Indonesian Journal of Agricultural Research Vol. 07, No. 03, 2024 | 182 – 190

talenta PUBLISHER

InJAR
Indonesian Journal of Agricultural Research

Evaluation of Production, Boron and Flavonoid Content of Shallot in the Lowlands Through the Application of Boron and Benzyl Amino Purine

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Abstract. Boron is a micro nutrient that plays a role in strengthening cell walls, increase growth and production of shallot optimally. Benzyl amino purine (BAP) is a synthetic cytokinin that responds to plant growth and development, regulates flowering, and stimulates cell division of shallot. This research aims to identify the production and content of boron in shallots. The study was conducted in the lowlands and a factorial randomized block design was used. Boron (0, 2, 4, and 6 kg boric acid/ha) was used as the first factor and BAP (0, 100, and 200 ppm) was used as the second factor. The research used Bima Brebes as shallot variety. The research result showed that boron application of 2 kg boric acid/ha increased the number of tillers, fresh weight of shallot bulb and flavonoid content. Application of 200 ppm of BAP increased significantly the number of tiller. In view of aftereffects of the orthogonal polynomial and regression tests, it was found that the optimum Boron dose 2.695 kg of boric acid/ha produced the highest dry weight of shallot 23.661 g, the dry weight of shallot bulbs increased by 14.23% compared to without Boron application.

Keywords: benzyl amino purine, boron, flavonoid, lowland, production, shallot

Received 06 July 2023 | Revised 18 October 2024 | Accepted 12 November 2024

1. Introduction

Shallots (*Allium ascalonicum* L.) are plants that are often used in various kitchen preparations, because apart from making dishes delicious, they can also be beneficial for our bodies. Shallots contain phytochemical compounds in the form of phenolic compounds, organosulfur, polysaccharides and saponins. The phenolic content of red onions is high, especially quercetin [1]

The main obstacle that occurs with the Bima Brebes variety of shallots is yield production. Shallot production in Indonesia is quite high every year but is still not enough to meet consumer needs, so the shortage still has to be imported. One effort that can increase shallot productivity is by using appropriate fertilizers and hormones for shallot such as boron and cytokinin fertilizers.

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p-ISSN: 2622-7681 | e-ISSN: 2615-5842 | DOI 10.32734/injar.v7i3.15938
Journal Homepage: https://talenta.usu.ac.id/InJAR

Boron (B) is a micronutrient that is important for plant growth. Boric acid (H3BO3) is the form of Boron that plants can obtain. Boric acid is somewhat dissolvable and handily washed away by rainwater. As a result, areas with high rainfall, such as Southeast Asia and Southeast China, frequently experience B deficiency [2]. Boron plays a role in accelerating plant metabolism, so that plant flowering time is accelerated, activating the glucose 6-phosphate enzyme, α and β amylase enzymes, forming pollen, flowers and fruit [3]. Boron is a constituent of chlorophyll which plays a role in photosynthesis, starch formation and protein synthesis which supports cell development and elongation, cell wall stability and plasma membrane firmness [4], [5].

BAP (6-Benzyl Amino Purine) is a compound derived from the cytokinin hormone which is effective in increasing the number of shoots, cell differentiation, proliferation of axillary shoots and actually inhibits root formation. BAP has a role for cell differentiation and processes related to cytokinesis control plant growth and development activities [6], [7].

There are currently only a few comprehensive studies on applying boron and BAP to shallot seeds in the lowlands to increase their productivity and quality. Previous researchers have researched the evaluation of production, chlorophyll content and number of flowers of Samosir local shallots through application of gibberellin and boron in the highlands [8], morphophysiological characters of shallot with application on boron and BAP [9], effect of boron and BAP on production and true shallot seed quality [10], BAP respons for flowering and production on shallot [11], respons of sulphur and paclobutrazole on true shallot seed growth [12] and physiological of shallot at lowlands and higlands [13]

A comprehension of shallot development strategies in the marshes will give exactness in picking the right development innovation to increment shallot productivity. Based on the description above, it is necessary to research the role of boron and BAP in the production and quality of shallot seeds in the lowlands.

2. Materials and Methods

The research was carried out in the screen house of the Faculty of Agriculture, Universitas Sumatera Utara from October 2023 to April 2024. Boron content analysis were conducted at the Integrated Laboratory, Faculty of Agriculture, Universitas Sumatera Utara, Medan. The materials used in this research were shallot bulbs of the Bima Brebes variety, topsoil, polybeg, boron and benzyl amino purine (BAP), *Trichoderma harzianum* Pers. , fungicide and water. The tools used in this research were a hoe, measuring tape, analytical scales, camera and writing tools, spectrophotometers UV absorbance detectors, porcelain cup, capillary tube, beaker glass, measuring cup, test tube, 1000 µL micro pipette, pipette, cuvette, vial, 10 mL volumetric flask, 1 mL and 5 mL measuring pipette, dropper pipette, and analytical balance.

The design used in this research was a factorial complete randomized block design with 2 factors and 3 replications. The first factor is boron (0, 2, 4, and 6 kg boric acid/ha), while the second factor is BAP (0, 100, and 200 ppm). The planting material used is tubers of the Bima Brebes variety (5-7 g/tuber). Boron is applied according to the treatment dose by spraying all parts of the plant leaves evenly at 2, 3 and 5 WAP which is applied in the morning as much as 100 ml per polybag, while Benzyl amino purine is applied according to the treatment dose by spraying all parts of the leaves. plants evenly at 2, 4 and 6 WAP applied in the morning.

The fertilization process involves dissolving 150 kg/ha of ZA fertilizer at 7 DAT, 200 kg/ha of NPK fertilizer (16:16:16) at 14 DAT, 250 kg /ha of NPK fertilizer (16:16:16) at 28 DAT, 250 kg/ha of NPK fertilizer (16:16:16) and 187.5 kg/ha of KCL fertilizer at 42 HST [13]. Shallot pest control process involves dissolving a pesticide containing the active ingredient difenoconazole at 0.4 cc/L. Control of Fusarium wilt (*Fusarium oxysporum*) process involves dissolving a fungicide containing the active ingredient mancozeb at 1.5 g/L. [14]

Observed variables include the number of tillers, fresh and dry weight of the tubers, boron content in the leaves and flavonoid content in the tubers. The method used for boron analysis is the spectrophotometer method. Determination of flavonoid levels process involves dissolving a colorimetric method using aluminum chloride and quercetin (Quercetine Equivalents/QE). Data analysis uses analysis of variance, followed by Duncan's Multiple Range Test at $\alpha = 5\%$ if there are significant differences and orthogonal polynomial tests and regression to obtain a response curve.

3. Results and Discussion

3.1. Number of Tillers

Utilization of 2 kg/ha of boron treatment increased the quantity of shallot tillers fundamentally contrasted with different treatments, because boron has a role in cell division thereby increasing the number of tillers. This is in accordance with previous research, that boron up to 3 kg/ha of boric acid increased the number of tillers, because boron assumes a significant part in increasing enzymes, translocation rates and photosynthetic activity. The best effect of boron is that it affects cell division and elongation, due to which plants can grow better [15], [16].

BAP application from 100 to 200 ppm has the potential to increase the number of tillers. This is beacuse BAP assumes a vital part in stimulating the formation of the number of tillers, increasing cell division and shoot initiation, controlling seed germination, influencing leaf abscission and transport auxin, allows gibberellins to work by eliminating growth inhibitors and delay aging [17].

Table 1. Number of Tillers with Boron and BAP Application

Boron (kg boric acid/ha)	BAP (ppm)			Mean
	B0 (0)	B1 (100)	B2 (200)	
	……..............tiller……...............			
A0 (0)	6.83	7.75	8.00	7.53b
A1 (2)	8.42	8.42	9.08	8.64a
A2 (4)	7.00	7.58	8.75	7.78b
A3 (6)	7.17	7.50	7.58	7.42b
Mean	7.35b	7.81ab	8.35a	

BAP application and number of tillers have a linear relationship because increasing BAP application will increase number of tillers (Fig.1). This is related to the role of BAP in encouraging shoot proliferation. Application of BAP in the right concentration will assume a part in cell division and shoot formation [18].

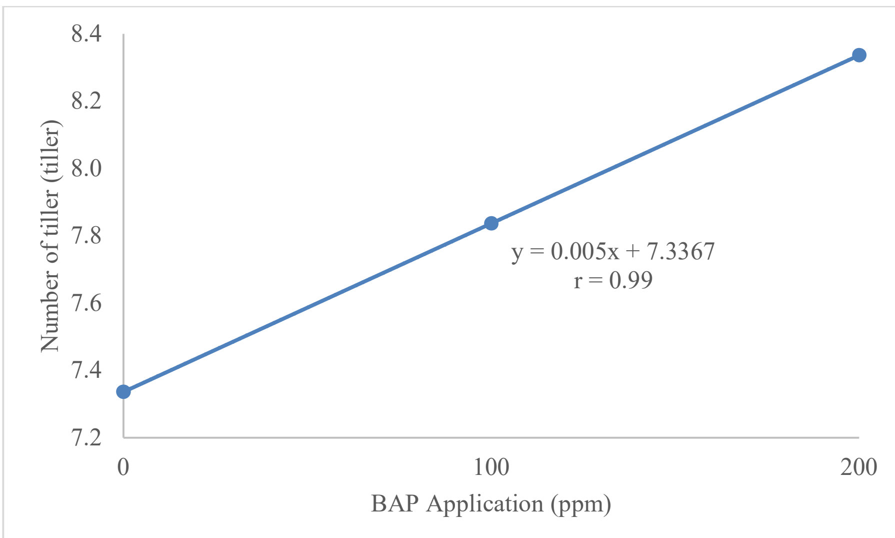

Figure 1. Relationship Between BAP Application and Number of Tiller

3.2. Fresh and Dry Weight of Bulb

Application of 2 kg boric acid/ha treatment increased the fresh and dry weight of bulb significantly compared to other treatments. There was a tendency to increase the fresh and dry weight of the bulb by increasing BAP application up to 200 ppm. Plant physiological processes like cell division and enlargement, shoot differentiation, and altering apical dominance are most heavily influenced by BAP [9], [18]. The interaction between boron (2 kg boric acid/ha) treatment and 100 ppm BAP increased the wetness and weight of shallots.

Table 2. Fresh and Dry Weight of Bulb with Boron and BAP Application

Variable observed	Boron (kg boric acid/ha)	BAP			Mean
		B0 (0)	B1 (100)	B2 (200)	
		……………………………g……………………………			
Fresh weight of bulb	A0 (0)	26.01	29.36	27.09	27.49bc
	A1 (2)	31.60	31.23	34.21	32.34a
	A2 (4)	30.25	29.66	31.30	30.41ab
	A3 (6)	25.62	27.41	25.17	26.07c
	Mean	28.37	29.41	29.44	
Dry weight of bulb	A0 (0)	19.22	21.73	20.02	20.32bc
	A1 (2)	23.35	23.06	25.27	23.89a
	A2 (4)	22.37	21.90	23.14	22.47ab
	A3 (6)	18.13	20.28	18.63	19.01c
	Mean	20.77	21.74	21.76	

Note: Numbers followed by the same letter in the same column and variable observed are significantly different based on Duncan's Multiple Range Test at α = 5%

The relationship between boron and fresh weight and dry weight of shallot bulbs showed a quadratic curve. Optimum boron application was achieved at 2.731 kg boric acid/ha with the highest fresh weight of shallots bulb 31.991 g. Optimum boron application was achieved at 2.695 kg boric acid/ha with the highest dry weight of shallot bulbs at 23.661 g [Fig. 2].

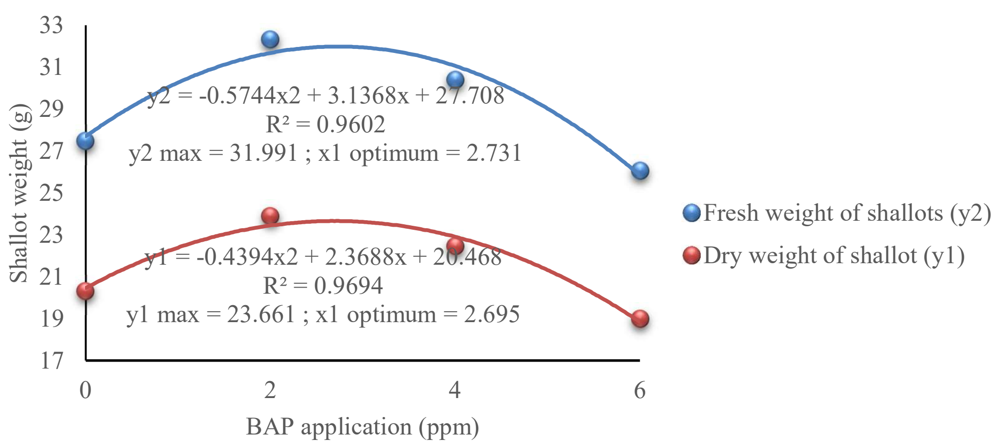

Figure 2. Relationship Between Boron and Fresh and Dry Weight of Shallot Bulbs

3.3. Boron Content in Leaves

Boron content in leaves tends to increase due to boric acid treatment of 4 kg/ha. BAP 100 ppm treatment increased the Boron content in shallot leaves. The interaction between 4 kg/ha boric acid treatment and 100 ppm BAP increased the boron content in shallot leaves (Table 4). Boron is classified as a micro nutrient with main functions related to cell wall strength and development, cell division, sugar transport, fruit and seed development and hormone development. The function of boron is closely related to nitrogen, phosphorus, potassium and calcium in plants. Optimizing plant growth is greatly influenced by nutrient balance [19], [20], [21].

Table 3. The Boron Content of Shallots with Boron and BAP Applications

Boron (kg boric acid/ha)	BAP			Mean
	B0 (0)	B1 (100)	B2 (200)	
		…............mg/kg….............		
A0 (0)	29.61	33.95	28.27	30.61
A1 (2)	31.95	34.92	28.54	31.80
A2 (4)	40.49	41.99	39.12	40.53
A3 (6)	27.37	29.42	32.42	29.74
Mean	32.36	35.07	32.09	33.17

3.4. Flavonoid Content of Shallot

Boron essentially affects the flavonoid content, while BAP and the interaction between boron and BAP have no significant effect on the flavonoid content of shallots. Application of 2 kg/ha of boron increased the flavonoid content in shallots (Table 4).

The relationship between boron application and flavonoid content in shallots is quadratic. Boron application of 2.756 kg/ha produced the highest flavonoid content, namely 3.009 mg QE/g (Fig. 3). Flavonoids (quercetin) and sulfur compounds (allyl propyl disulfide, diallyl disulfide) are the main components of shallots which are efficacious in improving health. Quercetin shallots play a role in antioxidants, anti-cancer, anti-osteoporosis, anti-diabetic, anti-allergies and anti- diarrhea [22], [23].

Table 4. Flavonoid Content of Shallots with Boron and BAP Applications

Boron (kg boric acid/ha)	BAP			Mean
	B0 (0)	B1 (100)	B2 (200)	
		…............mg QE/g…............		
A0 (0)	1.640	1.799	2.444	1.961c
A1 (2)	3.115	3.746	3.136	3.332a
A2 (4)	2.748	2.517	2.028	2.431b
A3 (6)	1.820	1.646	2.141	1.869c
Mean	2.331	2.427	2.437	

Note: Numbers followed by the same letter in the same column are significantly different based on Duncan's Multiple Range Test at $\alpha = 5\%$

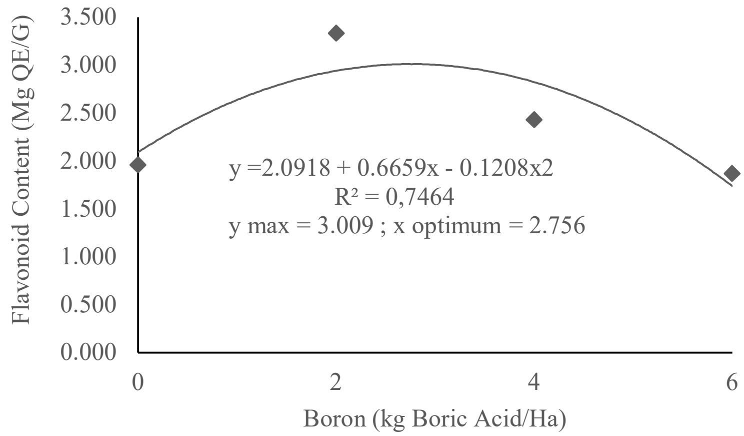

Figure 3. Relationship between boron application and flavonoid content of shallots

4. Conclusion and Recommendation

Boron application of 2 kg boric acid/ha increased quantity of tillers, fresh weight of shallot bulb, dry weight of shallot bulb, and flavonoid content of shallot. Application of 200 ppm of BAP increased significantly the number of tiller. In view of the aftereffects of the orthogonal polynomial and regression tests, it was found that the optimum Boron dose 2,695 kg of boric acid/ha produced the highest dry weight of shallot 23,661 g. The dry weight of shallot bulbs increased by 14.23% compared to those without boron application. Through this research, farmers and scientists can find out the best Boron dose and BAP concentration to increase shallot production and the flavonoid content in shallot bulbs.

Acknowledgement

This article is part of the 2023 Talenta Applied Research. The author would like to thank the Universitas Sumatera Utara Research Institute for funding this research.

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