.98 mg QE/g), with Bauji (1.25 mg QE/g) in between (Figure 16)

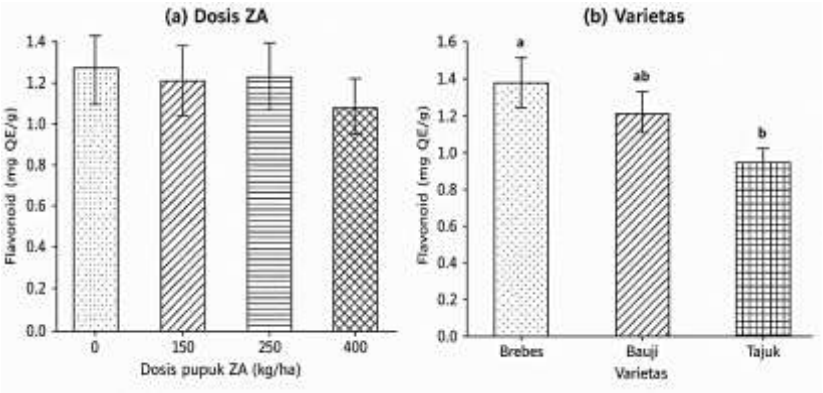


Figure 16. Average flavonoid content based on (a) ZA dose and (b) variety.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Antioxidant Activity (IC50, ppm)

Antioxidant activity was the only variable significantly affected by ZA dose, variety, and their interaction (Table 1). The response to ZA dose was polynomial: the IC50 value peaked at a dose of 150 kg/ha (123.33 ppm) and then declined (Figure 17a). Among varieties, the lowest IC50 value—meaning the strongest antioxidant capacity—was found in Brebes (101.56 ppm), significantly different from Bauji, which had the highest IC50 (123.72 ppm) (Figure 17b).

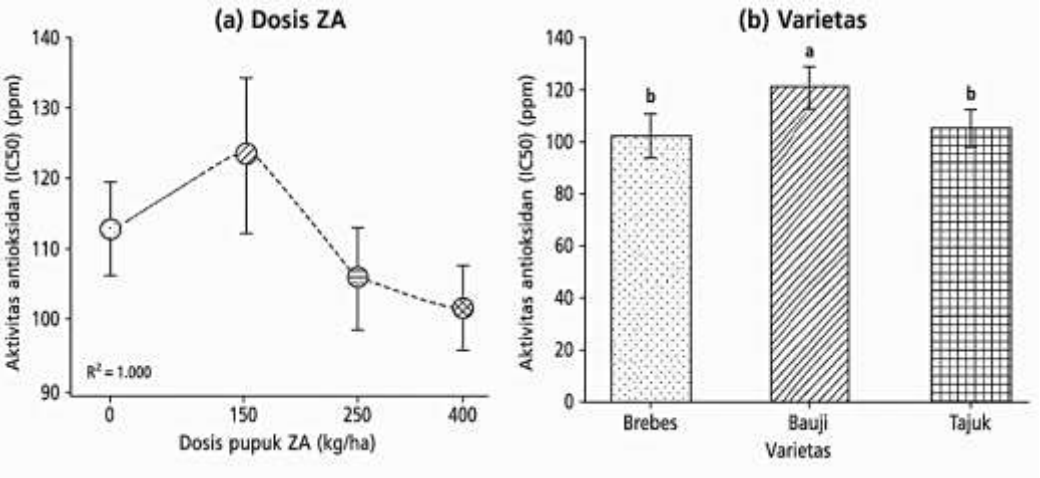


Figure 17. Antioxidant activity (IC50): (a) response to ZA dose with polynomial regression curve; (b) effect of variety (Tukey HSD).

Chlorophyll Content

Based on the results of the research that has been carried out, the analysis of diversity characteristics shows that the provision of ZA in a floating cultivation system using bamboo rafts has an effect on the parameters of leaf chlorophyll content in severalShallot cultivars. The highest average leaf chlorophyll content was found in the Bauji treatment, at around 8.84 units, while the lowest average leaf chlorophyll content was found in the Brebes treatment, at around 2.14 units.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

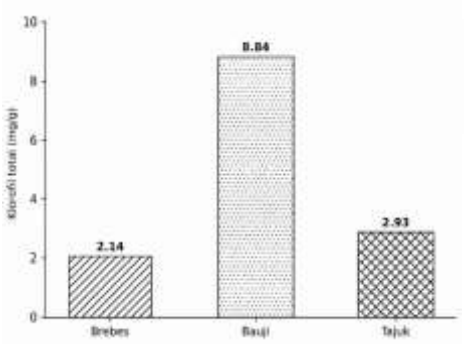


Figure 18. Total chlorophyll per variety (descriptive; data are only available as means without replications).

DISCUSSION

The results of the study showed that the growth, yield, and quality of shallots in the floating cultivation system were influenced by variety factors and ZA fertilizer dosage, although the magnitude of the two factors' influence was different. Based on the results of the analysis of variance, the variety factor had a more dominant influence than the ZA fertilizer dosage on most of the observed parameters. Variety had a significant to very significant effect on plant height, number of leaves, leaf greenness, leaf area, root length, bulb diameter, number of bulbs, bulb volume, fresh weight of the stalk, total phenol content, flavonoids, and antioxidant activity. In contrast, the ZA fertilizer dosage only had a significant effect on several parameters, especially the number of bulbs and antioxidant activity.

The dominant influence of variety indicates that genetics is the primary component determining the adaptability of shallots to floating cultivation systems. The constantly saturated media requires plant roots to adapt to low oxygen availability. The Bima Brebes variety demonstrated superior adaptability compared to Bauji and Tajuk. This was evident in its longer root length, larger bulb diameter, greater number of bulbs, and higher phenol and flavonoid content. This is consistent with research by Marlin et al. (2021) and Irawan et al. (2021), which found that differences in genetic characteristics result in each variety having a different ability to utilize nutrients and adapt to less than optimal environmental conditions.

In the vegetative growth phase, plant height and number of leaves increase until about 5–6 weeks after planting, then tend to decrease.g decreases before harvest. This pattern indicates a transition from the vegetative to the generative growth phase. In the vegetative phase, photosynthesis is used for leaf and stem formation, while during the bulb formation phase, most of the photosynthate is diverted to storage organs. This indicates that, according to Brewster (2018), this change in photosynthate distribution is a normal physiological characteristic of shallot

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

plants during the bulb formation process.

ZA fertilizer application tends to increase vegetative growth because it contains nitrogen and sulfur, which play a role in chlorophyll formation, protein synthesis, and photosynthesis. However, increasing the ZA dose does not always improve all growth parameters. Most vegetative variables show no significant differences between doses. This is suspected because the plant's nitrogen requirements are met by the growing medium, so adding higher amounts of nitrogen no longer significantly increases growth. This is in agreement withAccording to research by Hasanah et al. (2021), plant response to nitrogen fertilizer will decrease once nutrient requirements are met. This also aligns with research by Susilawati et al. (2022), which states that floating cultivation conditions with water-saturated media limit oxygen availability in the root zone, making variety adaptability a critical factor in determining plant growth and yield.

Regarding tuber number, ZA fertilizer application showed a significant effect. The highest tuber number was obtained at a dose of 150 kg ha^{-1}, while increasing the dose to 250 and 400 kg ha^{-1} actually resulted in a decrease in tuber number. This condition indicates that a moderate dose is the optimum dose for supporting tuber formation. Nitrogen at the optimum dose can increase the formation of shoots that subsequently develop into tubers. Conversely, excessive nitrogen application will prolong the vegetative phase, thus inhibiting tuber formation. These results are in line withRattink et al. (2022) stated that excess nitrogen causes plants to allocate more photosynthates to vegetative growth than to the formation of storage organs.

Variety factors also significantly influence yield characteristics. The Bima Brebes variety produces the highest number of tubers and tuber diameter, whileBauji has a larger leaf area and bulb volume. Bauji's higher leaf area indicates better light capture, resulting in increased photosynthetic capacity. However, the photosynthates produced are used more for bulb enlargement rather than increasing bulb number. Conversely, Bima Brebes is more efficient at producing productive tillers, resulting in a greater number of bulbs. This is consistent with research by Mallor et al. (2011) that suggests that shallot yield characteristics are strongly influenced by the genetic factors of the variety.

In terms of yield quality, the total phenol and flavonoid content and antioxidant activity were more influenced by variety than by the ZA fertilizer dosage. The Bima Brebes variety produced the highest phenol and flavonoid content, thus having the highest antioxidant activity. The high phenolic compound content indicates that this variety has a better ability to synthesize secondary metabolites. Phenolic compounds, especially flavonoids, function as natural antioxidants capable of scavenging free radicals through a hydrogen atom donor mechanism. This

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

suggests that, according to Yovita et al. (2021), phenol and flavonoid content are positively correlated with antioxidant activity in shallots.

The response of secondary metabolite content to ZA fertilizer shows a patternQuadratic. ZA administration at moderate doses can increase antioxidant activity, while excessively high doses cause a decrease in phenol and flavonoid content. This condition is thought to occur because excess nitrogen diverts plant metabolism toward protein synthesis and vegetative growth, thereby reducing the formation of secondary metabolites. This is in line with research by Agati et al. (2020), which explains that excessive nitrogen availability can suppress the activity of the phenylpropanoid pathway, thereby reducing the synthesis of phenolic compounds.

The results also showed that several parameters, such as fresh tuber weight, dry tuber weight, root length, and plant biomass, did not differ significantly between treatments. This condition is thought to be influenced by the characteristics of the floating cultivation system.Water-saturated media limits oxygen availability in the root zone. Low oxygen levels reduce root respiration, thus impairing optimal nutrient absorption. This is consistent with research by Larcher (2003) that hypoxic conditions in the root zone are a major limiting factor for plant growth in flooded media.

Overall, the research results indicate that the success of shallot cultivation in a floating system is more determined by variety selection than by increasing the dose of ZA fertilizer. The Bima Brebes variety is the most adaptive variety because it is able to produce better growth, yield, and bulb quality compared to other varieties. Meanwhile, a ZA fertilizer dose of 150 kg ha^{-1} is the optimum dose that can increase the number of bulbs and antioxidant activity without causing negative effects due to excess nitrogen. Therefore, the combination of the Bima Brebes variety with a ZA dose of 150 kg ha^{-1} can be recommended for shallot cultivation in a floating system. These findings also support the research results.Susilawati et al. (2019; 2021) reported that nitrogen fertilization at optimal doses can increase the growth and yield of shallots, while excessive doses do not always provide additional benefits.

CONCLUSION

Varietal factors significantly influenced the majority of agronomic, physiological, and antioxidant characteristics of shallots in floating cultivation, while ZA fertilizer only significantly affected the number of bulbs and antioxidant activity, with a significant interaction only on antioxidant activity. The Brebes variety consistently showed the best performance (the highest number of bulbs, the largest bulb diameter, the longest roots, the highest leaf greenness, and the

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

strongest antioxidant capacity). A ZA dose of 150 kg/ha was the most efficient dose to maximize the number of bulbs. Thus, the combination of the Brebes variety and a ZA dose of 150 kg/ha is recommended as an adaptive approach to shallot cultivation in flooded swampy areas.

REFRENCE

Ansar, M., Wulandari, E., & Putra, G.M.D. (2019). Growth and yield performance of several shallot varieties under different environmental conditions. IOP Conference Series: Earth and Environmental Science, 347, 012112.

Agati, G., Brunetti, C., Fini, A., & Tattini, M. (2020). Nitrogen nutrition modulates the biosynthesis of flavonoids in plants: A review. Environmental and Experimental Botany, 179, Article 104198.

Arianto, A., et al. (2025). Shallot crop harvest time and yield prediction in Brebes Regency. International Journal of Design & Nature and Ecodynamics.

Aryanta, I. W. R. (2019). Bawang merah dan manfaatnya bagi kesehatan. Widya Kesehatan, 1(1), 29–35. https://doi.org/10.32795/widyakesehatan.v1i1.280

Balai Penelitian Tanaman Sayuran. (2019). Teknologi budidaya bawang merah. Kementerian Pertanian Republik Indonesia.

Brewster, J. L. (2018). Onions and Other Vegetable Alliums (2nd ed.). CABI Publishing.

Chaudhari, N. R., et al. (2026). Effect of nitrogen fixer, phosphate and potash solubilizing bacterial consortium on vegetative growth of onion (Allium cepa L.). International Journal of Advanced Biochemistry Research.

Deng, B., Zhang, Y., & Yang, Y. (2019). Genetic variation in flavonoid accumulation and antioxidant capacity among different varieties of medicinal plants. Journal of Applied Botany and Food Quality, 92, 123–131.

El-Sayed, S. M., et al. (2024). Impact of irrigation and environmental factors on onion growth. Euro-Mediterranean Journal for Environmental Integration, 10, 1657–1670.

Fageria, N. K. (2016). The Use of Nutrients in Crop Plants. CRC Press.

Farid, N., & Ulinnuha, Z. (2022). Pertumbuhan dan hasil genotipe bawang merah pada peningkatan dosis sulfur melalui sistem hidroponik Nutrient Film Technique. Biofarm: Jurnal Ilmiah Pertanian, 18(2), 102–115. https://doi.org/10.31941/biofarm.v18i2.2346

Gardner, F. P., Pearce, R. B., & Mitchell, R. L. (1991). Fisiologi tanaman budidaya. Jakarta: UI Press.

Gebremedhin, et al. (2025). Yield and water use efficiency response of onions under different growth stages. Discover Sustainability.

Gebretsadik, K., & Dechassa, N. (2018). Effect of nitrogen fertilizer on growth, yield and quality of

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

onion (Allium cepa L.). Journal of Horticultural Science and Biotechnology, 93(2), 1–8.

Ghodke, P.H., Andhale, P.S., Gijare, U.M., et al. (2018). Evaluation of onion (Allium cepa L.) genotypes for growth and yield traits. International Journal of Current Microbiology and Applied Sciences, 7(10), 1234–1240.

Gill, S. S., & Tuteja, N. (2010). Reactive oxygen species and antioxidant machinery in abiotic stress tolerance in crop plants. Plant Physiology and Biochemistry, 48(12), 909–930. https://doi.org/10.1016/j.plaphy.2010.08.016

Hasanah, Y., Mawarni, L., Hanum, H., Sipayung, R., & Ramadhan, M. T. (2021). The role of sulfur and paclobutrazol on the growth of shallots (Allium ascalonicum (L.) Sanren F-1 varieties from true shallot seed. IOP Conference Series: Earth and Environmental Science, 782(4), 042039. https://doi.org/10.1088/1755-1315/782/4/042039

Irawan, J., Sudarsono, Maharijaya, A., & Dinarti, D. (2021). Shallot haploid breeding for sustainable production—callus induction from shallot anther tissues. IOP Conference Series: Earth and Environmental Science, 694(1), 012031. https://doi.org/10.1088/1755-1315/694/1/012031

Jurnal Hortikultura Indonesia. (2018). Pengaruh pemupukan terhadap pertumbuhan dan hasil bawang merah. Jurnal Hortikultura Indonesia, 9(2), 123–130.

Kindie, B., et al. (2023). Agro-morphological trait evaluation of garlic (Allium sativum L.) response to fertilizer. International Journal of Agricultural Bioscience.

Kumar, S., Singh, B., & Yadav, R. (2021). Growth, yield and nutrient uptake of onion (Allium cepa L.) as influenced by nutrient management. Scientia Horticulturae, 276, 109756.

Kumar, S., Singh, V., & Kumar, A. (2020). Effect of nitrogen levels on growth and productivity of onion (Allium cepa L.). International Journal of Chemical Studies, 8(4), 2845–2849

Lima, M. A., et al. (2019). Effect of nitrogen fertilization on the content of bioactive compounds and antioxidant activity in leafy vegetables. Scientia Horticulturae, 254, 1–8.

Marlin, M., Handajani, M., Yulian, Y., Rustikawati, R., & Herawati, R. (2021). Induction of plantlet regeneration on shallot (Allium cepa var. aggregatum). In Proceedings of the International Seminar on Promoting Local Resources for Sustainable Agriculture and Development (ISPLRSAD 2020) (Vol. 13, pp. 239–244). Atlantis Press. https://doi.org/10.2991/absr.k.210609.038

Mustikawati, R., Tadjudin, T., & Alfandi, A. (2020). Effect of phosphorus and sulfur fertilizers on growth and tield shallots (Allium ascalonicum L.) Bima variety. Agroswagati: Jurnal Agronomi, 8(2). https://doi.org/10.33603/agroswagati.v8i2.4945

Neeteson, J. J., et al. (2022). Nitrogen nutrition and fertilization of onions (Allium cepa L.). Scientia

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Horticulturae, 291, 110591.

Prior, R. L., Wu, X., & Schaich, K. (2005). Standardized methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. Journal of Agricultural and Food Chemistry, 53(10), 4290–4302. https://doi.org/10.1021/jf0502698

Petropoulos, S.A., Fernandes, Â., Ntatsi, G., & Barros, L. (2020). Nutritional value, chemical composition and health-promoting compounds of onion (Allium cepa L.): A review. Food Reviews International, 36(7), 1–28.

Rahman, A., Putra, R., & Fadilah, N. (2017). Peranan oksigen dalam pertumbuhan akar dan penyerapan hara pada tanaman. Jurnal Fisiologi Tumbuhan, 5(3), 112–120.

Rashid, M.H.A., Islam, M.R., & Hossain, M.M. (2019). Growth and yield performance of onion varieties under different growing conditions. Journal of Agricultural Science and Technology, 21(4), 867–876.

Salisbury, F. B., & Ross, C. W. (2012). Plant Physiology (Edisi ke-5). Wadsworth Publishing.

Saragih, R., Manurung, R., & Simanjuntak, D. (2023). Pengaruh pemupukan nitrogen terhadap pertumbuhan dan produksi bawang merah. Jurnal Pertanian Tropik, 10(2), 87–95.

Setiawan, A. Y. D., Putri, R. I., Indayani, F. D., Widiasih, N. M. S., Anastasia, N., Setyaningsih, D., & Riswanto, F. D. O. (2021). Kandungan kimia dan potensi bawang merah (Allium cepa L.) sebagai inhibitor SARS-CoV-2. Indonesian Journal of Chemometrics and Pharmaceutical Analysis, 1(3), 143–155. https://doi.org/10.22146/ijcpa.3584

Setyowati, E., et al. (2025). Impact of organic NPK nano fertilizer on growth and physiological parameters of shallot varieties. International Journal of Design & Nature and Ecodynamics.

Sharma, K., Mahajan, V., & Kumar, M. (2018). Onion and shallot production and improvement. Journal of Horticultural Science and Biotechnology, 93(6), 1–10

Siregar, M., Simanungkalit, T., & Ginting, J. (2021). Respons pertumbuhan dan produksi bawang merah terhadap pemupukan nitrogen dan kalium. Jurnal Agroekoteknologi Tropika Lembab, 4(1), 45–53.

Souminar, S., Fajriani, S., & Ariffin, A. (2018). Respon pertumbuhan dan hasil tiga varietas bawang merah (Allium ascalonicum L.) terhadap beberapa tingkat ketinggian bedengan. Jurnal Produksi Tanaman, 6(10), 2413–2422.

Susilawati, S., Lakitan, B., Wijaya, A., Kurnianingsih, A., Siaga, E., & Meihana, M. (2021). Floating cultivation system for shallot production in tidal swamp areas of South Sumatra, Indonesia. Biodiversitas, 22(5), 2639–2647

Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). Plant Physiology and Development.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Sinauer Associates.

Tripathy, P., Sahoo, B. B., & Mishra, S. R. (2020). Growth and development dynamics of onion under varying nutrient regimes. Journal of Agricultural Science, 12(3), 45–53..

Yoldas, F., Ceylan, S., Mordogan, N., & Esetlili, B.C. (2020). Effects of nitrogen fertilization on growth, yield and bulb quality of onion (Allium cepa L.). Applied Ecology and Environmental Research, 18(1), 1235–1247.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License