

Impact of Boron and Gibberellin on the Growth and Yield Bima Brebes Variety of Shallots in Bangka Island

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ABSTRACT

Shallot (*Allium ascalonicum* L.) is known as a horticultural commodity with significant economic value. Demand for shallot increases annually due to population growth and changes in consumption habits. High consumption of shallot on Bangka Island is not matched by adequate local production. Low local shallot production on Bangka Island is caused by nutrient deficiencies in the planting medium. The application of plant growth regulators (PGRs) such as gibberellin (GA3) and micronutrients such as boron (B) has been proven to increase shallot production. This study was conducted at the Bangka Tengah Farmers' Garden from July to September 2025. This study applied a randomized block design (RBD) with two factors and separate plots, where the main plot was the boron dose with three levels, namely 0 kg ha⁻¹ (B0), 2 kg ha⁻¹ (B1), and 4 kg ha⁻¹ (B2), while the subplot was the GA3 concentration, which included four levels, namely 0 ppm (G0), 25 ppm (G1), 50 ppm (G2), and 75 ppm (G3). Each treatment combination involved 5 plants and was repeated 3 times. The findings revealed that gibberellin application showed a very significant effect on plant height and fresh weight of shallots, and also had a significant effect on the number of tillers. On the other hand, the addition of boron did not have a significant effect on all measured variables. The use of gibberellin at a dose of 50 ppm is the best value for the number of tillers and is the highest average value for the leaf number variable compared to other concentrations. Meanwhile, a boron dose of 2 kg ha⁻¹ provided the best results for the number of leaves, number of offshoots, number of umbels, fresh weight, and dry weight of Bima Brebes onion varieties.

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1. INTRODUCTION

Shallots (*Allium ascalonicum* L.) is one of the main horticultural commodities in Indonesia with significant economic value. The demand for shallots continues to increase in line with population growth and changes in consumption habits. The total production of shallots in Indonesia in 2023 was 1,985,233 tons (BPS, 2023), while in the Bangka Regency the demand reached 31,00 quintals (BPS, 2024). The Bima Brebes shallot variety is a superior cultivar capable of adapting to various field conditions, including lowland areas such as Bangka Island. Environmental factors such as soil and climate conditions on Bangka Island present specific challenges in shallot cultivation (Oktaviani

et al., 2020). The soil on Bangka Island is characterized by a low pH and is generally dominated by red-yellow podzolic soil, in which the content of essential micronutrients, particularly boron (B), is very low (Prasetyo *et al.*, 2018). These conditions can inhibit the growth and formation of shallot bulbs, thereby reducing yield and quality. Boron and Gibberellin (GA₃) are reported to increase shallot production.

Giberelin (GA₃) is a plant hormone that plays an important role in cell division, stem elongation, and bulb formation. The application of giberelin has been proven effective in stimulating vegetative and generative growth in plants, including increasing plant height, number of tillers, bulb diameter, and fresh and dry weight of shallot bulbs (Tefa *et al.*, 2023). Studies show that the application of GA₃ at certain concentrations (100-200 ppm) can increase the growth and production of shallots (Oktaviani *et al.*, 2020). The application of GA₃ at a dose of 0.5-2.0 significantly increased plant height, bulb weight, and dry weight of the Bima Brebes onion variety in Brebes (Cokrosudibyo, 2023). In addition to gibberellin, the micronutrient boron (B) also has a vital function in plant development, especially in sugar transformation, cell wall formation, and carbohydrate metabolism. Boron deficiency can inhibit the transfer of photosynthetic products to the bulb, causing the bulb to become small and brittle (Hardito *et al.*, 2021). Boron application has been proven to increase the number of shoots, fresh tuber weight, flavonoid content, and dry weight of red onion tubers with an optimal dose of approximately 2.7 kg of boric acid per hectare (Kusriarmin *et al.*, 2024). The combination of boron application with planting distance and organic fertilization has also been proven effective in increasing crop yields and soil health in a sustainable manner (J. *et al.*, 2024).

The combined application of gibberellin and boron is anticipated to improve vegetative development, yield, and bulb productivity of the Bima Brebes shallot variety cultivated on Bangka Island. Gibberellin (GA₃) promotes optimal cell elongation and division, while boron (B) supports effective nutrient translocation and increases the tuber formation process. This study aims to assess the effect of GA₃ and boron application on the growth and yield of Brebes shallots in Bangka Belitung. The results of this research are expected to serve as a reference for improving shallot cultivation practices on Bangka Island, thereby increasing the production and productivity of the Bima Brebes shallot variety and reducing dependence on shallot supplies from outside the region.

2. METHOD

2.1 Time and Place of Research

This research will be conducted at the Banggka Tengah Farmer's Garden, Bangka Belitung Province, with geographical coordinates of 2°13'26" south latitude and 106°09'47" east longitude, and an altitude ranging from 50 to 100 meters above sea level. The research period lasted from July to September 2025. Seed testing was conducted at the Agricultural Laboratory, which is under the auspices of the Faculty of Agriculture, Fisheries, and Marine Sciences, Bangka Belitung University.

2.2 Research Materials and Tools

The materials used in this research were Bima Brebes shallots bulbs weighing 5-7 g per bulb, gibberellin (GA₃), compost fertilizer, Mutiara and DGW NPK fertilizers, boron, SP36, KCl, dolomite, fungicide, clear PE plastic, and silver-black plastic mulch. The research used various tools, were meters, hoes, watering can, digital scale, camera, and other writing instruments.

2.3 Research Methods

This experiment was designed based on a randomized block design (RBD) with a split-plot pattern covering two factors. The main factor was boron dosage, which was divided into three levels: 0 kg ha⁻¹ (B0), 2 kg ha⁻¹ (B1), and 4 kg ha⁻¹ (B2). Meanwhile, the subplot factor was GA₃ concentration, with four levels: 0 ppm (G0), 25 ppm (G1), 50 ppm (G2), and 75 ppm (G3). Each treatment combination was repeated three times, resulting in a total of 36 experimental units. Each unit consisted of five plants, giving a total of 180 plants, all of which were used as observation samples. The data obtained were analyzed using analysis of variance (ANOVA), and if a significant effect was found, the means were separated using Duncan's Multiple Range Test (DMRT) at a 95% confidence level.

2.4 Research Implementation

This study used a variety of shallots, namely Bima Brebes, which were cultivated by farmers previously. This was done so that the plants produced would be adapted to the surrounding environment. The research activities began with land preparation, fertilization, and bed formation. Before planting, seeds were selected based on bulb weight criteria of 5-7 g. Before planting, the

seeds were soaked in gibberellic acid at concentrations of 0 ppm, 25 ppm, 50 ppm, and 75 ppm for 45 minutes before transplanting (Sudjarwo *et al.*, 2021). The onion bulbs were planted in the prepared beds. Before planting, the beds were watered, then the soaked bulbs were planted in planting holes with a depth of three-quarters of the bulb (± 1.5 cm from the base of the bulb). Each planting hole was planted with 1 bulb with a planting distance of 15 cm per planting hole. Boron treatment is applied by sprinkling it into each planting hole. Boron application is given when the shallots plants are 3, 5, and 7 weeks old after planting (MST).

Fertilization was carried out once a week using NPK (16:16:16) with a total dose of 600 kg/ha⁻¹. The fertilizer solution was applied 10 times starting 10 days after planting (DAP). This was followed by plant maintenance activities such as watering, weeding, weed control, pest and disease control if necessary. Watering is done daily from the start of planting in the morning or evening. The data obtained is analyzed using DSAASTAT, and if the treatment had a real effect, it was continued with the DMRT test at the 5% level.

2.5 Observed Parameters

The observed parameters included plant height, number of leaves, number of tillers, number of umbels, fresh weight, dry weight, and bulb diameter.

3. RESULTS AND DISCUSSION

3.1 Results

The results of the analysis of variance (Table 1) show that the addition of gibberellin has a very real influence on the parameters of plant height and wet weight of Bima Brebes shallot plants. Gibberellins also have a real impact on the number of offspring. However, boron administration did not affect the overall observation parameters. There was no visible interaction in the combination of the two treatments.

Table 1. Recapitulation of data on gibberellin and boron application on the growth and production of shallots

Parameter	Gibberellin	Boron	CV(%)	Interaction	CV(%)
	Pr>F	Pr>F		Pr>F	
Plant Height (cm)	0.0004**	0.5616 ^{ns}	6.72	0.2166 ^{ns}	3.31
Number of Leaves	0.0984 ^{ns}	0.0746 ^{ns}	19.95	0.7893 ^{ns}	8.30
Number of Tillers	0.0342*	0.1460 ^{ns}	22.64	0.5284 ^{ns}	10.00
Number of Umbels	0.4516 ^{ns}	0.5378 ^{ns}	127.25	0.1681 ^{ns}	165.54
Wet Weight (g)	0.0060**	0.3445 ^{ns}	20.9	0.2150 ^{ns}	13.13
Dry Weight (g)	0.3476 ^{ns}	0.3624 ^{ns}	32.29	0.9192 ^{ns}	8.52
Tuber Diameter (mm)	0.0597 ^{ns}	0.3030 ^{ns}	7.20	0.2083 ^{ns}	3.06

Description: F hit = Calculated F value, Pr>f = Probability value, CV = Coefficient of variation, ** = Very significant effect, * = Significant effect, ns = not significant

Further DMRT test results showed that gibberellin treatment at a concentration of 0 ppm (G0) produced the highest plant height, namely 40.30 cm, although this was not significantly different from the application of 50 ppm gibberellin (G2). The 0 ppm treatment (G0) also produced the highest fresh tuber weight, namely 490.89 g, which was not significantly different from the 50 ppm (G2) and 75 ppm (G3) concentrations. As for the parameter of the number of gibberellin tillers, the 50 ppm concentration reached the highest value, around 10.22 tillers, but was not significantly different from the 0 ppm (G0) application (Table 2).

Table 2. Results of the DMRT test of different gibberellin doses on the observed variables

Observed variables	Giberelin dosage (ppm)			
	G0	G1	G2	G3
Plant height (cm)	42.56a	36.33c	40.30ab	37.70bc
Number of tillers	8.57ab	7.20b	10.22a	8.57ab
Wet weight (g)	490.89a	334.56b	417.44ab	381.67ab

Description : Numbers followed by the same letter in the same row indicate no significant difference based on the DMRT test. G0 = control, G1 = gibberellin 25 ppm, G2 = gibberellin 50 ppm, G3 = gibberellin 75 ppm.

Gibberellin application in this study did not have an effect on the overall observation parameters. Gibberellin with a dose of 0 ppm (B0) produced the highest average in the parameters of the number of umbels (0.67), dry weight (255.00 g), and bulb diameter (25.66 mm) in Bima Brebes onions. However, Gibberellin with a dose of 50 ppm (G2) produced the highest average number of leaves, namely 46.53. (Table 3).

Table 3. Average effect of gibberellin concentration application on the number of leaves, number of umbels, dry weight, and bulb diameter of Bima Brebes shallot variety

Observed variables	Gibberellin Dosage (ppm)			
	G0	G1	G2	G3
Number of leaves	45.77	36.86	46.53	41.80
Number of umbels	0.67	0.22	0.56	0.44
Dry weight (g)	255.00	192.44	230.67	217.44
Tuber diameter (mm)	25.66	24.33	23.59	23.47

Description: G0 = control, G1 = gibberellin 25 ppm, G2 = gibberellin 50 ppm, G3 = gibberellin 75 ppm.

The application of boron in this study did not affect all observed parameters. Applying boron at a dose of 2 kg ha⁻¹ (B1) resulted in the highest yield compared to 0 kg ha⁻¹ and 4 kg ha⁻¹ (Table 4). At a boron dose of 2 kg ha⁻¹ (B1), the highest average was obtained for the number of leaves (45.47), number of tillers (9.60), number of flowers (0.58), fresh weight (426.50 g), and dry weight (230.83 g) in Brebes shallots in Bima. Meanwhile, the boron dose of 0 kg ha⁻¹ (B0) produced the highest average for plant height (39.52 cm) and bulb diameter (24.53 cm) in Brebes shallots in Bima. However, the number of umbrella flowers produced at a dose of 0 kg ha⁻¹ (B0) was the same as that produced at a dose of 2 kg ha⁻¹ (B1).

Table 4. Average effect of boron application on plant height, number of leaves, number of tillers, number of umbels, fresh weight, dry weight, and bulb diameter of the Bima Brebes shallot variety.

Observed variables	Boron Dosage (kg ha ⁻¹)		
	B0	B1	B2
Plant height (cm)	39.52	38.91	39.25
Number of leaves	41.22	45.47	41.55
Number of tillers	8.15	9.60	8.18
Number of umbels	0.58	0.58	0.25
Wet weight (g)	400.75	426.50	391.17
Dry weight (g)	222.42	230.83	218.42
Tuber diameter (mm)	24.53	24.26	23.99

Description: B0 = control, B1 = boron 2 kg ha⁻¹, B2 = boron 4 kg ha⁻¹.

The interaction between boron and gibberellin in this study did not have an effect on the overall observation parameters. The interaction of boron and gibberellin with a boron dose of 2 kg ha⁻¹ and gibberellin 50 ppm (B1G2) yielded the highest average results for leaf number, which was 49.73, and tiller number, which was 11.80. The interaction of boron and gibberellin with a boron dose of 0 kg ha⁻¹ and gibberellin 50 ppm (B0G2) produced the highest average results for umbel number, which was 1.33. However, the interaction of boron and gibberellin with a boron dose of 0 kg ha⁻¹ and gibberellin 0 ppm (B0G0) yielded the highest average results for plant height, which was 43.27 cm, fresh weight, which was 576.33 g, dry weight, which was 280.00 g, and tuber diameter, which was 26.85 mm.

Table 5. Average effects of gibberellin and boron interaction on plant height, leaf number, tiller number, umbel number, fresh weight, dry weight, and bulb diameter of Bima Brebes shallot variety

Interaction	Observed variables						
	Plant height (cm)	Number of leaves	Number of tillers	Number of umbels	Wet weight (g)	Dry weight (g)	Tuber diameter (mm)
B0G0	43.27	48.07	9.60	0.33	576.33	280.00	26.85
B0G1	33.62	33.67	6.53	0	257.67	165.00	23.41
B0G2	42.45	442.93	8.53	1.33	405.00	341.33	23.66
B0G3	38.74	40.20	7.93	0.67	364.00	203.33	24.23
B1G0	42.31	44.33	8.47	1.00	456.33	247.00	24.01
B1G1	36.73	39.40	7.93	0.67	384.67	207.00	24.96
B1G2	39.12	49.73	11.80	0.33	440.33	222.00	23.62
B1G3	37.47	48.40	10.20	0.33	425.67	247.33	24.47
B2G0	42.11	44.93	7.67	0.67	440.00	238.00	26.11
B2G1	38.66	37.53	7.13	0	362.33	205.33	24.61
B2G2	39.34	46.93	10.33	0	407.00	228.67	23.51
B2G3	36.73	36.80	7.60	0.33	355.33	201.67	21.73

Description: B0G0 (boron 0 kg ha⁻¹ + gibberellin 0 ppm), B0G1 (boron 0 kg ha⁻¹ + gibberellin 25 ppm), B0G2 (boron 0 kg ha⁻¹ + gibberellin 50 ppm), B0G3 (boron 0 kg ha⁻¹ + gibberellin 75 ppm), B1G0 (boron 2 kg ha⁻¹ + gibberellin 0 ppm), B1G1 (boron 2 kg ha⁻¹ + gibberellin 25 ppm), B1G2 (boron 2 kg ha⁻¹ + gibberellin 50 ppm), B1G3 (boron 2 kg ha⁻¹ + gibberellin 75 ppm), B2G0 (boron 4 kg ha⁻¹ + gibberellin 0 ppm), B2G1 (boron 4 kg ha⁻¹ + gibberellin 25 ppm), B2G2 (boron 4 kg ha⁻¹ + gibberellin 50 ppm), and B2G3 (boron 4 kg ha⁻¹ + gibberellin 75 ppm)

3.2 Discussion

The results of the analysis of variance on the growth and production of shallots treated with boron and gibberellin did not show a significant effect on a number of variables, particularly shallot production (Table 1). Boron application did not have a significant effect on plant height, number of

leaves, and bulb diameter, because boron is easily carried away by rain or irrigation, so that its dissolution rate exceeds the plant's absorption capacity (Maghfiroh *et al.*, 2025). Plant physiology is influenced by various environmental factors, such as rainfall and the availability of nutrients that can be absorbed by plants (Margaretha *et al.*, 2015). During the period from July to September 2025, rainfall conditions in Bangka Belitung will generally be light rain, with humidity ranging from 64-94% and air temperatures between 24-32°C. In early September 2025, the entire province will still experience light rain, with relatively stable temperatures ranging from 23-32°C and high humidity, reaching 66-99% (BMKG, 2025). The high relative humidity in Bangka Belitung, namely 66-99%, during this study period is very relevant to shallot growth, because humidity plays a role in regulating transpiration and nutrient absorption by plants (Vincekovic *et al.*, 2019). However, excessive humidity can also increase the risk of fungal diseases.

Boron treatment at 2 kg ha⁻¹ (B1) showed the highest average values for generative variables, including the number of tillers, number of flower umbels, wet weight, and dry weight. Boron is one of the micro nutrients that is very much needed by plants in the generative phase because boron plays a role in accelerating physiological processes during the reproductive period. Plant-accessible boron, 5% of the total B in the soil, is present in the form of hydrated borate ions B(OH)₄⁻, which is absorbed by plants as boric acid (H₃BO₃) (Nurani *et al.*, 2020). Boron plays a role in chlorophyll formation, photosynthesis, starch formation, and protein synthesis, which affect cell growth, wet weight, and the number of shallot bulbs (Debnath *et al.*, 2018). Boron also plays a role in the accumulation of photosynthetic organic matter stored in onion tissues (Kusuma & Wahyudi, 2023), as well as stimulating flowering and bulb formation through auxin hormone metabolism (Ammanulah *et al.*, 2010).

The use of gibberellin had a significant effect on plant height when compared to the 0 ppm treatment (G0), which means no gibberellin was applied, while the 50 ppm treatment (G2) also showed the highest average value for plant height. According to Zairina (2022), gibberellin can significantly increase the height of shallots because of its role in stimulating cell division and elongation in meristem tissue. In terms of the number of leaves, gibberellin treatment did not show any significant differences. These findings are in line with the research by Cokrosudibyo *et al.*, (2023), which states that the addition of GA₃ at various doses did not significantly change the number of onion leaves. However, the use of GA₃ made a real difference, with the highest average number of shallot shoots seen at a dose of 50 ppm (G2). Gibberellin functions to activate lateral buds that subsequently grow into suckers, so that its application can significantly increase the number of suckers (Indrawati & Susilo, 2023). The use of gibberellin at concentrations between 50-100 ppm can increase the number of tillers by up to 30% compared to the control, especially in varieties that are responsive to the hormone (Maharani *et al.*, 2022). Giving gibberellin on wet weight had a real effect, with the highest average value in the 0 ppm (G0) treatment, indicating no gibberellin treatment, but the 50 ppm (G2) treatment also had the highest average value for wet weight. This is in line with research by Elshyana *et al.* (2019), which shows that the application of GA₃ at 50, 100, and 200 ppm on shallots does not have a real effect on total wet weight.

Gibberellin treatment did not show any effect on the variables of number of umbels, dry weight and bulb diameter. According to Triharyanto *et al.* (2023), gibberellin only affects flower formation and seed number, while umbel formation is influenced by genetics. In plants of the genus *Allium cepa*, plants that develop from seeds yield just one flower stalk, whereas those that originate from bulbs generate multiple flower stalks. Gibberellin functions in the vegetative phase, while dry weight is influenced by photosynthetic efficiency and photosynthate translocation in the long term. Environmental factors such as light intensity, temperature, and CO₂ have a greater influence on determining dry biomass accumulation than external hormone application (Wijayanti & Setiawan, 2022). The effect of gibberellin on tuber diameter is related to its role in regulating the transport of photosynthates to storage organs. The application of gibberellin can increase the translocation of carbohydrates from the leaves to the tubers. Research on geophyte plants indicate that gibberellin can enhance tuber diameter by 10-15% by boosting the activity of the enzymes invertase and sucrose synthase, which are involved in sucrose metabolism in tubers (Kustiawan & Pratiwi, 2022).

The combination of Boron and Gibberellin treatments did not show any significant effect on any variables. This was due to environmental factors such as humidity, temperature, and water availability, which can affect the water content in onion tissue. This was exacerbated by harvesting conditions during the dry season and inappropriate dosage and timing of application. Although there is no apparent effect, shallots plants deficient in boron will experience disturbances in cell wall structure and affect bulb quality, thereby reducing yield (Nurhayati & Budiman, 2021). Gibberellin also plays a role in the vegetative phase, influencing cell division, cell elongation, and

tissue expansion, which results in an increase in plant volume and total weight (Fitri & Nugroho, 2023).

4. CONCLUSION

The application of gibberellin (GA₃) on Brebes shallot varieties affects the number of offshoots. A concentration of 0 ppm was not significantly different from a concentration of 50 ppm on the variables of plant height and fresh weight. a concentration of 50 ppm is the best value for the number of tillers and is the highest average value for the leaf number variable compared to other concentrations. Meanwhile, giving boron did not have a significant effect on the number of tillers. However. Boron dose of 2 kg ha⁻¹ gave the best results for the number of leaves, number of branches, number of umbels, fresh weight and dry weight. Meanwhile. the application of GA₃ and boron did not show a significant effect on plant height. number of leaves. number of flower umbels. wet weight. dry weight. and tuber diameter. Further research is needed to determine the optimal dose suitable for marginal soil conditions in Bangka. The use of local organic fertilizers is recommended to improve soil structure and increase the effectiveness of treatment. Routine observation in the generative period must be done regularly. In addition, multi-location field trials are important so that the research results can be widely applied in the Bangka Belitung agroecosystem.

REFERENCES

- A. Hardjito. W. Wijaya. and S. Rahayu. "The Effect of Boron Application on the Growth and Production of Shallots (*Allium ascalonicum* L.) in Ultisol Soil." *Journal of Agricultural Science*. 24(1). 58-67. 2021. <https://ejournal.litbang.pertanian.go.id/index.php/JIPI/article/view/11267>
- A. Kusriarmin. Y. Hasanah. D. N. Hanafiah. and H. Hanum. "Evaluation of Production. Boron and Flavonoid Content of Shallot in the Lowlands Through the Application of Boron and Benzyl Amino Purine". *Indonesian Journal of Agricultural Research*. 2024. <https://doi.org/10.32734/injar.v7i3.15938>
- A. Kusuma. and T. Wahyudi. "Analysis of biomass accumulation in shallot plants in lowlands." *Indonesian Journal of Agronomy*. 51(2). 167-176. 2023.
- A. Tefa. H. Manlea. R. Kolo. A. Ola. and G. Gelyaman. "Vegetative and Generative Growth Responses of Eban Local Cultivar Shallots Treated with Gibberellins (GA₃) and P Fertilizers". *Jurnal Penelitian Pendidikan IPA*. 2023. <https://doi.org/10.29303/jppipa.v9i4.3112>
- B. Prasetyo. D. A. Suriadikarta. and R. D. M. Simanungkalit. "Characteristics. Potential. and Challenges of Acidic Land Utilization in Indonesia." *Journal of Soil and Climate*. 42(2). 1-12. 2018. <https://ejournal.litbang.pertanian.go.id/index.php/jti/article/view/8276>
- BMKG. Weather and climate forecast for Bangka Belitung July-September 2025. Meteorology, Climatology, and Geophysics Agency. Weather data obtained from the official BMKG website. 2025.
- C. Margaretha. Y. Yafizham. K. F. Hidayat. and A. Karyanto. "The effect of the combination of inorganic fertilizer and liquid slurry fertilizer doses on the growth and production of mung beans (*Phaseolus radiatus* L)". *Jurnal Agrotek Tropika*. 3(1). 2015.
- Central Bureau of Statistics. "SPH/BPS-Statistics Indonesia Agricultural Statistics for Horticulture. Agricultural Statistics for Horticulture SPH". 2024.
- Central Bureau of Statistics. Horticulture Agriculture Statistics SPH/BPS-Statistics Indonesia. Agricultural Statistics for Horticulture SPH. 2023.
- E. Triharyanto. "Promoting Flowering and Yield in Indonesian Shallot Varieties Through the Application of Gibberellins". *International Journal of Design & Nature and Ecodynamics*. 18(6): 1481-1490. 2023.
- F. M. Cokrosudibyo. "The Effect of Gibberellin (GA₃) on the Growth and Yield Components of Bima Brebes Variety Red Onions (*Allium cepa* var. *aggregatum*)". *Agrohorti Bulletin*. 11(2). 277-285. 2023. <https://doi.org/10.29244/agrob.v11i2.46936>
- F. Zairina. M. Rahmawati. and M. Hayati. "The Effect of Gibberellin Concentration on the Growth and Yield of Several Varieties of Red Onion (*Allium ascalonicum* L.)". *Scientific Journal of Agricultural Students*. 7(2). 102-110. 2022. <https://doi.org/10.17969/jimfp.v7i2.20155>
- H. K. Sudjarwo. I. R. Moeljani. and D. U. Pribadi. The effect of GA₃ immersion duration and several types of TSS on the growth of shallots (*Allium ascalonicum* L.). *Indonesian Journal of Agricultural Sciences*, 23(2). 2021.
- I. S. Elshyana. D. R. Lukiwati. Karno. "Growth response of true shallot seeds of several onion varieties (*Allium cepa* L.) to gibberellin application". *J. Agro. Complex*. 3(3):114-123. 2019.
- J. I Jimenez. D. S Bucac. J. A. Bernabe. R. G Rosales. N. B. Legaspi. and M. A. Antonio. "Influence of Planting Distances. Boron Application and Varying Fertilizer Levels on the yield Performance of Shallot (*Allium Cepa* var. *Aggregatum*) Across Season in Ilocos Norte. Philippines". *East African Scholars Journal of Agriculture and Life Sciences*. 2024. <https://doi.org/10.36349/easjals.2024.v07i11.001>
- K. C. Nurani. S. Budiyanto. and E. D. Purbajanti. "Boron dosage and application timing on the growth and yield of mung beans". *Agrosains: Journal of Agronomy Research*. 22(2): 64-71.. 2020. <http://dx.doi.org/10.20961/agsjpa.v22i2.42058>

- L. Fitria. and P. Nugroho. "Response of onion plants to gibberellin application at various concentrations". *Journal of Food Crop Research*. 7(1). 89-97. 2023.
- M. Indrawati. and J. Susilo. "The formation of suckers in onion plants: The role of hormones and environmental factors." *Bulletin of Spice and Medicinal Plant Research*. 34(1). 67-78. 2023.
- M. M. Amanullah. S. Sekar. and S. Vincent. "Plant growth substances in crop production: A Review". *Asian J. Plant Sci.* vol. 9. pp. 215-22. 2010.
- M. Vinceković. L. Maslov Bandić. S. Jurić. N. Jalšenjak. A. Čaić. I. Živičnjak. S. Topolovec-Pintarić. The enhancement of bioactive potential in *Vitis vinifera* leaves by application of microspheres loaded with biological and chemical agents. *Journal of Plant Nutrition*, 42(6), 543–558. 2019. <https://doi.org/10.1080/01904167.2019.1568467>
- N. Wijayanti. and R. Setiawan. "Photosynthesis and carbon allocation in onion plants in tropical environments." *Journal of Photobiology*. 8(2). 89-102. 2022.
- P. Debnath. S. K. Pattanaik. D. Sah. G. Chandra. and A. K. Pandey. "Effect of boron and zinc fertilization on growth and yield of cowpea (*Vigna unguiculata* Walp.) in inceptisols of arunachal Pradesh". *J. of Indian Society of Soil* 66 (2):229-234. 2018.
- P. Maghfiroh. H. Historiawati. and E. Jannah. "Growth and Yield of Shallots in Response to Irrigation Frequency and Boron Fertilizer on Sand Media." *JOURNAL OF AGRICULTURAL CULTIVATION*. 21 (1). 73-79. 2025. <https://doi.org/10.30598/jbdp/2025.21.1.73>
- P. Maharani. L. Sari. and B. Hartanto. "The Effectiveness of Gibberellin in Increasing Lateral Bud Formation in Red Onions." *Journal of Horticultural Research*. 28(4). 289-298. 2022.
- S. Nurhayati. and A. Budiman. "Cell wall structure of onion bulbs: The effect of boron and its implications for quality." *Indonesian Journal of Microscopy*. 5(1). 34-42. 2021.
- Z. Oktaviani. M. Hayati. and E. Kesumawati. "The response of shallot (*Allium ascalonicum* L.) growth and yield to gibberellin concentration and the interval of NASA liquid organic fertilizer". *IOP Conference Series: Earth and Environmental Science*. 425. 2020. <https://doi.org/10.1088/1755-1315/425/1/012071>